Socioeconomic Development Paths and their implications for Water Resources, Agricultural, and Environmental Systems

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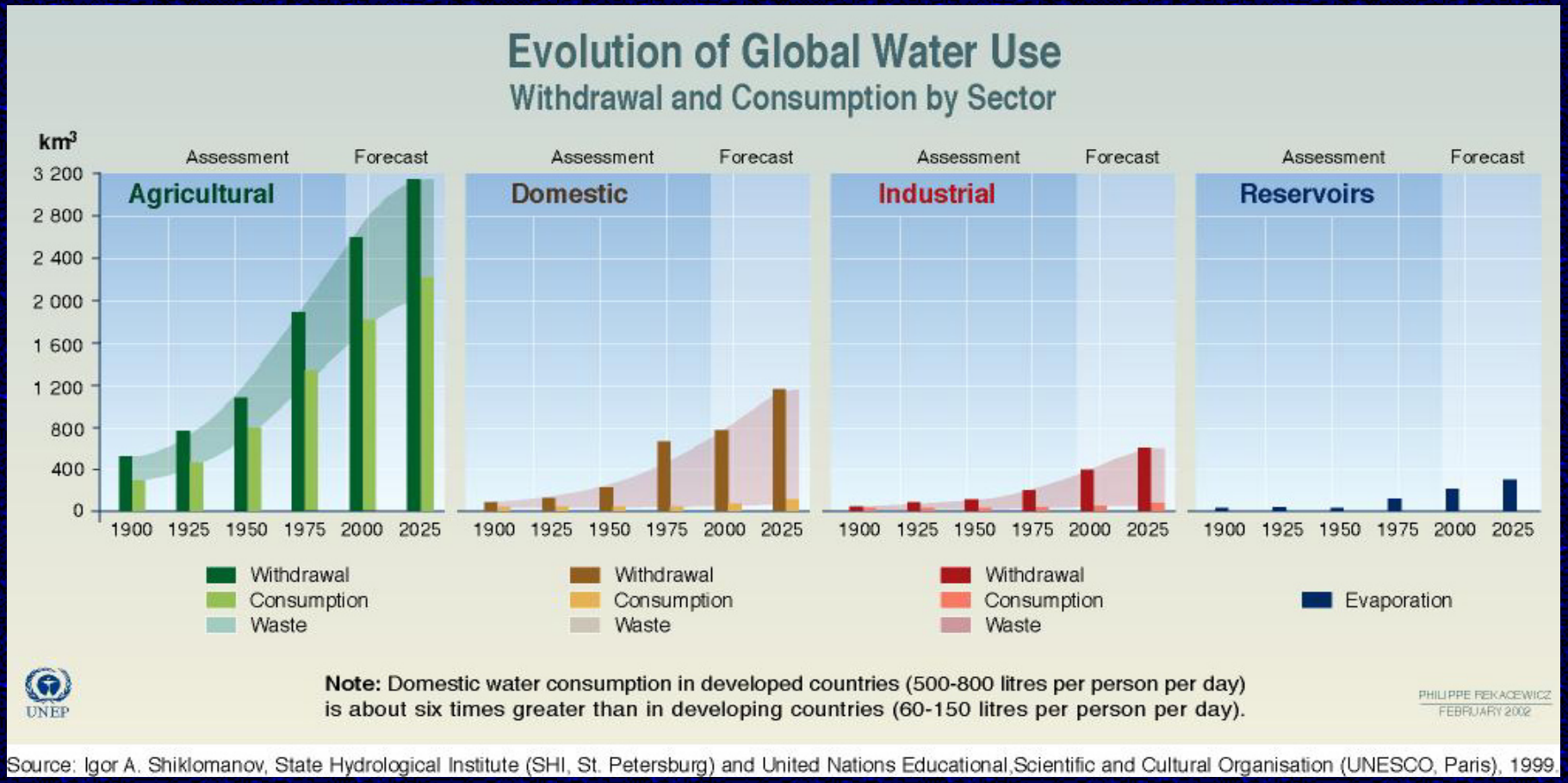
Elements of the Water System

- The Hydrologic System
  - Climate and Land Use
- The Managed Water Supply System
- Water Demand
  - Aquatic Ecosystem
  - Market Activities
  - Human Health
  - Non-Market Activities
- Excess Water/Flooding
- Role in Economic Development

Trends in Global Water USE



Source: Igor A. Shiklomanov, State Hydrological Institute (SHI, St. Petersburg) and United Nations Educational,Scientific and Cultural Organisation (UNESCO, Paris), 1999.

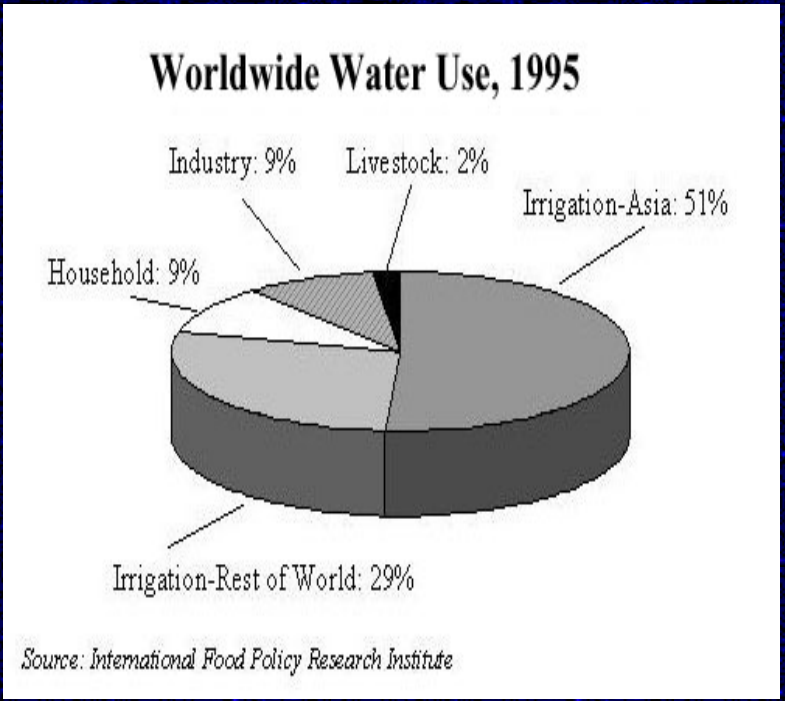
WATER FOR FOOD & NATURE

Article 2

"to ensure that food production is not threatened"

in light of:

- Population Growth
- Diet Change
- Resistance to Dams
- "allow ecosystems to adapt naturally"

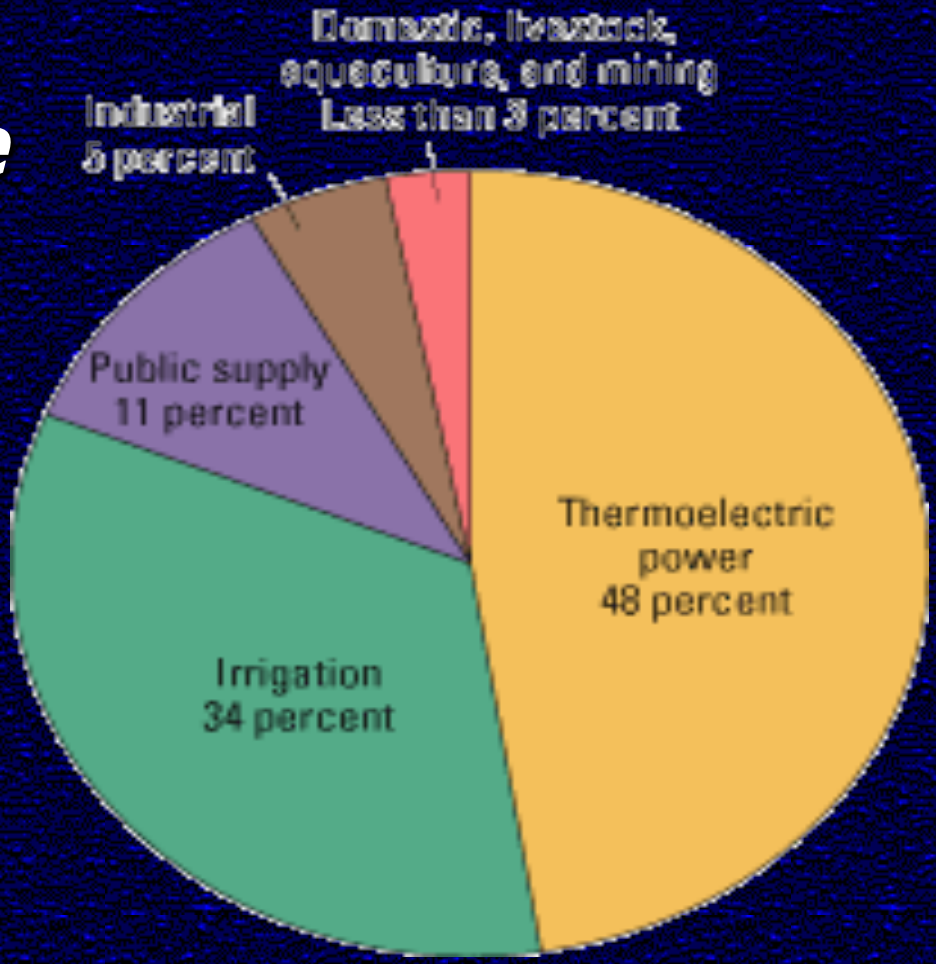


Energy Water Demands ?

- ***86 % East of Mississippi***
- ***Only 8% Consumed***

- ***EPA Best Practice***
  - ***Recirculation***
  - ***Dry cooling feasible***

High Capital and Operating cost to Move to Rec/Dry



The Future Water Issues?

- ***Future Water Demands are driven by***
  - ***Economic Development***
  - ***Population Growth***
  - ***Technology***
  - ***Policy***
- ***Extremely uncertain***
- ***Protection of Population and Infrastructure from Floods***

Uncertain Economic Growth

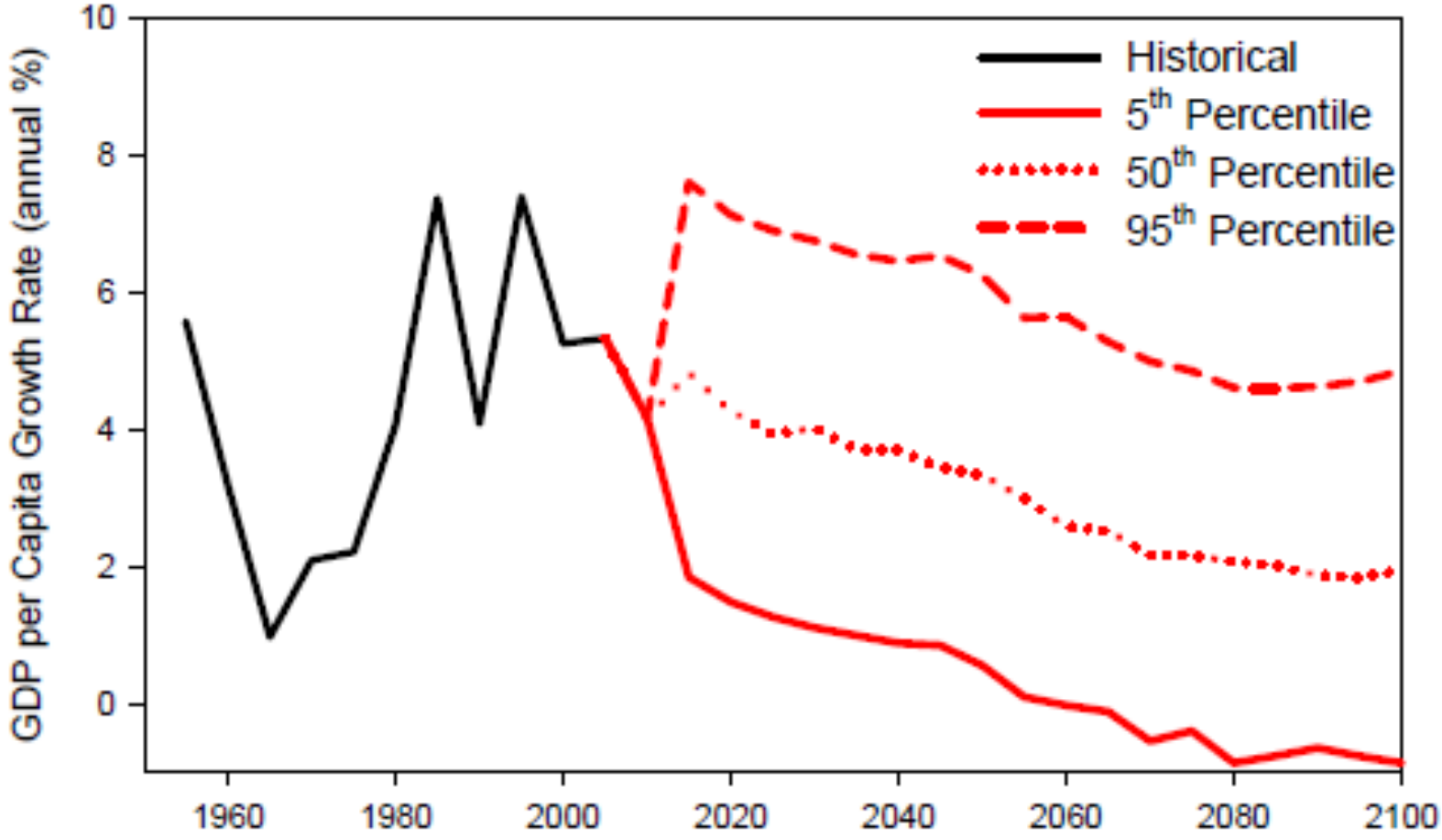


Figure A10. GDP per capita growth rates for China (CHN).

Uncertain Population Growth

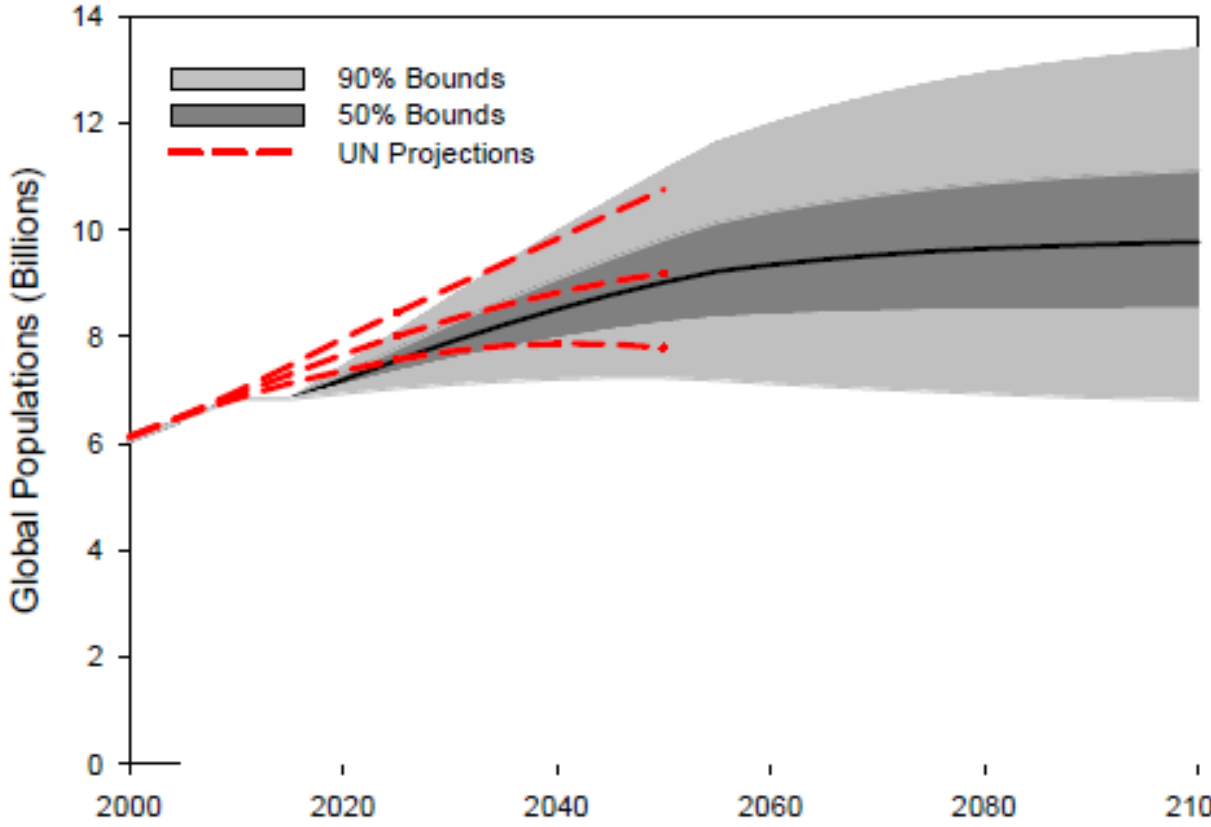
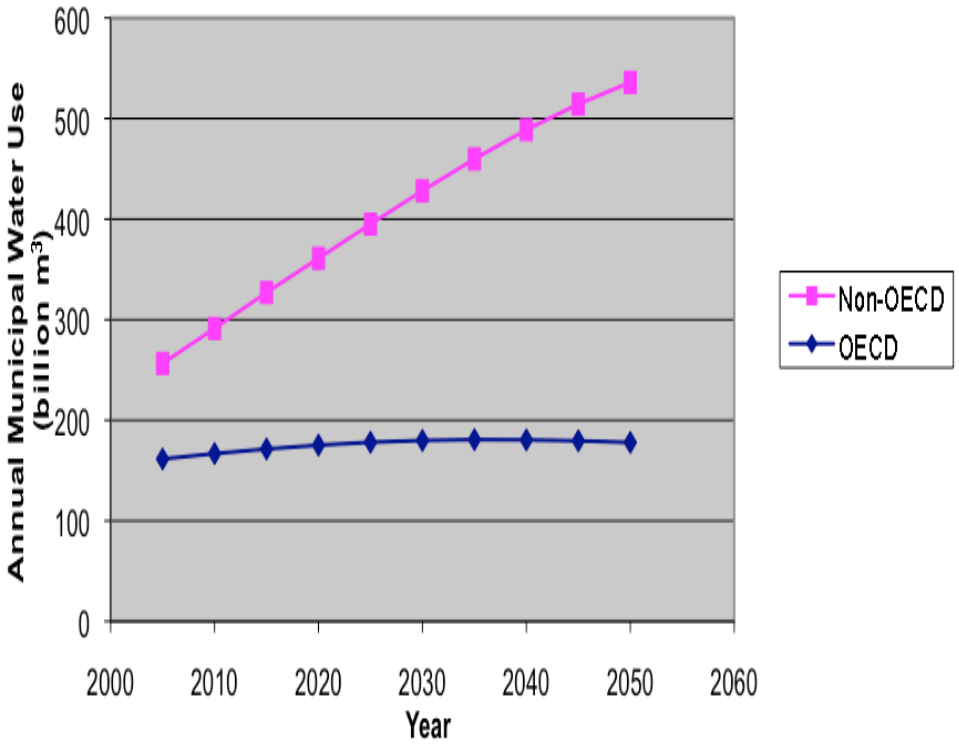
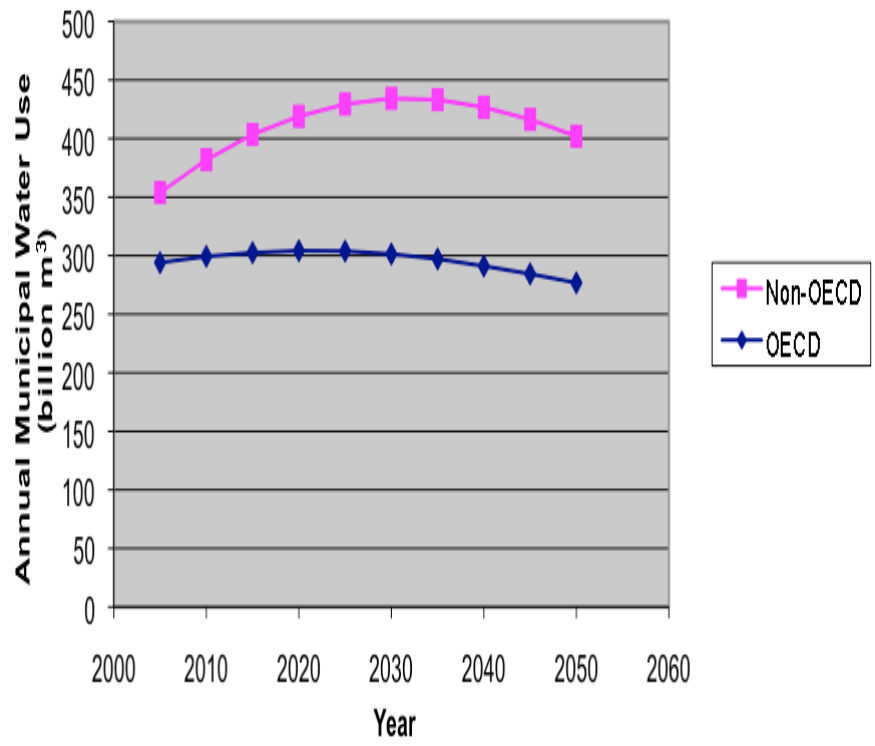


Figure 4. Shaded regions show the 50% (darker) and 90% (lighter) ranges of the EPPA population projections to 2100, and lines show the UN population projections to 2050 (source: UN, 2007).

Municipal and Industrial Demands

Municipal Water Use **2005 to 2050** **Industrial Water Use**





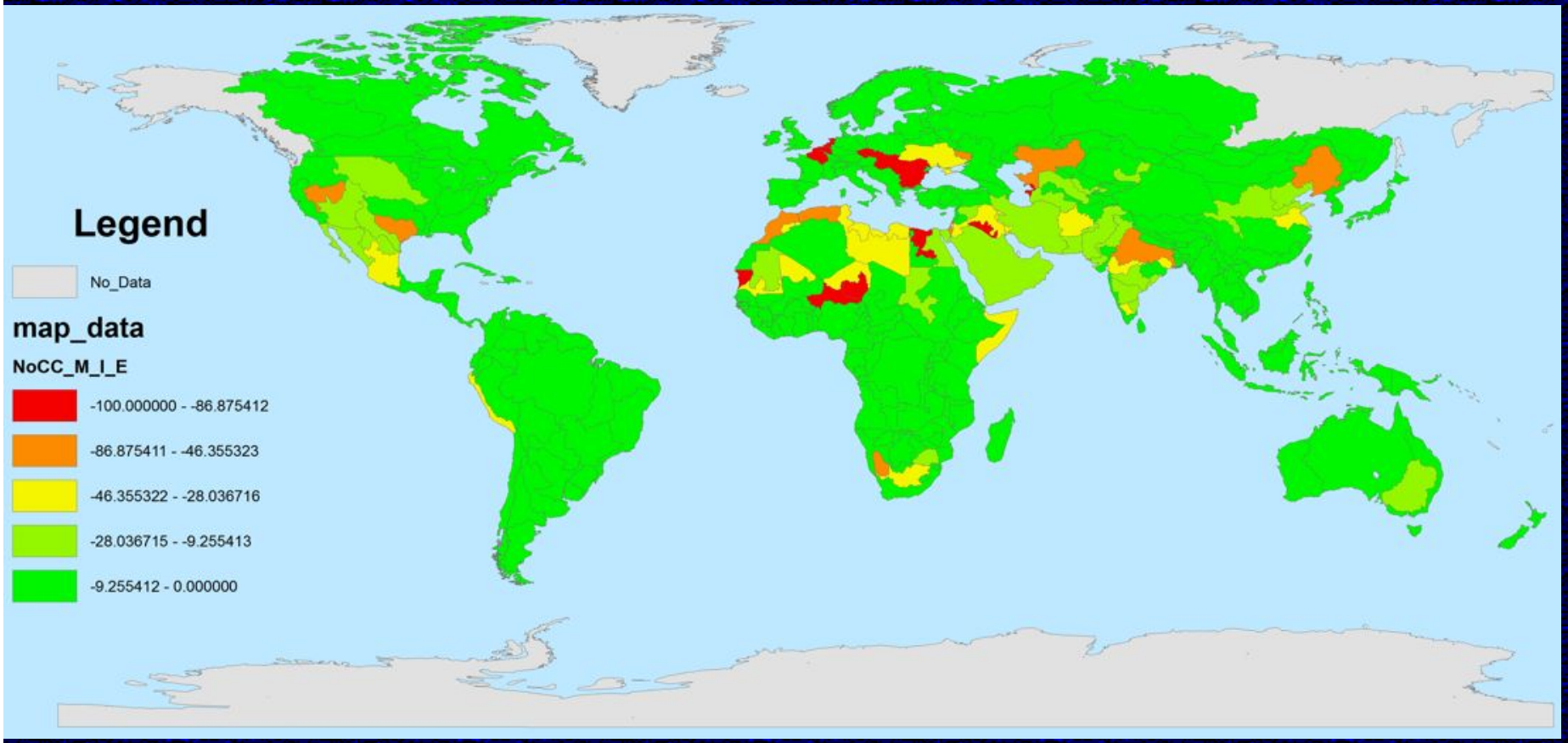
Energy Water Important Locally but Cooling Towers and Dry Cooling Viable Options at a COST

Environment Flows a major Water use

Preserving and Restoring water for:

- Wetlands (Sudd, Okavango, Everglades)
- Delta (Indus, Yellow, Colorado)
- In-stream fish- Low (Klamath River Basin)
- Fish Habitat – Floods – Colorado River
- Restoring natural flow variability

Threats to Existing Ag Water



Threats to Existing Ag Water

Foresight Region	2000 Agricultural Withdrawals (billion m^3)	No Climate Change		
		2050 M&I	EFRs	2050 M&I and EFRs
World	**2,946**	**7.3%**	**9.4%**	**17.7%**
Europe	**263**	**2.5%**	**7.7%**	**14.4%**
European Union	95	0.7%	12.8%	18.7%
Northwestern Europe	16	4.5%	11.7%	8.2%
United Kingdom	0.6	0.0%	0.0%	0.0%
Former Soviet Union	186	3.2%	10.0%	19.7%
Africa	**246**	**9.8%**	**5.8%**	**15.8%**
Sub-Saharan Africa	50	11.9%	7.2%	16.4%
Nile River Basin	146	9.1%	0.2%	9.2%
North America	**255**	**-0.1%**	**15.2%**	**14.9%**
Asia	**2,060**	**8.8%**	**8.9%**	**18.6%**
China	558	2.7%	7.3%	10.1%
India	866	13.5%	12.1%	27.7%
Latin America and the Caribbean	**182**	**3.8%**	**12.3%**	**16.1%**
Brazil	21	0.0%	0.0%	0.0%
Oceania	**50**	**0.2%**	**14.3%**	**14.5%**

Geographical Conflict for Water

Ag Upstream – Other Downstream

The New York Times

Meeting the Food Demand in 2050

- Food Demand with Double by 2050
- Irrigation Accounts for 40+% of Grains grown on 16% of Crop Lands
- Increased Production, expand Cropland
  - Expansion of More Irrigated Land and more Dams
  - Increase irrigation efficiency
  - Expansion of rainfed lands via: Deforestation ; Wetland draining, marginal lands
- Increased Production via Yield Increases
  - GMO Crops
  - Fertilizers and pesticides
  - Energy intensification
  - Large Commercials Farms

Food Security v. Food Self-Sufficiency vs. BIOFUEL

Maximizing Food Self-Sufficiency increases pressure to increase Production = Yields times Area

- Wetland destruction
- Degradation of Lands
- Deforestation
- Water Quality
- Environmental Flows
- Groundwater Mining

Summary Thoughts

to ensure that food production is not threatened"

While we "allow ecosystems to adapt naturally"

we can if we make

Investments in agricultural R&D, Extension, water mgt, desalination for M&I, on-farm technology, transport Infrastructure, human capacity building, and international trade.

Conclusion

- ***Scenarios of Drivers***
  - ***Economic Development***
    - ***Infrastructure Development***
  - ***Population Growth***
    - ***urbanization***
  - ***Technology***
    - ***dissemination***
  - ***Policy***
- ***Spatial and temporal Disaggregation very important***
- ***All these water demands are highly climate sensitive and path hard to separate from future climate scenariso***