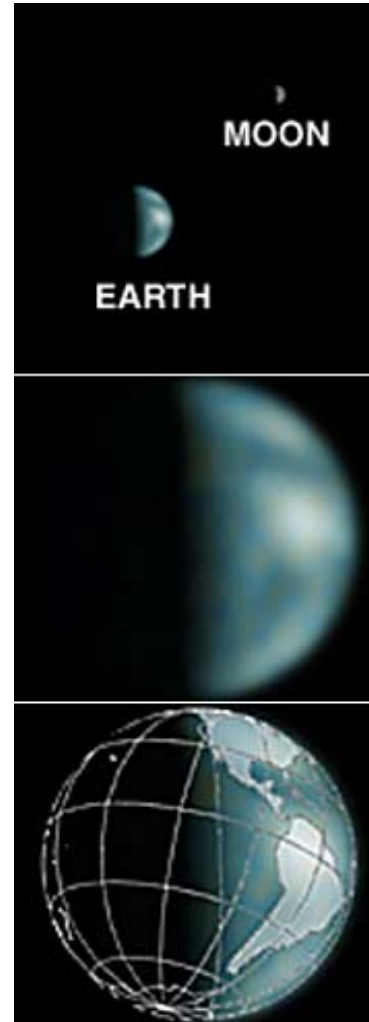
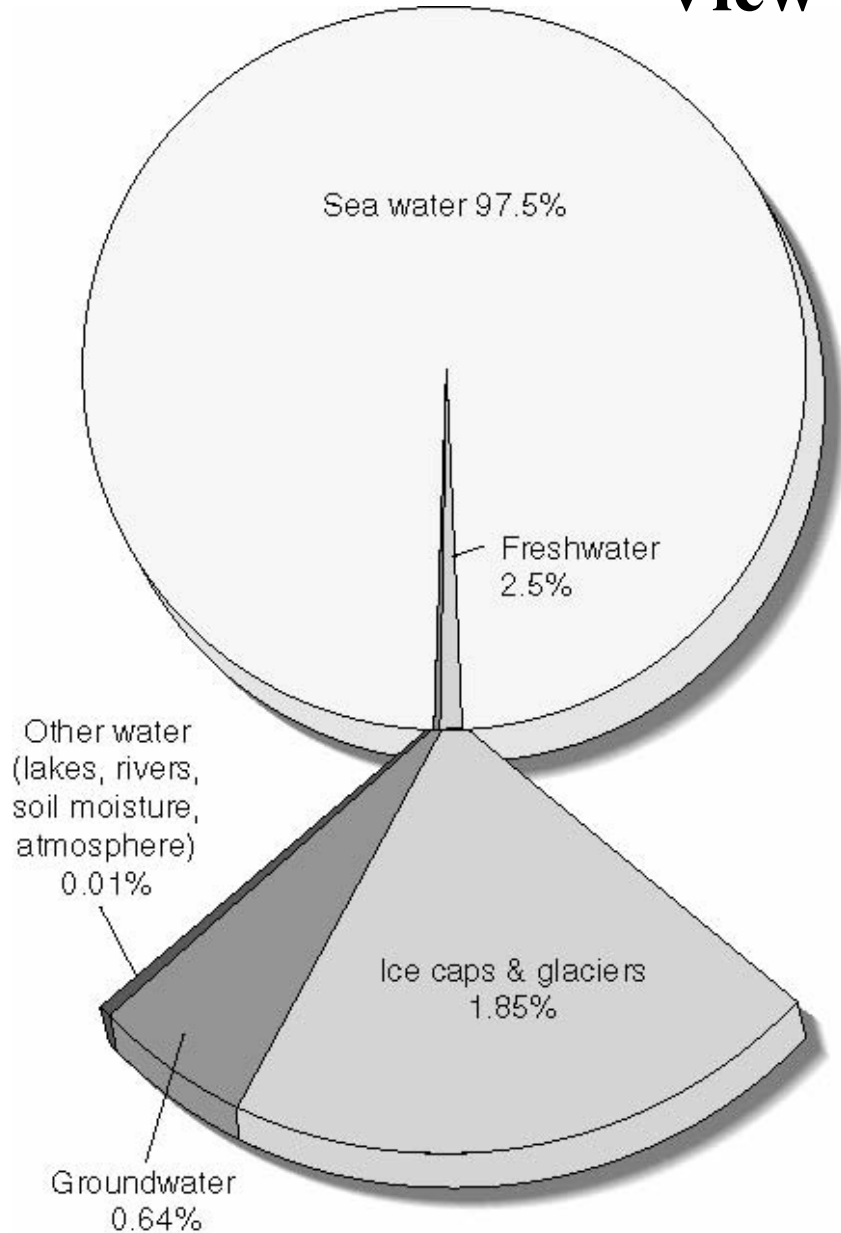


Lecture 1: A Global Water Crisis?



View of Earth from Mars



- Groundwater is an integral part of hydrological cycle
- Est. 4.2 million km³ of groundwater
- Within 1 km of earth's surface

Compared to:

- 125 000 km³ freshwater lakes
- 1250 km³ in streams

'the invisible resources'

**TABLE 4.4 Estimated Residence Time
of the World's Water Supply**

Water Type	Residence Time
Oceans and seas	4000 years (approx.)
Lakes and reservoirs	10 years (approx.)
Swamps	1–10 years (approx.)
Rivers	2 weeks
Soil moisture	2 weeks–1 year
Groundwater	2 weeks–10,000 years
Icecaps and glaciers	10–1000 years
Atmospheric water	10 days

Source: Adapted from R. Allen Freeze and John A. Cherry, *Groundwater* (Englewood Cliffs, NJ: Prentice-Hall, 1979), 5.

Canada

- ***0.5% of world's population***
- ***20% of global freshwater***
- ***25% of wetlands (recharge)***
- ***7% flow of renewable water***
- ***\$7.5-\$23 billion annual contribution to Canada's economy***

Global Water Security

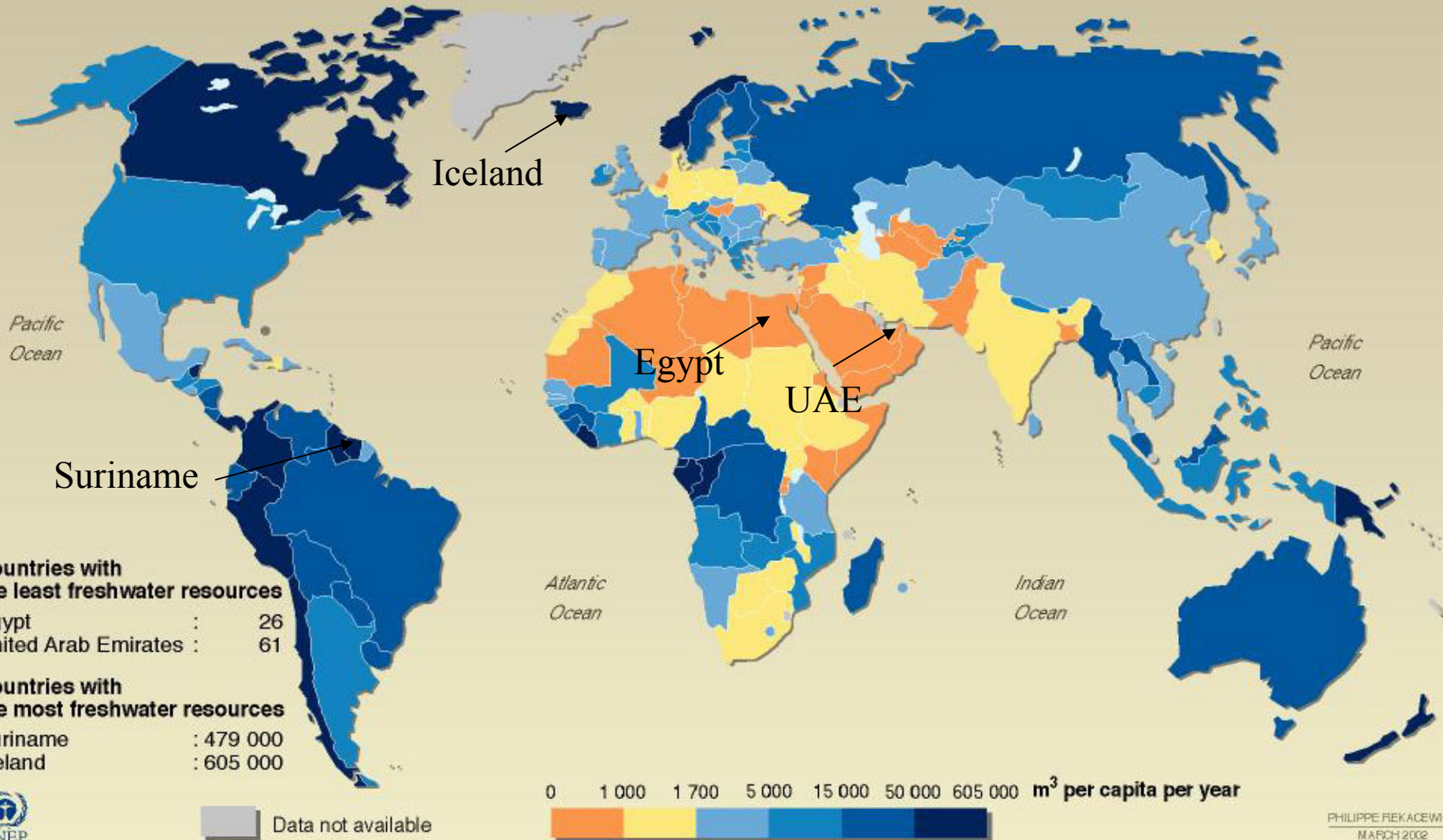


- **Control of Water Resources** (state and non-state actors): where water supplies or access to water is at the root of tensions.
- **Military Tool** (state actors): where water resources, or water systems themselves, are used by a nation or state as a weapon during a military action.
- **Political Tool** (state and non-state actors): where water resources, or water systems themselves, are used by a nation, state, or non-state actor for a political goal.
- **Terrorism** (non-state actors): where water resources, or water systems, are either targets or tools of violence or coercion by non-state actors.
- **Military Target** (state actors): where water resource systems are targets of military actions by nations or states.
- **Development Disputes** (state and non-state actors): where water resources or water systems are a major source of contention and dispute in the context of economic and social development.

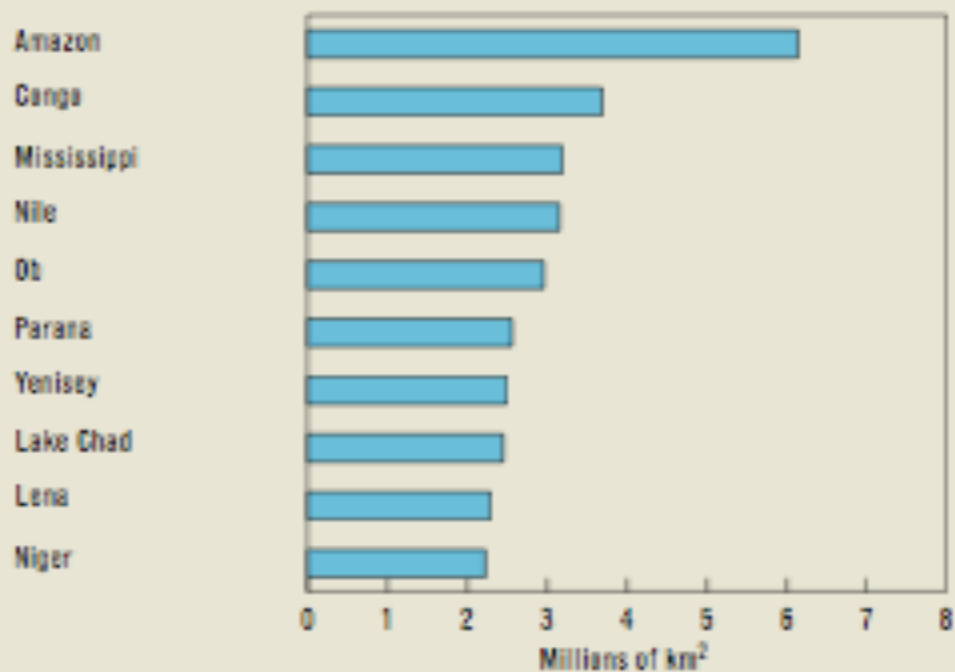
<http://www.worldwater.org/conflictchronology.html>

Global Water Issues

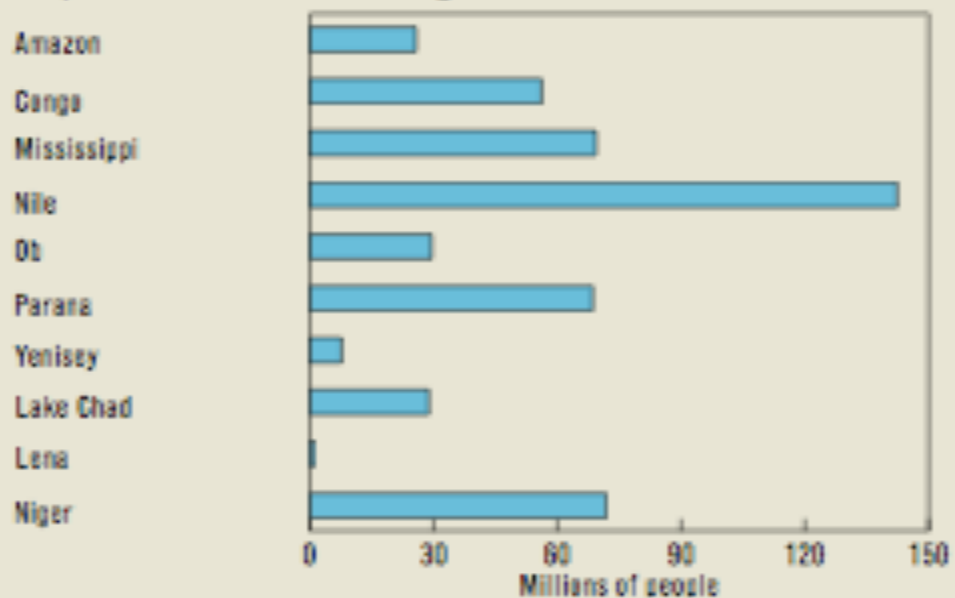
Availability of Freshwater in 2000
Average River Flows and Groundwater Recharge



Area of the 10 Largest Watersheds



Population of the 10 Largest Watersheds



Ensure sufficient quantity/quality of water adequate for human use

- 1.1 billion globally without access to safe water supplies
- 2/5 without adequate sanitation
- Humans become thirsty after losing 1% of bodily fluids
- Danger of death when this approaches 10%

- 41 percent of the world's population, or 2.3 billion people, live in river basins under water stress, where per capita water availability is less than 1,700 m³/year

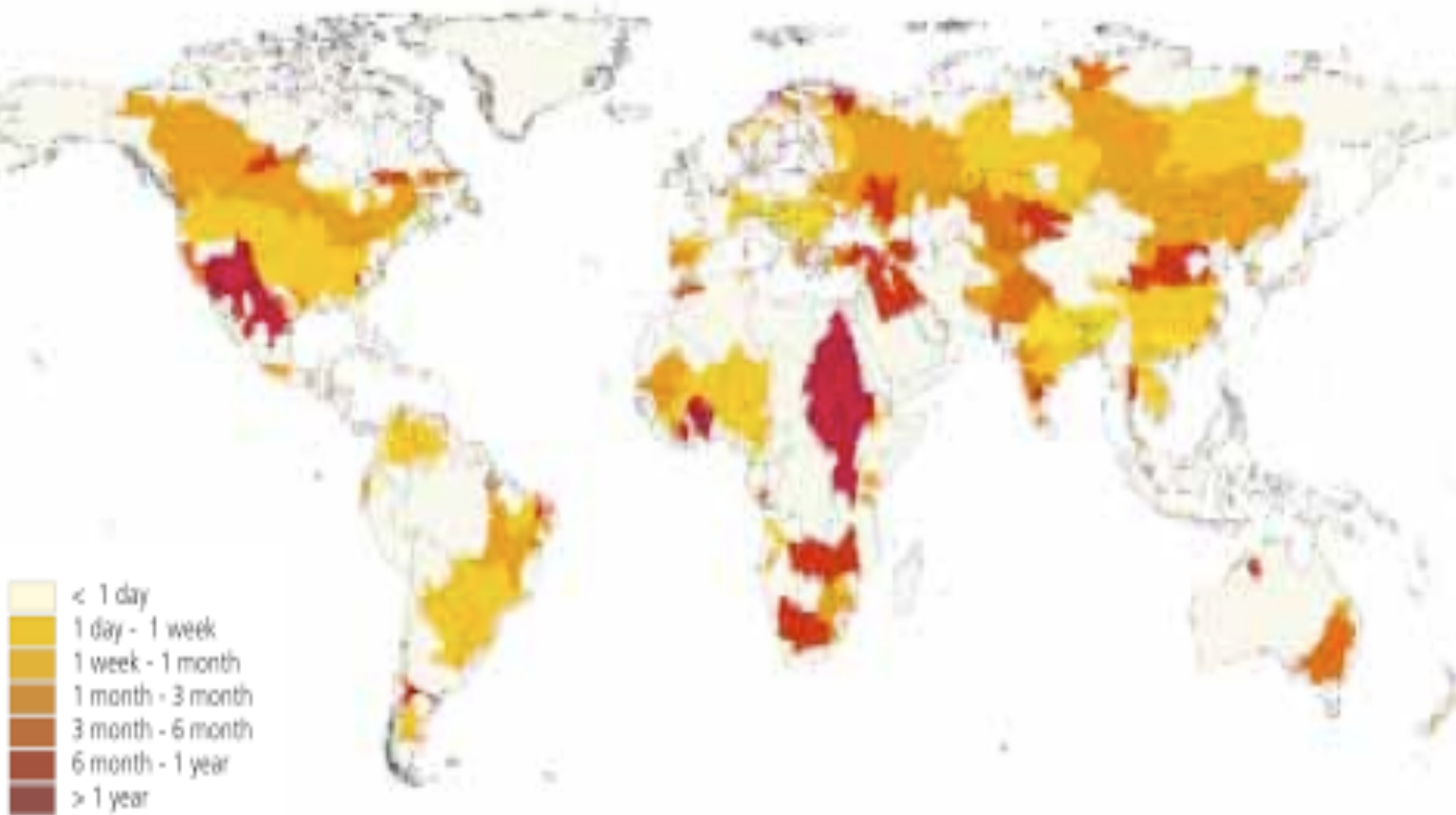
- Of these, 1.7 billion people reside in highly stressed river basins where annual water availability is less than 1,000 m³/person.

- Assuming current consumption patterns continue, by 2025, researchers project that at least 3.5 billion people, or 48 percent of the world's population will live in water-stressed river basins. Of these, 2.4 billion will live under high water stress conditions

Modification of Water Resources

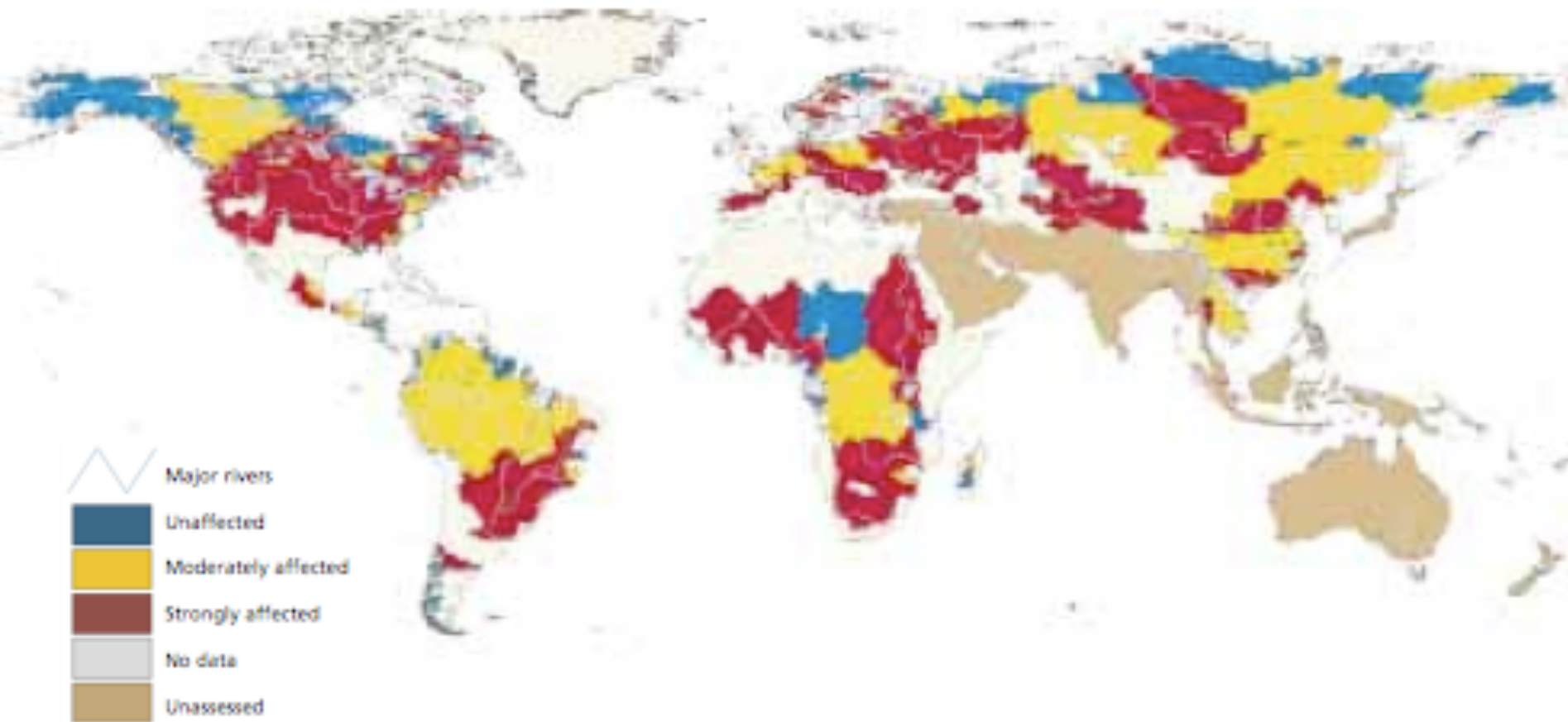
- Global demand in the 20th century
 - Population growth
 - Industrialization
 - Expansion of irrigated agriculture

Aging of Continental Runoff in Major Reservoir Systems



The pandemic construction of large reservoirs represents an important component of the terrestrial water cycle and one that merits due consideration in future global change studies.

River Channel Fragmentation and Flow Regulation



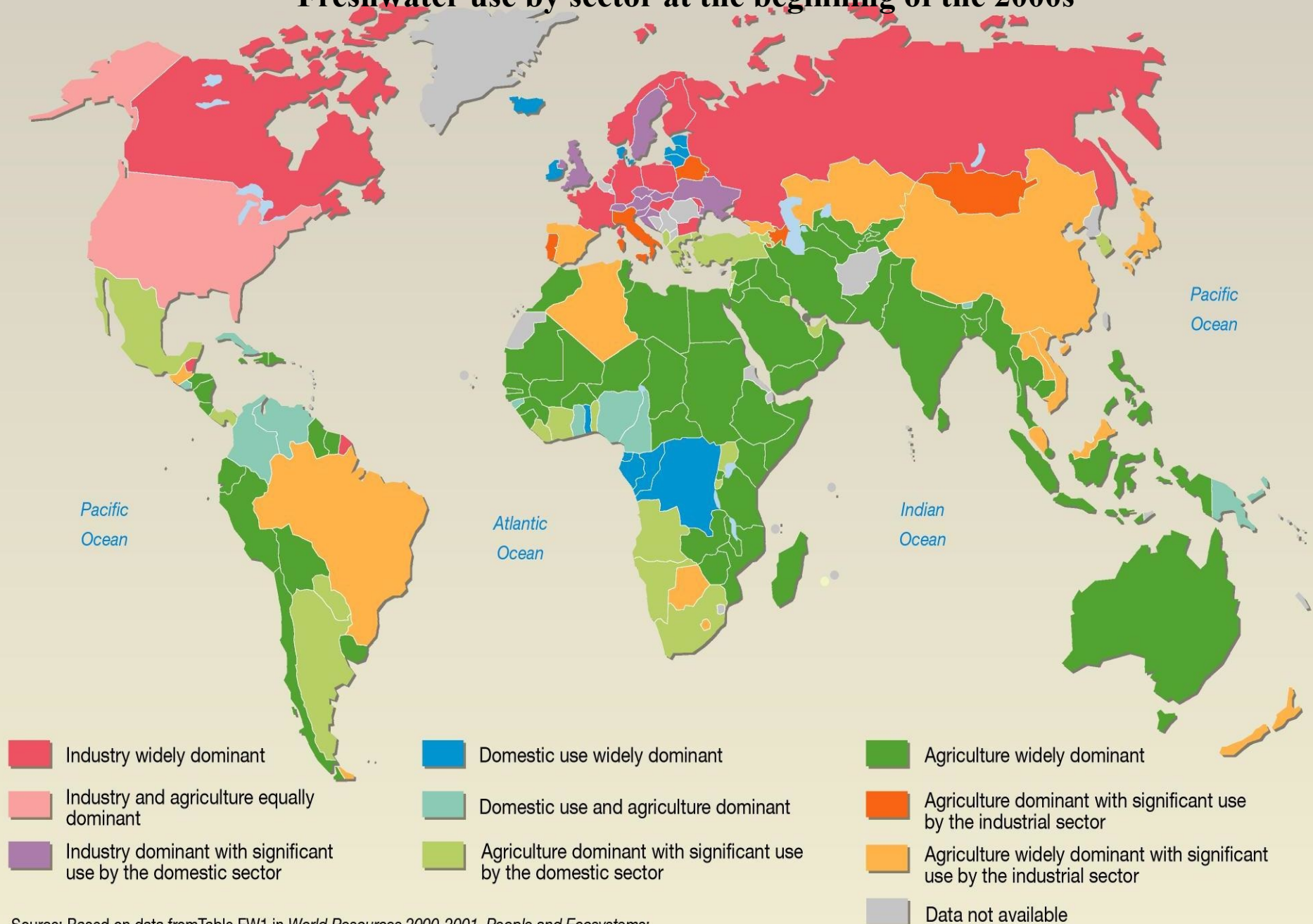
The map shows the extent of fragmentation, or interruption of natural flow, caused by human intervention in 227 large river systems

New Dams under Construction by Basin, 1998



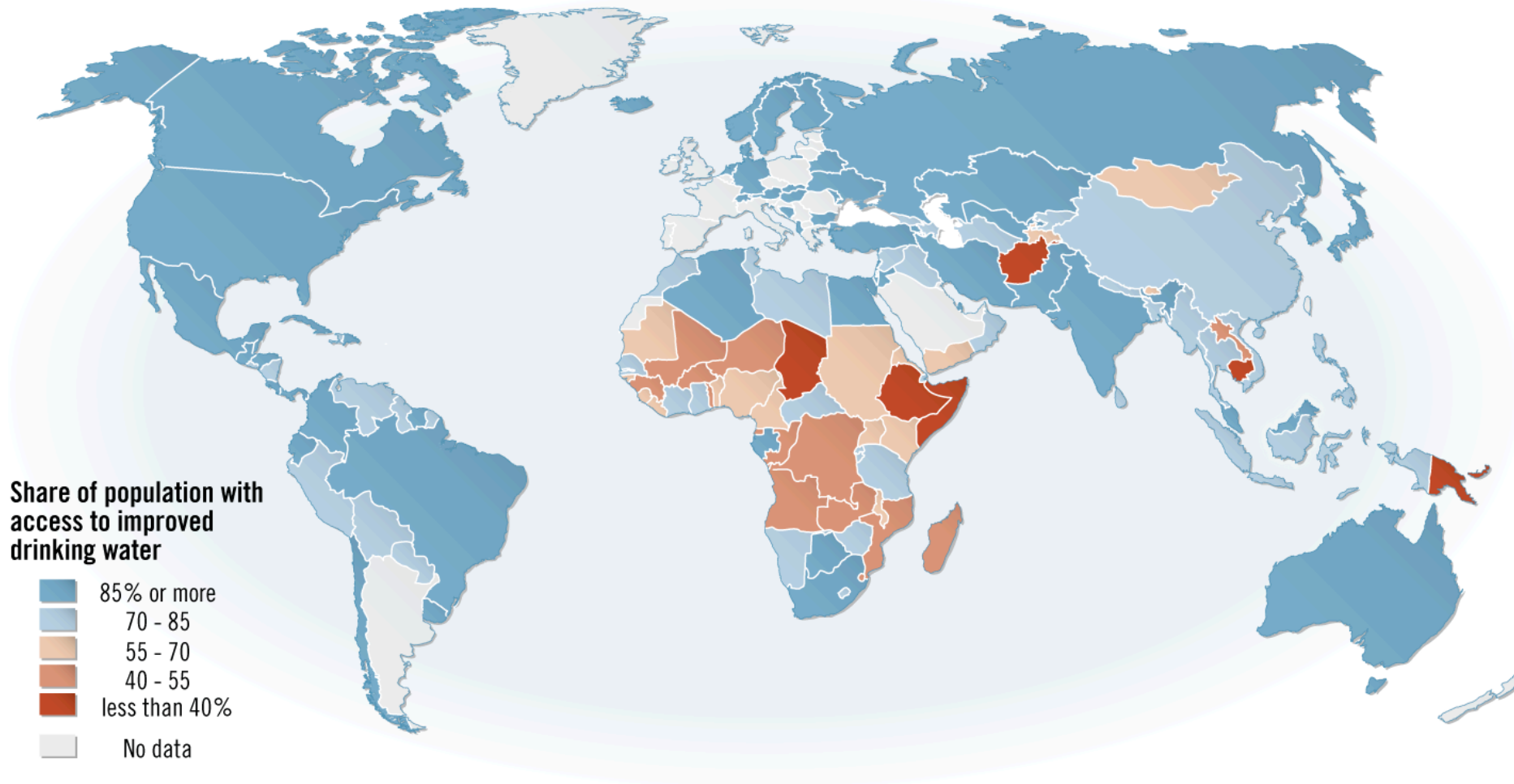
Dams slow the rate of natural flow, thereby increasing sedimentation and lowering levels of dissolved oxygen.

Freshwater use by sector at the beginning of the 2000s

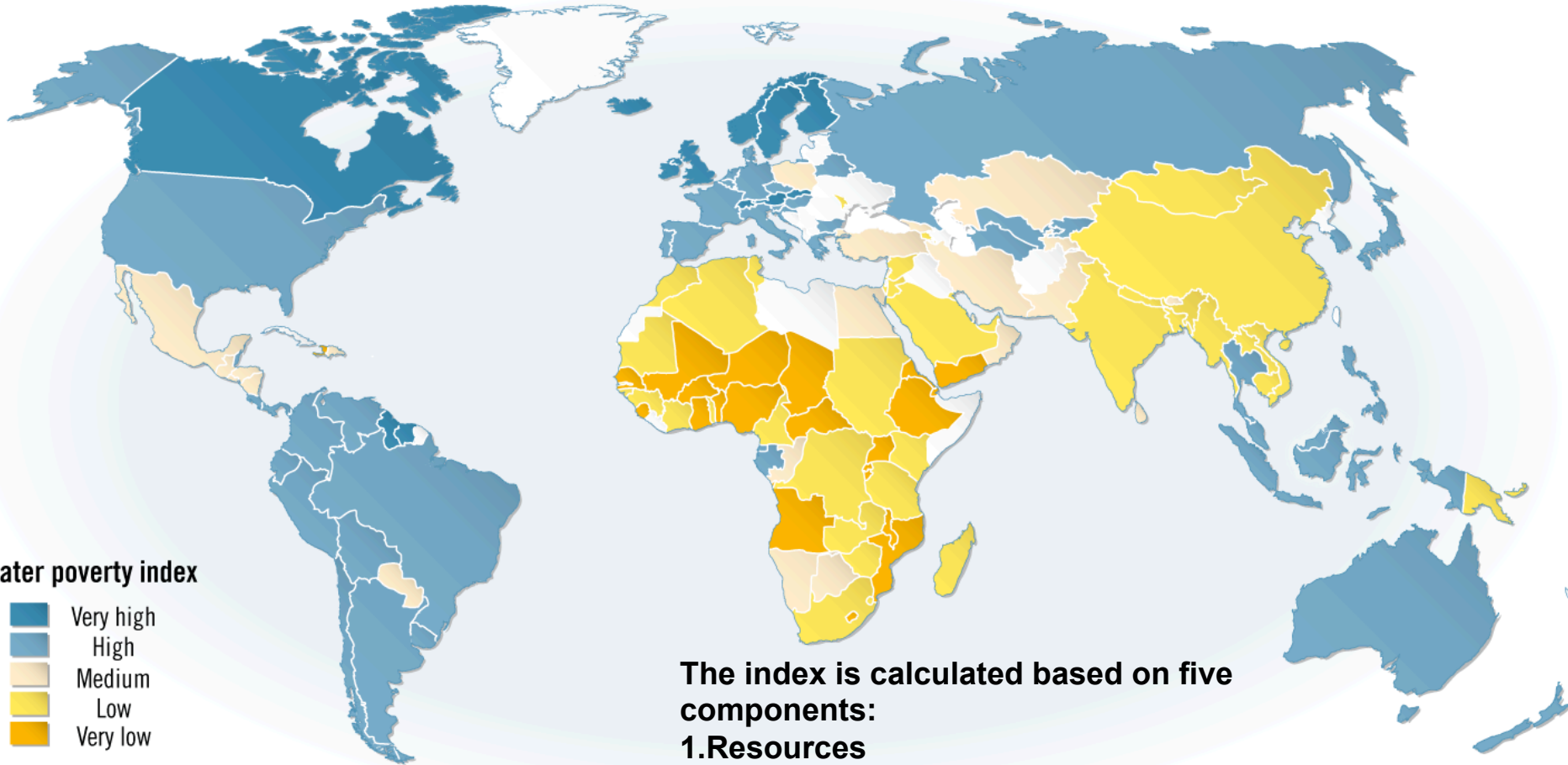


Source: Based on data from Table FW1 in *World Resources 2000-2001, People and Ecosystems: The Fraying Web of Life*, World Resources Institute (WRI), Washington DC, 2000.

Access to Safe Drinking Water



Water Poverty Index

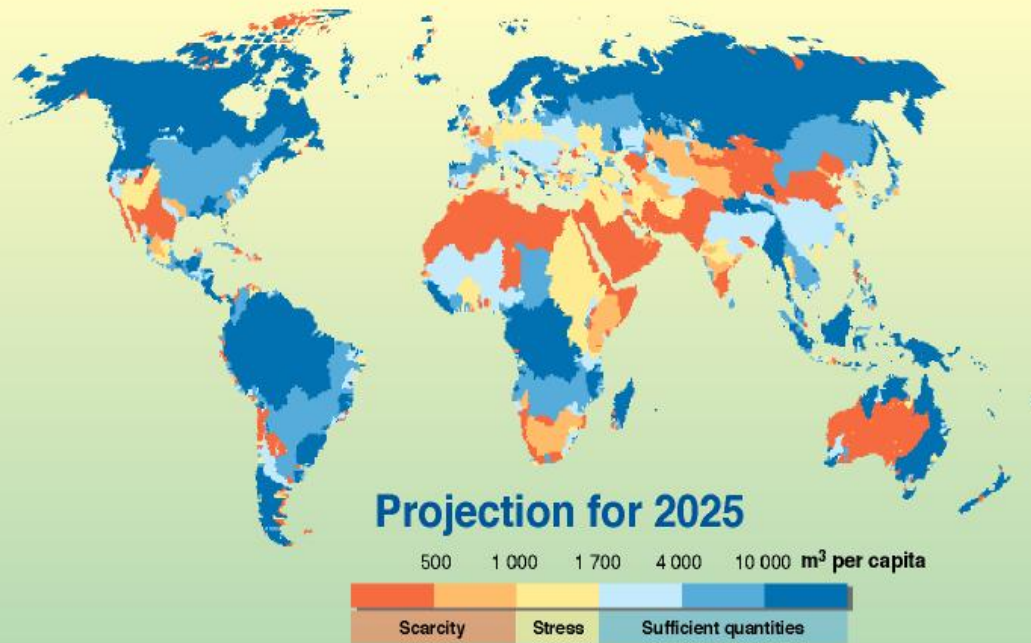
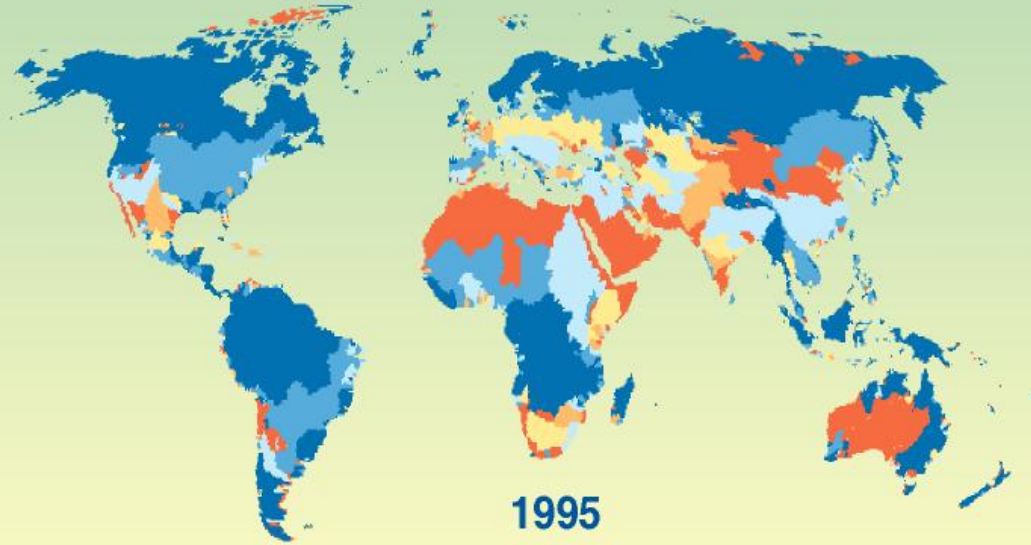


The index is calculated based on five components:

1. Resources
2. Access
3. Capacity, use
4. Environment

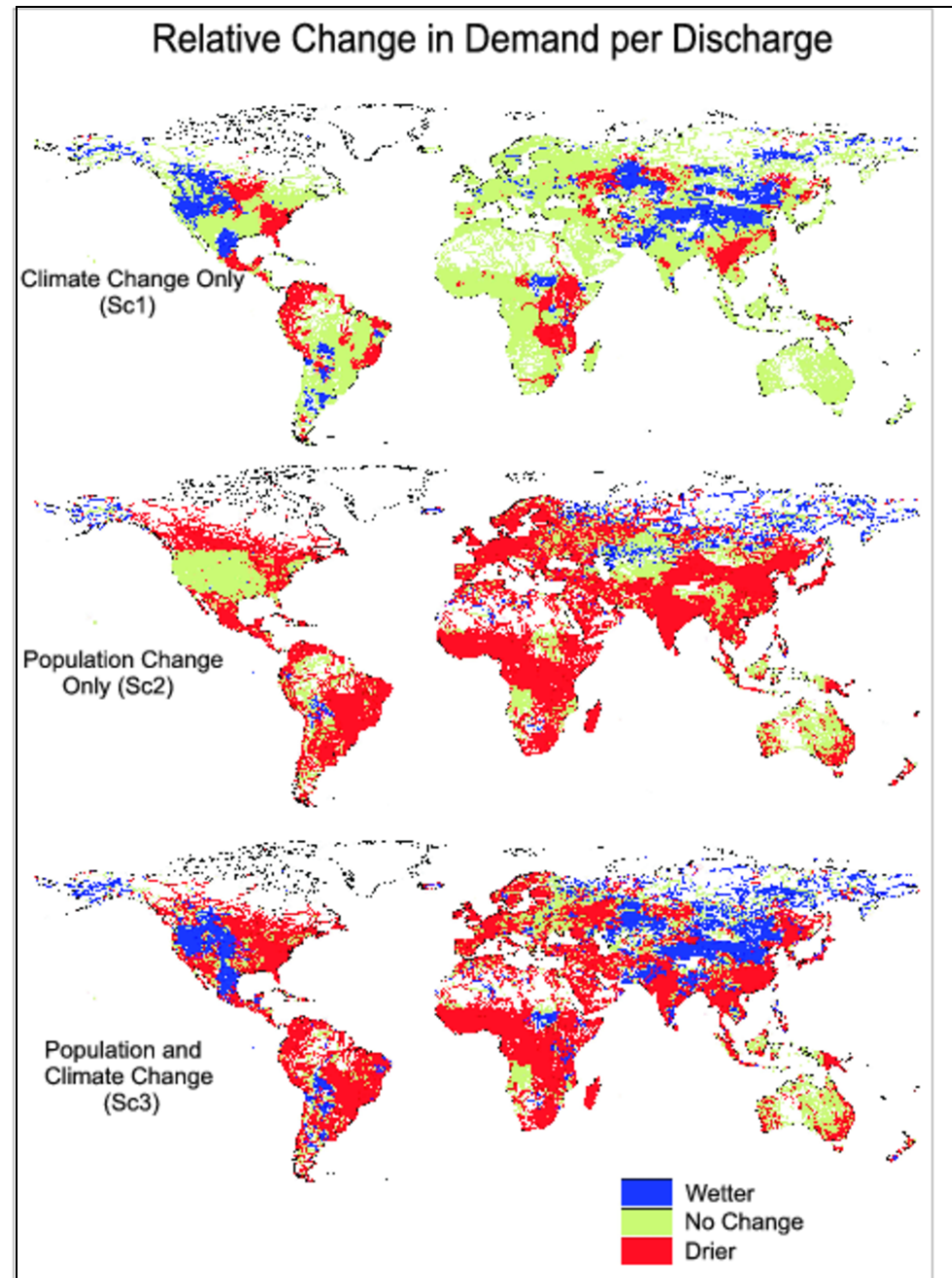
The World's Freshwater Supplies

Annual Renewable Supplies per Capita per River Basin



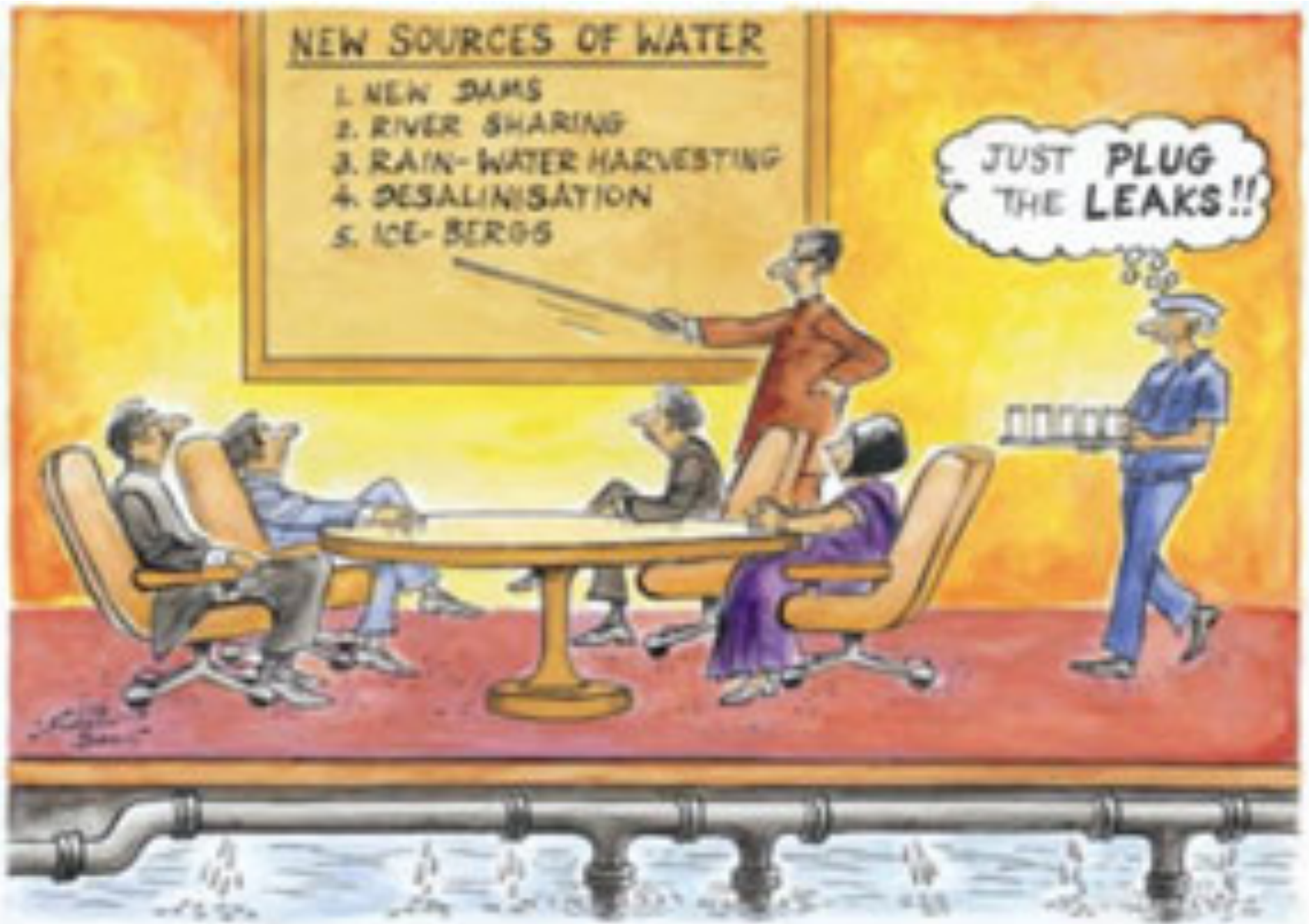
Water Stress Changes to 2025

- 80% of future stress from **population & development**, not **climate change**!
- Future distortions of the water cycle are inevitable
- High resolution operational mapping of water stress important to food, health, international security



Water Resource Management

- **World Bank:** Water Resources Management is the integrating concept for a number of water sub-sectors such as hydropower, water supply and sanitation, irrigation and drainage, and environment.
- An integrated water resources perspective ensures that social, economic, environmental and technical dimensions are taken into account in the management and development of water resources.
- The decision-making, manipulative and nonmanipulative processes by which water is protected, allocated or developed
- **Principles of Water Resources:** Historical, development, management and policy arenas surrounding water resources



Other Global Issues...