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Reducing water scarcity possible by 2050: Linking global assessments to policy dimensions

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PCR-GLOBWB

WATER FUTURES and SOLUTIONS

WFaS

THE EARTH INSTITUTE COLUMBIA UNIVERSITY

COLUMBIA UNIVERSITY IN THE CITY OF NEW YORK

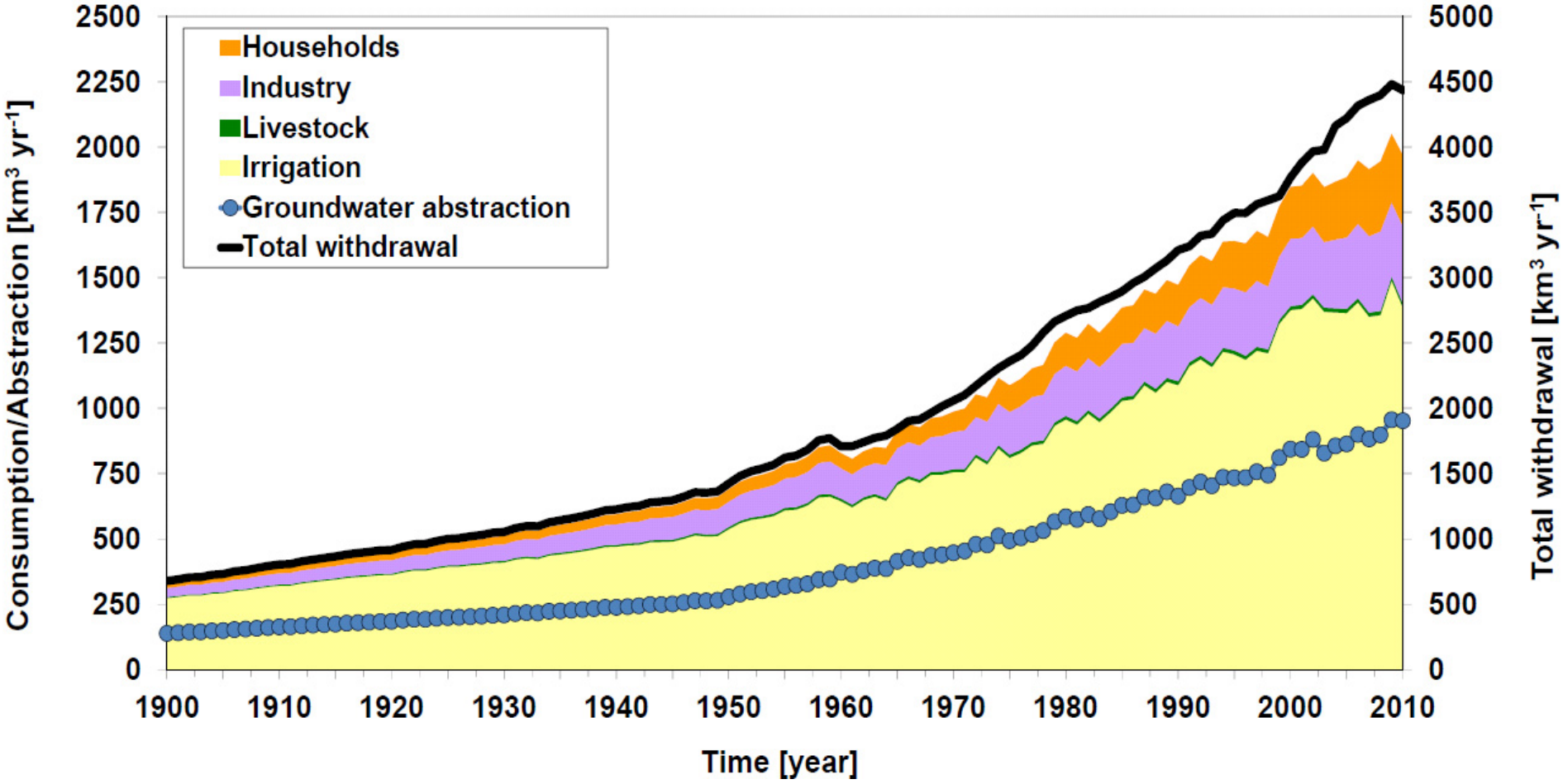
UNESCO United Nations Educational, Scientific and Cultural Organization

IIASA

ISI-MIP

NASA National Aeronautics and Space Administration Goddard Institute for Space Studies

Human Water Use
20th and Early 21st Century

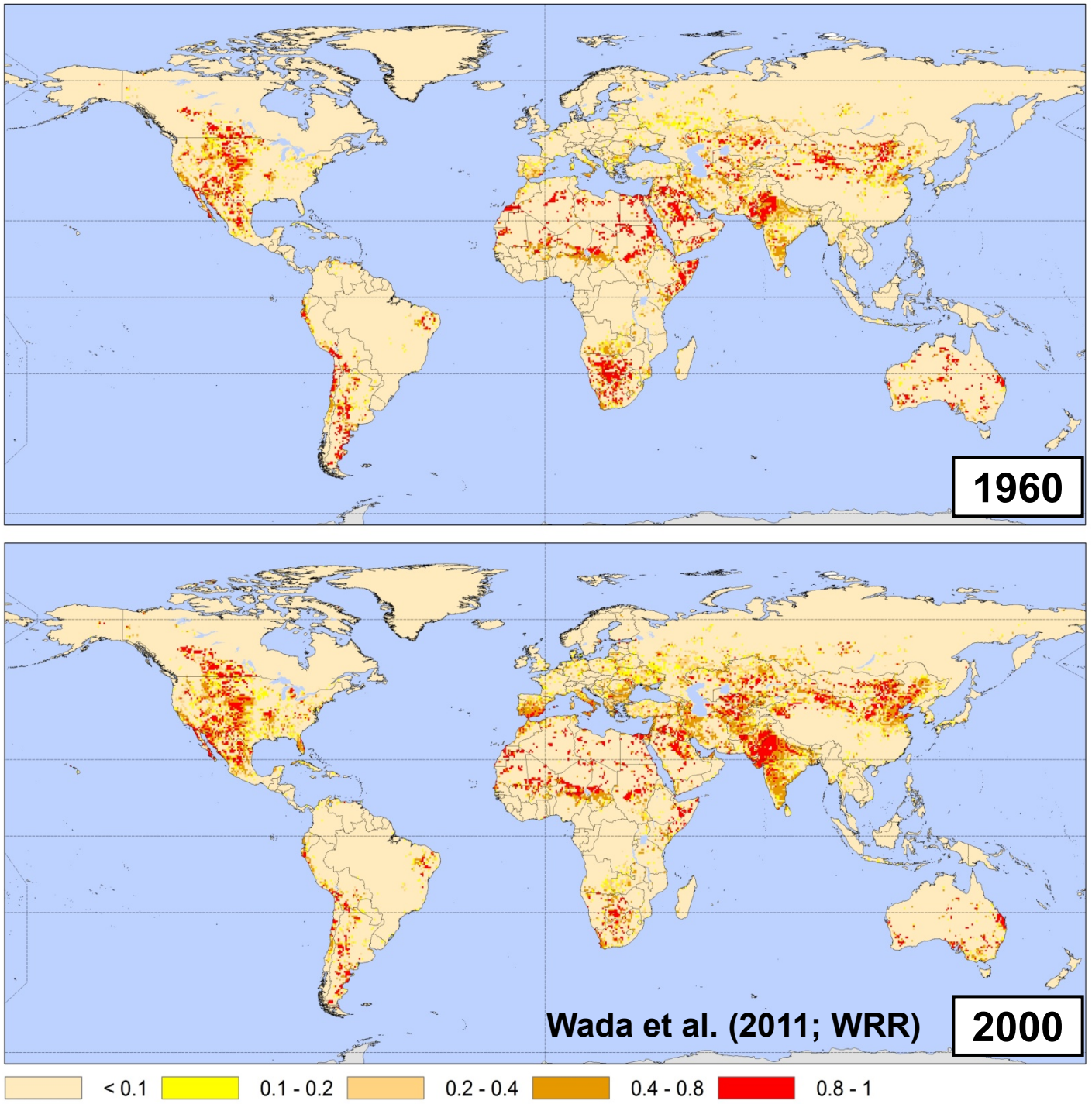


Water Scarcity Index

$$WSI = \frac{D}{A}$$

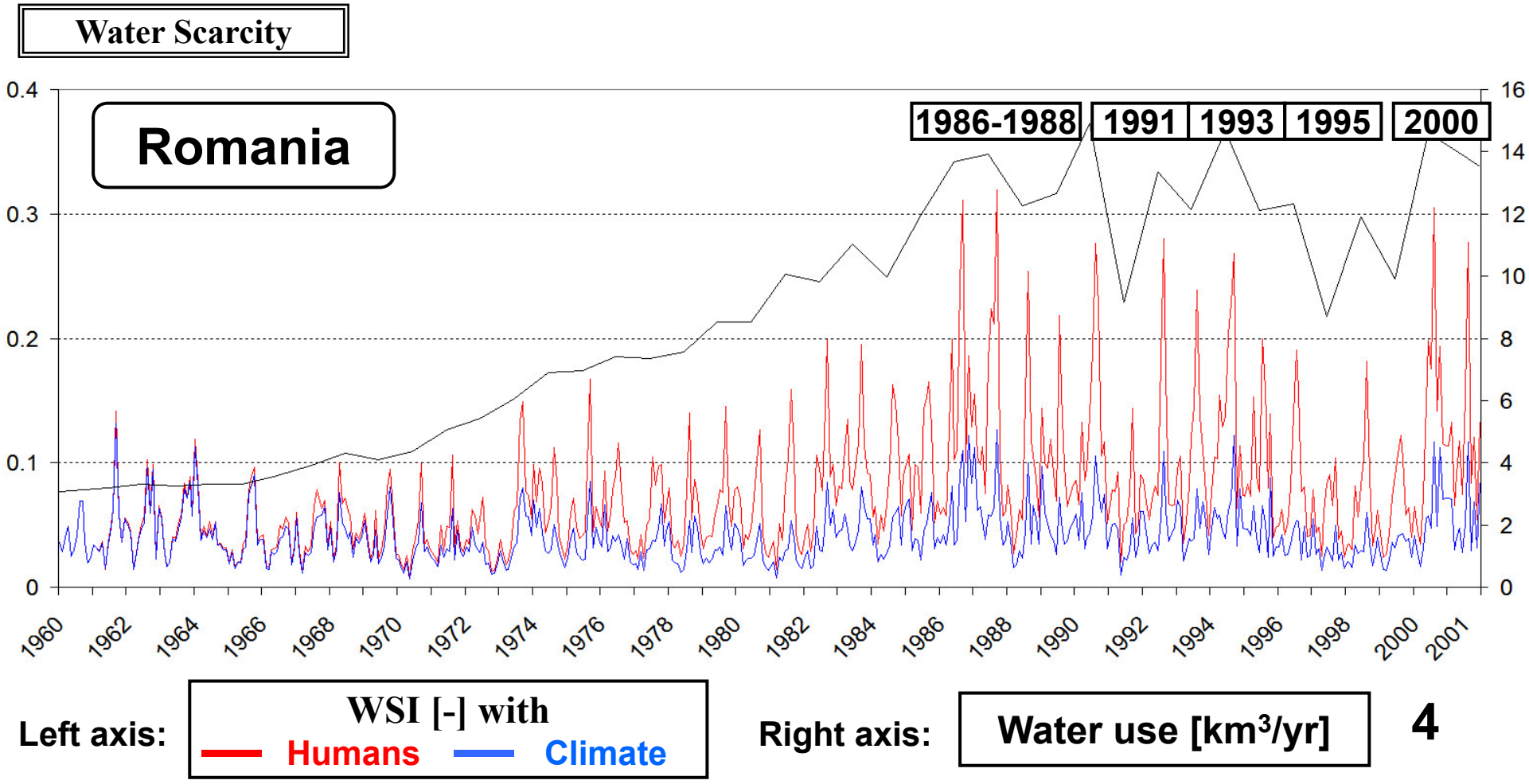
Global population under high water stress (WSI > 0.4)

Year	Billions (% of total)
1960	0.5 (17%)
1970	0.7 (19%)
1980	1.0 (23%)
1990	1.2 (23%)
2000	1.8 (30%)

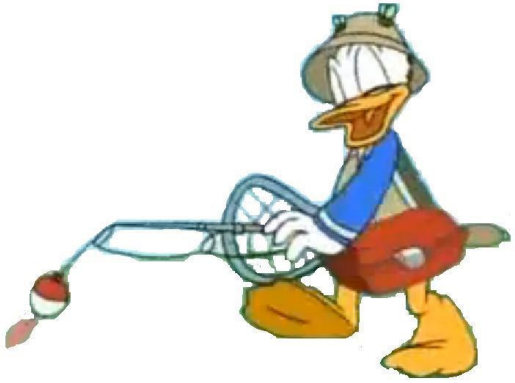


Human and Climate System

- Water use : Agriculture: 60%, Industry: 30% and Households: 10%
- Water scarcity since 1980s has been anthropogenically driven rather than climate induced.



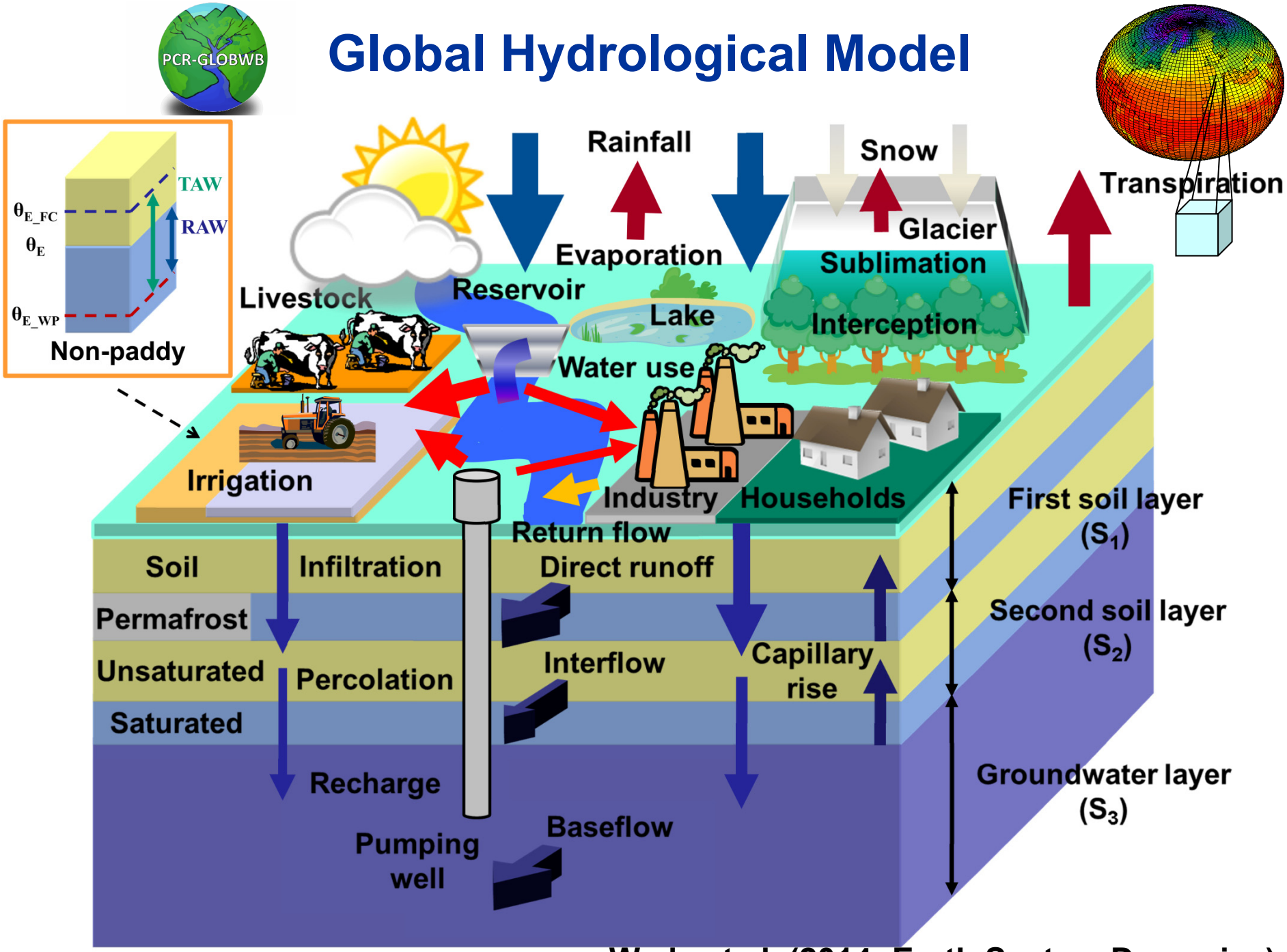
Is there enough water for all (humankind…)?



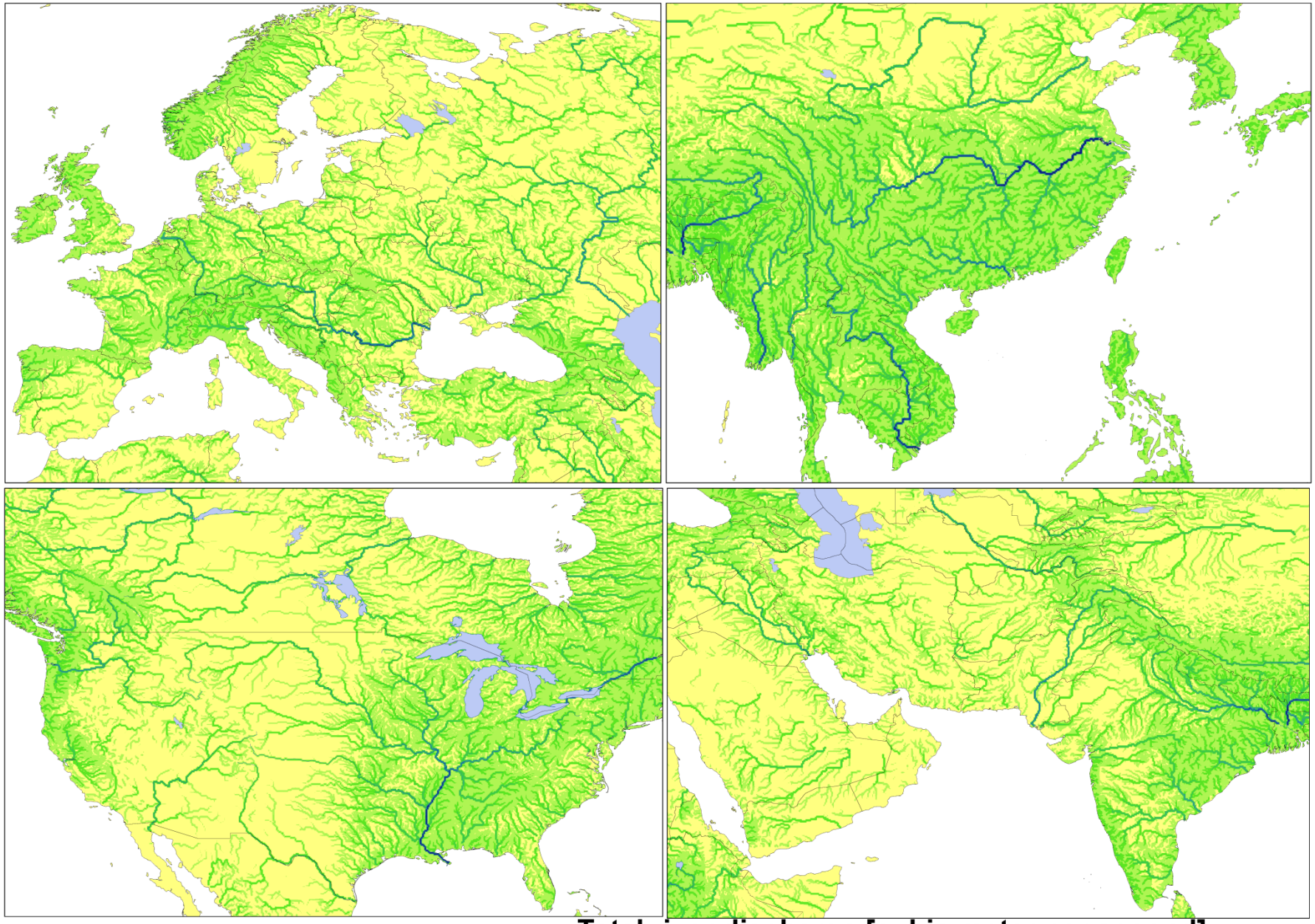
and

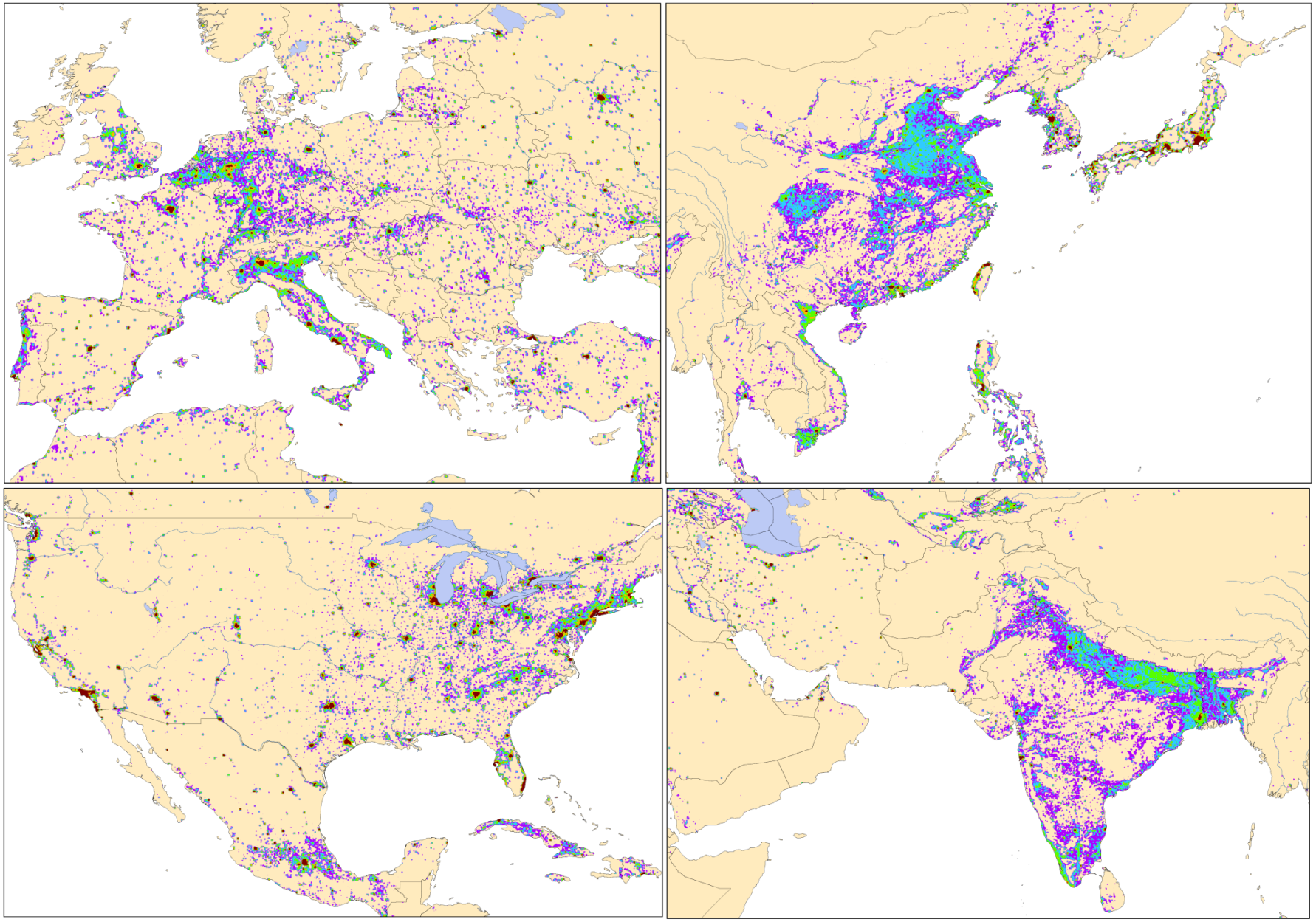
Will there be enough water?

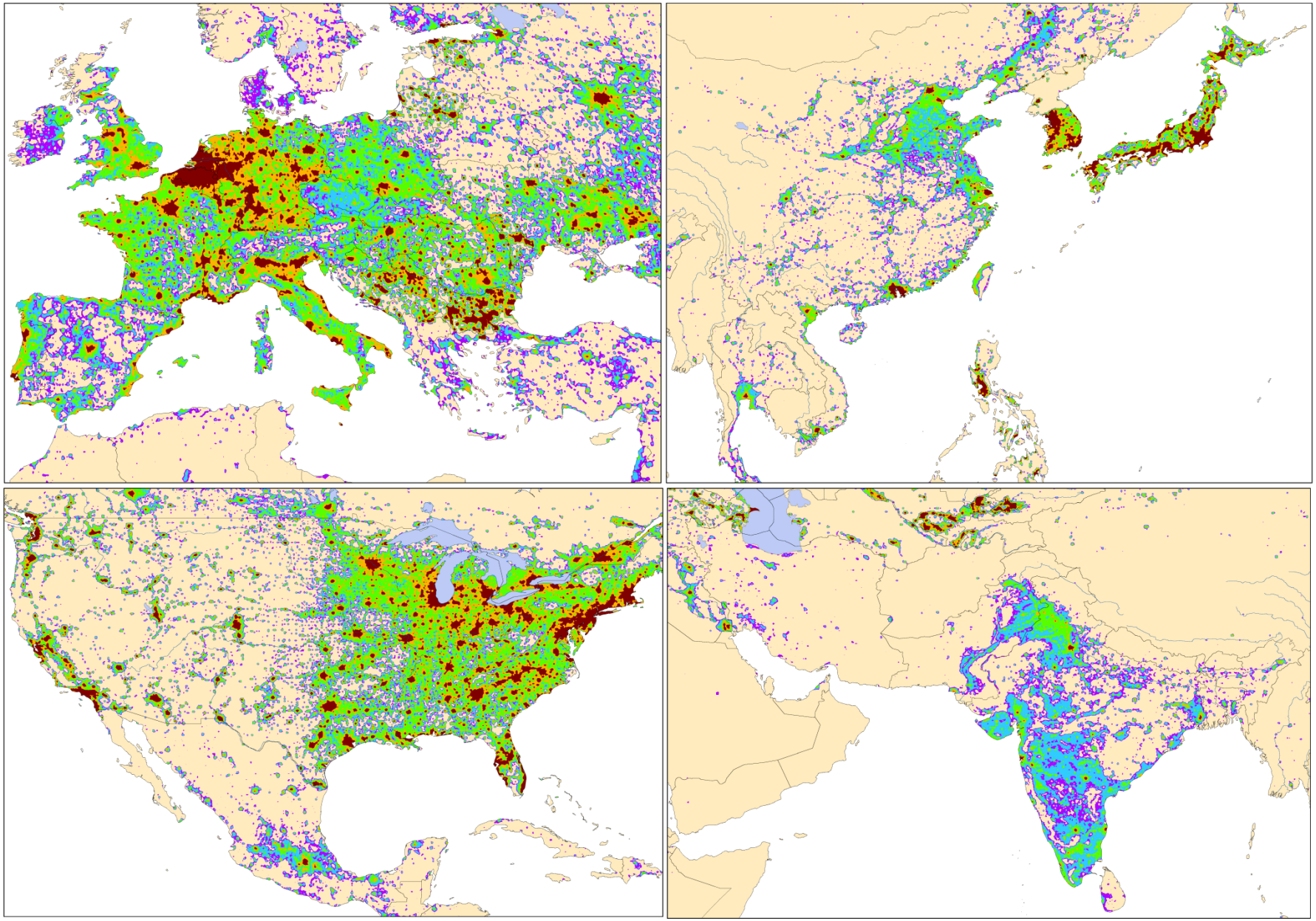
Global Hydrological Model

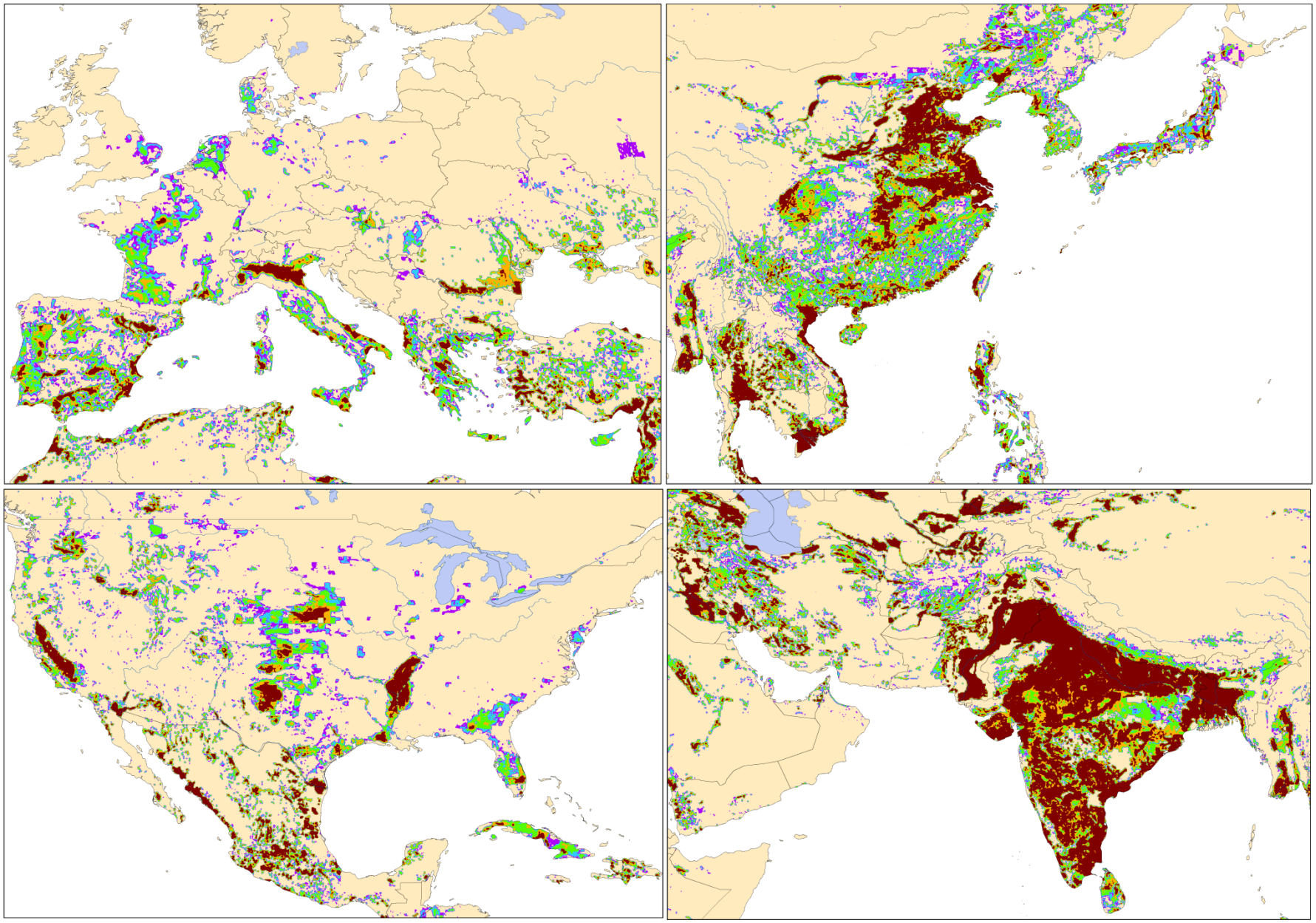


Wada et al. (2014; Earth System Dynamics)


Total river discharge [cubic meter per second]
0 - 1
1 - 10
10 - 100
100 - 1,000
1,000 - 2,500
2,500 - 5,000
5,000 - 10,000
> 10,000


Domestic water use [million cubic meter per year]
0 - 0.5
0.5 - 1
1 - 2
2 - 5
5 - 10
> 10


Industrial water use [million cubic meter per year]
0 - 0.5
0.5 - 1
1 - 2
2 - 5
5 - 10
> 10


Irrigation water use [million cubic meter per year]
0 - 0.5
0.5 - 1
1 - 2
2 - 5
5 - 10
> 10

Water Futures and Solutions (WFaS)

Consists of three major coalitions

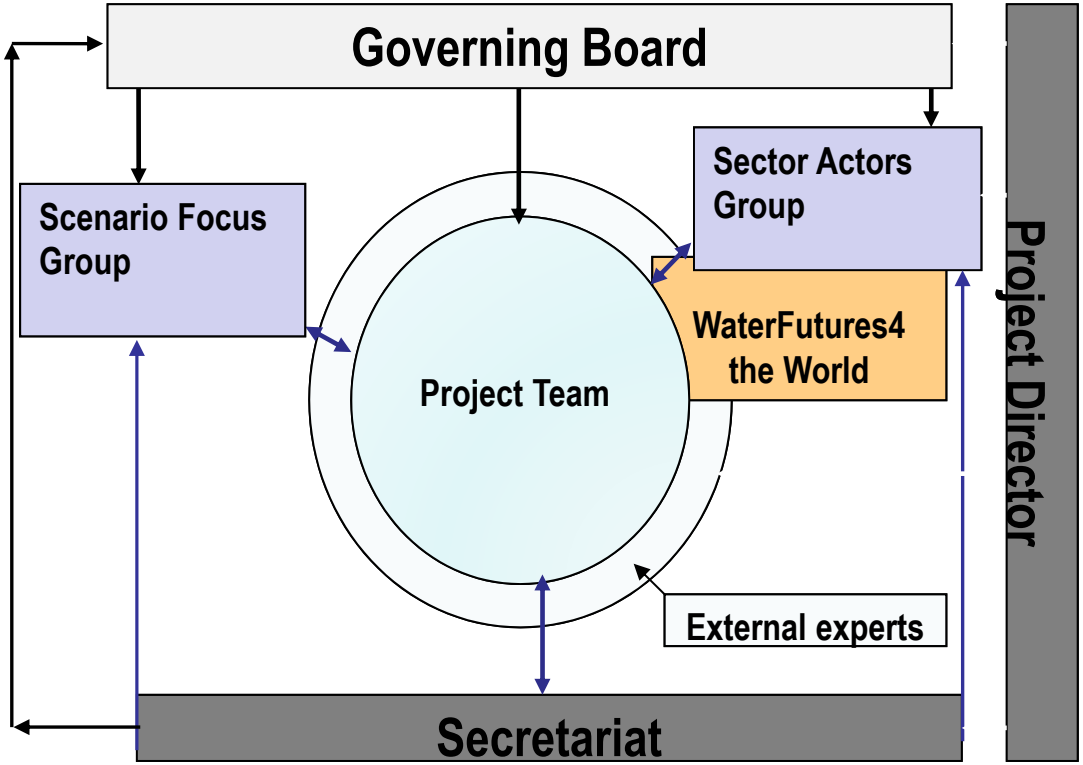
Sponsor Coalition

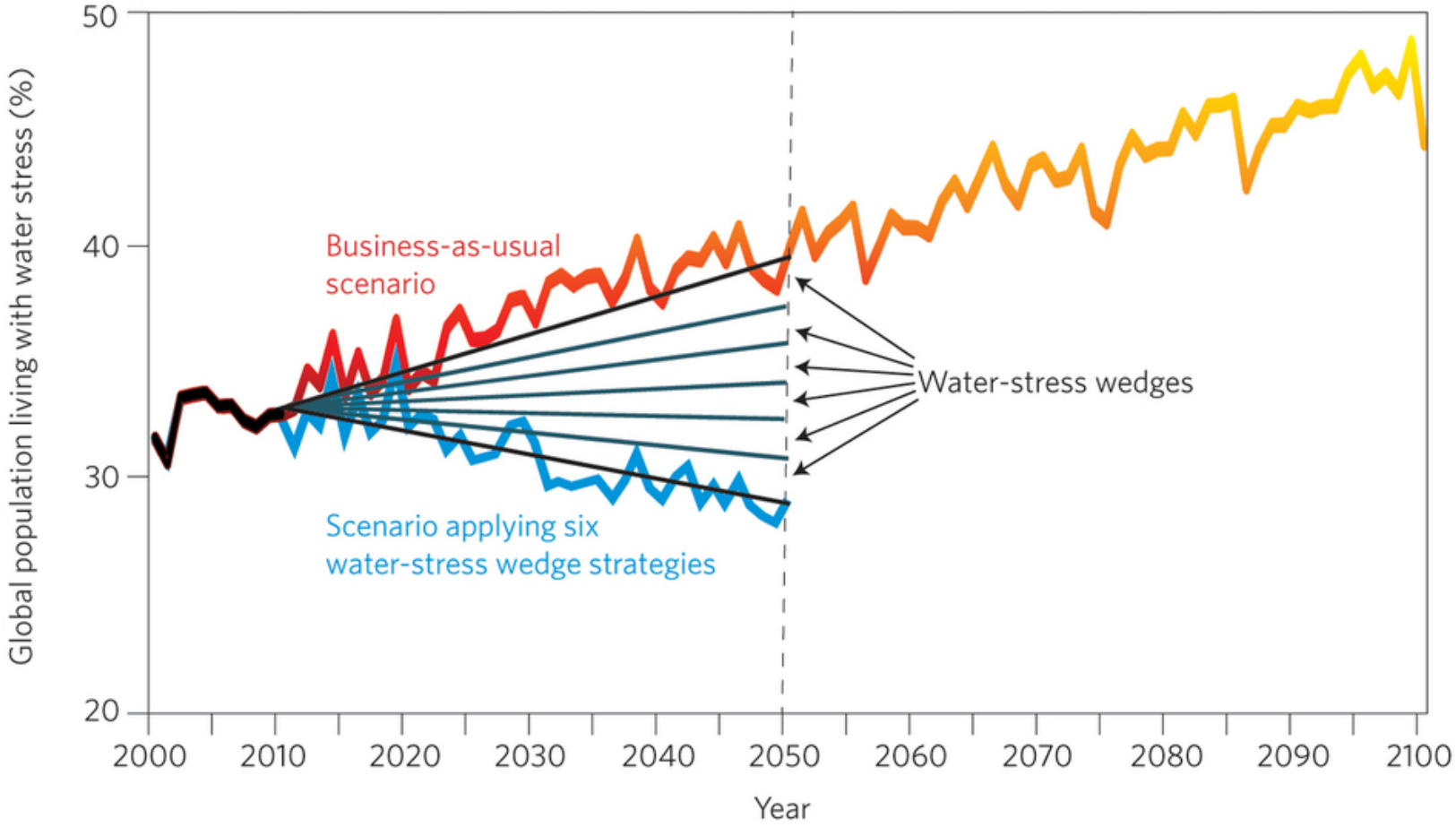
ensuring consistency & usefulness of outputs

Science Coalition

Stakeholder Coalition

Organized into the following groups





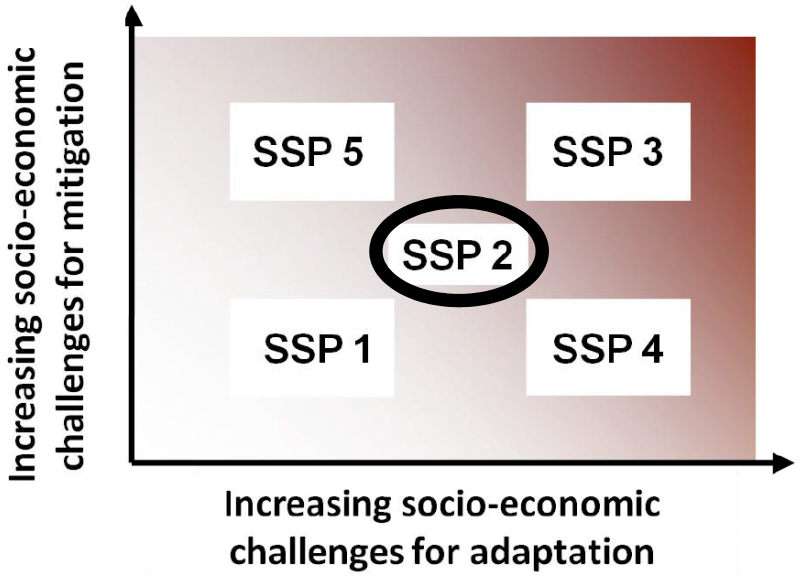
About 30% of the global population currently lives with water stress. This fraction may increase up to about 50%.

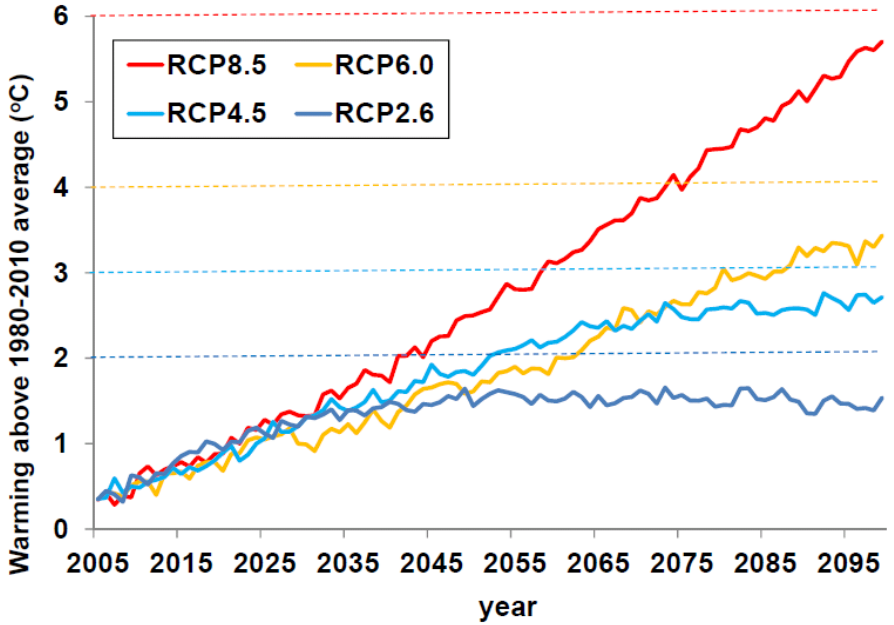
We present six strategies, or water-stress wedges, that collectively lead to a reduction in the population affected by water stress by 2050, despite an increasing population.

Wada et al. (2014), Nature Geoscience, doi:10.1038/ngeo2241

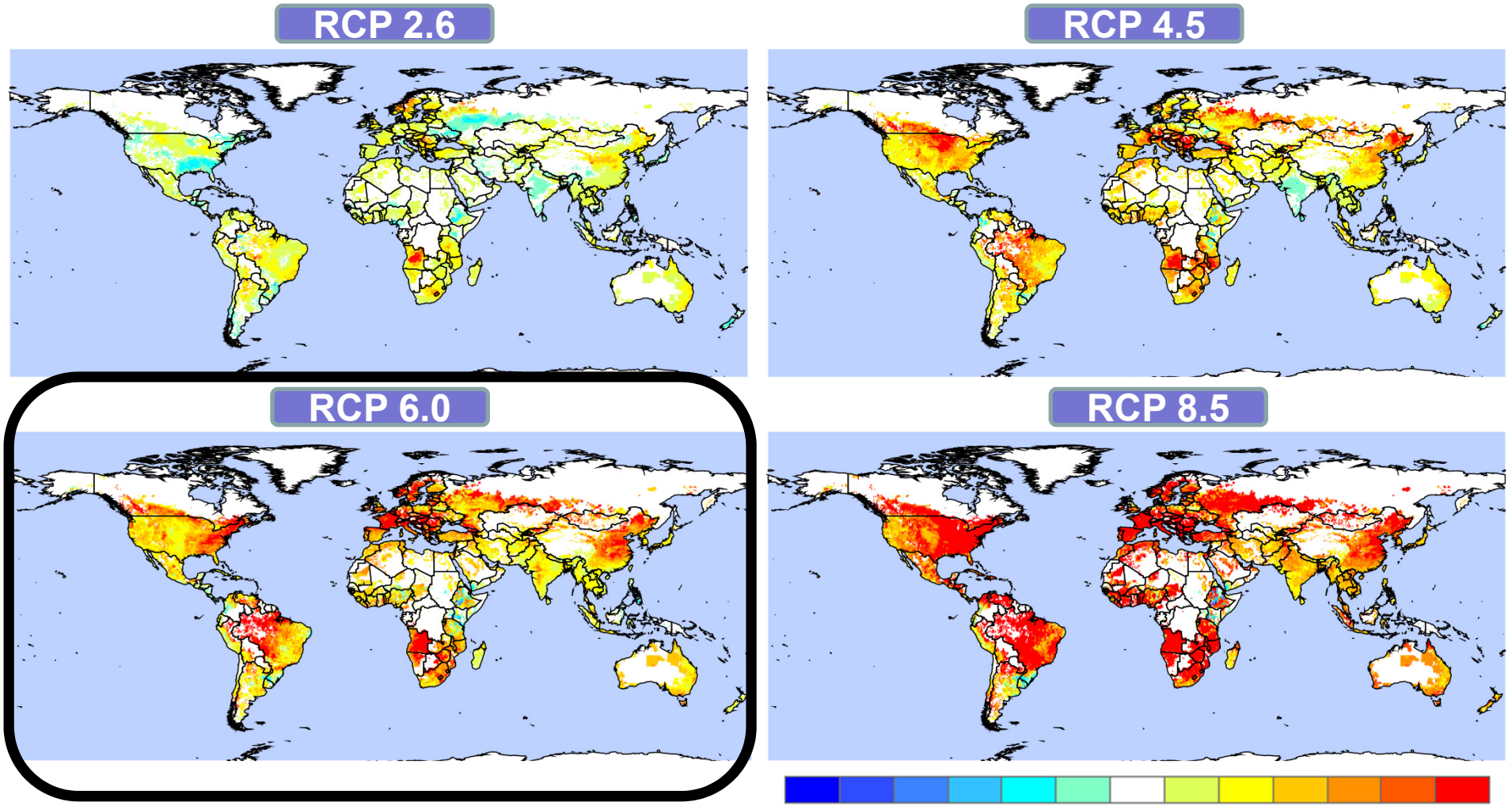
Future projections: Climate and socio-economic change

	Radiative forcing	CO_2 equivalent concentration	Rate of change in radiative forcing
RCP 8.5	8.5 W/m^2	1350 ppm	Rising
RCP 6.0	6.0 W/m^2	850 ppm	Stabilizing
RCP 4.5	4.5 W/m^2	650 ppm	Stabilizing
RCP 2.6	2.6 W/m^2	450 ppm	Declining





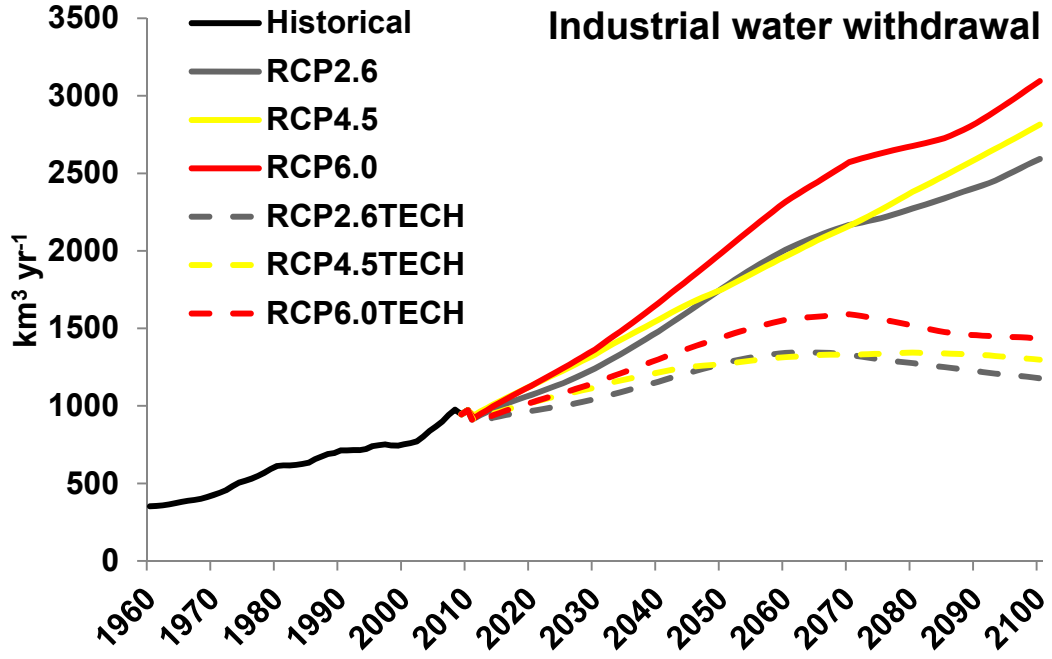
Global change in future irrigation water demand

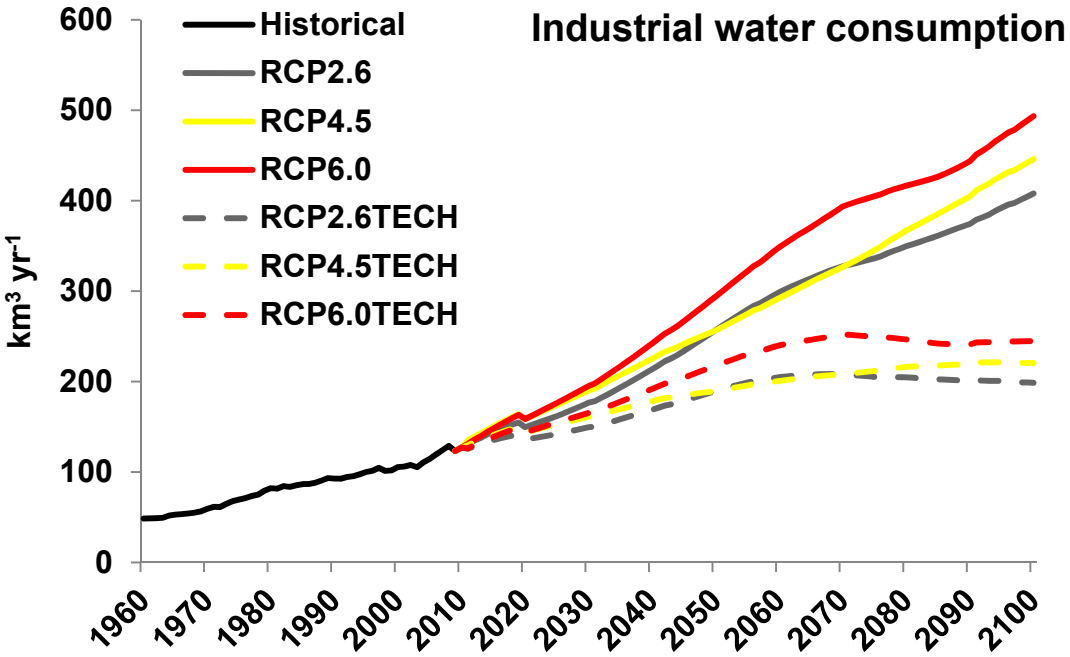


Relative increase compared to the present-day condition (2000), i.e. mean of 1980-2010

Wada et al. (2013; GRL)

Industry





Water use intensity

Reference year: 2010

1. Business-as-usual scenario

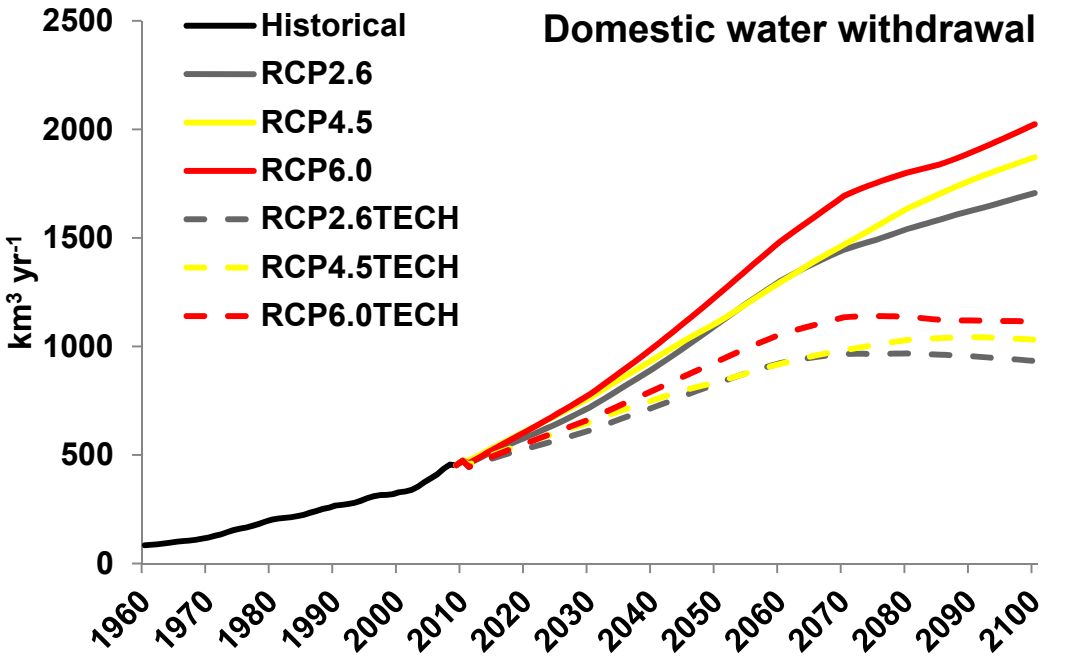
No improvement

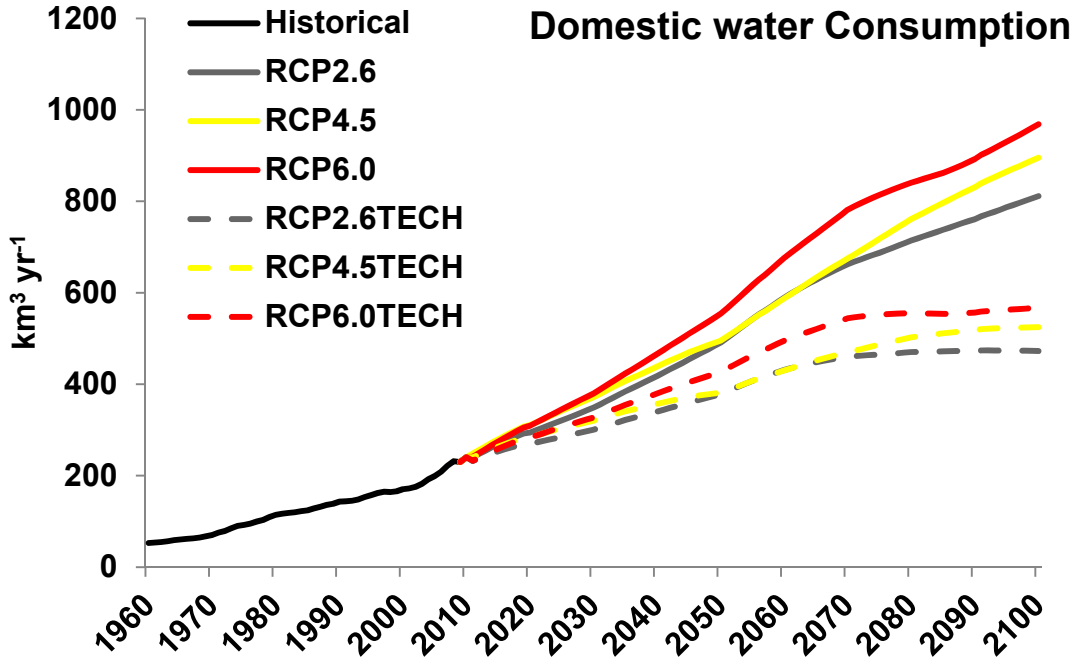
2. TECH scenario

An improvement based on energy consumption per unit electricity production

(energy consumption intensity)

Households





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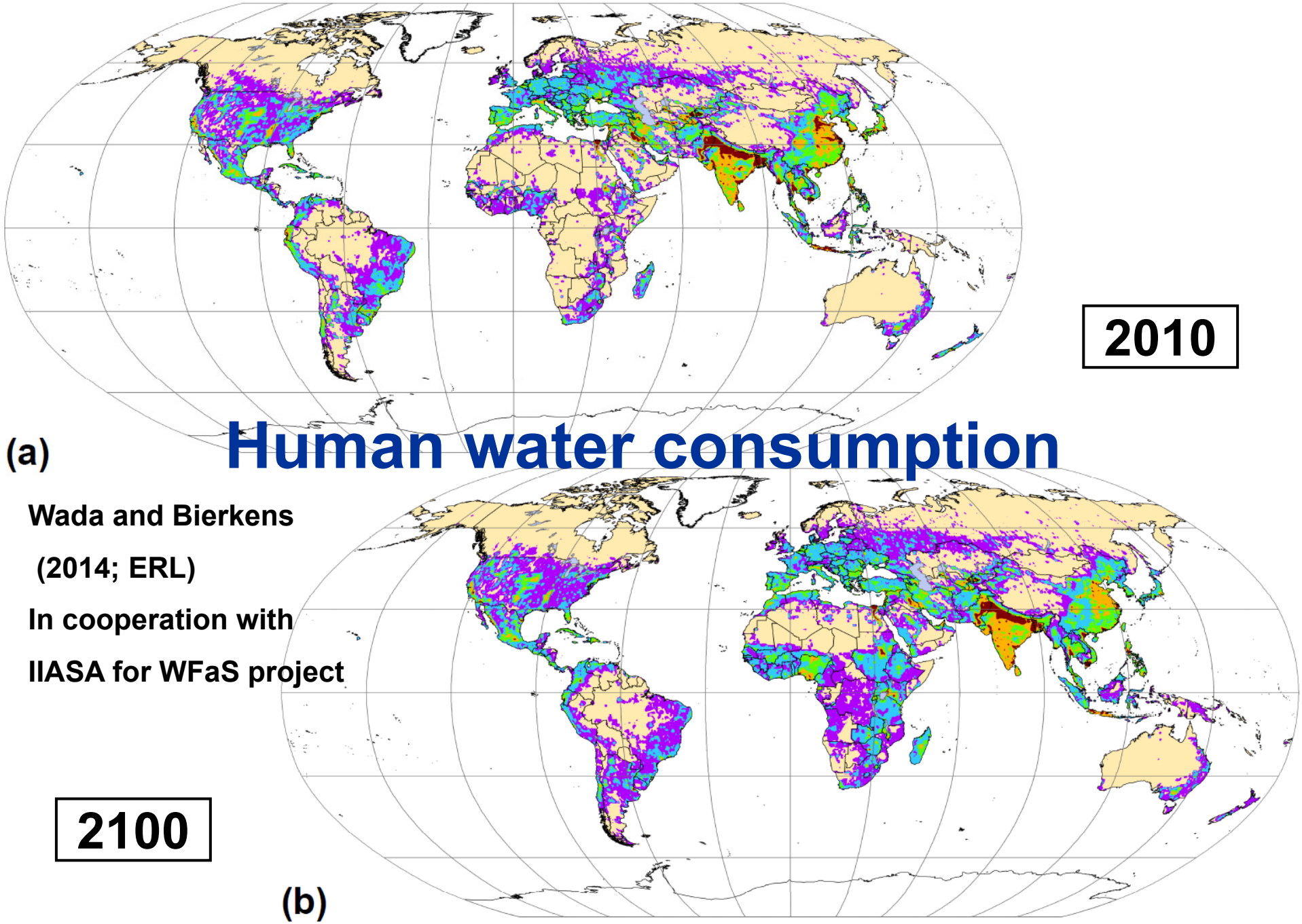
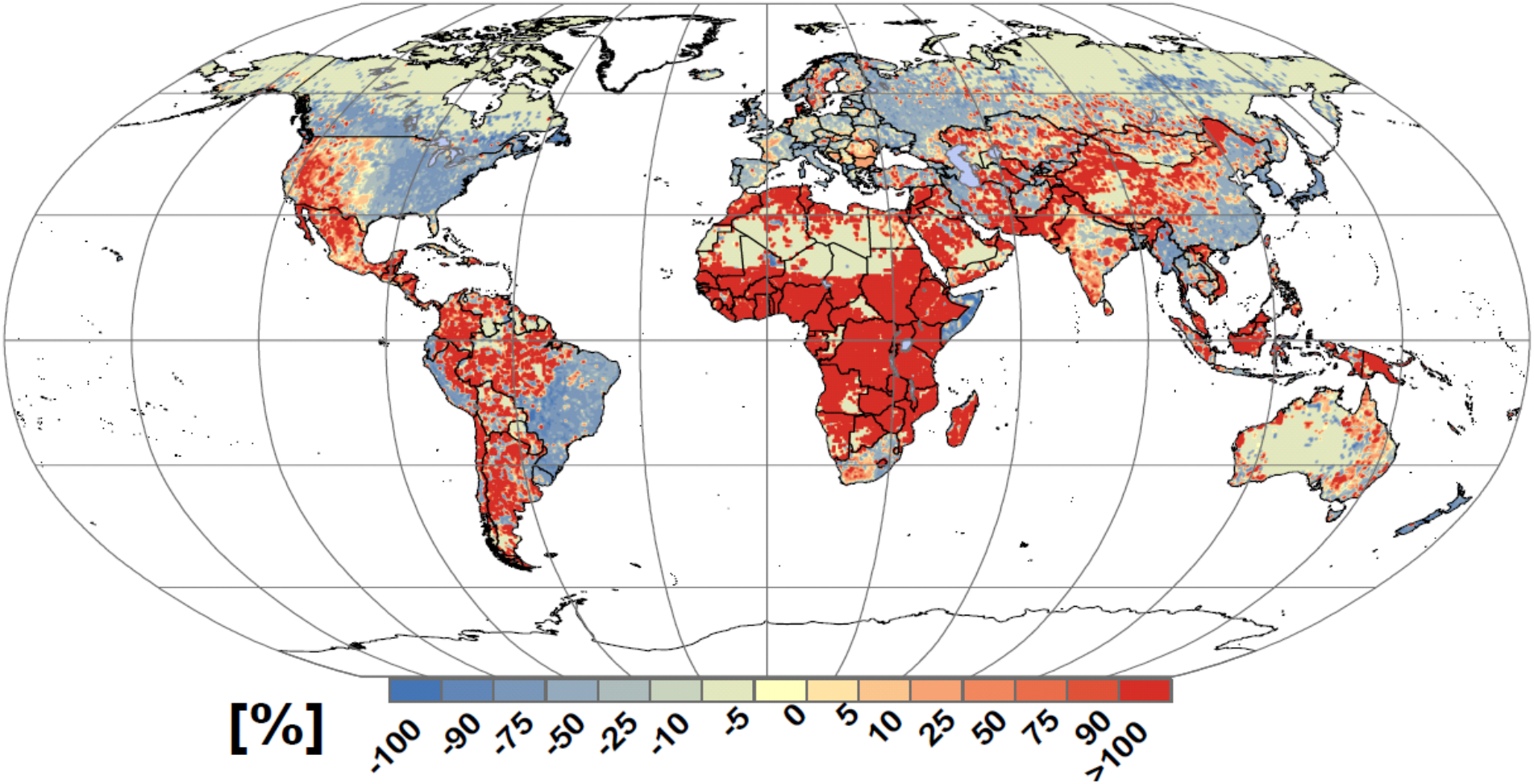
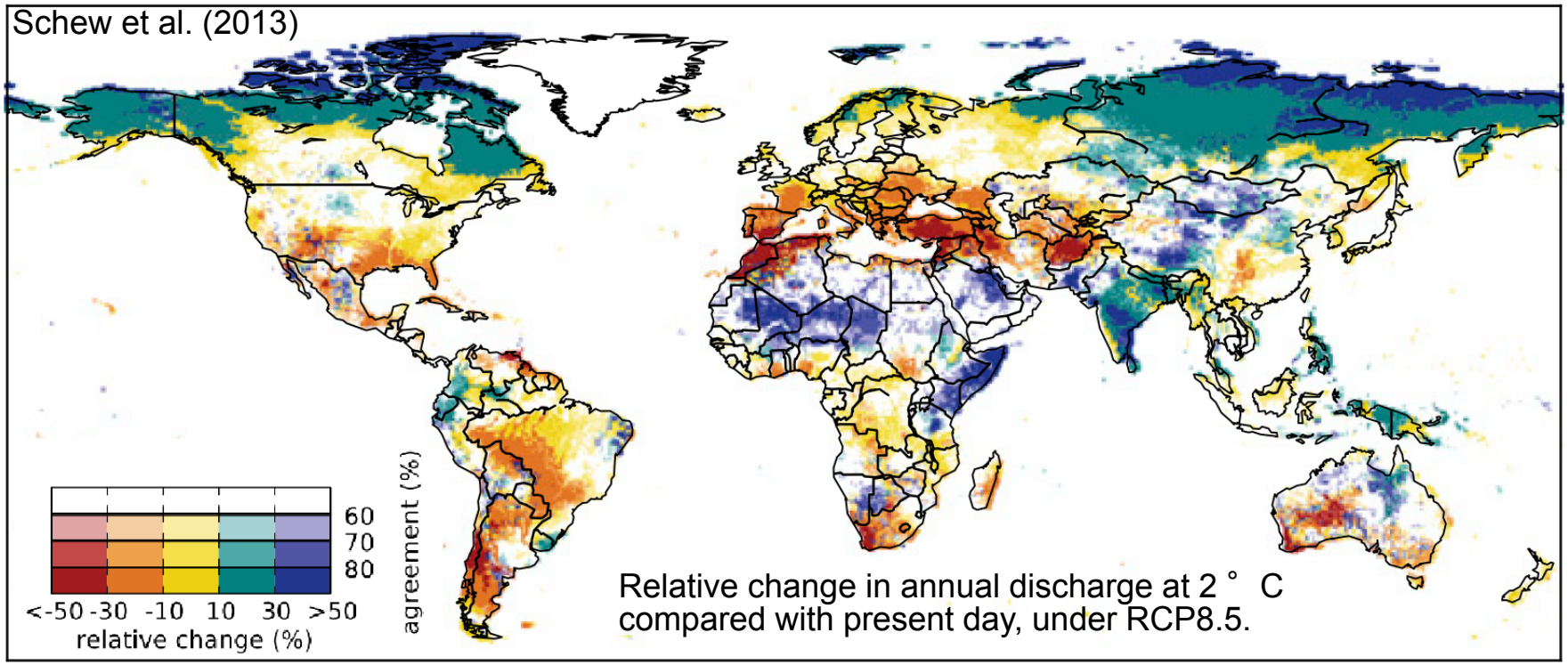

2010
(a)
Human water consumption
Wada and Bierkens
(2014; ERL)
In cooperation with
IIASA for WFaS project
2100
(b)
Total blue water consumption [million cubic meter per year]
0 - 2
2 - 20
20 - 100
100 - 300
300 - 1000
> 1000

Relative change in human water consumption



2100 – 2010

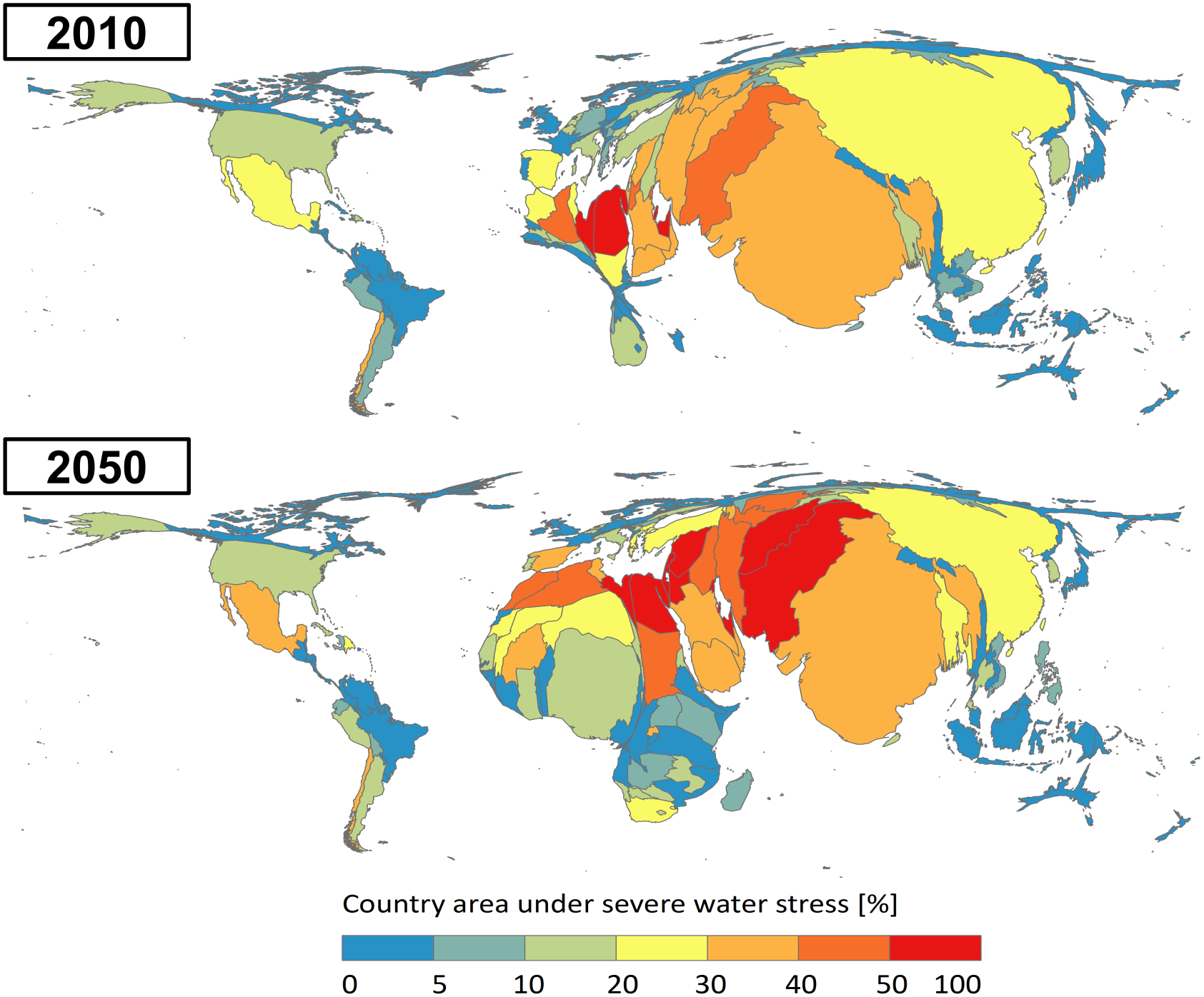
Future water availability (2100)



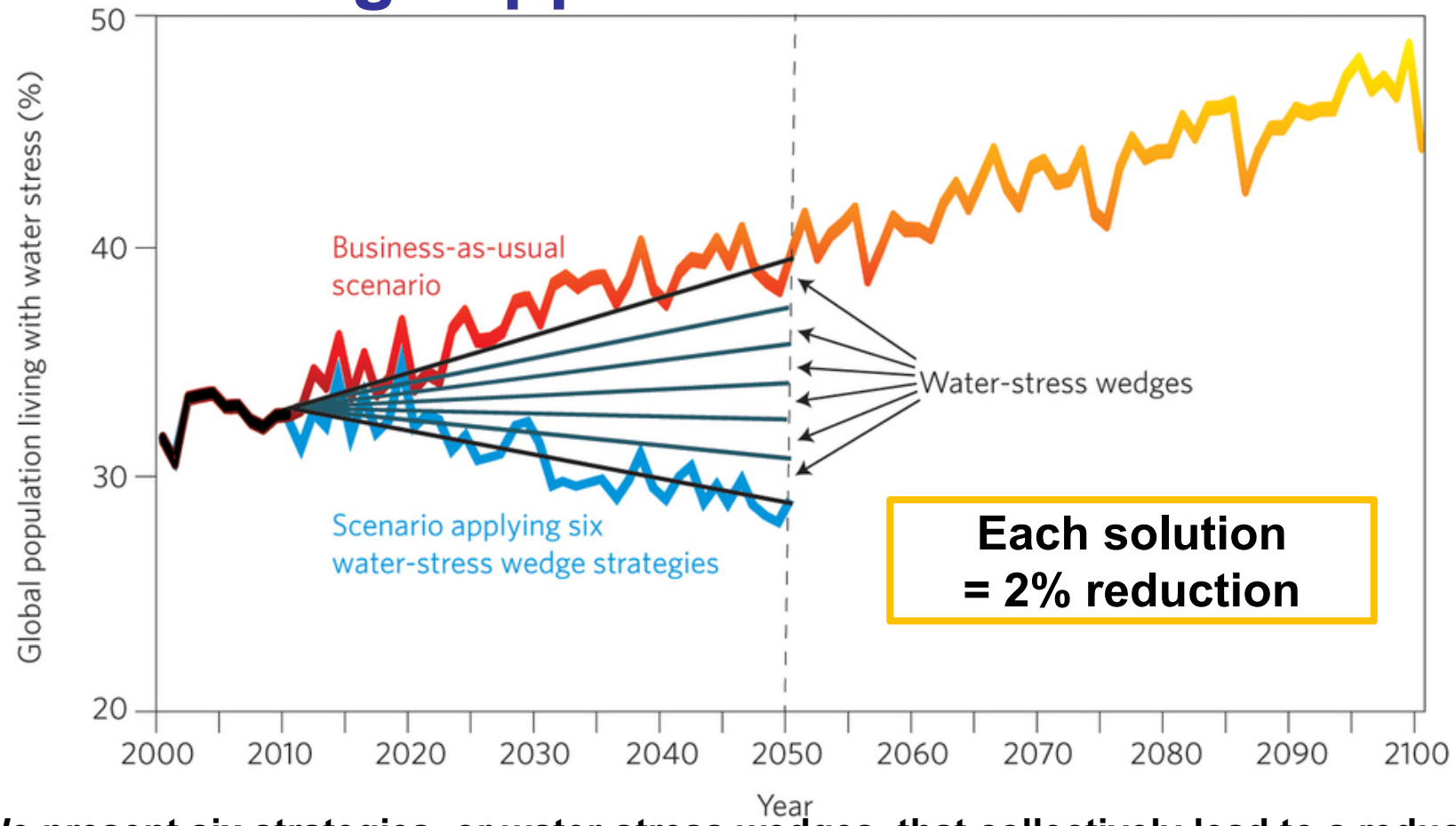
Results analyzed for 5 climate models and 4 RCPs

Schellnhuber HJ, Frieler K, ***Kabat P*** *(Eds) (2014). Global Climate Impacts: A Cross-Sector, Multi-Model Assessment Special Feature. Proceedings of the National Academy of Sciences (PNAS), 111(9):3225-3297 (4 March 2014)*

Water Futures


2010
2050
Country area under severe water stress [%]
0
5
10
20
30
40
50
100

Wedge approach to water stress



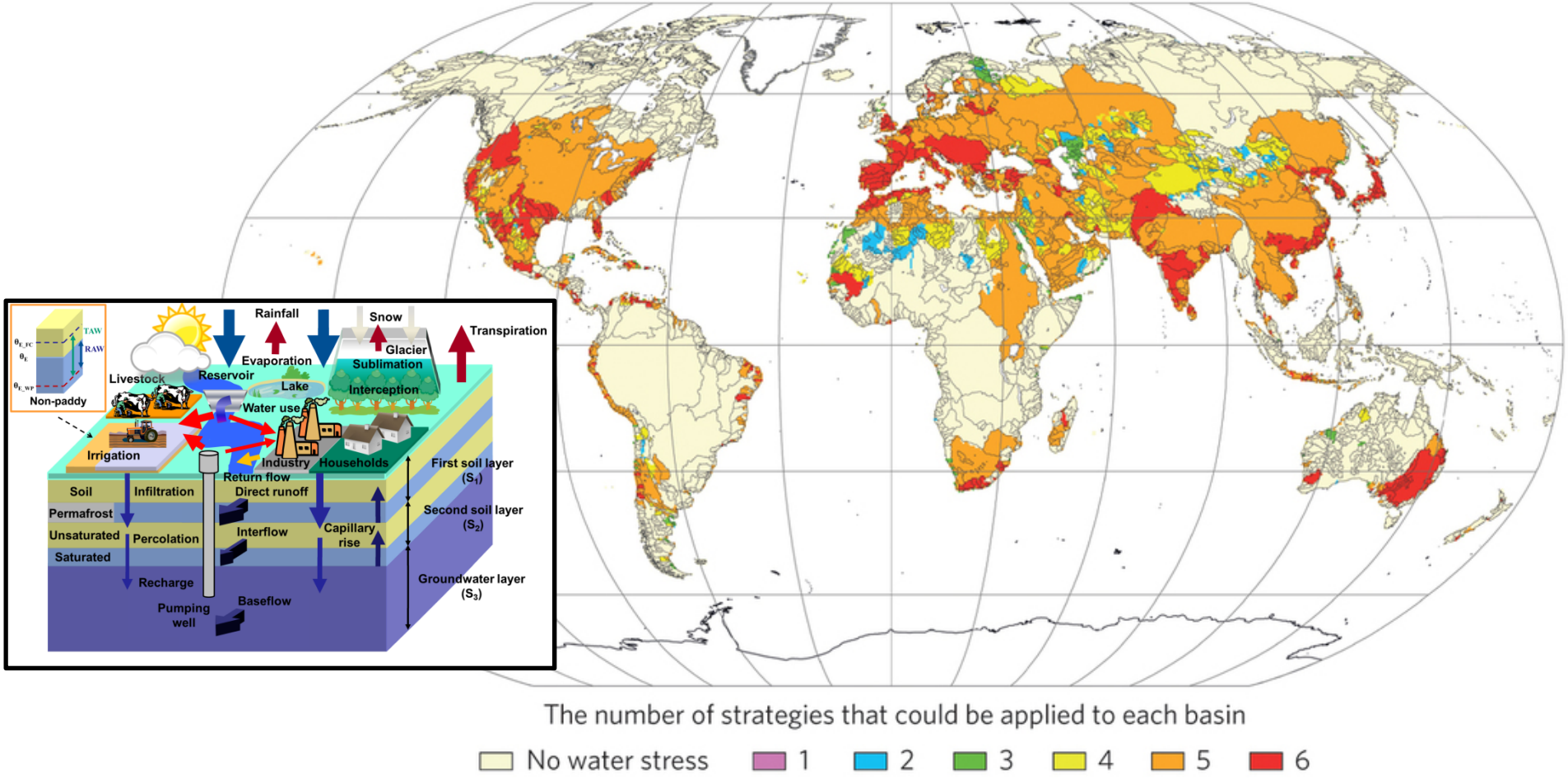
Each solution = 2% reduction

We present six strategies, or water-stress wedges, that collectively lead to a reduction in the population affected by water stress by 2050, despite an increasing population.

- **Water productivity – crop per drop**
- **Irrigation efficiency – decrease losses**
- **Water use intensity – industry and domestic**
- **Population**
- **Reservoir storage**
- **Desalination**

Hard path vs. Soft path

Wada et al. (2014), Nature Geoscience



Different basins lend themselves to different measures for reducing water stress:

Agricultural water productivity*, *Irrigation efficiency*, *Improvements in domestic and industrial water-use intensity*, *Limiting the rate of population growth*, *Increasing water storage in reservoirs*, *Desalination of seawater

Wada et al. (2014), Nature Geoscience, doi:10.1038/ngeo2241

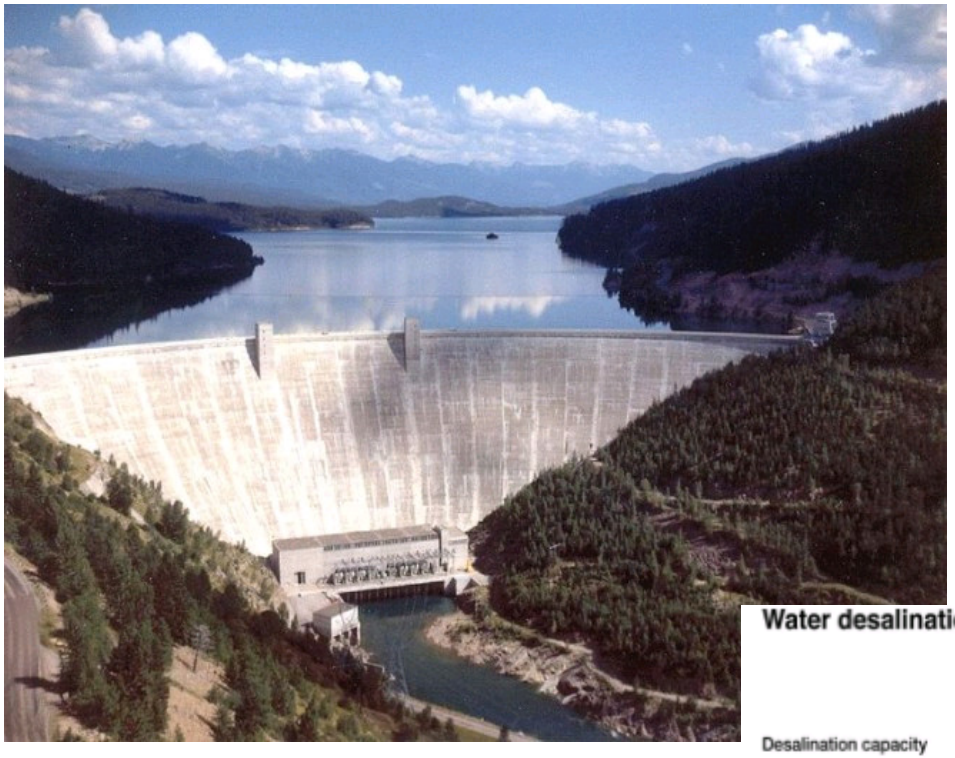
More Crop Per Drop

Improvement in water productivity at 0.5% per year (20% by 2050)

Efficiency increase by 1% per year (40% by 2050)

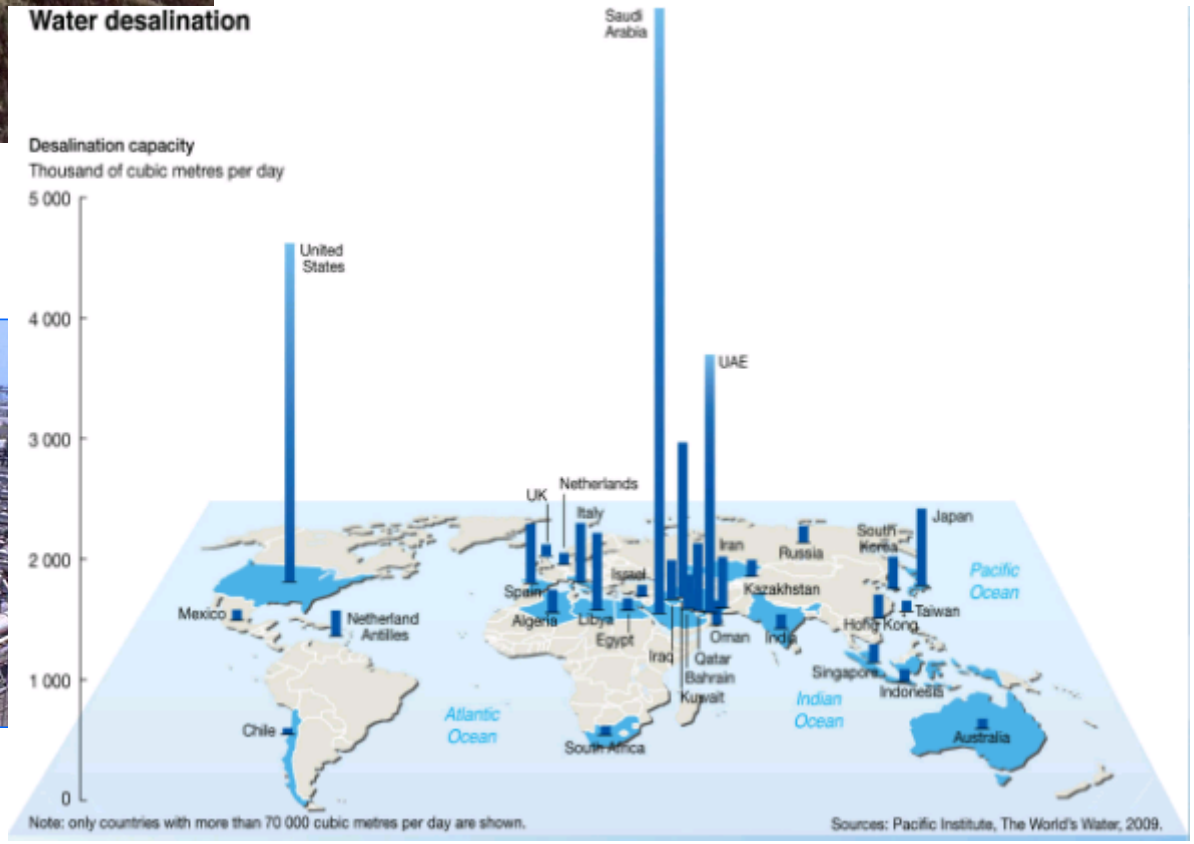
Improvement of 0.5% per year (20% by total)

Limit population growth by 0.5 billion (8.5 billion by 2050)



Additional 600 km^3 reservoir storage (by 2050)

50 times increase in desalination capacity (by 2050)



WFaS approach

- Significant reductions in the number of people that live with water stress are possible by 2050, compared with a business-as-usual situation.

- Water availability and use are inherently regional concerns. However, a global-scale approach to evaluating strategies to reduce water stress can help maximize mitigation.

- A strong commitment and strategic efforts are required to make the solutions happen.

- Economic and environmental costs need to be considered.

- Stronger link to food and energy sector.