

Indicators of Water Scarcity

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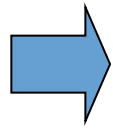
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- Germany is a water-rich country with a potential water resources of an average of 188 billion cubic meters per year (BfG 2006). But there also exists some areas, where water demand exceeds water resources. Measures of water management can achieve a balance between water demand and water resources.
- Water scarcity occurs when the available **water resources does not meet the demand** of users in all sectors of human society and those of the environment both **in terms of quantity and quality**.
- Water scarcity is relative and may impact economic sectors differently.

- **Detailed balances of water resources** at balancing profiles in rivers or in sub-catchments allow to identify and assess water scarcity conditions over space and time differentiated for uses. Moreover, a **broad variety of summarizing parameters exist** for assessments of regional and lokal water scarcity:

1. A rather simply parameter that establishes a relation between water resources and the number of inhabitants is the availability of water → **Human Water Stress Index** (Falkenmark/Widstrand 1992). The World Bank uses a threshold of 1,000 m³ of water per inhabitant and year to define water scarcity.
2. **Environmental Scarcity Index** (in Dobner 2010): relation between water resources and the ecological water demand (Enhancement of the Human Water Stress Index)
3. One relatively straightforward indicator of the pressure or stress of freshwater resources is the „**Water Exploitation Index WEI**“, which is calculated annually as the ratio of total freshwater abstraction to the total renewable resource. A WEI above 20% implies that a water resource is under stress and values above 40% indicate severe water stress and unsustainable use of water resource. (Raskin et al. 1997, in EEA-report 2009).

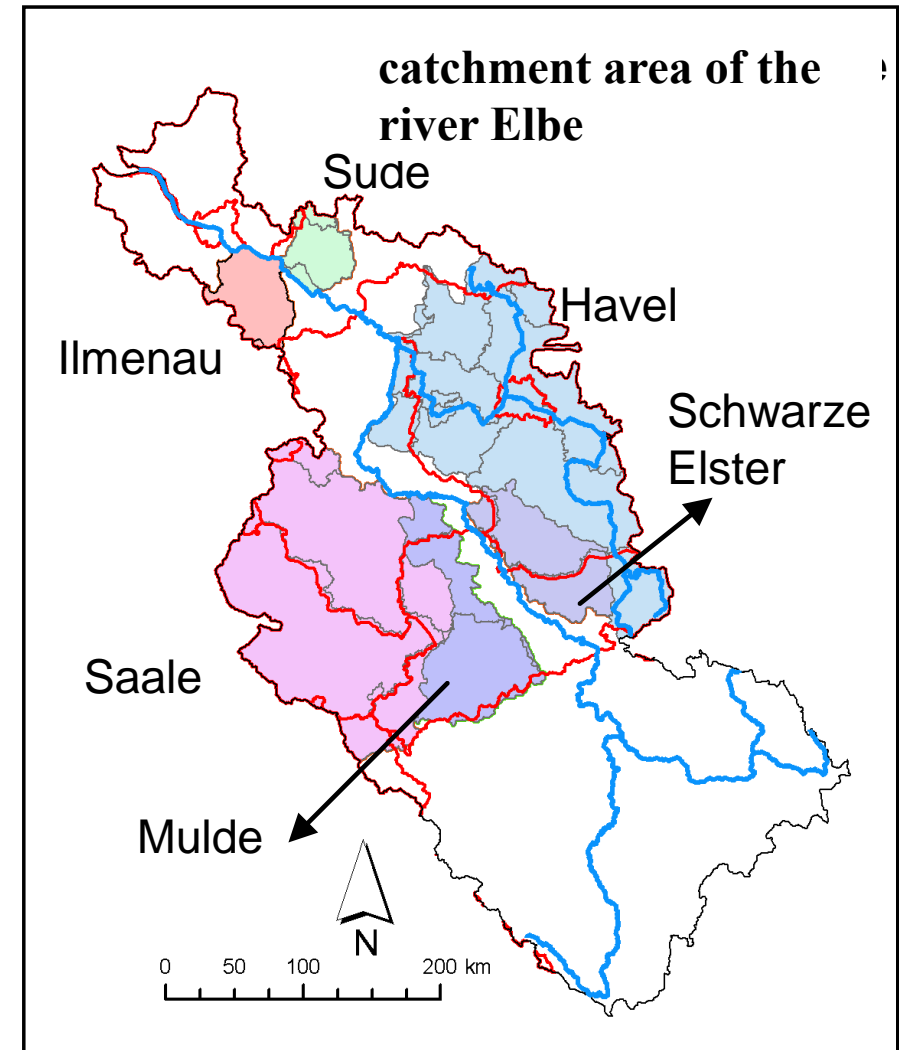
Method *Human Water Stress Index* (1)



Calculation of the **Human Water Stress Index** demonstrated with the German sub – catchments in the Elbe river basin

1. Selection of the study areas (Following literature sources (IKSE, 2005) six German tributaries to the Elbe were considered that have catchments larger than 2,000 km²:

- Saale 24,079.1 km²
- Havel 23,858 km²
- Mulde 7,400.3 km²
- Schwarze Elster 5,704.9 km²
- Ilmenau 8,852.0 km² and
- Sude 2,253.4 km²



Method *Human Water Stress Index* (2)

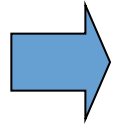


Calculation of the Human Water Stress Index demonstrated with the German sub – catchments in the Elbe river basin

2. Establishment of long-term mean water balances $\bar{R} = \bar{P}_{korr} - \bar{Eta}$ with
- mean runoff depth \bar{R}
 - mean corrected precipitation depth \bar{P}_{korr}
 - mean actual evapotranspiration depth. \bar{Eta}

The time series of the period 1961-1990 were compiled in the context of the Project „Hydrological Atlas of Germany“ (HAD, 2003). Then followed GIS based analyses to determine the area averages of the mean runoff depths.

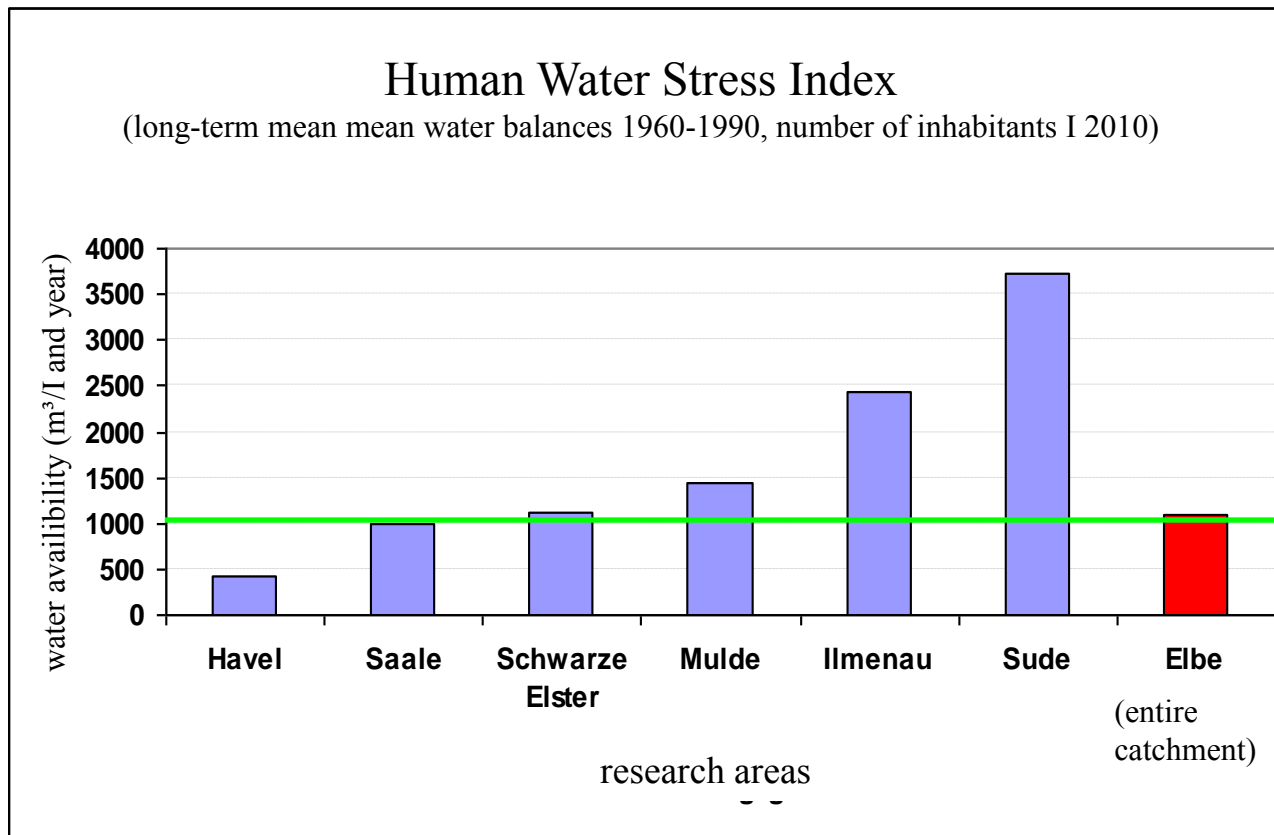
Method *Human Water Stress Index* (3)



Calculation of the Human Water Stress Index demonstrated with the German sub – catchments in the Elbe river basin

3. The **numbers of inhabitants** in the selected catchments **were determined** from free Internet information provided by the statistical agencies of the German Federal government and of the pertinent Federal States (Statistische Ämter, 2010).
4. Determination of **water availability [in m³] per inhabitant and year**.
5. **Validation** of the results by means of the data on water availability in the Hydrological Atlas of Germany (HAD 2003). It must be noted here that the atlas shows only the potential water resources related to the area of the individual German Federal States.

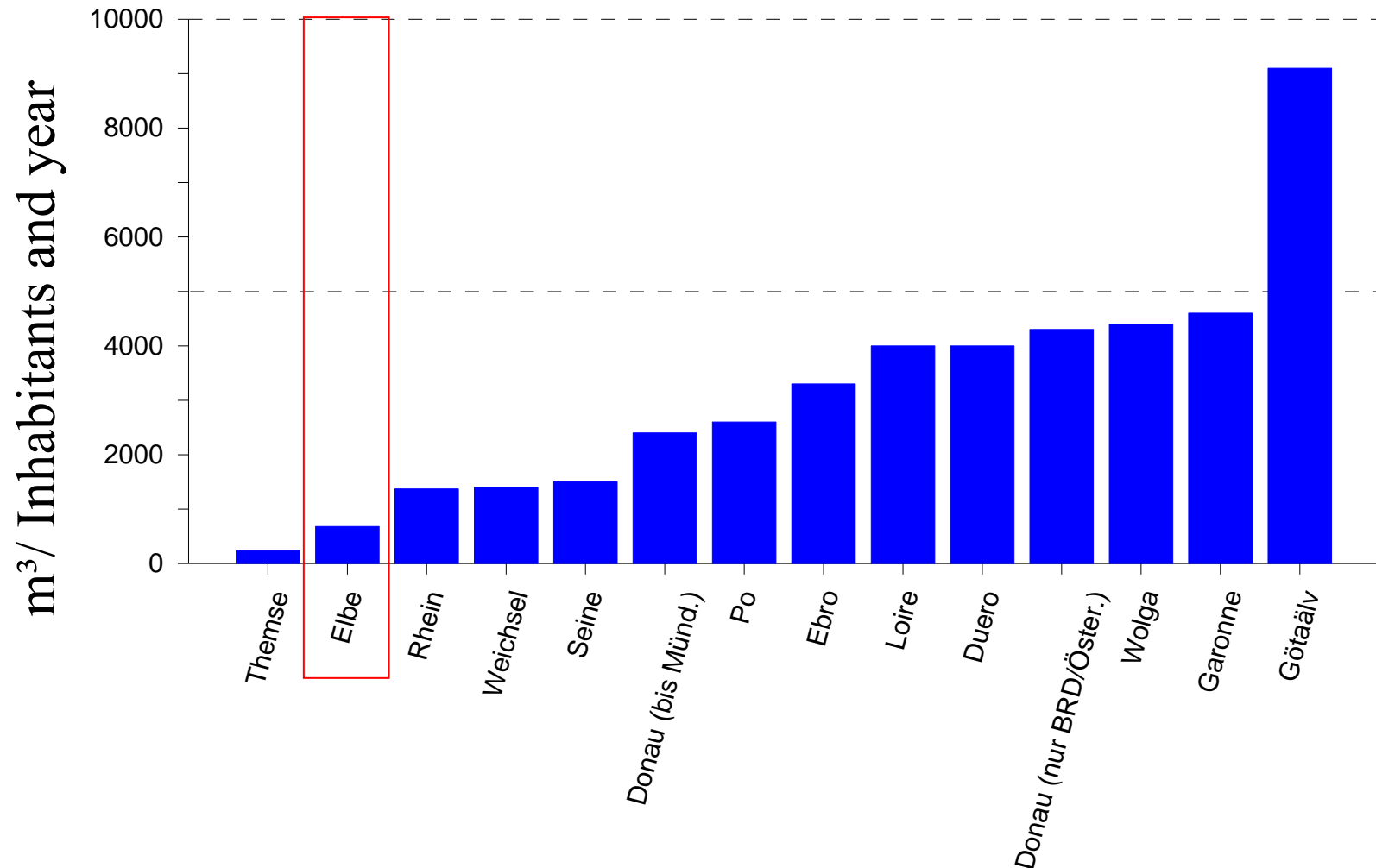
Results *Human Water Stress Index (1)*



water scarcity: water availability is under 1,000 m³ of water per inhabitant and year (world bank)

- The water availability in the Elbe basin varies regionally.
- The lowest availability is found in the basin of the River Havel, where the values of mean annual precipitation depths are low and those of mean annual evapotranspiration depths are high. Moreover, the city of Berlin, where only 48 m³ of water are available per capita and year considering only the potential resources in this area is embedded in this basin.
- The highest water availability was observed in the basin of the River Sude, what is explained by the low number of inhabitants there.

Results *Human Water Stress Index (2)*



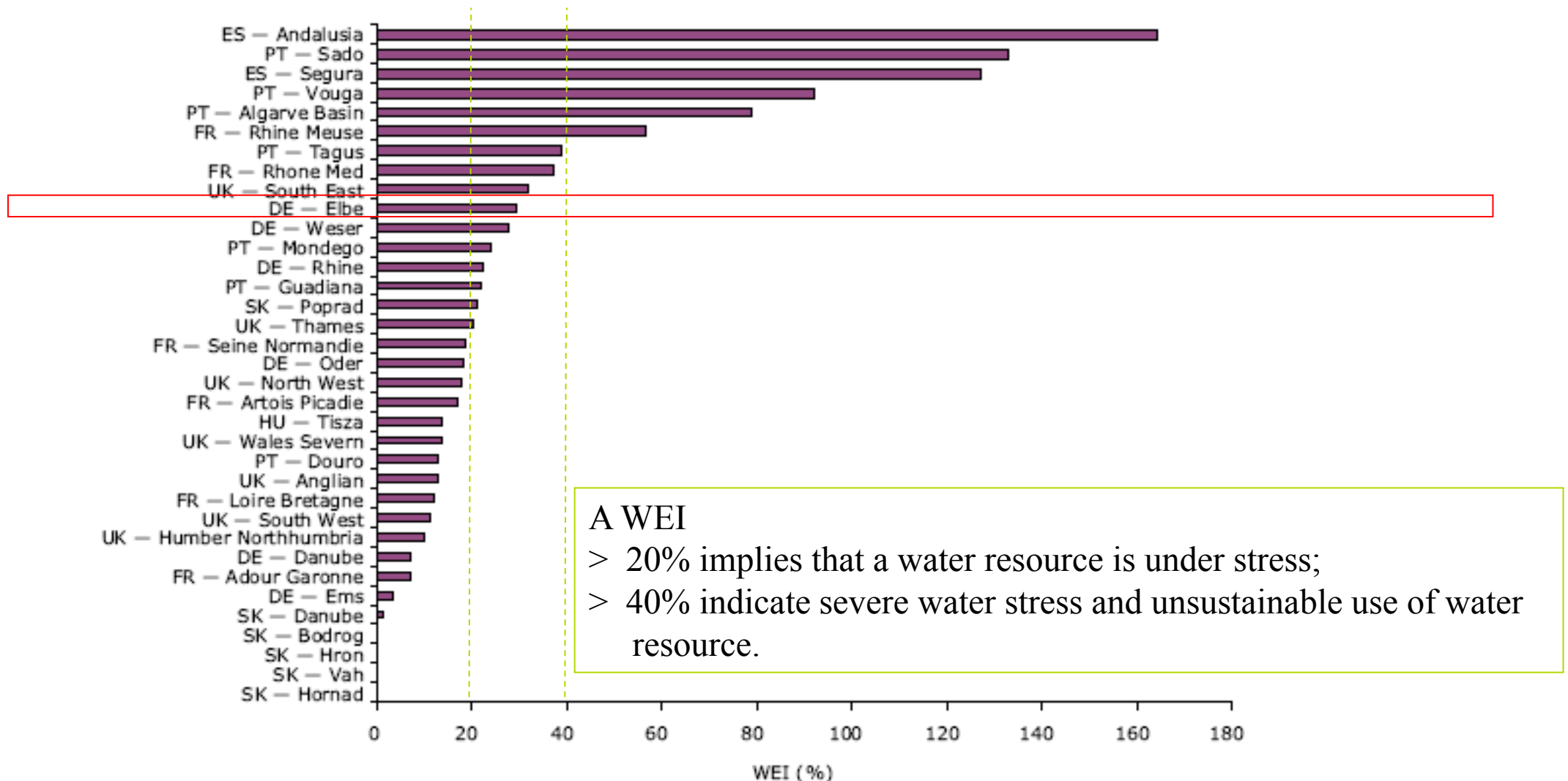
It is shown, the mean annual availability of water per inhabitant based on the potential water resources in selected European river basins (Grünewald 2012). In this European comparison the entire basin of the River Elbe has low water availability.

Results *Water Exploitation Index*

- *river basin catchments*

Figure 2.5 WEI for selected river basins across Europe

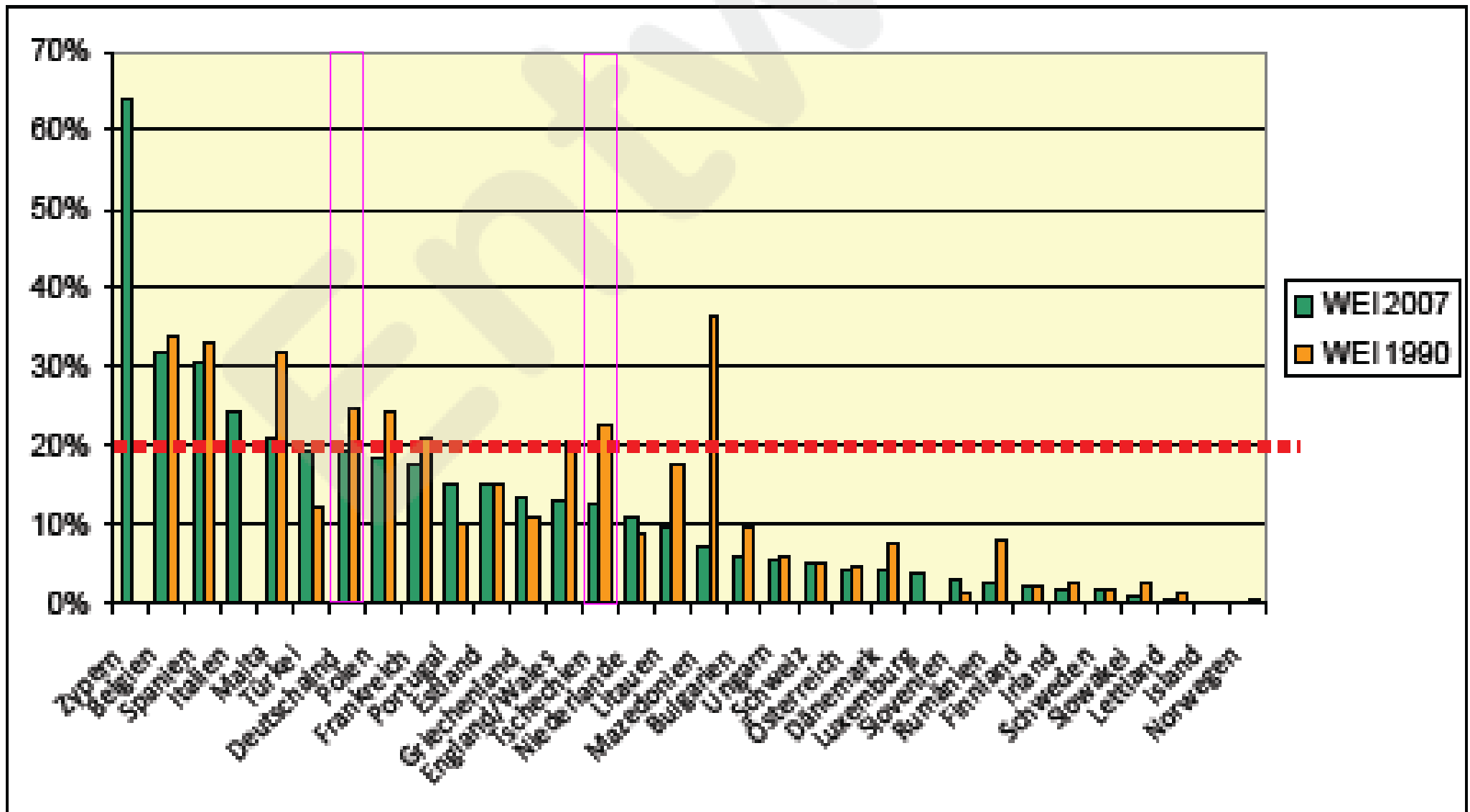
(EEA-report 2009, page 18)



Source: EEA based on data submitted to the European Commission, 2007.

Results *Water Exploitation Index*

- countries

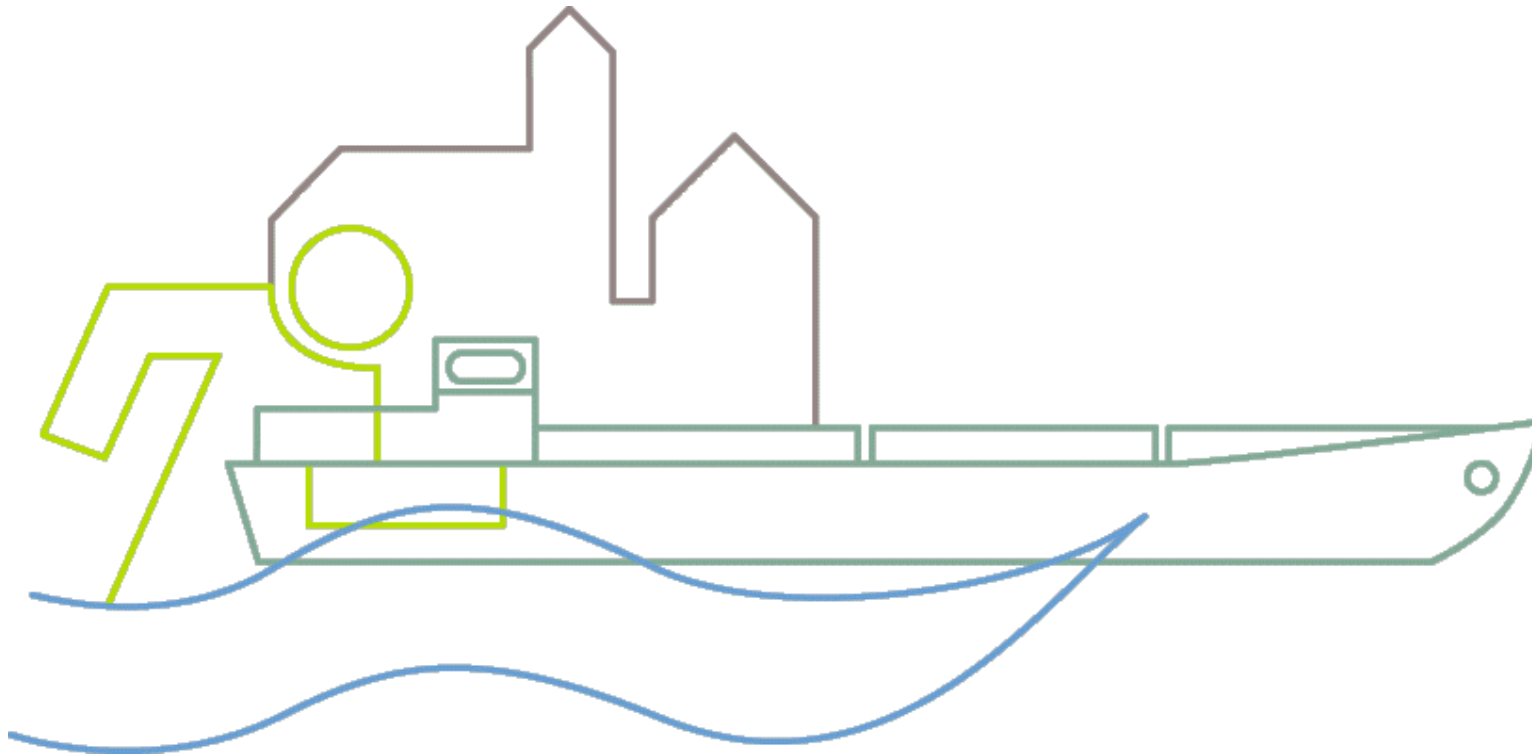


(EEA-report 2011)

1. **Water Exploitation Index WEI+** (monthly time step)

- Meeting of the group of experts “Water Scarcity and Drought” in Prag in December 2011, next meeting: February/ March 2012
- Motivation for the current discussion: WEI does not include the return flow (→thermal power plants)

2. **Environmental Scarcity Index** -> Estimation of the ecological water demand is difficult (first proposal Q90)



Thank you for your attention!

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