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Water and Sustainability: A Global Perspective

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Water and Sustainability: A Global Perspective

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- Options and outlook

A wrong slogan

Source: dropshipabc.com

To produce 1 l of wine about 900 l of water are needed…

Four important concepts

- **Volume and renewal rate**
- **“Blue “ and “green“ water**
- **Consumptive and non-consumptive use**
- **Virtual water and real water**

Global fresh water resources

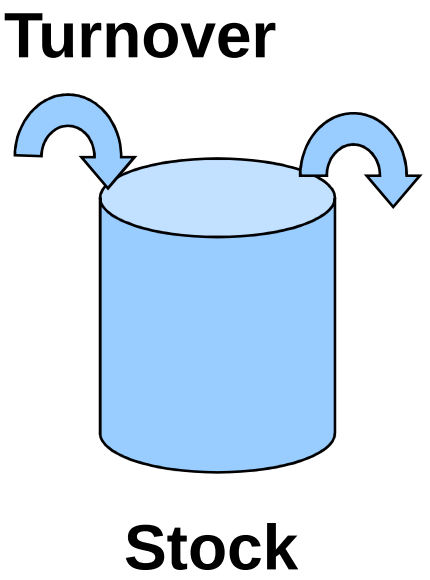
Two types

Surface water (Lakes and rivers):

- **Volume** **104,000 km^3**
- **Renewal rate** **37,000 km^3/a**

Groundwater (incl. soil water):

- **Volume** **10,000,000 km^3**
- **Renewal rate** **3,000 km^3/a**



The renewal rates must be the basis of sustainable management!

„Blue“ and „green“ water

- Terms coined by Malin Falkenmark
- Green water is rain water stored in the root zone of plants
- Blue water is runoff
- Rain fed agriculture is green water use
- Irrigated agriculture is blue water use
- Only blue water is easily managed and distributed
- Green water can be managed by changes in land use

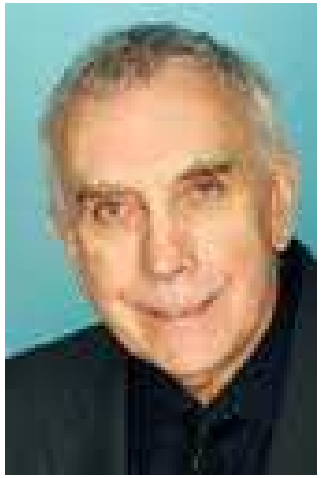
Water use

- **Non-consumptive water use**
  - **using water as solvent, coolant or means of transport**

- **Consumptive water use**
  - **evaporation (above all in agriculture and vegetation)**

Virtual water

- **Virtual water = water used in the production of a good**
- **Term coined by John Anthony Allan around 1995 („Stockholm water prize“ 2008)**
- **Water is called virtual, as after production hardly any of it is still contained in the good**



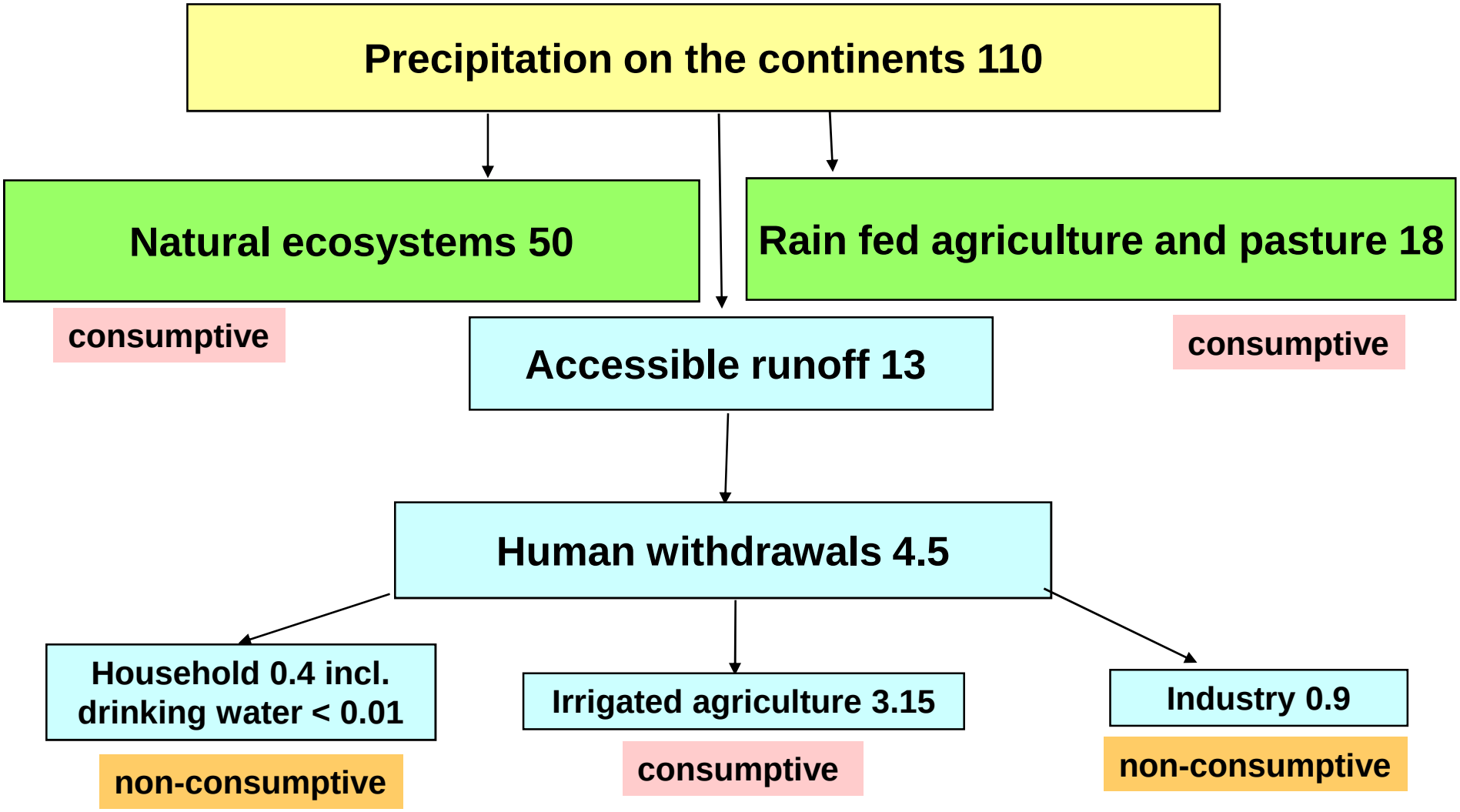
Water for food

Daily drinking water	2-5 L/day
Daily household use	30-200 L/day
1 kg grain	500-2000 L
1 kg animal products (meat, milk)	5000-15000 L

Should we become vegetarian?

Global water balance

in 1000 km^3/a

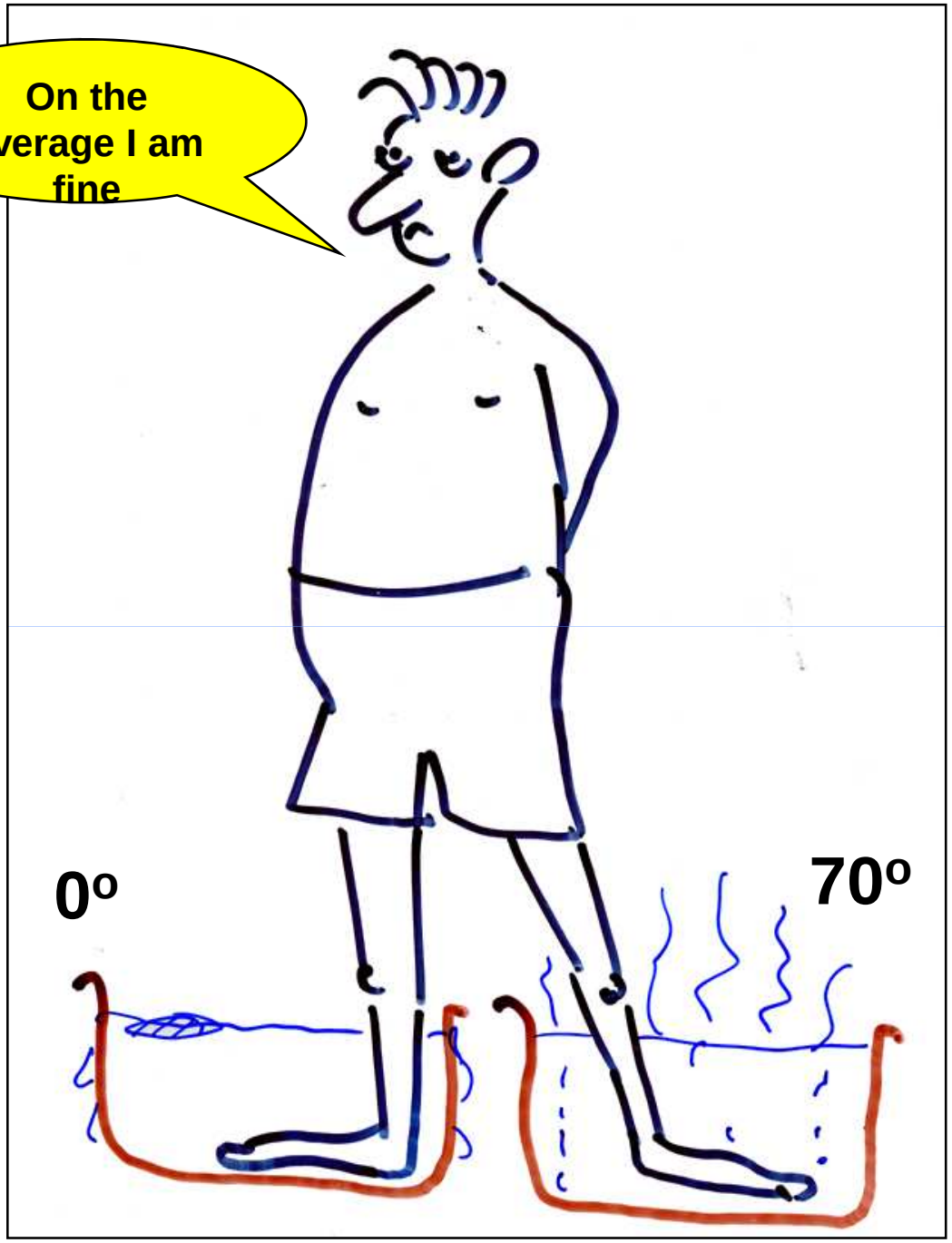


1000 km^3/a is about 1/6 of the Amazone

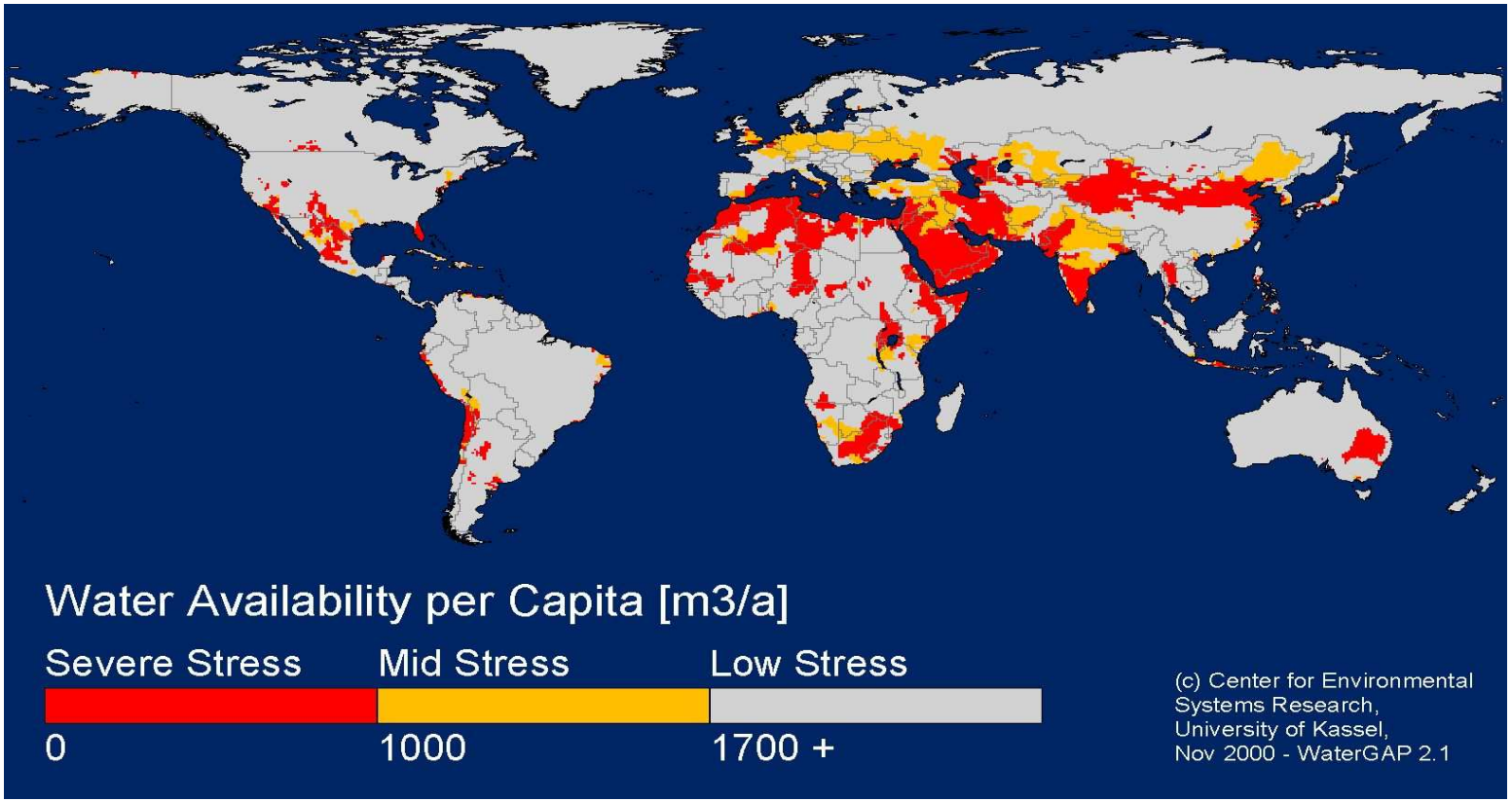
Why worry if accessible runoff is still larger than withdrawals?

Averaging is misleading because of spatial and temporal variability of water availability

Drought cannot be averaged against flooding and 4.5 out of 13 is already uncomfortable



Water availability per capita 2000



Source: WaterGAP 2.1, 2000

Definition of UN: Serious water scarcity: < 1000 m^3/a/P

2000 407 Mio. people

2025 3 Bio. people

Future water scarcity

Scarcity is increasing due to

- Population growth (to about 9 Bio. In 2050)
- Increase of living standards (last doubling of population caused tripling of water demand)
- Water requirements for agrofuels
- Climate change

Demand could grow by 3000-5000 km^3/a

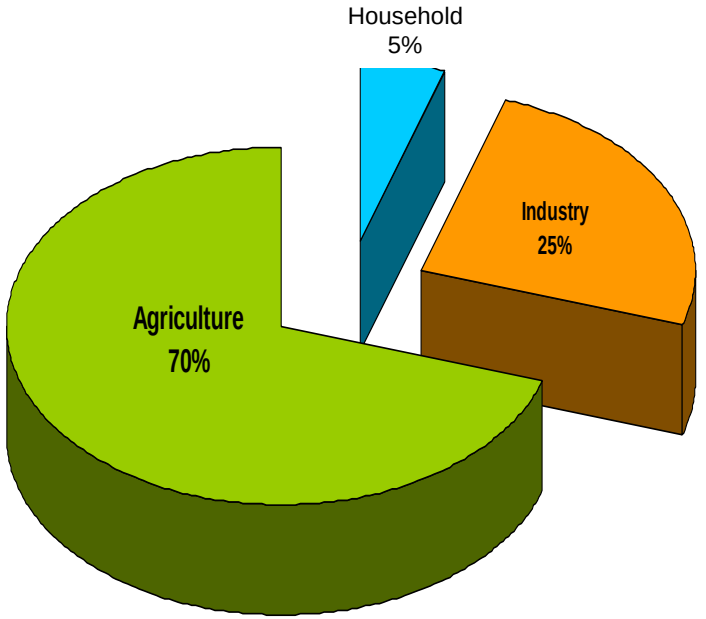
Water scarcity is in principle a local problem, but there are global connections …

Global aspects of water scarcity

- Global food security
  - World market for food
- Agrofuel
  - World market for energy
- Global change in climate
  - Push and pull for migrations
- International river basins
  - 261 out 405 river catchments are international
- Ecosystems of global importance
  - Biodiversity

Global aspect agriculture

- 70% of runoff withdrawals are used in agriculture
- Irrigated agriculture is more than twice as productive as rainfed agriculture
- It produces on roughly 20% of cultivated area more than 40% of world food
- 1 t of grain requires 1000-2000 t of water
- There is a world market for grain



A global water problem will show in the form of a global food problem and a global migration problem

Global aspect climate

Overall precipitation will increase, but distribution in time and space will change

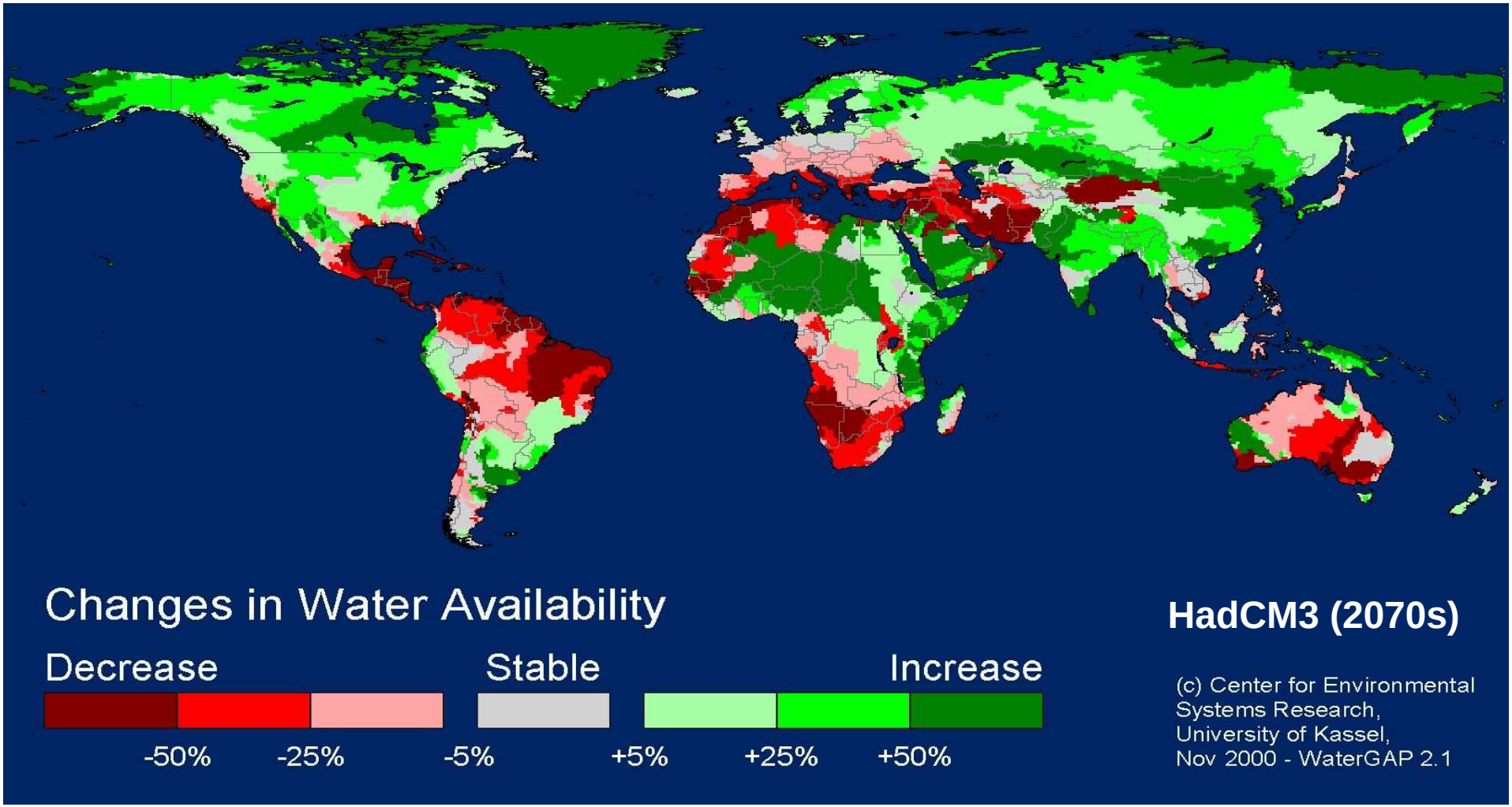
To be expected:

- **Stronger extremes**
- **Shift of climate zones**
- **Systematic losers**

e.g. Australia, South Africa, Northern Brasil, Mediterranean

No reliable predictions can be made, but trends have been observed in the last 20 years

Climate change and water availability



Source: WaterGAP, 2001

The hidden water problem:

Non-sustainable use of water resources

What is „non-sustainable“ in the context of water resources?

Non-sustainable is a practice, for which there is no alternative and which at the same time cannot go on indefinitely without running into a crisis

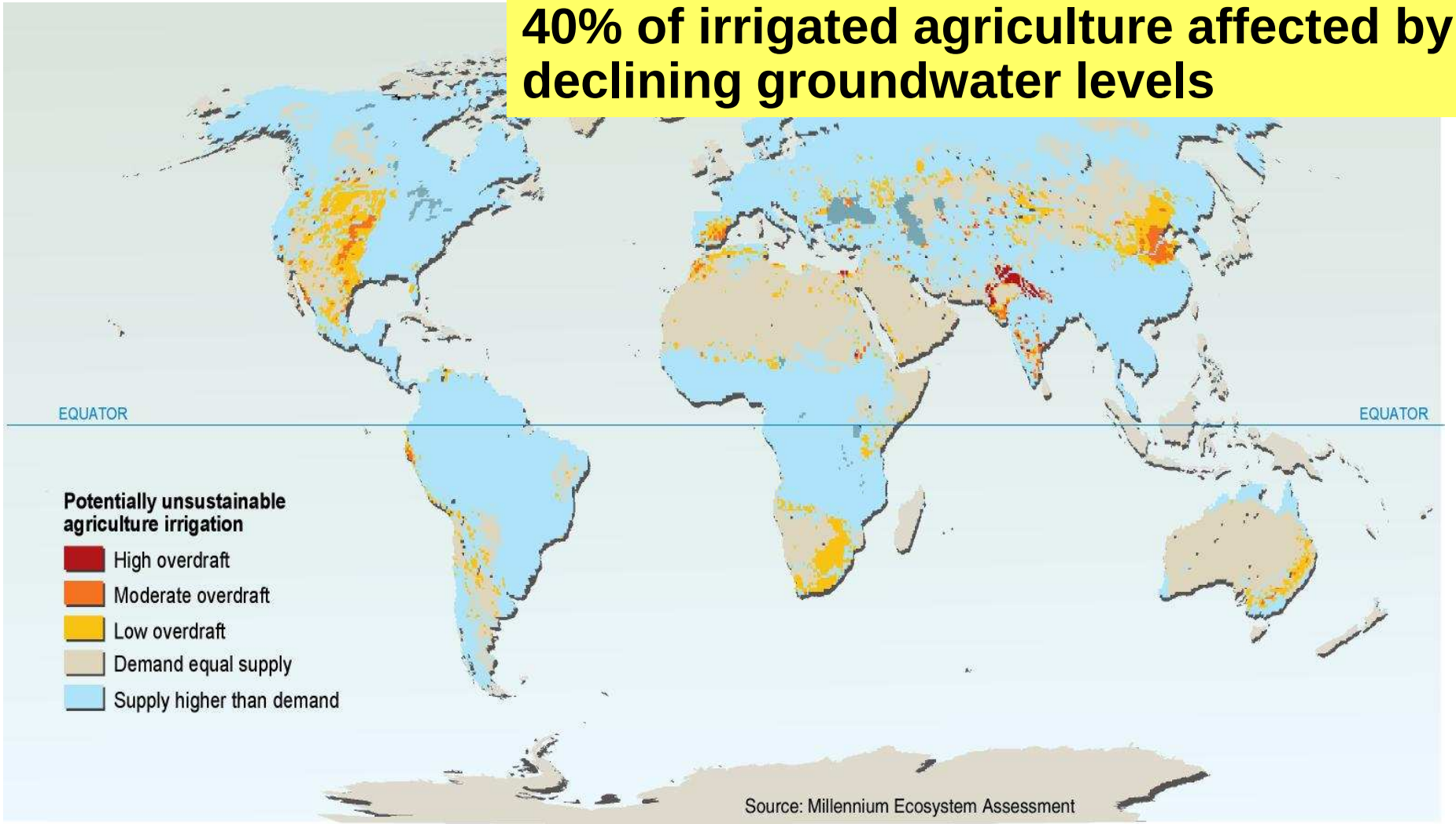
Non-sustainability shows in

- **depletion of a finite resource, which cannot be substituted (groundwater, soil, biodiversity)**
- **accumulation of substances to harmful levels (salts, nutrients, heavy metals, etc.)**
- **unfair allocation of a resource leading to conflict (upstream-downstream problem)**
- **breakdown of institutions due to bad governance**
- **runaway costs**

The most serious problems of non-sustainability in the water sector on a global scale

Depletion of aquifers

1/4 of withdrawals non-renewable
40% of irrigated agriculture affected by declining groundwater levels



Source: Millenium Ecosystem Assessment

Example for non-sustainable groundwater abstraction: Saudi Arabia

Abstraction of nonrenewable groundwater resources 2004:

685 m^3/s (= Rhine at Schaffhausen)

Almost exclusively used in Agriculture. Exhaustion in 20 to 30 years

Overpumping only advisable as temporary fix, and only if there is an exit strategy!

Decrease of base flow of rivers

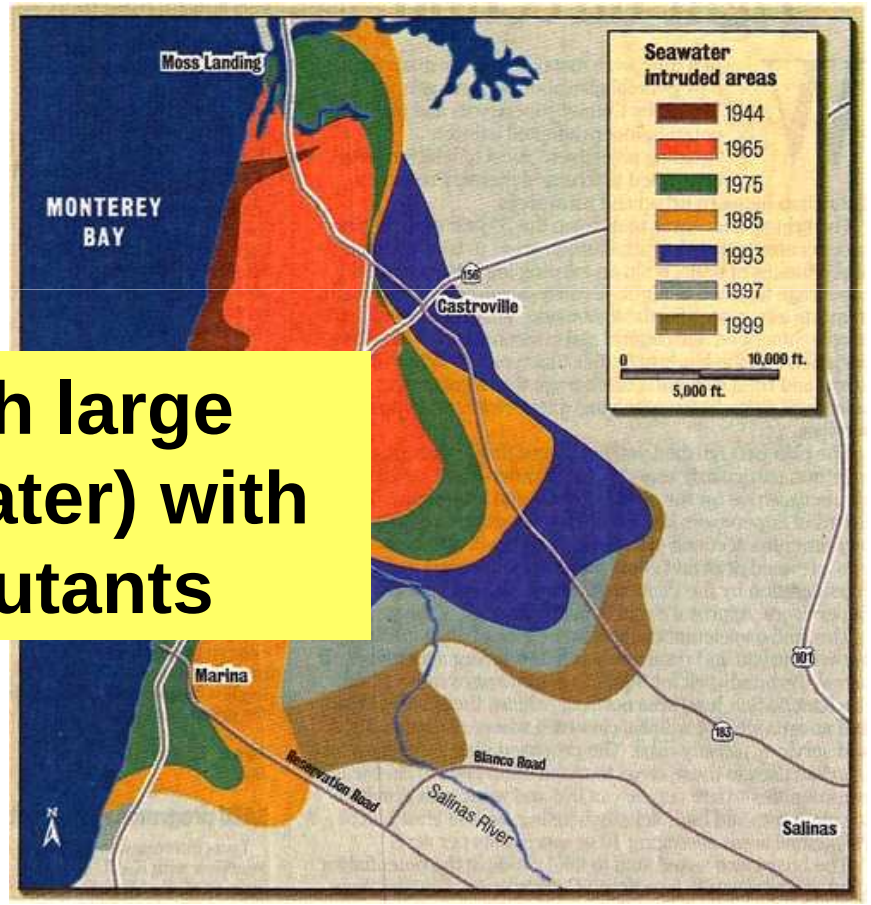
even large rivers become ephemeral, lakes dry up, upstream-downstream conflicts increase. Most tragic example: Aral sea

Drying up of wetlands

Area reduced by 50% since 1900
Competitor: Agriculture

Soil salinization

80 Mio. of 260 Mio. ha irrigated land in some way affected



Pollution of water bodies with large residence times (e.g. groundwater) with persistent or recyclable pollutants

And of course:

Climate change

Options for solutions

Big options (order of 1000 km^3/a)

- **Water saving in agriculture by improved technology and improved management (including post-harvest losses)**
- **Increasing yield of rain-fed agriculture by biotechnology**
- **Increasing efficiency of the international division of labour and increased imports of virtual water**

A series of smaller options (order of 100 km^3/a)

- **Water harvesting and storage (new dams)**
- **Desalination of seawater and brackish water**
- **Intrabasin transfers**
- **Waste water recycling**
- **Resettlement of people and birth control**

How much more is needed till 2050?

Increments due to population growth +
Ending non-sustainable practices +
Mitigation of climate change +
Agrofuels
4000 – 6000 km^3/a

Potential of all options

3000 - 4000 km^3/a

Discrepancy will most probably be covered by taking water from natural ecosystems

Conclusions

- **Serious regional water problems exist already today and increase in intensity.**
- **A part of present water supply is not sustainable. Climate change will increase that part.**
- **A global water/food crisis can probably be avoided.**
- **But water resources remaining for the natural ecosystems will further decrease in favour of agriculture.**
- **The solution of water problems requires the application of a wide spectrum of methods. Some solutions lie beyond the water sector and agriculture plays the main role.**
- **Generally humankind will have to allocate in future a larger portion of its income to food and water.**
- **The socio-economic obstacles to problem solving are as a rule at least as critical as the technical obstacles.**
- **The main question will be: How can we allocate the resources on the earth in a more equitable way among its people?**