Everything Flows

A GERMAN WATER BALANCE

307 km³
Precipitation

190 km³
Evaporation

Where water is scarce in Germany

Many regions in Germany use a lot more water than they are able to obtain themselves within their territory (the yellow and orange areas on the map). The reasons for this include highly concentrated economic and settlement structures, features of the natural landscape and contamination of the groundwater. That is why Stuttgart and the surrounding area, for example, takes its water from sources such as Lake Constance, which is over 100 km away.

Natural water flows

Germany is a country rich in water resources. While it is true that three-fifths of rainwater evaporates again, 117 km³ is left over and a further 71 km³ flows in from neighbouring countries. **This means that – in theory – 188 km³ of water is available**, which would be enough to fill a two-metre-deep swimming pool covering the area between Cologne, Hamburg, Berlin and Dresden. However, the natural water supply is not distributed equally across the country: in the mountainous regions of southern Germany between 10 and 20 times more water is available than in Brandenburg.

Artificial water flows

Almost one-fifth of the water that is available in Germany is used and flows through technical infrastructures – through cooling water pipes, pipes for industrial and domestic water and drinking water; through sewers, dams and ship canals. More than one in four households is supplied with water via long-distance pipelines, since water is not available in sufficient quantity or quality regionally. Climate change and population development pose new challenges for infrastructure operators. The biggest consumers of water are power stations, followed by industry and households. Until now the direct use of water for agriculture in Germany has been almost negligible (0.3 km³ per year).

Pipe diameter of the long-distance pipelines:
- > 4 m
- 1 to 4 m
- < 1 m

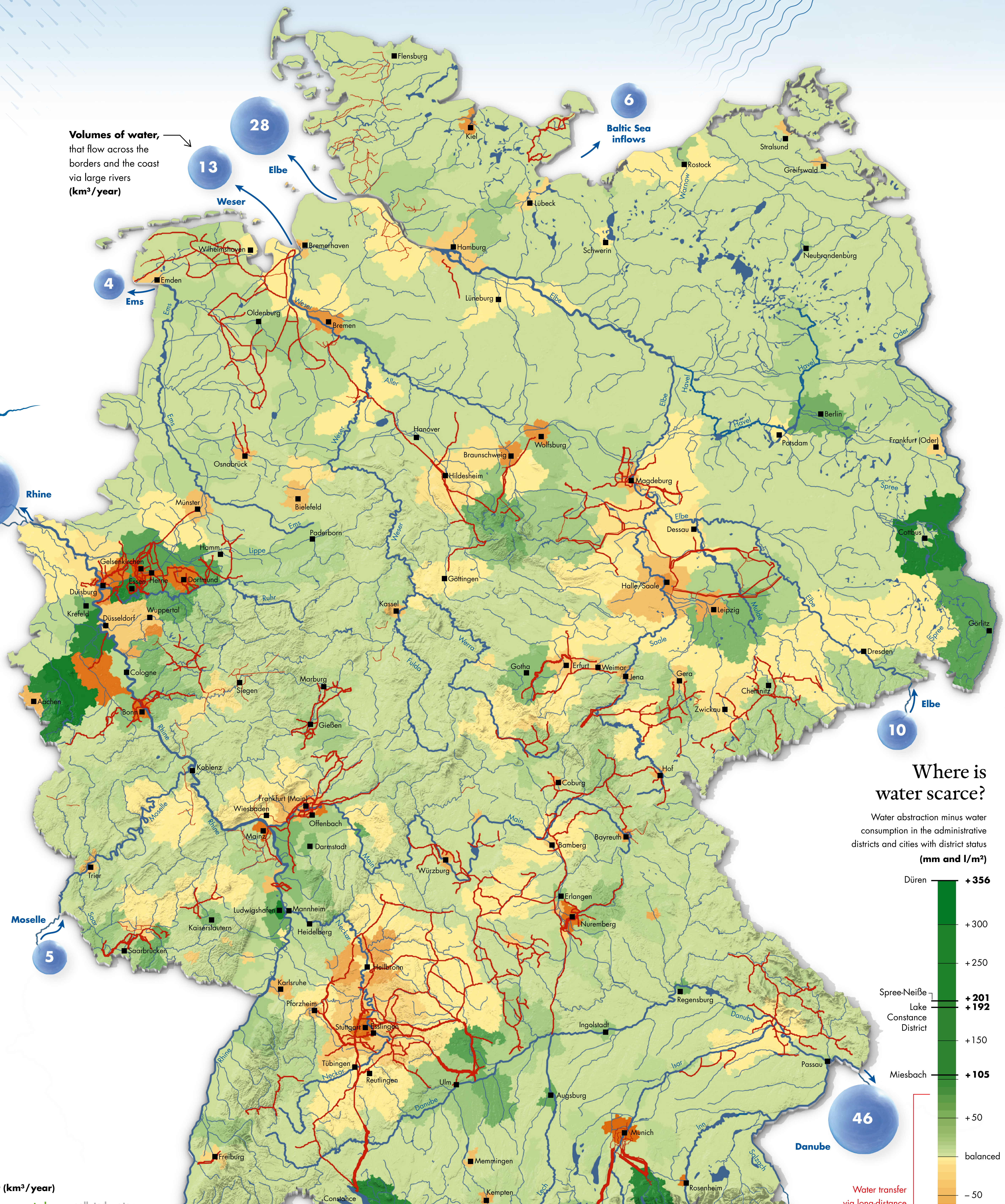
Water consumption in Germany (km³/year)

4	7	21
Households	**Industry**	**Power stations**

Virtual water flows

Manufacturing goods requires water. This water can be attributed to the products as virtual water content. A distinction is made here between evaporated groundwater and surface water (blue), evaporated rainwater (green) and the volume of polluted water (grey). Thus trade flows can also be considered to be virtual water flows. **Viewed in this way, Germany imports approximately 120 km³ of virtual water per year from around the world – almost twice as much as it exports.**

Volumes of water, that flow across the borders and the coast via large rivers **(km³/year)**



Where is water scarce?

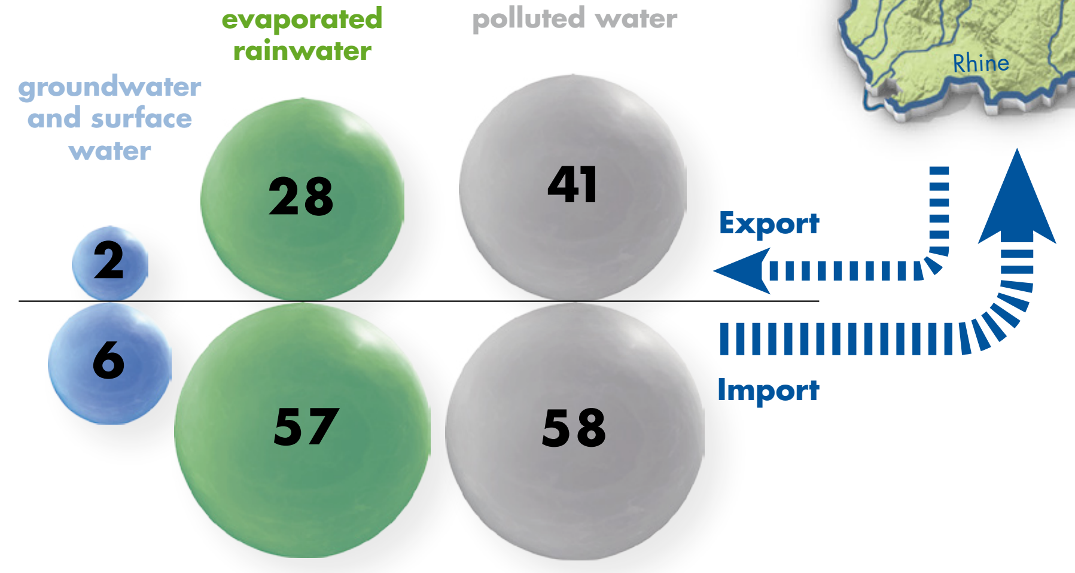
Water abstraction minus water consumption in the administrative districts and cities with district status

(mm and l/m²)

Düren	**+356**
	+300
	+250
Spree-Neiße	**+201**
Lake Constance District	**+192**
	+150
Miesbach	**+105**
	+50
	balanced
	−50
	−100
Stuttgart	**−140**
Oberhausen	**−153**
	−200
Herne	**−220**
Munich	**−248**
Gelsenkirchen	**−283**

Water transfer via long-distance pipelines

Virtual Water (km³/year)



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bfg German Federal Institute of Hydrology

kib

IMPRINT

This poster was developed in 2014 as part of the project "Water Flows in Germany" (FKZ 033L056).

Authors: Jesko Hirschfeld (IÖW), Enno Nilson (BfG), Florian Keil (kib)

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Further information on Water Flows in Germany is available via the project website:

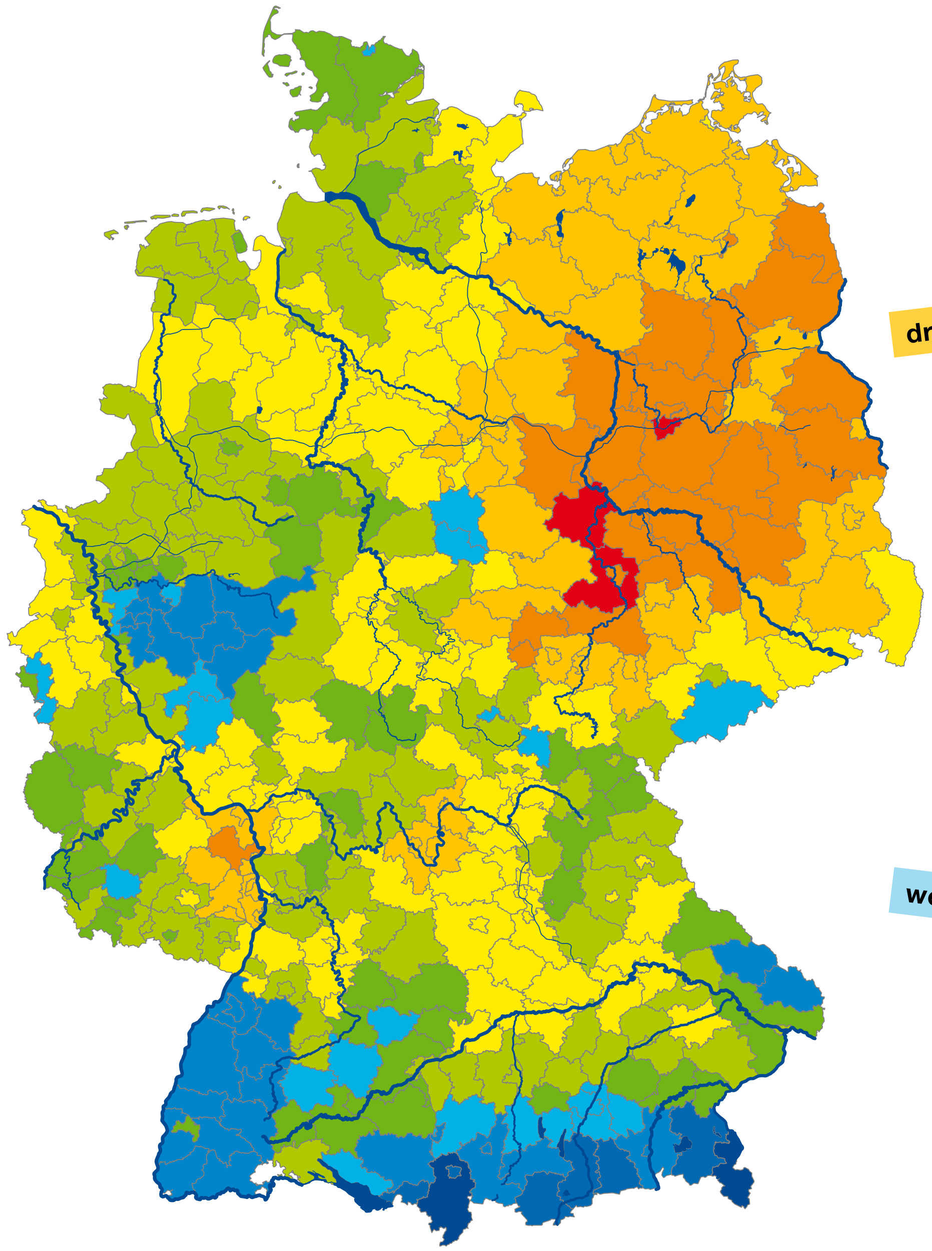
www.bmbf.wasserfluesse.de

Germany is rich in water resources

What remains of the rain

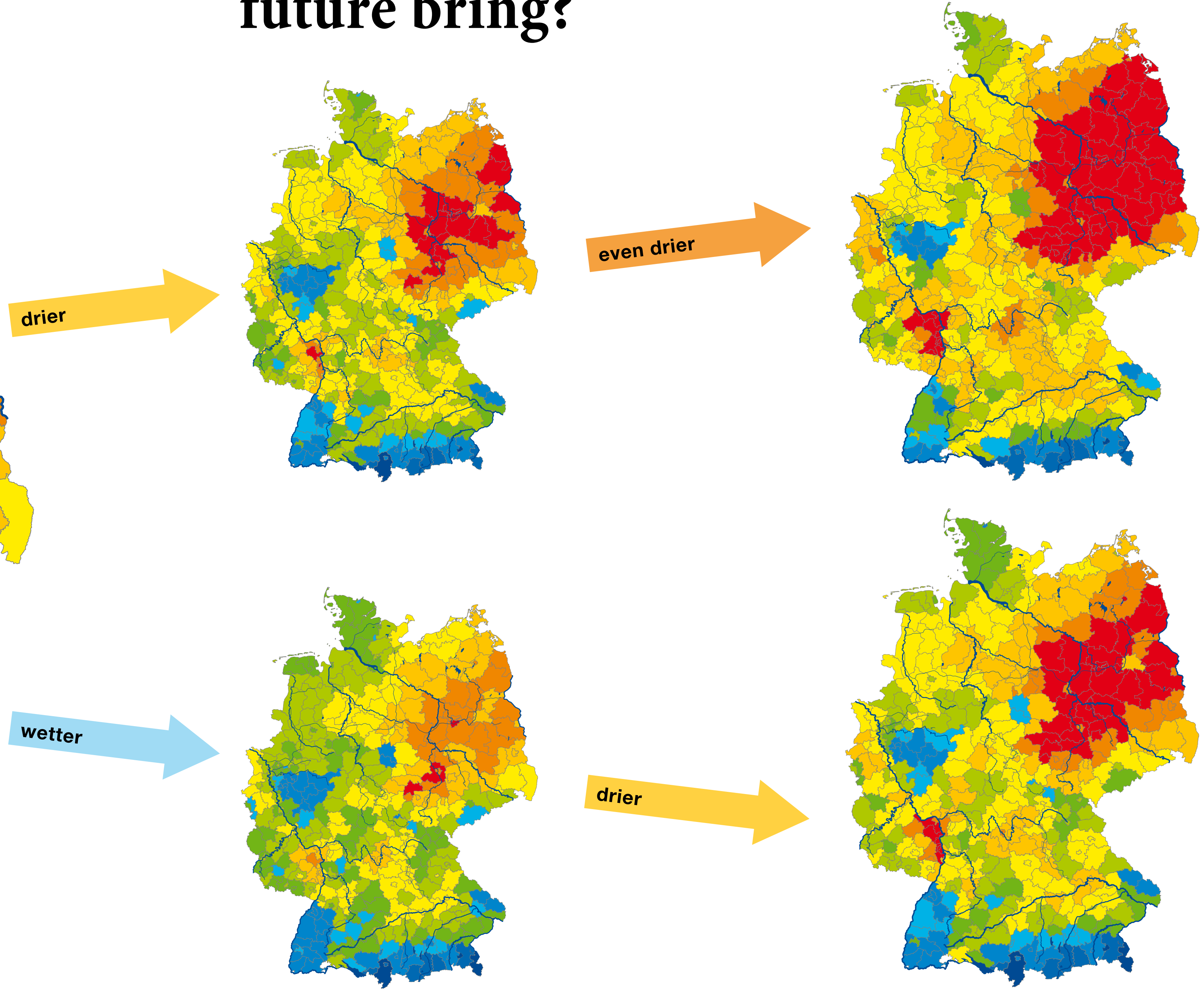
Precipitation minus evaporation (l/m²/year)

🟥 < 50
🟧 < 100
🟧 < 200
🟨 < 300
🟩 < 400
🟩 < 500
🟦 < 600
🟦 < 1000
🟦 < 1500
🟦 > 1500



Recent past 1961-1990

But what will the future bring?



Scenarios 2050

Scenarios 2100

The water availability is not distributed equally

There is a lot of water in Germany but it is distributed unevenly between the different regions. While a lot of rain and snow falls in the Alps and Central Uplands, there is so little precipitation in other areas that almost all of it evaporates again. Without influxes of water via natural rivers or expensive long-distance water pipelines, households, industry and agriculture in these areas would have to manage with very little water. Climate change could cause these regional shortages to intensify in the future. Shown on the left are the annual volumes of water from precipitation that were left over after subtracting the evaporated precipitation in recent years. This water either adds to the groundwater or it flows away in surface waters and is known as "regional runoff depth" (referring to the administrative districts and cities with district status). The values range from below 50 l/m² in some parts of Brandenburg, Saxony-Anhalt, Thuringia and Rhineland-Palatinate to above 1500 l/m² in some Alpine areas. In the 1961-1990 period the national average was just over 300 l/m².

Wetter in the medium term?

Climate scenarios are no weather forecasts. Since the climate system is so complex and the uncertainties concerning the socioeconomic developments in the 21st century are considerable, the scenarios represent different versions of how future water flows could vary from those of today. The lower map in the centre is based on a scenario, in which some regions become even wetter by the middle of the century. Other scenarios suggest that there could be a decrease in the availability of water by 2050 (depicted on the top map in the centre). Large areas in Brandenburg and Saxony-Anhalt would then have regular droughts within just a few decades.

Drier in the long term

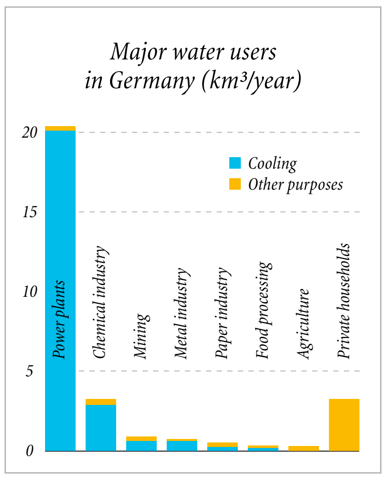
In the second half of the century, above all, researchers expect water availability to decrease in almost all parts of Germany, but at different rates. In particular, the increase in evaporation means that even in moderate scenarios, the regional runoff in large parts of eastern Germany, which is already very small, could decrease by 40% to 60% by the end of the century. A decline in the availability of water could pose a great challenge to agriculture and forestry as well as water management. In order to avoid temporary shutdowns, the technologies and practices currently used for cooling and supplying power stations and industries along the rivers would have to be reviewed to see whether they would work if water levels were frequently low.

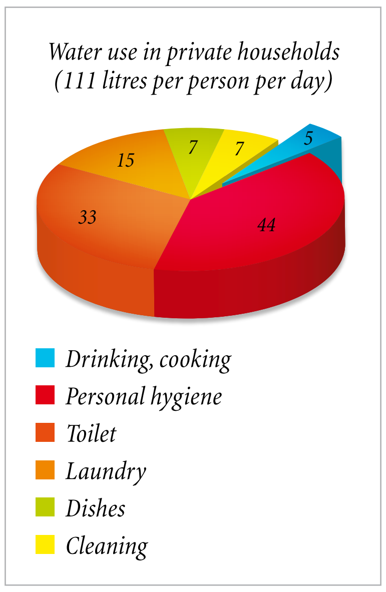
Nothing works without water

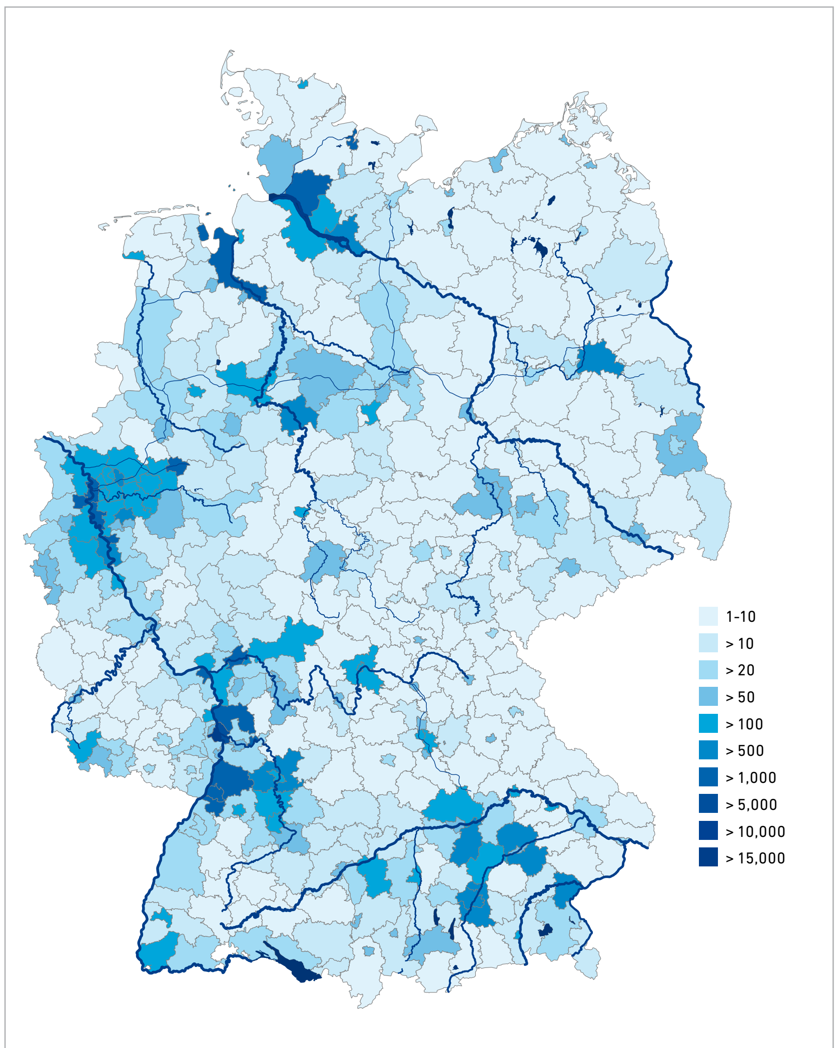
In theory, Germany has 188 km³ of water available per year. Around one-fifth of it is used by humans: as a coolant for power stations and in industry, for household use and for the irrigation of agricultural crops.

Over 60% of the water we use goes into power stations, where it is pumped into cooling systems and then, for the most part, fed back into rivers when it is still warm. 22% is used by other industries for cooling and production. Households are only the third-largest consumers of water, with 16% of the share. Just 0.4% of water is actually used for drinking and for preparing meals.

However, water requirements are very different in individual regions. Places with a high concentration of inhabitants and industry use significantly more water than sparsely populated, rural areas. The biggest consumers of water – power stations – are usually located right next to rivers, where water for cooling is directly available. Thus the water shortages depicted on this poster's main map (see overleaf) are not necessarily caused by natural conditions, but rather by the interplay between the natural water supply and society's demand for water.

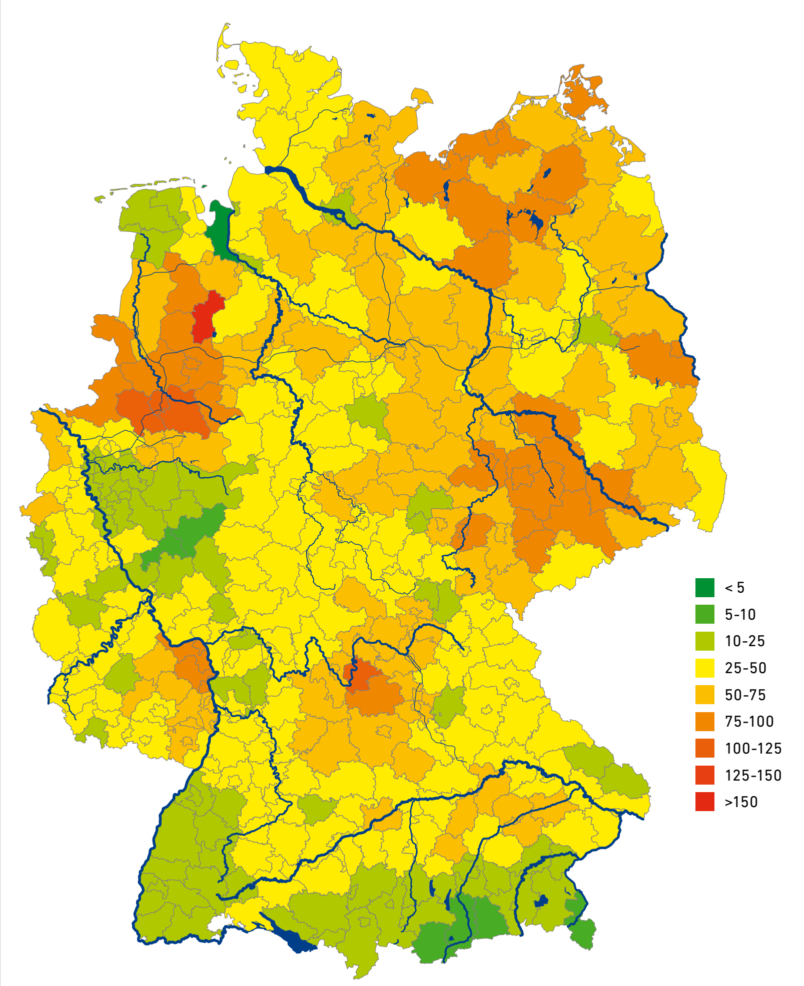

Major water users in Germany (km³/year)


Water use in private households (111 litres per person per day)



Annual water requirements in the administrative districts (litres per square metre)

Over-fertilisation leads to a scarcity of clean water

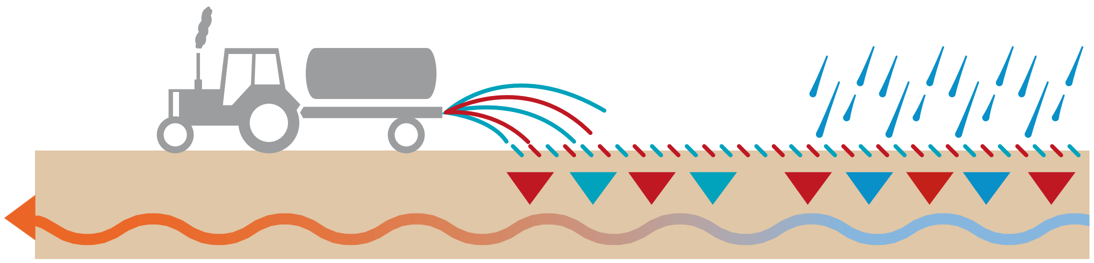


Nitrate concentration (mg/l) in water percolating through the soil (average values in the administrative districts)

Direct use of water for agriculture in Germany is almost negligible (just 0.3 km³ per year nationwide). At the moment intensive irrigation only takes places in a few regions. In fact, indirect water use has much more of an impact on the water balance: current fertilisation practises pollute the natural water cycle with nutrients.

The map shows the concentration of nitrate in water percolating through the soil below the root zone. In many administrative districts it is higher than 50 mg of nitrate per litre. In a number of districts it is higher than 75 mg/l, while in some districts it even exceeds 100 mg/l. The limits for drinking water are 50 mg of nitrate per litre in Germany, a stricter limit of 25 mg/l is in place in Switzerland.

In order to dilute the nutrient content to a level that is not harmful to humans or the environment, some regions, if they were to observe the German limit, would need more than twice as much water as they have available naturally. The real consequence of the agriculture sector's grey water footprint is that clean groundwater is becoming scarce at regional level. As a result, drinking water must be either processed locally, which is costly, or obtained from other regions via long-distance water pipelines.

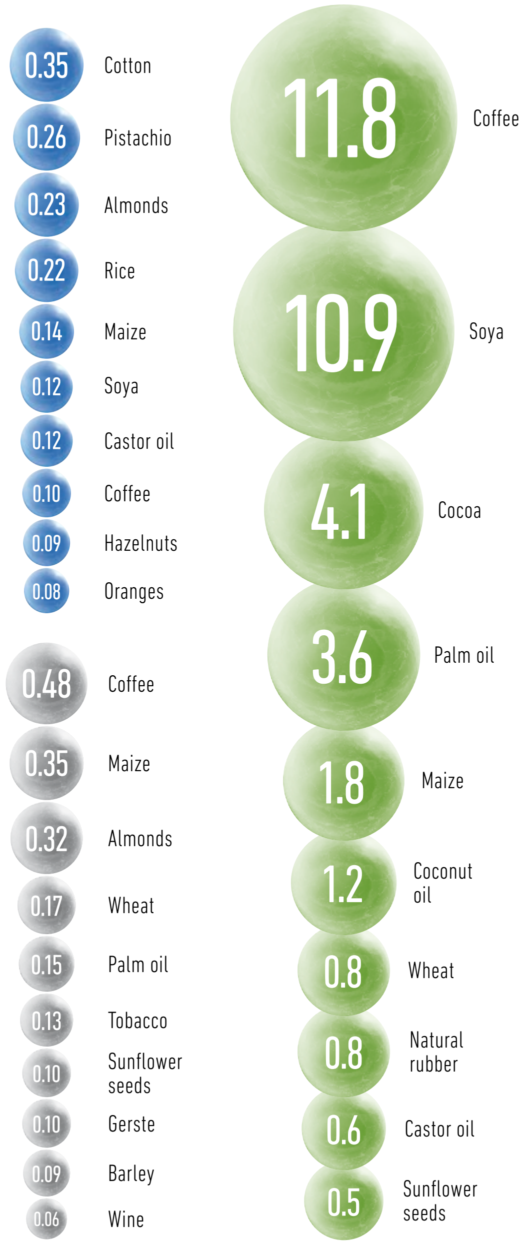


Water also flows virtually

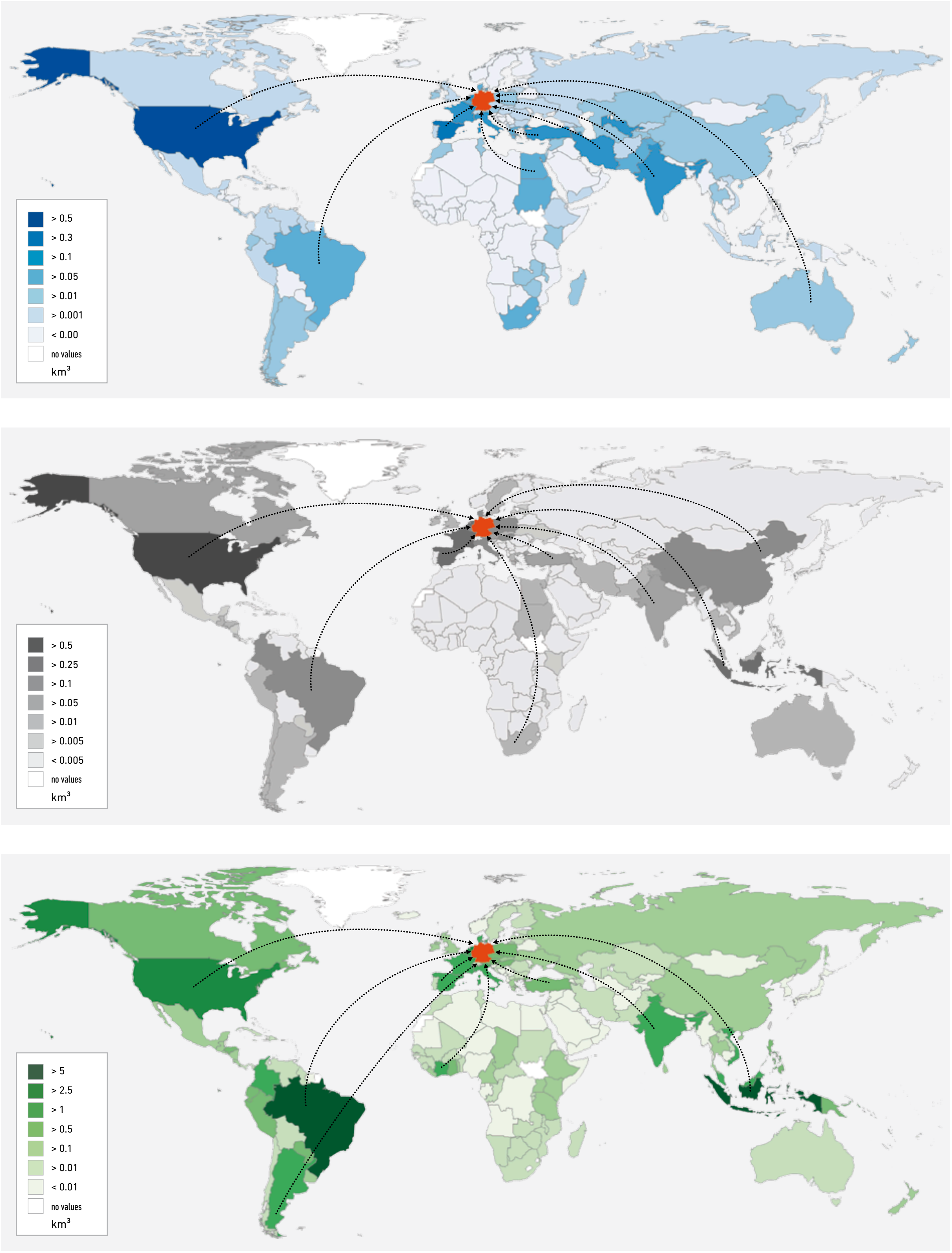
Water does not just flow in streams and rivers outside our own door; there are also invisible water flows known as virtual water flows. They represent the water that is used for the manufacture of goods – water that evaporates or is polluted during the production process. It is possible to calculate this consumption for many products and assign them a virtual water content. Thus we do not just use and consume water in this country, in households, agriculture, industry and power stations – we also use considerable quantities of water in lots of other countries around the world with which we have trade relations.

Blue, grey and green water – the example of agriculture

Every year Germany imports over 35 million tonnes of agricultural products – and thus over 65 km³ of virtual water from all around the world. In contrast, virtual water exports via agricultural exports only come to 33 km³ per year. While the volume of evaporated groundwater and surface water (blue water) can be determined quite accurately, methods for logging the production-related evaporation of rainwater (green water) and water pollution (grey water) still require further improvement. The world maps to the right show the countries in which we use or pollute water by importing agricultural products.



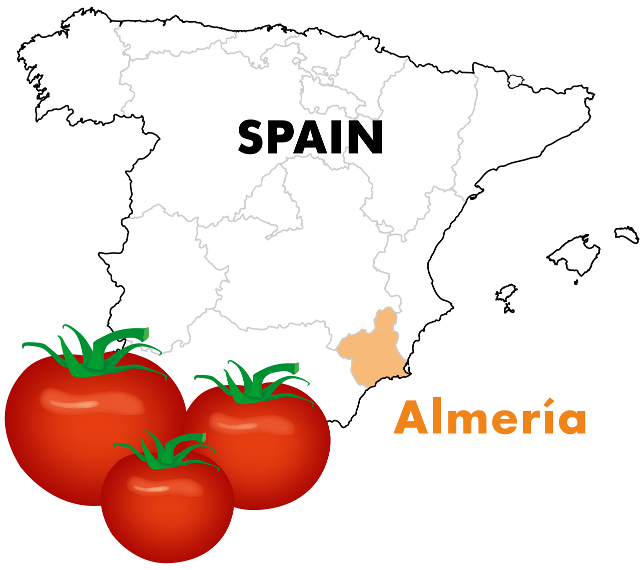
Crops with the largest contributions to Germany's virtual water imports, amounts of blue, grey and green virtual water in km³ per year



Germany's imports of blue, grey and green virtual water with agricultural products, arrows depicting the most prominent flows

The real consequences of virtual water flows

It is difficult to directly connect virtual water flows with environmental and social consequences. In-depth analyses must be carried out locally, where the water is actually used. However, an example from the province of Almeria in southern Spain shows what imports of virtual blue water can mean in reality: every year three billion litres of water are used there for irrigation to produce 80,000 tonnes of tomatoes for the German market. In particularly dry years that can comprise almost 15% of the amount of water available to the region as a whole. The environmental consequences can be seen in the progressive lowering of the groundwater level and in increasing salinization due to inflowing sea water.



Did you know that one in four households in Germany is reliant on long-distance water pipelines?

How does climate change affect the availability of water in Germany?

Where is water scarce in Germany?

How much water does Germany consume in Spain?

Without Lake Constance Stuttgart would be left high and dry. Why?

Why do we import grey water with almonds and green water with soya?

Which of Germany's regions is the driest?

Imprint

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Authors: Jesko Hirschfeld (Institute for Ecological Economy Research), Enno Nilson (German Federal Institute of Hydrology), Florian Keil (keep it balanced)
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Virtual Water Flows: Water Footprint Network; FAO; Statistisches Bundesamt; United Nations; reference year: 2007.
All data referring to 2010 (unless stated otherwise)

For more information please visit the English project website providing texts, graphics and films on Water Flows in Germany:

www.bmbf.wasserfluesse.de