

Establishing an environmental sustainability threshold on freshwater quantity

Concept of environmental sustainability thresholds

Human activities continue to put pressure on the world's natural resources and ecosystems. Many of these natural systems can withstand this pressure only up to a certain threshold – a so-called tipping point – beyond which serious negative and possibly irreversible consequences occur. As the exact thresholds are often unknown, prudence requires identifying danger zones before the threshold is reached, or safety zones in which humanity can safely operate. It is therefore important to find out where environmental thresholds exist, what values they have and to measure the distance to this threshold. This should help to alert policy makers in due time before a danger zone is reached and enable them to respond effectively to avoid unsustainable consequences. One objective of the [study](#) to which this factsheet is linked was to propose indicators for environmental thresholds relevant in the EU policy-making context.

Relevance of the topic

The provision of water in sufficient quantity (and quality¹) for drinking, agricultural and industrial use (e.g. for cooling) as well as for the maintenance of ecosystem functions plays a crucial role in our societies. Yet, empirical evidence shows that the availability of freshwater in Europe has become increasingly problematic, especially in the Mediterranean countries and in regions with intensive agricultural productions. Over the past 30 years, droughts have dramatically increased in number and intensity in the EU. The size of areas and number of people affected by droughts went up by almost 20% between 1976 and 2006. The scarcity of water in some regions leads to an increasing dependency on water resources from countries outside the EU, especially for water used in the production of imported goods, e.g. Malta.

As water scarcity is likely to become a problem for more regions, and its effects can be highly destructive for ecosystems and affect human society both directly and indirectly, it is important to identify and monitor thresholds and danger zones in freshwater use and its impacts. In the context of this exploratory work, only issues linked to intra-EU sustainability are tackled, while it is recognised that water availability issues also have to be assessed at a more global level, taking into account the fact that the European way of life may lead to the reaching of environmental thresholds in other parts of the world (for example by importing water-intensive products).

Readily available and potential future threshold indicators

To find thresholds for water scarcity, one can either look at the amounts of water use or at the impacts of water use. Considering water use first, it is important to distinguish between extraction and consumption. Extraction describes the process of taking water from any source, either temporarily or permanently, whereas consumption only describes the water that is taken from a specific source and not directly returned, e.g. through evaporation in a production process. Thresholds of environmentally sustainable use differ according to the “types” of water:

1. Non-renewable water (ground water and other natural reservoirs that is not recharged, or is recharged so slowly that significant withdrawal will cause depletion),

¹ Polluted waters, even if available in large quantities, are useless for most human and ecosystem uses. For more information on environmental thresholds in water quality, see Ecologic Institute and SERI. 2010. Establishing an environmental sustainability threshold on water quality, Fact Sheet, October 2010.

2. Blue water (fresh surface and ground water),
3. Green water (rainwater stored in the soil as soil moisture).

Identifying threshold values and indicators helps to answer the key question: When does water use become unsustainable in EU? Threshold values for the three different types of water mentioned above tell us how much water can be extracted and consumed sustainably without causing serious negative and possibly irreversible consequences. Ideally, a set of three complementary threshold indicators would cover all different types and sources of water: maximum values for non-renewable, blue and green water use. So far, no threshold values have been defined for specific water types and uses – as water systems and usages can be very different on regional level with monthly and yearly variations.

An existing but less comprehensive indicator to identify whether the rates of extractions in countries are sustainable over the long term has been suggested by the European Environment Agency (EEA). The Water Exploitation Index (WEI) in a country is defined as the mean annual total authorised extraction of fresh water divided by the long-term average freshwater resources (hence without taking into account intra- and inter-annual variations). In comparison to the water use thresholds suggested above, the WEI uses only extraction (and not consumption) of blue (and not green) water, which reflects only a part of the aspects of human water use. The EEA defines a warning threshold of 20% to distinguish a non-stressed region / country from a stressed one. Severe water stress can occur when the WEI exceeds 40%. This indicates strong competition for water but does not necessarily trigger frequent water crises. These values are still debated (Alcamo et al., 2000).

Apart from water extraction and consumption, it is also possible to monitor when thresholds are reached by looking at the impacts of water use, for example on groundwater bodies or rivers. Two useful indicators for such monitoring are the quantitative status of groundwater (e.g. minimum sustainable level) and hydrological pressures on streams (e.g. minimum river levels, streamflow regime). Data for these indicators are already partly available in the River Basin Management Plans of some EU Member States. However, these data are not always based on scientific/technical studies, but sometimes on agreements between water users, and threshold values still need to be defined.

Advantages and disadvantages of different threshold indicators for water quantity

The advantages and disadvantages of the different threshold indicators for water use (extraction and consumption) and the impacts of water consumption are summarised in the tables below.

Threshold indicators for water use

	Maximum non-renewable water extraction	Maximum blue water consumption	Maximum green water consumption
Advantages	<ul style="list-style-type: none"> • Addresses non-renewable (fossil) water abstraction as the irreversible part of human water use 	<ul style="list-style-type: none"> • Most directly linked to human activities (e.g. irrigation, water used in food production) • Includes sub-indicator of use (extraction) of blue water and can be illustrated at the level of its components (e.g. agricultural water extraction) 	<ul style="list-style-type: none"> • Most comprehensive threshold indicator, also includes evapo-transpiration of plants • Includes sub-indicator of use (extraction) of green water and can be illustrated at the level of its components (e.g. agricultural water extraction)
Disadvantages	<ul style="list-style-type: none"> • Data to calculate threshold indicator currently not available, as data on extraction of non-renewable water missing • Does not comprehensively 	<ul style="list-style-type: none"> • Data only available from a private network (Water Footprint Network), not from statistical institutions 	<ul style="list-style-type: none"> • Data only available from a private network (Water Footprint Network), not from statistical institutions

	cover all water sources, thus needs to be complemented by additional indicators		
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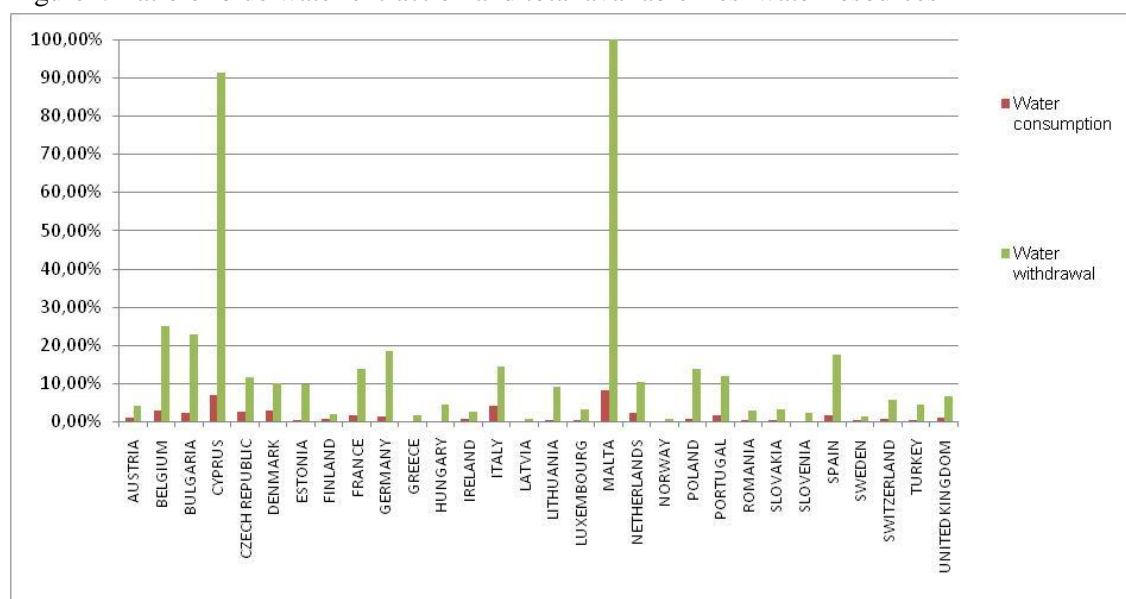
Threshold indicators for the impacts of water use

	Groundwater quantitative status	Hydrological pressures on streams
Advantages	<ul style="list-style-type: none"> Addresses the direct impact of human water appropriation on the level of the groundwater body Data on groundwater body, not on national level 	<ul style="list-style-type: none"> Addresses the direct impact of hydrological pressures (e.g. water abstraction) on streams Data on river basin, not on national level
Disadvantages	<ul style="list-style-type: none"> Some River Basin Management Plans are still missing Interval of data updates is irregular 	<ul style="list-style-type: none"> Some River Basin Management Plans are still missing Interval of data updates is irregular

Water Scarcity in the EU – an illustration

An illustration of current water scarcity problems in Europe is illustrated by the figure below, which shows the relation between water extraction and water availability in 30 European countries. Using this data the EEA’s Water Exploitation Index can be calculated and conclusions about the distances to water scarcity thresholds can be drawn.

Figure 1: Ratio of blue water extraction and total available freshwater resources²



Results show that Belgium, Bulgaria, Cyprus, Germany, Malta, and Spain reach the water scarcity threshold of 20%. Differences regarding the WEI in European countries are large. Ratios above 100% (like in the case of Malta) mean that water demand has to be satisfied through withdrawals from non-freshwater (desalination, treated wastewater, etc) or non-renewable sources or through imports.

Data availability

² Sources: Alcamo, J., Doll, P., Henrichs, T. et al. 2003. Development and testing of the WaterGAP 2 global model of water use and availability. *Hydrological Sciences J* 48(3), 317-337; EUROSTAT. 2010. Water statistics. Statistical Office of the European Communities, Luxembourg; FAO, 2010); FAO. 2010. AQUASTAT. <http://www.fao.org/nr/water/aquastat/data/query/index.html>.

The data availability to measure and monitor the different thresholds of water quantity in the EU differs substantially. The following table provides an overview of the data requirements and availabilities for the suggested thresholds. It shows that data is not readily available for all the underlying pressure indicators, and the available data still lack completeness and quality. However, due to the rising relevance of the topic, as already recognised in the Water Framework Directive, various institutions (Eurostat, UNStat, EEA, etc.) are working on an improvement of accounting structures, data comprehensiveness and quality.

Maximum blue water consumption	
Unit of measurement	Million m ³ /year (month)
Most suitable level of measurement	Local river-basin level (currently available: national level)
Current availability of data at the most suitable level in the EU, best practice example	Water Footprint Network – on an aggregated level (modelled); also planned for new Eurostat Standard Tables by 2012 (partly measured partly modelled data); EXIOPOL database available from 2011 for 44 countries and regions (measured and modelled data)
Maximum green water consumption	
Unit of measurement	Million m ³ /year (month)
Most suitable level of measurement	Local river-basin level – current: national level
Current availability of data at the most suitable level in the EU, best practice example	Water Footprint Network – on an aggregated level (modelled); also planned for new Eurostat Standard Tables by 2012 (modelled); EXIOPOL database available from 2011 for 44 countries and regions (modelled data)
Maximum non-renewable water use	
Unit of measurement	Million m ³ /year (month)
Most suitable level of measurement	Local river-basin level – current: national level
Current availability of data at the most suitable level in the EU, best practice example	So far no data available; accounting foreseen in the new Eurostat Standard Tables by 2012; yearly data
Groundwater quantitative status	
Unit of measurement	Million m ³ /year (month)
Most suitable level of measurement	Groundwater body
Current availability of data at the most suitable level in the EU, best practice example	Varying; River Danube Water Basin District Management Plan; yearly data
Hydrological pressures on streams (: running surface water)	
Unit of measurement	Meter / m ³ / Million m ³ /year (month)
Most suitable level of measurement	River basin
Current availability of data at the most suitable level in the EU, best practice example	Varying; River Danube Water Basin District Management Plan

Conclusion

As human activities continue to put pressure on European freshwater resources which may lead to serious negative and possibly irreversible consequences, it is important to identify and monitor thresholds and danger zones in our use of freshwater and its related impacts. Three complementary indicators could provide a comprehensive measure of the sustainable use of different types of water: maximum extraction of non-renewable water, maximum blue water consumption, and maximum green water consumption. Future research should aim to define threshold values for these indicators. Two useful indicators for monitoring the effects of water use are the quantitative status of groundwater and hydrological pressures on streams. Data on these indicators are already partly available in the River Basin Management Plans of different Member States and will be the basis for the further development of indicators.

If more data becomes available it will be possible to get a comprehensive picture on how close different countries, regions or sectors in the EU are to these thresholds and its related consequences. Improving the data collection to measure thresholds and defining values for thresholds and danger zones in water use and its effects can help to devise prudent environmental and economic policies

which respect the limits of the ecosystem. This should help to alert policy makers in due time before a danger zone is reached and enable them to respond effectively to avoid unsustainable consequences. At the level of economic sectors, threshold values could help water management authorities or user cooperatives to allocate a specific amount of consumable water per accounting unit (time and space) to each economic sector and thus help to ensure that sustainable limits are not surpassed.

Further reading:

- Alcamo, J., Henrich, T., Rösch, T., 2000. World Water in 2025 – Global modeling and scenario analysis for the World Commission on Water for the 21st Century. Report A0002, Centre for Environmental System Research, University of Kassel, Germany.
- Ecologic Institute and SERI. 2010. Establishing an environmental sustainability threshold on water quality, Fact Sheet, October 2010.
- Ecologic Institute and SERI. 2010. Establishing an environmental sustainability threshold on soil erosion, Fact Sheet, October 2010.
- Ecologic Institute and SERI. 2010. Establishing an environmental sustainability threshold on non-renewable resource use, Fact Sheet, October 2010.
- EEA. 2009. Water resources across Europe — confronting water scarcity and drought. EEA Report 2/2009, European Environment Agency, Copenhagen.
- European Commission. 2007. Communication from the Commission to the European Parliament and the Council. Addressing the challenge of water scarcity and droughts in the European Union. COM(2007) 414 final. COM(2007) 414 final, European Commission, Brussels, 18.7.2007.
- Rockström, J., Steffen, W., Noone, K., Persson, A., Chapin, F. S., Lambin, E. F., et al. 2009. A safe operating space for humanity. *Nature*, 461(7263), 472-475.