Managing Water Sustainably: Chasing a Rainbow?

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Scientific Session

"Water II: Water Management for the Future"
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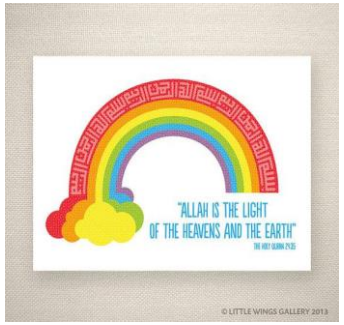
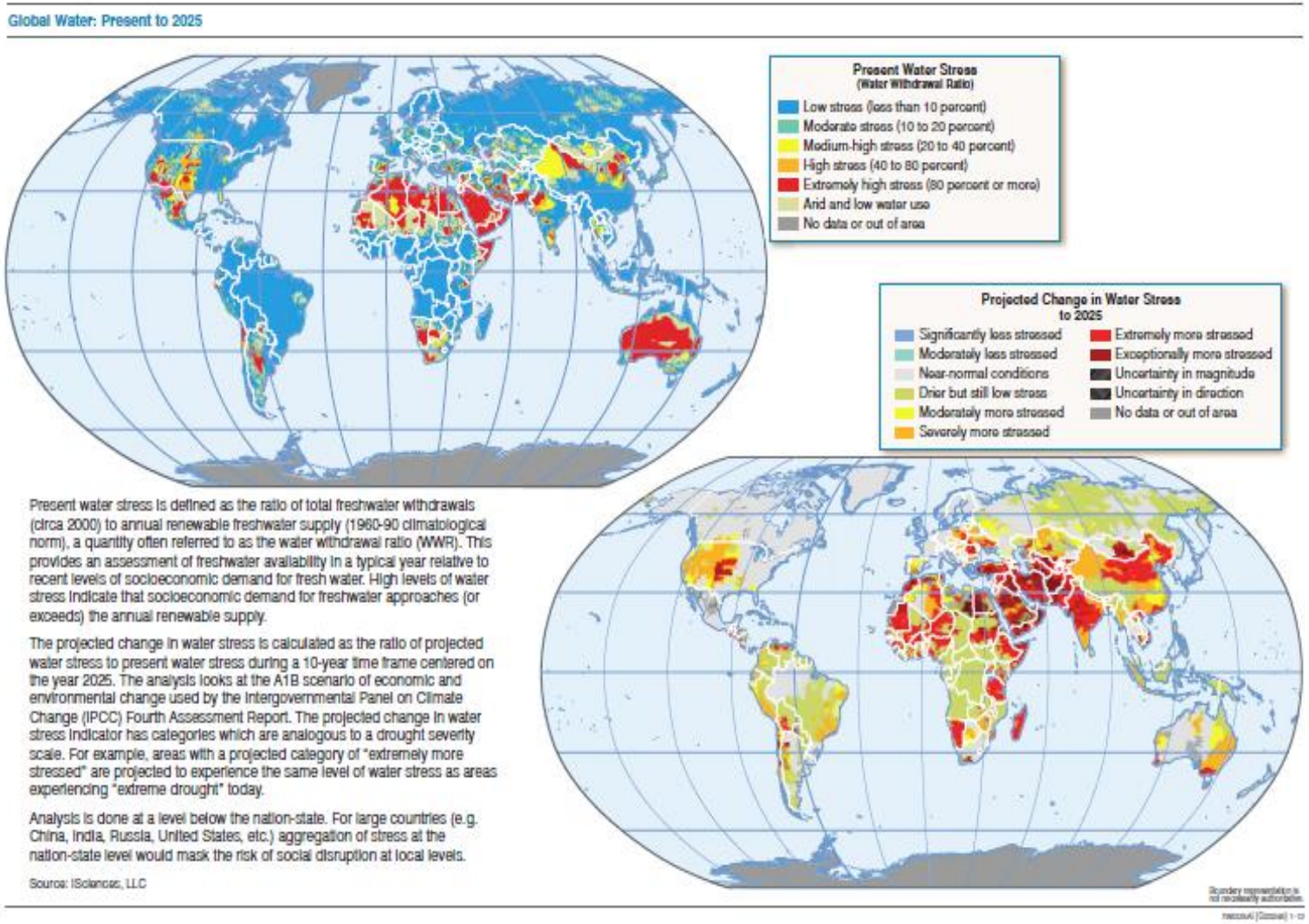
Hydrologist Geologist Agronomist Microbiologist Engineer	Chair, Global Water Partnership Chair, Advisory Ctee to Suez Water Company Founding Chair, Water Agenda Council for Davos Vice Chair, Canadian Water Network UN Secretary General's Advisory Board on Water Nebraska – Water for Food International Water Management Institute

What we will go today.

- Huge global challenge of water management
- Potential solutions directions
- Why ‘good’ solutions often ‘over the rainbow’
- Some health implications….
- Foreseeable legal challenges
- Any pots of gold ? ……..Leprechauns?



Water for all…..a tall order



The Earth's Water

Water Distribution

	percent
Oceans	**97.5**
Fresh water	**2.5**
Glaciers	68.7
Groundwater	30.1
Permafrost	0.8
Surface and atmosphere	**0.4**
Freshwater lakes	67.5
Soil moisture	12.0
Atmosphere	9.5
Wetlands	8.5
Rivers	1.5
Vegetation	1.0

Freshwater Use

Sector usage of withdrawn water (consumptive and nonconsumptive)

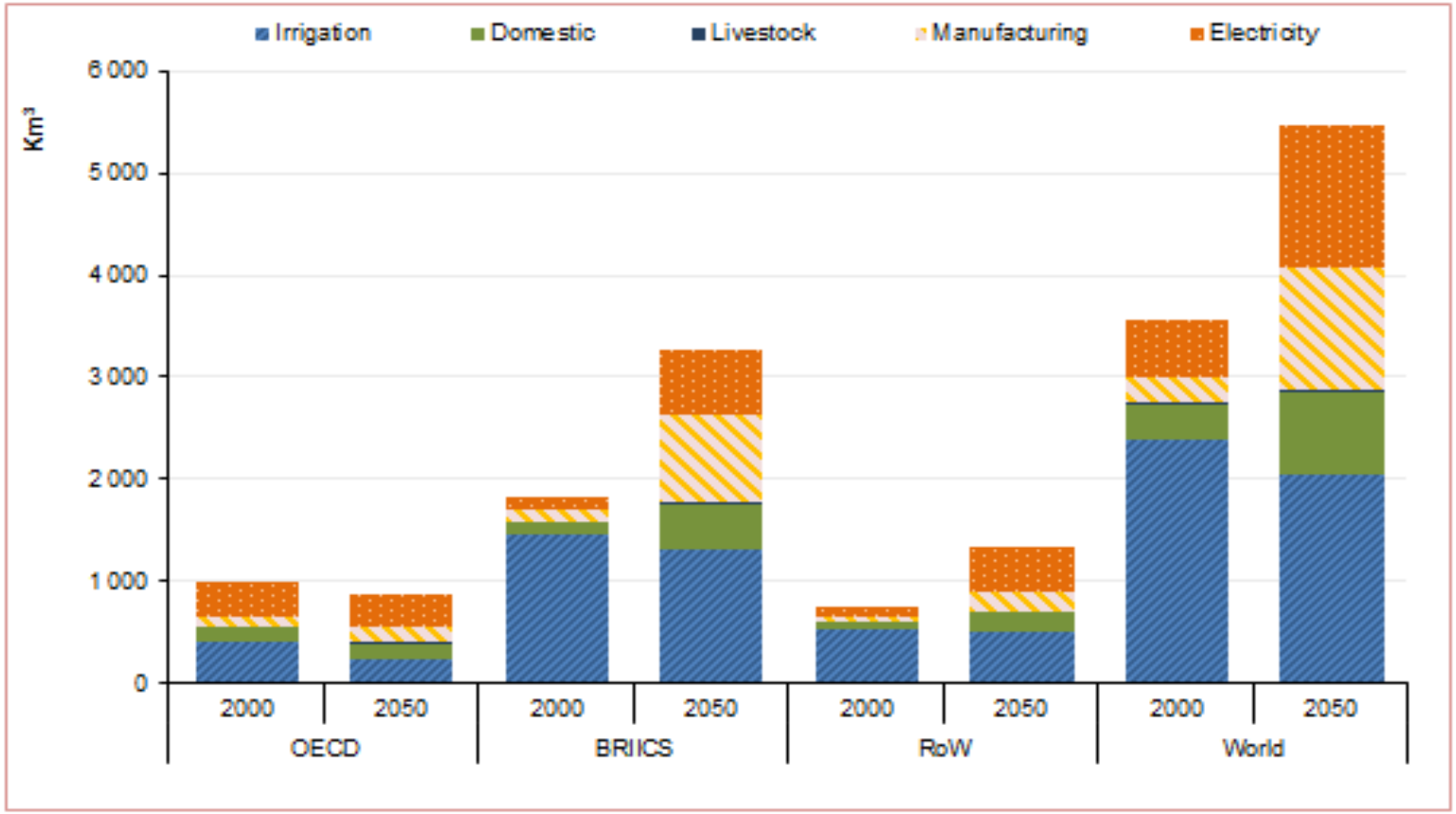
Rivers, lakes, and groundwater	*percent*
Agriculture	68
Domestic and other industrial	19
Power	10
Evaporation from reservoirs	3

Freshwater Use

Consumptive use of withdrawn water by sector

Rivers, lakes, and groundwater	*percent*
Agriculture	93
Domestic and other industrial	7

World water demand projected to grow by 55% by 2050



Source: OECD Environmental Outlook Baseline; output from ENV-Linkages.

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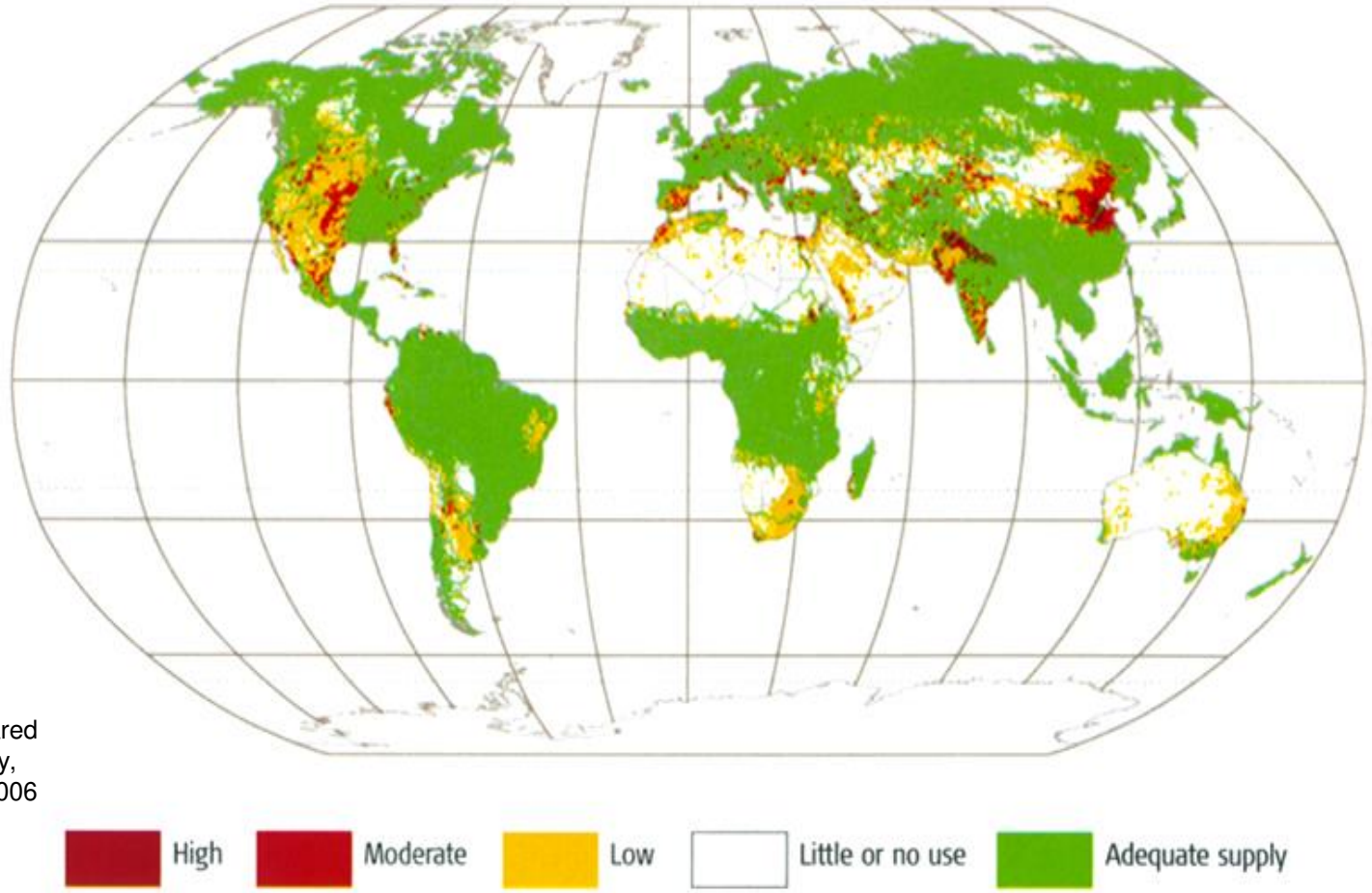
Withdrawals already exceed replenishment



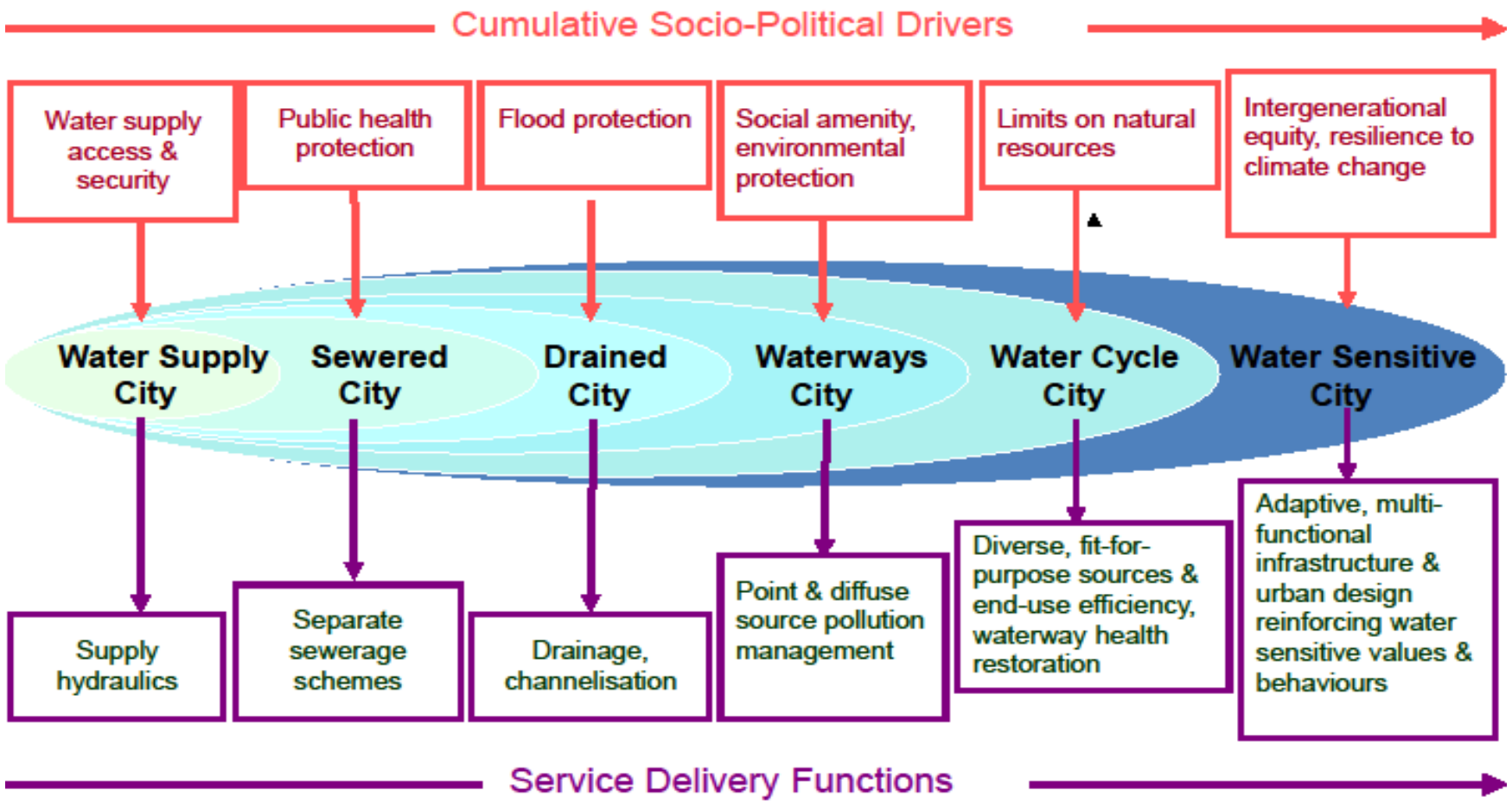
Source: UN, Water a shared responsibility, New York 2006

Major World Challenges in Water Management

- Quantity:
  - 1.2m people lack reliably safe water all year long
  - One in five child deaths
  - Important major rivers no longer flow into the sea
  - 28% of freshwater fish under extinction threat
  - Hypoxic zones in gulf of Mexico: nutrients
  - Ogallala under threat in places.
  - Groundwater levels falling world wide
  - Coping with increasing variability: heat, drought, flood

- Quality: most of the health issues
  - 80% of sewage not treated; into rivers+ POLLUTANTS
  - Water is life: bad water practice = death, illness, contagion, misery, indignity
  - Getting “more of anything’ takes more water . Fertilizer, industry,

Evolving Urban Water Hydro-Social Contract



Brown *et al* (2008), and Wong and Brown (2008)

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New Science, new idea for Water?

- Conservation – bet option – toughet - PRICING
- Desalination…….IF
- Energy from Waste Water sources
- New Urban water Design – the cell phone not the landline.
- Buildings for water neutral….well, almost
- Water sparing, disease resistant high yield crops
- Waste Water ReUse - agriculture

The BIG problem $$$$$$$$$$ - and

Major challenges of water reuse

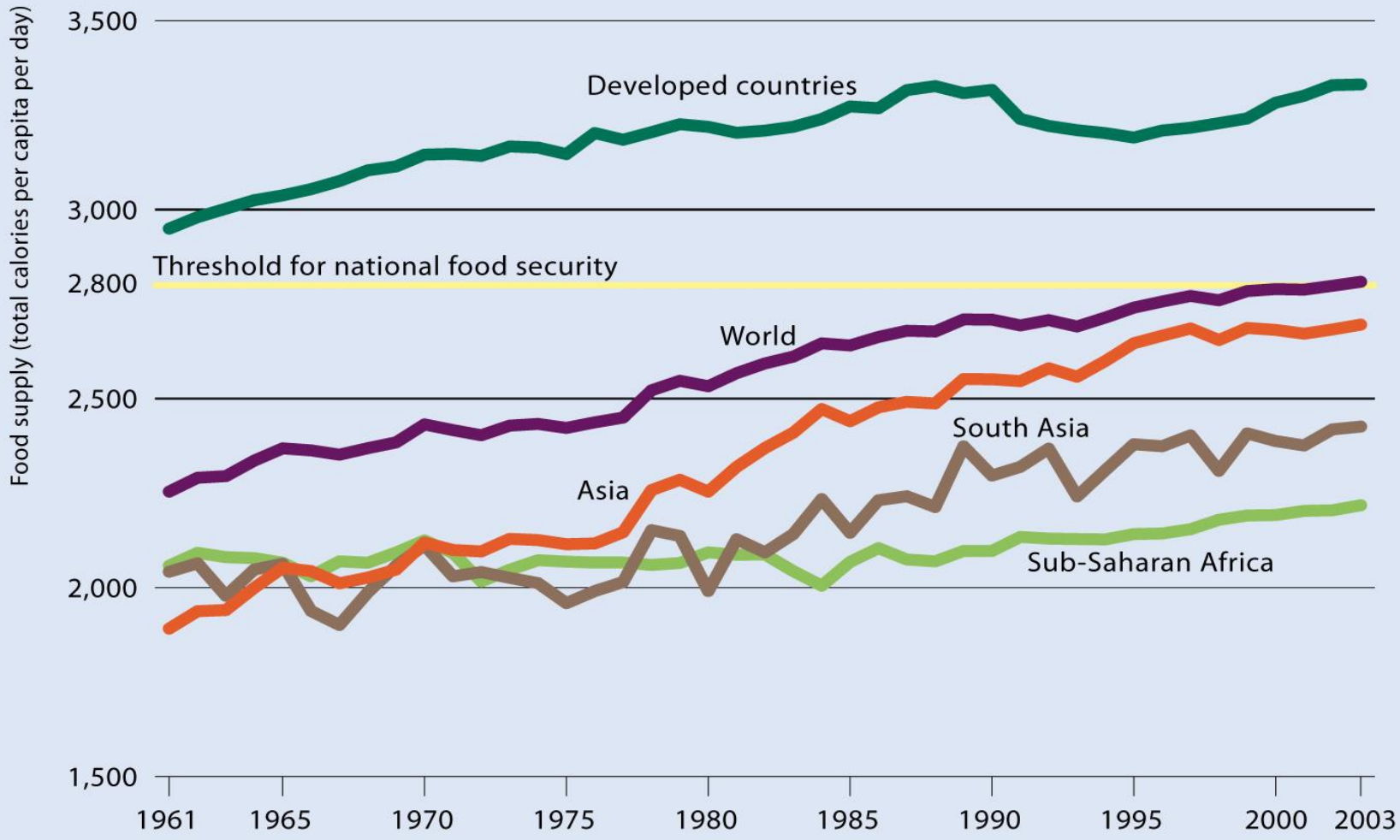
- Technical challenges
- Institutional obstacles
- Food safety and public perception
- Public education, participation and support
- Acceptance
- Economic viability
- Government support, politics and public policy

BAD LEPRECHAUN

Water for Agriculture : an essential key

- Irrigation efficiency in Philipines, Thailand, India, Pakistan…….25-40%
- 1 of 3 sacks of)fertilizer hits plant roots
- 40% food wasted between farmer and fork
- Water storage essential: design, system impact, governance issues
- This is ALL bioscience:which crops, which techniques,

WEnout<o ealt?;e???? Rising food security concerns

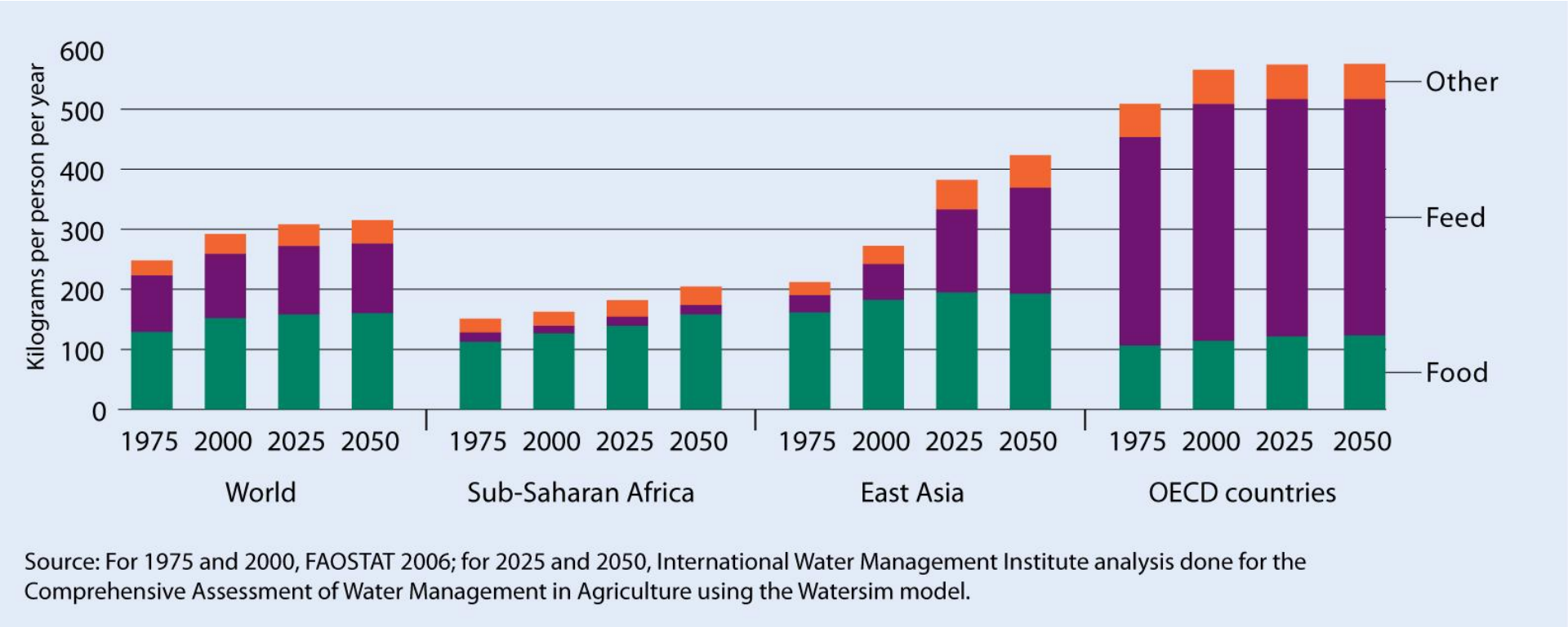


Source: FAO 2006b.

It takes a litre of water to produce every calorie, on average

Carlson

A richer world = more water for cereals

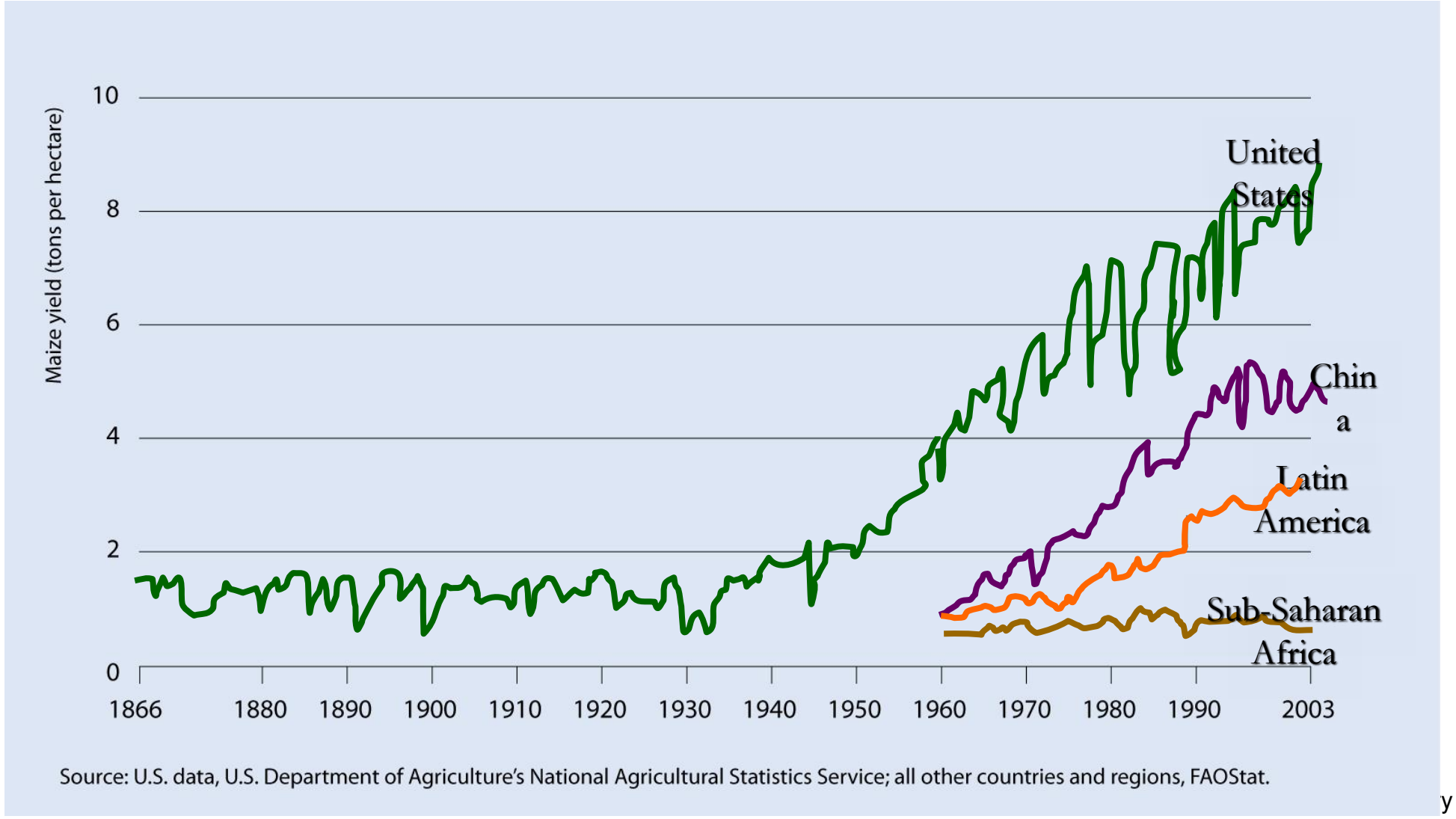


Source: For 1975 and 2000, FAOSTAT 2006; for 2025 and 2050, International Water Management Institute analysis done for the Comprehensive Assessment of Water Management in Agriculture using the Watersim model.

Food demand doubles over the next 50 because of diet and population

Water Needs (ET) will double – without water productivty gains

Keeping up with population growth



Source: U.S. data, U.S. Department of Agriculture's National Agricultural Statistics Service; all other countries and regions, FAOStat.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Not just him – it's us

Saudi Arabia scraps wheat growing to save water

- **Reuters Tue Jan 8, 2008 11:02am**

- RIYADH, Jan 8 (Reuters) - Saudi Arabia is abandoning a 30-year programme to grow wheat that achieved self-sufficiency but depleted the desert kingdom's scarce water supplies.

The kingdom aims to rely entirely on

- imports by 2016.

www.the-world-around-water.net

Big New Issues moving into Legal areas

- Water
- Perennial SouthWestern water disputes.
- Atlanta, Florida
- GROUNDWATER – just starting
- Fertilizer residue in soil and water.
  - Flint, Michigan.
  - Toledo, Ohio
- Nitrates in France
- Groundwater recharge

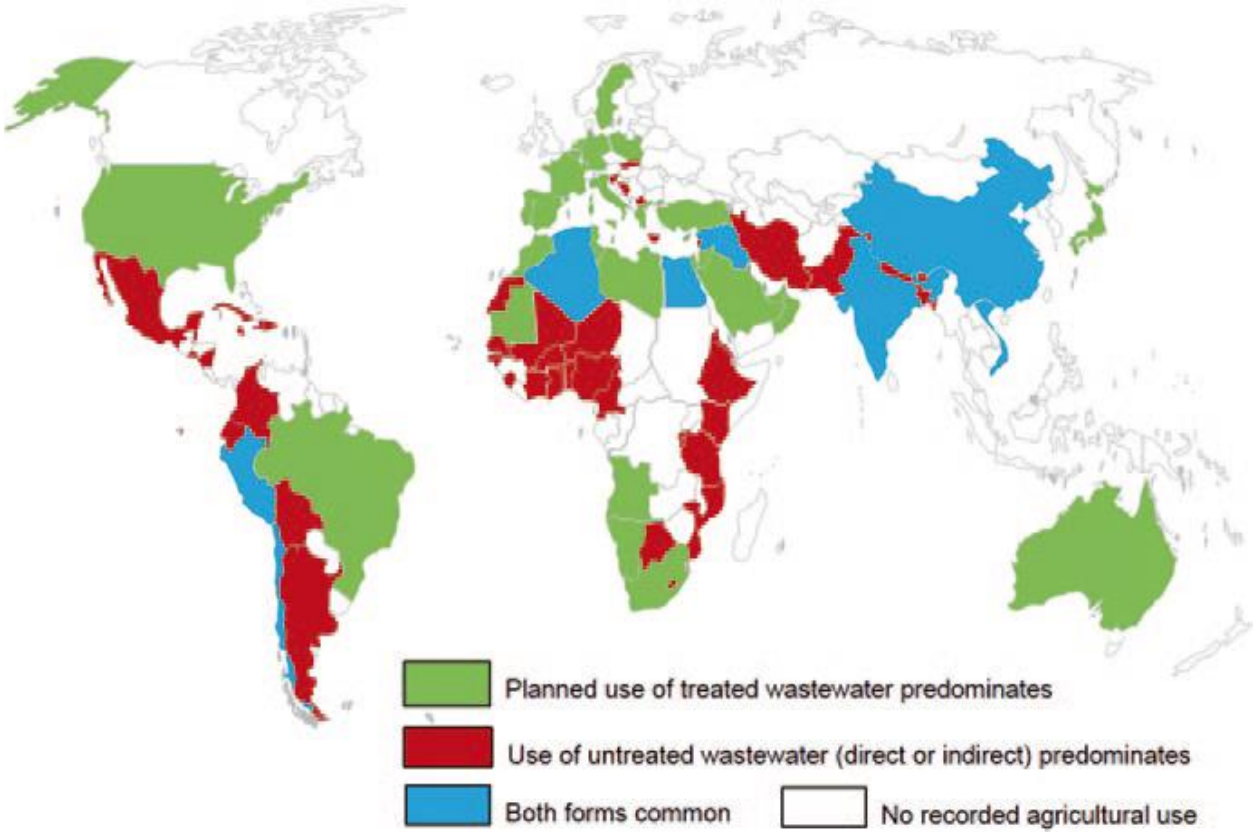
PLUS: A VERY big stream out of sight…

- two million tons of waste, estimated to equal **two or more billion tons** of wastewater are discharged daily into rivers and seas
- It's a big river. It subtracts from available H20
- Canada- strengths here

In recovering energy, using Waste water

- Water cleaning loops
- Okanagan moving here

Countries with recorded water reuse for irrigation



- **≈ 50 million m^3/d (18 km^3/yr)** of WW are **reused** (5-7% of the amount) - 58% is used untreated for irrigation (Jiménez and Asano, 2008)
- **≈ 29.3 million ha (≈ 9% of the global irrigated area)** irrigated with mostly raw wastewater (Thebo et al., 2017)
- Crops produced from irrigation with raw wastewater **≈ 10% of global agricultural production from irrigation** (Scheierling et al., 2010; Drechsel et al., 2010)

Source: www.fao.org/nr/water/aquastat/wastewater/index.stm; and IWMI, unpublished

Proven Ideas – Expand and Extend Use

- greenhouse technology to grow tomatoes, cucumbers and eggplants in the Abu Ghraib benchmark site of Iraq.
  - saving water, the technology is proven to
  - increase yield and farmers' revenue 10 X ++
- sub-surface drip irrigation both saves water and increases yield.

Major challenges of water reuse

- Health and regulatory
- Technical challenges
- Institutional obstacles
- Food safety and public perception
- Public education, participation and support
- Acceptance
- Economic viability
- Public policy, politics, subsidy.
- $$$$$$$$$$$$$$$$

Irrigation of food and non-food crops in Kuwait

Canadian Emviron/Climate Ministers ask:

- Which wastewater contaminants do we need to worry about most, now and future?
- options to address these contaminants through wastewater treatment?
- opportunities and trade-offs involved in treatment choices,
  - including resource recovery, costs, implications for related issues like greenhouse gas emissions, and socio-economic and cultural fit?
- Political/economic/legal/reg. aspects of each….

To conclude: tantalizing science possibilities

- Solar panels to pull drinking water out of the air – cost could be amortized by cost to Mexican family for water
- two years.
- Solar toilet

Solar water – Zero Mass

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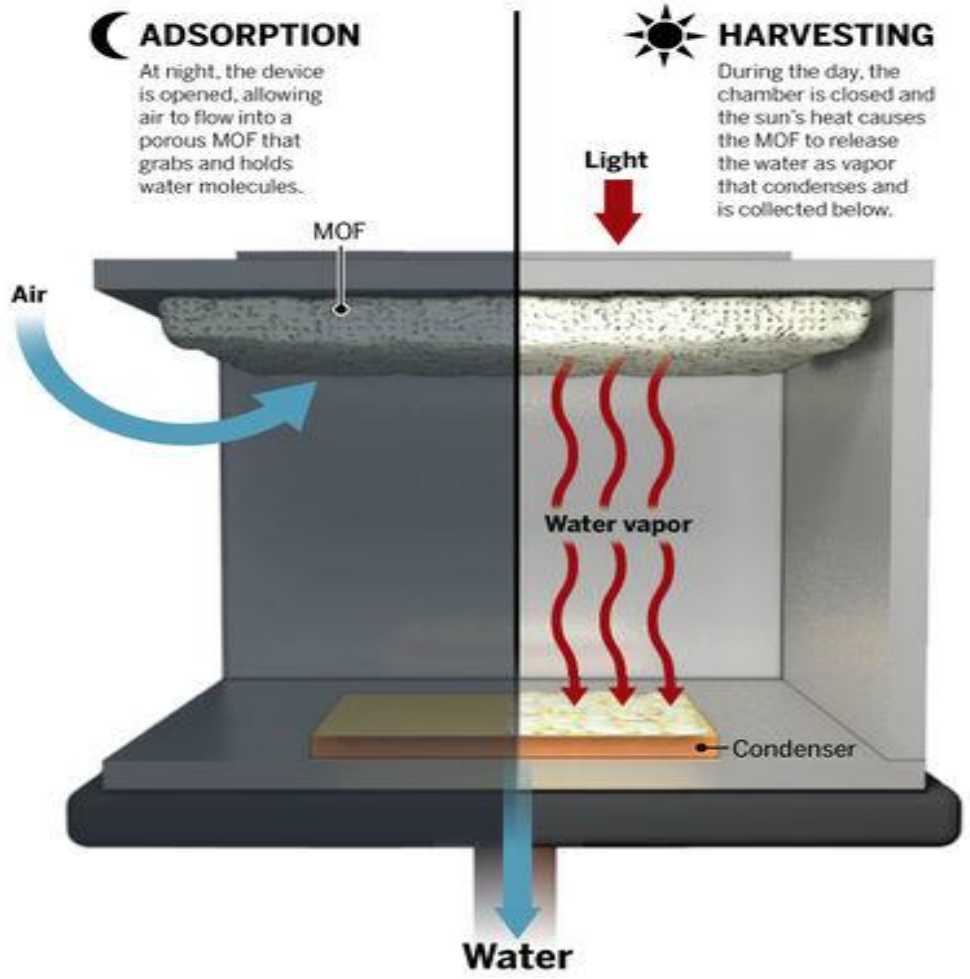

Wastewater as a resource: next frontier

- *microbial electrochemical cell convert organic wastes into renewable hydrogen gas, electrical power, or hydrogen peroxide.*
- *photosynthetic microorganisms that can capture sunlight and CO2 to produce feedstock for renewable forms of liquid fuels and chemicals.*
- *applied Anammox technology for efficient nitrogen removal. the treatment of municipal wastewater energy positive.*
  - *Aerobic granular sludge is a recently introduced*

  makes municipal wastewater treatment simpler and significantly more sustainable:
    - *e.g., 75% less land area, 30% less energy use, and 25% less capital cost.*
- *Since its introduction in the Netherlands in 2012, the Nereda process already is installed in Portugal, South Africa, Brazil, and England.*

New use for existing technologies

- *"UVWaterworks". Tougher robust technology disinfects drinking water using UV light*

- *electrochemical method (called ECAR) that removes arsenic*
  - *Chronic exposure to arsenic substantially increases the risk of internal cancers, ulcerated skin, gangrenes, cardiovascular disease, and reduced IQ in children.*
-
- *Enriching the soil with bio-fertilisers for sustainable food production,*
  - *conserving soil moisture content, minimizing large-scale water contamination with chemical fertilisers, pesticides as well as sludge, and producing almost carbon neutral energy.*

Not enough science or $$$$$ to face new water issues and definitely not enough public and political push

- *guidelines for determining how land around a body of water can be safely set aside for agricultural, residential, and other types of development, worldwide.*
- *forensic studies of the long-term effects of various mining industries on our waterways, demonstrating the long-term impacts of Arctic gold mining on the water resources that Northern Indigenous peoples depend on*
- *blue-green networks"*
  - *appropriately equipped green spaces to cope with issues such as urban flooding, polluted urban storm water generating toxic algal blooms,*

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What's the water sustainability Rainbow

- Water for all people.
- Water for all purposes
  - Environmental functions
  - Food supply
  - Cities and industries
  - Recreation
  - Transport
- Governance that allow science happen.
- Regulation and Litigation that facilitate