

Goal 6: Ensure availability and sustainable management of water and sanitation for all

Target 6.4: By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity

Indicator 6.4.2: Level of water stress: freshwater withdrawal as a proportion of available freshwater resources

Institutional information

## Organization(s):

Food and Agriculture Organization of the United Nations (FAO)

# Concepts and definitions

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## Definition:

The level of water stress: freshwater withdrawal as a proportion of available freshwater resources is the ratio between total freshwater withdrawn by all major sectors and total renewable freshwater resources, after taking into account environmental water requirements. Main sectors, as defined by ISIC standards, include agriculture; forestry and fishing; manufacturing; electricity industry; and services. This indicator is also known as water withdrawal intensity.

## Concepts:

This indicator provides an estimate of pressure by all sectors on the country's renewable freshwater resources. A low level of water stress indicates a situation where the combined withdrawal by all sectors is marginal in relation to the resources, and has therefore little potential impact on the sustainability of the resources or on the potential competition between users. A high level of water stress indicates a situation where the combined withdrawal by all sectors represents a substantial share of the total renewable freshwater resources, with potentially larger impacts on the sustainability of the resources and potential situations of conflicts and competition between users.

Total renewable freshwater resources (TRWR) are expressed as the sum of internal and external renewable water resources. The terms "water resources" and "water withdrawal" are understood here as freshwater resources and freshwater withdrawal.

Internal renewable water resources are defined as the long-term average annual flow of rivers and recharge of groundwater for a given country generated from endogenous precipitation.

External renewable water resources refer to the flows of water entering the country, taking into consideration the quantity of flows reserved to upstream and downstream countries through agreements or treaties.

Total freshwater withdrawal (TWW) is the volume of freshwater extracted from its source (rivers, lakes, aquifers) for agriculture, industries and municipalities. It is estimated at the country level for the following three main sectors: agriculture, municipalities (including domestic water withdrawal) and industries. Freshwater withdrawal includes primary freshwater (not withdrawn before), secondary freshwater (previously withdrawn and returned to rivers and groundwater, such as discharged wastewater and agricultural drainage water) and fossil groundwater. It does not include non-conventional water, i.e. direct use of treated wastewater, direct use of agricultural drainage water and desalinated water. TWW is in general calculated as being the sum of total water withdrawal by sector minus direct use of wastewater, direct use of agricultural drainage water and use of desalinated water.

Environmental water requirements (Env.) are the quantities of water required to sustain freshwater and estuarine ecosystems. Water quality and also the resulting ecosystem services are excluded from this formulation which is

confined to water volumes. This does not imply that quality and the support to societies which are dependent on environmental flows are not important and should not be taken care of. Methods of computation of Env. are extremely variable and range from global estimates to comprehensive assessments for river reaches. For the purpose of the SDG indicator, water volumes can be expressed in the same units as the TWW, and then as percentages of the available water resources.

## Rationale:

The purpose of this indicator is to show the degree to which water resources are being exploited to meet the country's water demand. It measures a country's pressure on its water resources and therefore the challenge on the sustainability of its water use. It tracks progress in regard to “withdrawals and supply of freshwater to address water scarcity”, i.e. the environmental component of target 6.4.

The indicator shows to what extent water resources are already used, and signals the importance of effective supply and demand management policies. It indicates the likelihood of increasing competition and conflict between different water uses and users in a situation of increasing water scarcity. Increased water stress, shown by an increase in the value of the indicator, has potentially negative effects on the sustainability of the natural resources and on economic development. On the other hand, low values of the indicator indicate that water does not represent a particular challenge for economic development and sustainability.

## Comments and limitations:

Water withdrawal as a percentage of water resources is a good indicator of pressure on limited water resources, one of the most important natural resources. However, it only partially addresses the issues related to sustainable water management.

Supplementary indicators that capture the multiple dimensions of water management would combine data on water demand management, behavioural changes with regard to water use and the availability of appropriate infrastructure, and measure progress in increasing the efficiency and sustainability of water use, in particular in relation to population and economic growth. They would also recognize the different climatic environments that affect water use in countries, in particular in agriculture, which is the main user of water. Sustainability assessment is also linked to the critical thresholds fixed for this indicator and there is no universal consensus on such threshold.

Trends in water withdrawal show relatively slow patterns of change. Usually, three-five years are a minimum frequency to be able to detect significant changes, as it is unlikely that the indicator would show meaningful variations from one year to the other.

Estimation of water withdrawal by sector is the main limitation to the computation of the indicator. Few countries actually publish water use data on a regular basis by sector.

Renewable water resources include all surface water and groundwater resources that are available on a yearly basis without consideration of the capacity to harvest and use this resource. Exploitable water resources, which refer to the volume of surface water or groundwater that is available with an occurrence of 90% of the time, are considerably less than renewable water resources, but no universal method exists to assess such exploitable water resources.

There is no universally agreed method for the computation of incoming freshwater flows originating outside of a country's borders. Nor is there any standard method to account for return flows, the part of the water withdrawn from its source and which flows back to the river system after use. In countries where return flow represents a substantial part of water withdrawal, the indicator tends to underestimate available water and therefore overestimate the level of water stress.

Other limitations that affect the interpretation of the water stress indicator include:

- difficulty to obtain accurate, complete and up-to-date data;
- potentially large variation of sub-national data;
- lack of account of seasonal variations in water resources;
- lack of consideration to the distribution among water uses;
- lack of consideration of water quality and its suitability for use; and

- the indicator can be higher than 100 per cent when water withdrawal includes secondary freshwater (water withdrawn previously and returned to the system), non-renewable water (fossil groundwater), when annual groundwater withdrawal is higher than annual replenishment (over-abstraction) or when water withdrawal includes part or all of the water set aside for environmental water requirements.

Some of these issues can be solved through disaggregation of the index at the level of hydrological units and by distinguishing between different use sectors. However, due to the complexity of water flows, both within a country and between countries, care should be taken not to double-count.

## Methodology

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### Computation method:

Method of computation: The indicator is computed as the total freshwater withdrawn (TWW) divided by the difference between the total renewable freshwater resources (TRWR) and the environmental water requirements (Env.), multiplied by 100. All variables are expressed in km<sup>3</sup>/year (10<sup>9</sup> m<sup>3</sup>/year).

$$\text{Stress (\%)} = \text{TWW} / (\text{TRWR} - \text{Env.}) * 100$$

It is proposed to classify the level of water stress in three main categories (levels): low, high and very high. The thresholds for the indicator could be country specific, to reflect differences in climate and national water management objectives. Alternatively, uniform thresholds could be proposed using existing literature and taking into account environmental water requirements.

### Treatment of missing values:

- **At country level:**

If scattered data are available, a methodology will be developed with regards to inter- and extrapolation

- **At regional and global levels:**

For the MDGs, latest values were used to obtain regional or global aggregates, even if not available for the same year. It is expected that through the baseline that will be produced for the SDG monitoring, data for more or less the same range of years become available.

### Regional aggregates:

Regional and global estimates will be done by summing up the national figures on renewable freshwater resources and total freshwater withdrawal, considering only the internal renewable water resources of each country in order to avoid double counting.

### Sources of discrepancies:

Differences might occur due to the following, amongst others: For national estimates incoming water is counted as being part of the country's available water resources, while global estimates can only be done by adding up the internal renewable water resources (water generated within the country) of all countries in order to avoid double counting.

### Methods and guidance available to countries for the compilation of the data at the national level:

This indicator provides an estimate of pressure by all sectors on the country's renewable freshwater resources. A low level of water stress indicates a situation where the combined withdrawal by all sectors is marginal in relation to the resources, and has therefore little potential impact on the sustainability of the resources or on the potential competition between users. A high level of water stress indicates a situation where the combined

withdrawal by all sectors represents a substantial share of the total renewable freshwater resources, with potentially larger impacts on the sustainability of the resources and potential situations of conflicts and competition between users.

The indicator is computed based on three components:

**Total renewable freshwater resources (TRWR)**

**Total freshwater withdrawal (TWW)**

**Environmental flow requirements (EFR)**

$$\text{Water Stress (\%)} = \frac{TWW}{TRWR - EFR} * 100$$

Several documents exist that can be used to support countries in the computation of this indicator. Among them:

***Understanding AQUASTAT - FAO's global water information system***

This information note covers a twenty year history of the collection and analysis of water-related data and its dissemination as an international public good, freely available to all. The process of collecting and checking the data has resulted in the establishment of a unique network of collaborators who provide data, use data from other countries for comparative purposes, and exchange views and experiences on how best to measure and account for water-related use. Users range from international private companies to non-governmental organizations, and virtually all significant reports related to water depend on the data provided by AQUASTAT.

<http://www.fao.org/3/a-bc817e.pdf>

***Renewable Water Resources Assessment - 2015 AQUASTAT methodology review***

<http://www.fao.org/3/a-bc818e.pdf>

***Global database on municipal wastewater production, collection, treatment, discharge and direct use in agriculture***

This paper describes the rationale and method to setup and feed the AQUASTAT database on municipal wastewater production, collection, treatment, discharge or direct use in agriculture. The best available sources of information have been reviewed, including peer-reviewed papers, proceedings of workshops, conferences and expert meetings, global or regional databases, as well as country briefs, national reports and direct communications by country government officials and experts

<http://www.fao.org/3/a-bc823e.pdf>

***Cooling water for energy generation and its impact on national-level water statistics***

This technical note, describing the issue of cooling water for energy generation and its impact on national-level water statistics, has two purposes: 1) to act as a general informational resource and 2) to encourage governmental agencies responsible for water usage to gather and report information disaggregated by sub-sector (keeping thermoelectric withdrawals separate from industrial and hydroelectric withdrawals), and to determine the point at which lower water withdrawal designs are more favourable, even if the required capital cost is higher.

<http://www.fao.org/3/a-bc822e.pdf>

***Municipal and industrial water withdrawal modelling for the years 2000 and 2005 using statistical methods***

This document describes the efforts to generate models that estimate the municipal and industrial water withdrawals for the years 2000 and 2005.

<http://www.fao.org/3/a-bc821e.pdf>

***Disambiguation of water statistics***

The nomenclature surrounding water information is often confusing and gives rise to different interpretations and thus confusion. When discussing the way in which renewable water resources are utilized, the terms water use, usage, withdrawal, consumption, abstraction, extraction, utilization, supply and demand are often used without clearly stating what is meant.

<http://www.fao.org/3/a-bc816e.pdf>

## ***Country survey on water use for agriculture and rural development***

### ***Questionnaire for water survey***

These Guidelines and Questionnaire have been prepared for the updating of the data and country profiles in AQUASTAT.

[http://www.fao.org/nr/water/aquastat/sets/aq-5yr-quest\\_eng.xls](http://www.fao.org/nr/water/aquastat/sets/aq-5yr-quest_eng.xls)

[http://www.fao.org/nr/water/aquastat/sets/aq-5yr-guide\\_eng.pdf](http://www.fao.org/nr/water/aquastat/sets/aq-5yr-guide_eng.pdf)

### ***International Recommendations for Water Statistics***

The International Recommendations for Water Statistics (IRWS) were developed to help strengthen national information systems for water in support of design and evaluation of Integrated Water Resources Management (IWRM) policies.

<https://unstats.un.org/UNSD/envaccounting/irws/>

### ***UNSD/UNEP Questionnaire on Environment Statistics – Water Section***

<http://unstats.un.org/unsd/environment/questionnaire.htm>

<http://unstats.un.org/unsd/environment/qindicators.htm>

### ***UNSD ‘National Accounts Main Aggregates Database’***

<http://unstats.un.org/unsd/snaama/selbasicFast.asp>

## **Quality assurance:**

Every data in AQUASTAT goes through a thorough validation process.

Before uploading, data is compared to other variables to ensure it is logically correct (in other words: 1+2=3) and whether the reference used is not leading back to AQUASTAT itself. In other words, AQUASTAT frequently finds data for 2014, which is really AQUASTAT data for 2000 with the year changed (most probably when the data was harvested).

During uploading into the Main Database, another validation process takes place, using a set of about 300 validation rules. Of these, about 100 rules are obligatory rules, which means that if the data-point doesn't obey this rule, the validation process cannot go on. For example, the cultivated area of a country cannot be larger than the total area of the country. The other set of about 200 validation rules are warning signs for the person doing the validation. For example, in general the area equipped for irrigation using surface irrigation technology is at least half of the total area equipped for irrigation. However, in some countries the localized irrigation area or the sprinkler irrigation area might be larger than the surface irrigation area. If this is the case, then a warning pops up during validation for the analyst to check whether for this country it is possible. Also during the validation process each new data-point is compared to other data already available for this variable in other years or in the same year. If it is impossible to harmonize or reconcile the different data, then one or the other data-point has to be deleted from the database.

[http://www.fao.org/nr/water/aquastat/sets/WhyDBIsEmpty\\_eng.pdf](http://www.fao.org/nr/water/aquastat/sets/WhyDBIsEmpty_eng.pdf)

[http://www.fao.org/nr/water/aquastat/About\\_us/index3.stm](http://www.fao.org/nr/water/aquastat/About_us/index3.stm)

Beyond the usual AQUASTAT validation described above, in the compilation of the indicator countries will be encouraged and supported in setting up their own quality control system, ensuring that all data used in the computation are checked, and that consistency is kept over the years to ensure comparability and robust identification of trends.

The indicator requires data from different sectors of expertise. Internationally, they are available of different datasets from various institutions, such as FAO, UNSD and IWMI. Each of these institutions has its own established mechanism to consult and validate the data with the countries.

For the data deriving from FAOSTAT and AQUASTAT, data are collected in countries through surveys consisting of data collection and country description by means of a detailed questionnaires were the source reference and comments are associated with each value, through national resource persons. Critical analysis of information and data processing is done by FAO staff. Data are then organized in standard data tables, and feedback and approval is sought from national institutions before publication and dissemination.

However, for the SDG process a specific mechanism will be put in place, consisting in the identification in each country, by the national government, of a national focal point and a technical team, in charge of the collection and computation of the indicator, in close consultation with FAO. This system has been successfully tested

during the initial phase of the GEMI project, carried out by FAO and other seven UN agencies, coordinated by UN-Water.

For those countries that could initially have difficulties in compiling and computing the indicator, FAO will provide support and ultimately will be able to produce the indicator starting from internationally available data. However, no data will be made public without the prior approval by the relevant national authorities.

## Data sources

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### Description:

Data for this indicator are usually collected by national ministries and institutions having water-related issues in their mandate, such as ministries of water resources, agriculture, or environment. Data are mainly published within national water resources and irrigation master plans, national statistical yearbooks and other reports (such as those from projects, international surveys or results and publications from national and international research centres).

The data for the indicator are collected through questionnaires to be answered by the relevant institutions in each country. Examples of the questionnaires that can be used can be found at:

AQUASTAT

[www.fao.org/nr/water/aquastat/sets/aq-5yr-quest\\_eng.xls](http://www.fao.org/nr/water/aquastat/sets/aq-5yr-quest_eng.xls)

UNSD/UNEP

[http://unstats.un.org/unsd/environment/Questionnaires/q2013Water\\_English.xls](http://unstats.un.org/unsd/environment/Questionnaires/q2013Water_English.xls)

OECD/Eurostat

[http://ec.europa.eu/eurostat/ramon/coded\\_files/OECD\\_ESTAT\\_JQ\\_Manual\\_version\\_2\\_21.pdf](http://ec.europa.eu/eurostat/ramon/coded_files/OECD_ESTAT_JQ_Manual_version_2_21.pdf)

### Collection process:

1. Official counterparts at country level are the line ministry for water resources and the national statistics office
2. Countries are expected to put in place a process of Quality Control (QC), Quality Assurance (QA) and data verification. The process should be carried out internally for the QC part, ensuring that all the planned steps are properly carried out at each round of data collection. The QA should be carried out by independent experts, either national or international, to assess the consistence and robustness of the data produced. Finally, where possible the resulting data should be verified by comparison with similar data from other sources.
3. As the data will be collected through different questionnaires, harmonization will be needed among the eventual differences in definitions and aggregations.

## Data availability

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### Description:

**Countries (2010 to present):**

Asia and Pacific 2

Africa 6

Latin America and the Caribbean 16

Europe, North America, Australia, New Zealand and Japan 24

### **Countries (2000-2009):**

Asia and Pacific 42

Africa 49

Latin America and the Caribbean 27

Europe, North America, Australia, New Zealand and Japan 47

### **Time series:**

1961-2015 (Discontinuous, depending on country)

### **Disaggregation:**

To compute this indicator sectoral data are needed. The indicator can be disaggregated to show the respective contribution of different sectors to the country's water stress, and therefore the relative importance of actions needed to contain water demand in the different sectors (agriculture, municipalities and industry).

At national level, water resources and withdrawal are estimated or measured at the level of appropriate hydrological units (river basins, aquifers). It is therefore possible to obtain a geographical distribution of water stress by hydrological unit, thus allowing for more targeted response in terms of water demand management.

## **Calendar**

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### **Data collection:**

2016-2018

### **Data release:**

New data for the indicator are planned to be produced for most countries between 2017 and 2018.

## **Data providers**

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### **Description:**

National Statistical Offices line ministry national consultants. The institutions responsible for data collection at national level vary according to countries. However, in general data for this indicator are provided by the Ministry of Agriculture, Ministry of Water and Ministry of Environment, and sometimes channeled through the National Statistical Office.

## **Data compilers**

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Food and Agriculture Organization of the United Nations (FAO) through AQUASTAT, its global water information system (<http://www.fao.org/nr/aquastat>).

## **References**

## URL:

[www.fao.org/nr/aquastat](http://www.fao.org/nr/aquastat)

## References:

Food and Agricultural Organization of the United Nations (FAO). AQUASTAT, FAO's Global Water Information System. Rome. Website <http://www.fao.org/nr/aquastat>.

The following resources of specific interest to this indicator are available on this site:

- AQUASTAT glossary (<http://www.fao.org/nr/water/aquastat/data/glossary/search.html>)
- AQUASTAT Main country database (<http://www.fao.org/nr/water/aquastat/data/query/index.html?lang=en>)
- AQUASTAT Water use ([http://www.fao.org/nr/water/aquastat/water\\_use/index.stm](http://www.fao.org/nr/water/aquastat/water_use/index.stm))
- AQUASTAT Water resources ([http://www.fao.org/nr/water/aquastat/water\\_res/index.stm](http://www.fao.org/nr/water/aquastat/water_res/index.stm))
- AQUASTAT publications dealing with concepts, methodologies, definitions, terminologies, metadata, etc. (<http://www.fao.org/nr/water/aquastat/catalogues/index.stm>)

For surface water, environmental water requirement databases include:

- [http://waterdata.iwmi.org/apps/flow\\_management\\_classes/](http://waterdata.iwmi.org/apps/flow_management_classes/)
- <http://www.iwmi.cgiar.org/resources/models-and-software/environmental-flow-calculators/>
- [http://waterdata.iwmi.org/Applications/Global\\_Assessment\\_Environmental\\_Water\\_Requirements\\_Scarcity/](http://waterdata.iwmi.org/Applications/Global_Assessment_Environmental_Water_Requirements_Scarcity/)
- UNSD/UNEP Questionnaire on Environment Statistics – Water Section (<http://unstats.un.org/unsd/environment/qindicators.htm>)
- Framework for the Development of Environment Statistics (FDES 2013) (Chapter 3) <http://unstats.un.org/unsd/environment/FDES/FDES-2015-supporting-tools/FDES.pdf>
- OECD/Eurostat Questionnaire on Environment Statistics – Water Section
- International Recommendations for Water Statistics (IRWS) (2012). <http://unstats.un.org/unsd/envaccounting/irws/>)

## Related indicators

6.4.1: Change in water-use efficiency over time

6.1.1: Proportion of population using safely managed drinking water services

6.3.1: Proportion of wastewater safely treated

6.6.1: Change in the extent of water-related ecosystems over time

6.5.1: Degree of integrated water resources management implementation (0-100)

2.4.1: Proportion of agricultural area under productive and sustainable agriculture

15.3.1: Proportion of land that is degraded over total land area

11.5.1: Number of deaths, missing persons and persons affected by disaster per 100,000 people [a]