



# Indicators of water shortage

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- ⇒ a country suffers from water shortage if the availability of renewable water less than 1,000 m<sup>3</sup> the per inhabitant and per year (Kundzewicz et al., 2007)
- ⇒ in Germany 1,878 m<sup>3</sup> water per inhabitant and year
- ⇒ following classification for water shortage / water scarcity by Helvetas Swiss Intercooperation (2005):
  - enough water > 1.700 m<sup>3</sup> (per person and year)
  - water scarcity 1.000 – 1.700 m<sup>3</sup>
  - water shortage 500 – 1.000 m<sup>3</sup>
  - extreme water shortage < 500 m<sup>3</sup>



- ⇒ UNESCO (2006) described water scarcity by the "Relative Water Stress Index" (RWSI)
  - ratio between total water consumption (industry, households and agriculture) to the long-term average of the surface runoff (rainfall - evapotranspiration)
  - water scarcity exists when the values are greater than 0.4
- ⇒ description for water shortage in natural systems many related terms such as drought, aridity, low water

# Direct respectively indirect indices/ indicators for water shortage

## **important indicators:**

⇒ decrease of climatic water balance/ available water supply

⇒ surface water:

- reduction of runoff formation and water availability
- increasing low-water phases
- decline of water level in lakes

⇒ groundwater:

- decrease groundwater recharge
- dipping groundwater table

# Direct respectively indirect indices/indicators for water shortage

## important indicators:

### ⇒ soil water balance:

- decrease in infiltration rate
- decrease in soil moisture – spring drought in the period April to June



Quelle: [www.n-tv.de](http://www.n-tv.de)

### ⇒ plant water balance:

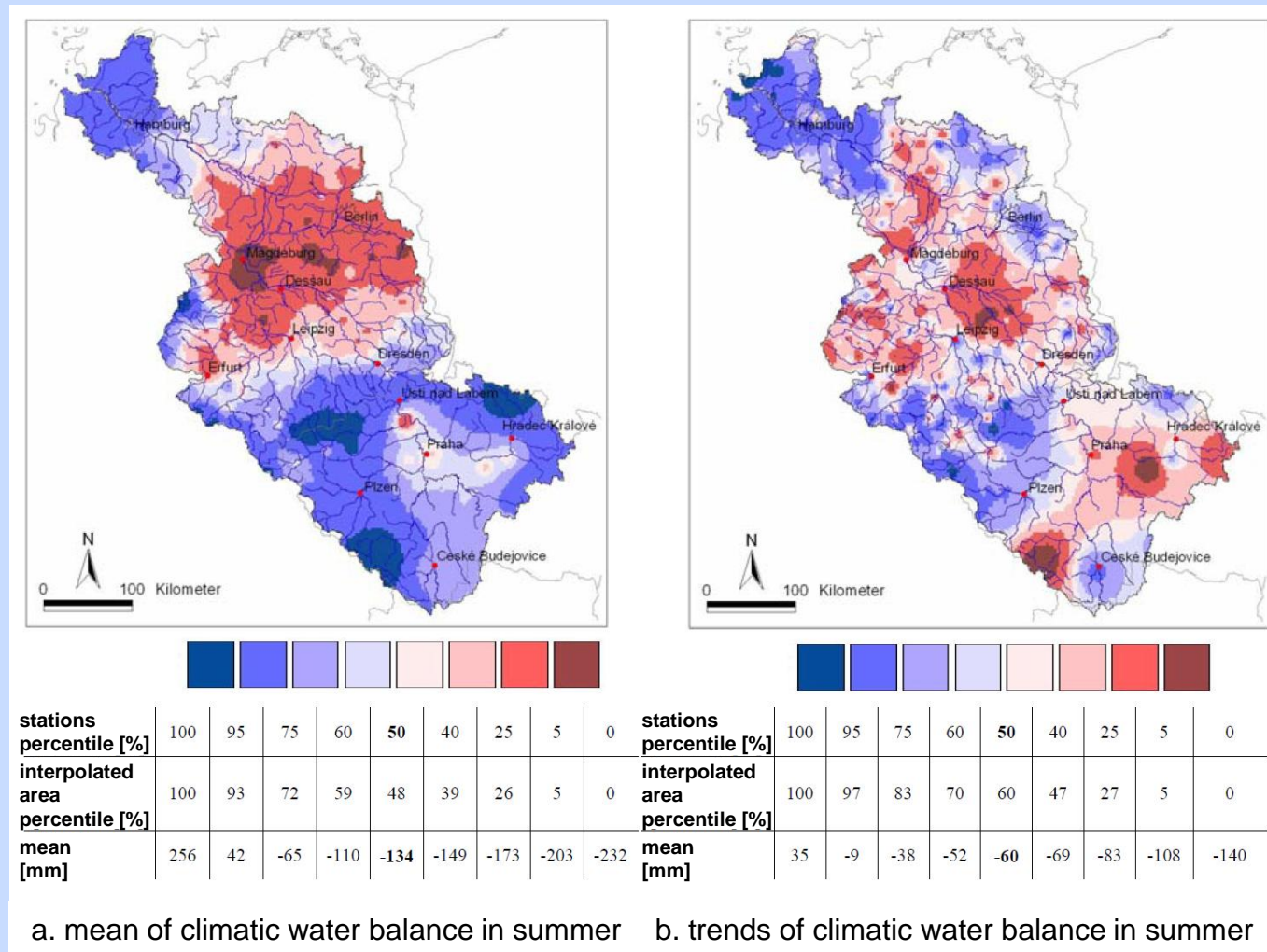
- physiological plant transpiration index
- Index of relatively usable soil water in rooted soil zone

### ⇒ changes in species composition

# Examples for indices/ indicators for water shortage

## Decrease of climatic water balance in the Elbe catchment

mean (a) and average trends (b) of climatic water balance in period 1951-2000 in the hydrological summer



# Examples for indices/ indicators for water shortage

## Runoff formation and water availability in the federal states of germany for time series 1961-1990 by HAD (2003)

⇒ runoff formation values of Brandenburg (88 mm/y) and Saxony-Anhalt (93 mm/a) are well below the national average (296 mm/y)

➔ „waterpoorest“ federal states of germany

Bundesland	Fläche in km <sup>2</sup>	Ein- wohner in 1000 E	Abfluss in m <sup>3</sup> /s	Abflusshöhe in mm/a	Wasserverfüg- barkeit in m <sup>3</sup> /(E·a)
Baden-Württemberg	35 751	10 524	535	472	1 603
Bayern	70 548	12 230	855	382	2 205
Berlin	881	3 382	5	182	48
Brandenburg	29 477	2 602	82	88	994
Bremen	404	660	4	289	177
Hamburg	755	1 715	8	315	139
Hessen	21 114	6 068	205	308	1 065
Mecklenburg-Vorpommern	23 171	1 776	97	132	1 717
Niedersachsen	47 614	7 926	404	268	1 609
Nordrhein-Westfalen	34 080	18 010	438	405	767
Rheinland-Pfalz	19 847	4 035	202	321	1 579
Saarland	2 570	1 069	33	410	974
Sachsen	18 413	4 426	134	229	954
Sachsen-Anhalt	20 447	2 615	60	93	728
Schleswig-Holstein	15 764	2 790	165	330	1 863
Thüringen	16 172	2 431	118	230	1 532
Deutschland	357 020	82 260	3 345	296	1 282
Deutschland mit ausl. Zustrom	357 020	82 260	5 955	526	2 283

# Examples for indices/ indicators for water shortage

## Increasing low-water phases in the rivers

- ⇒ in Brandenburg many rivers in the Havel catchment year by year more intensive low-water phases in summer
- ⇒ at the Elbe in the last 150 years earlier entry of low-water periods, reasons:
  - decline in snow storage of low mountains by warming as well as
  - earlier consumption of soil water storage by the earlier onset of growing season



# Examples for indices/ indicators for water shortage

## Increasing low-water phases in the rivers

⇒ increase in the annual incidence of low water in the river Elbe since the 1990s, reasons:

- distribution of inner annual precipitation
- greater frequency and duration of high-pressure weather conditions over the area of Elbe with rainless weather



Elbe at low water (near Parey)  
reference: [www.lothar-specht-parey.de](http://www.lothar-specht-parey.de)

# Examples for indices/ indicators for water shortage

## Decline of water level in lakes

⇒ by indicator-based study of Roithmeier (2008) lakes in the Mecklenburg Lake District more exposed to risk of decline in water level caused by climate change

### fig.: Fallen dry lake in northeastern Germany

Eastern shore of the Redernswalder lake in the Biosphere Reserve Schorfheide-Chorin (Sep 2009)



reference: Kaiser et al. 2010

Southeastern shore of the Großen Fürstenseer lake in Müritz national park (May 2009)



reference: Kaiser et al. 2010

# Examples for indices/ indicators for water shortage

## Decrease groundwater recharge

- ⇒ current particularly in East Germany decrease of ground water recharge in summer
- ⇒ for Brandenburg for the period 2040-2050 compared to the period 1980-1990 possible decrease of ground water recharge by up to 42%
- ⇒ for Spreewald in partial areas to 2052 decrease groundwater recharge of up to 54% (climate model: STAR, scenario: A1B), reasons:
  - mainly by increasing evaporation in summer,
  - declining precipitation in Spreewald as well as
  - reduced inflows of mining region Lausitz

# Examples for indices/ indicators for water shortage

## Dipping groundwater table

- ⇒ in the Biosphere Reserve Schorfheide-Chorin (Brandenburg) large drop of the water level in the ground moraine fens, reasons:
  - human-induced declining of groundwater table,
  - wrong stocking in the catchment area (pine),
  - reduced near-surface flows as well as
  - early stage of forest on the fen surface
- ⇒ in Spreewald in the fen-peats higher soil temperatures and falling groundwater tables
  - greater warming of the topsoil and so increased microbial degradation → depletions of peats



# Examples for indices/ indicators for water shortage

## Changes in species composition

- ⇒ in the central area of the Spreewald lowland conversion of alder forests in a less wet black cherry-ash-forest by climate change on 15% of its area

**Thank you  
for your attention!**

