Exploring the Water Energy and Food nexus- constraints and opportunities

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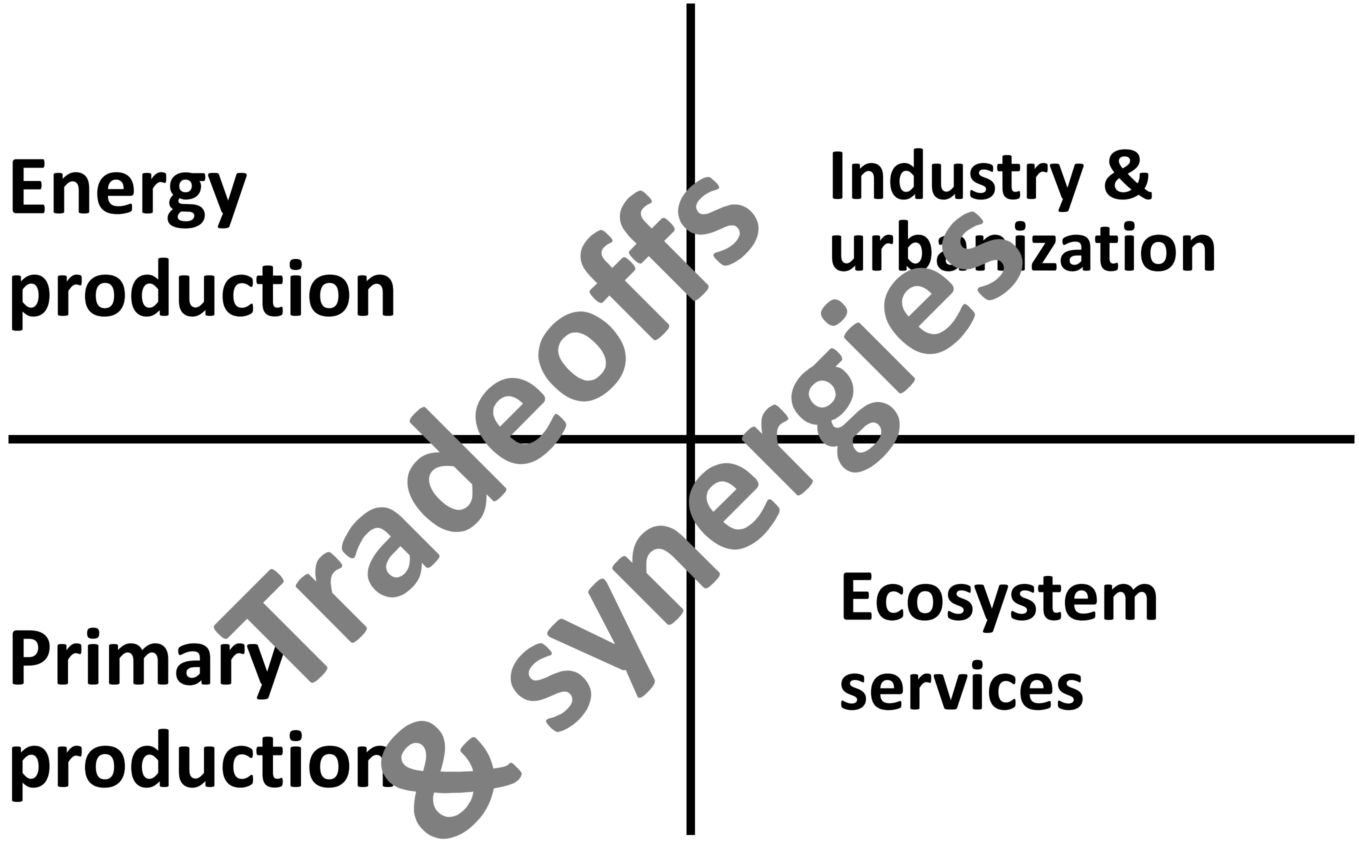
The water-energy-production-eco-system nexus – context specific, beyond the basin



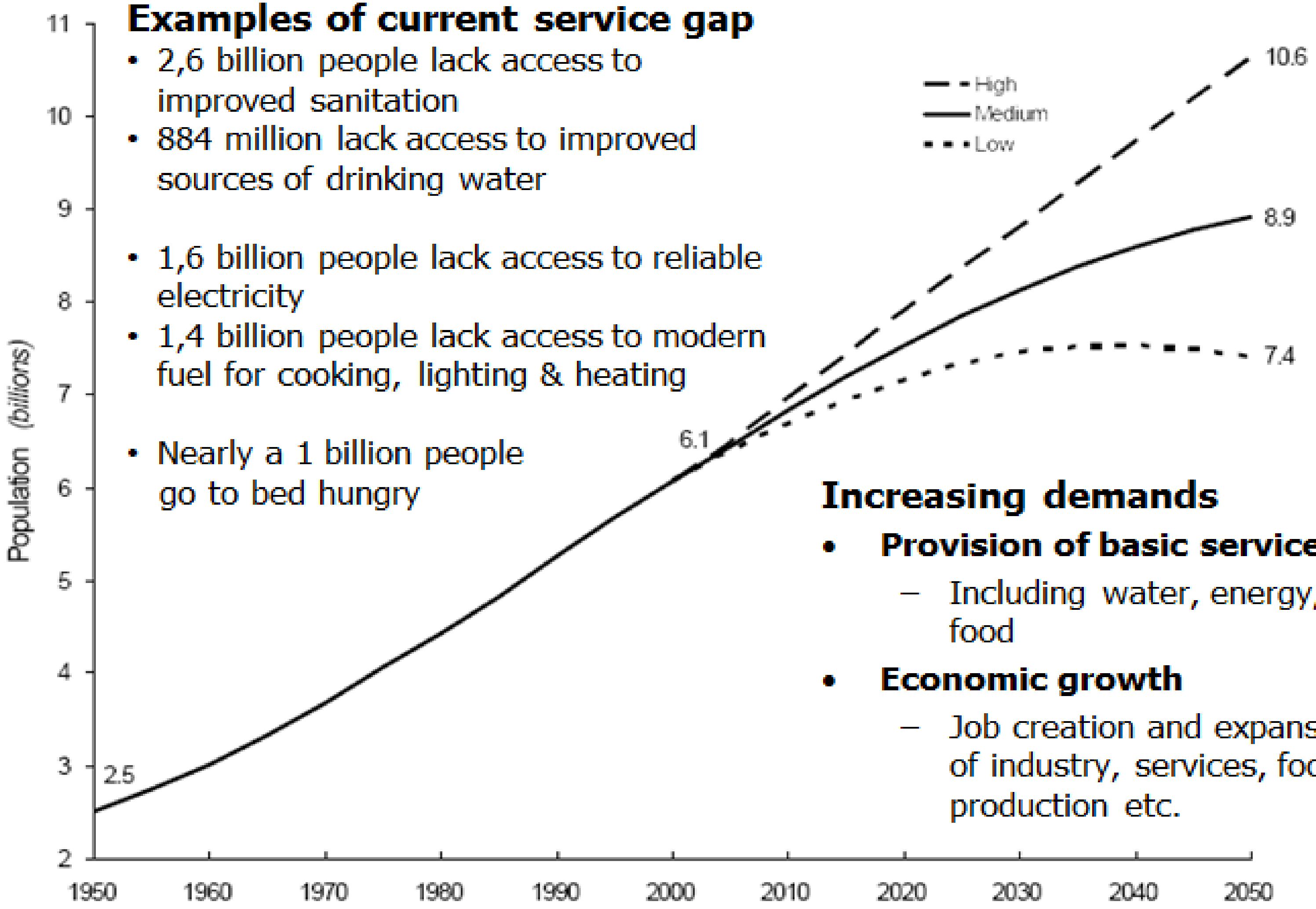
Dynamic systems: political economic considerations global, regional & local / institutions & markets / incentives & behaviour

Based on Phillips, et.al. (2008).
Söderbaum & Granit 2014, the Political Economy of Regionalism

Why now? Trends and drivers- growing pressures on global water resources

Global trends and drivers

- Increasing demand



Examples of current service gap

- 2,6 billion people lack access to improved sanitation
- 884 million lack access to improved sources of drinking water
- 1,6 billion people lack access to reliable electricity
- 1,4 billion people lack access to modern fuel for cooking, lighting & heating
- Nearly a 1 billion people go to bed hungry

Increasing demands

- **Provision of basic services**
  - Including water, energy, food
- **Economic growth**
  - Job creation and expansion of industry, services, food production etc.

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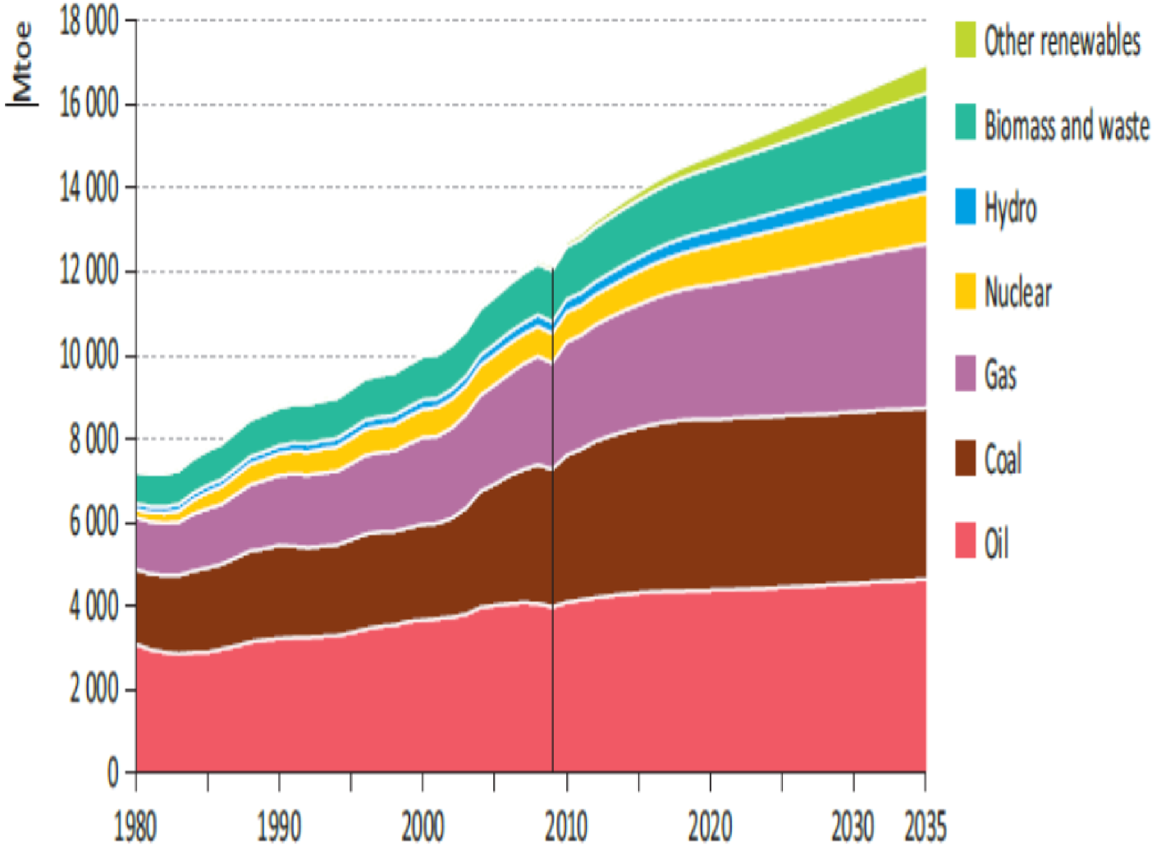
UN 2004, JMP 2010, UN Energy 2010, EIA 2010, OXFAM 2011

Projected energy demand
- Increases by 40 % to 2035

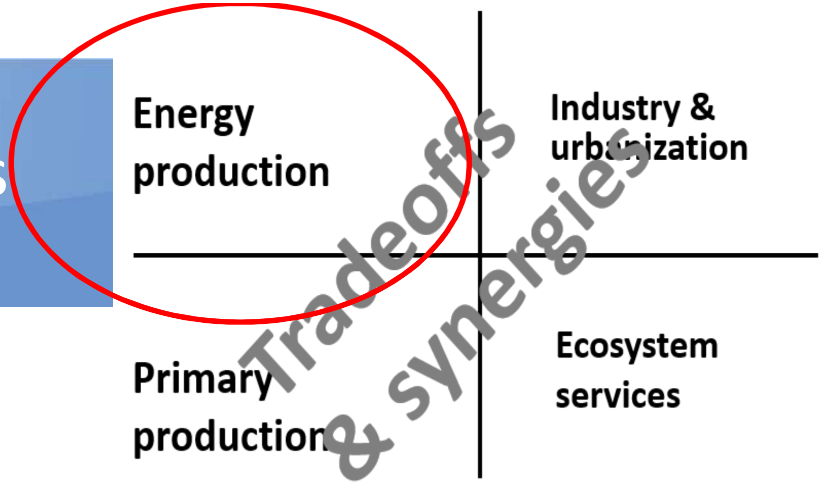
- Oil: 18%
- Coal: 25%
- Natural gas: 43 %
- Nuclear: 70%
- RE: Grows the fastest in relative terms- little impact in absolute terms
  - Includes most water efficient options

IEA; 2012

Figure 2.6 • World primary energy demand by fuel in the New Policies Scenario



Water-Energy Connections



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Nexus snapshots

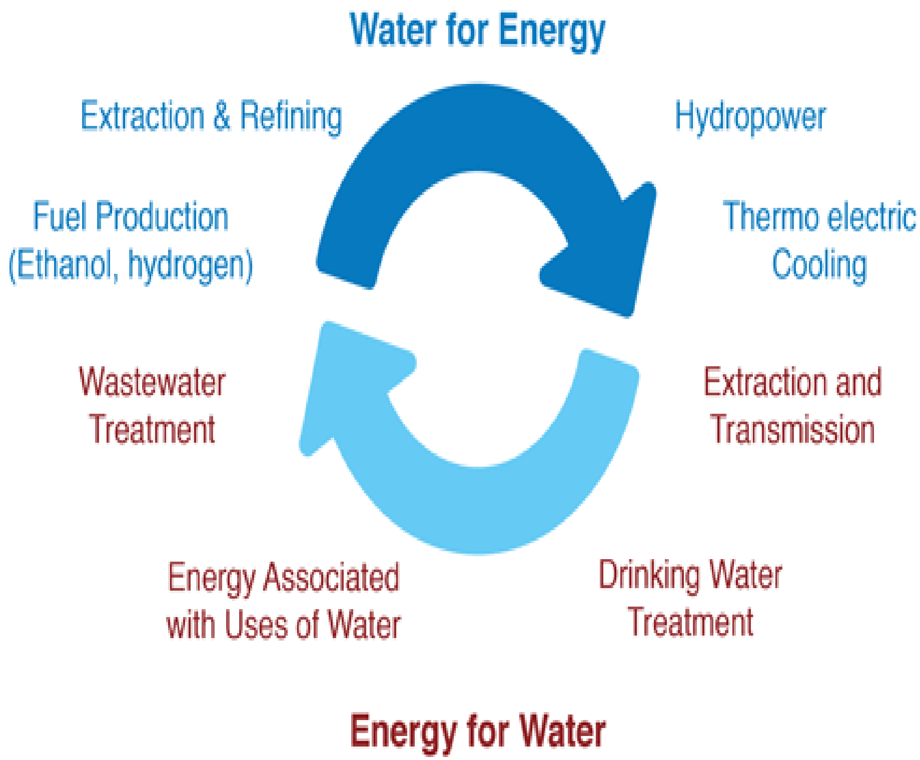
•70% of water used for irrigation, 20% for industry and 10% domestic purposes (CAWMA, 2007).

•US & EU- <u>40-50</u> % water withdrawal for energy (Granit & Lindström, 2011).

•Jordan- 15-20 % electricity for the water sector (Granit & Lindström, 2011).

•75 % of KSA´s water comes through energy intense desal processes (Stanford University, 2013)

•15% US energy consumption in food producing industry (EIA, 2012)



SEI, 2011

Ranges of water consumption in the energy production chain

Fuel production

Oil	Coal	Bio fuels	Natural gas	Nuclear fuels	Water for HEP
6-640 m3/TJ (various types as specified by EIA , 2011)	2-12 m3/TJ (various mining types)	9,000 – 100, 000 m3/TJ (corn)	Negligible (Shale gas 0,4-1 m3/TJ)	Negligible-0,1m3/TJ (Uranium-different extraction methods) 2-12m3/TJ (Uranium processing steps)	Nil

Power generation

Fossil fuels	Nuclear	Biopower	Solar	Hydro power	Wind, Ocean
Negligible-4 m3/ MWh (fossil fuels-various cooling techniques)	1,5-3,3 m3/ MWh (various cooling techniques)	0,8-3,2 m3/ MWh (steam, biogas)	Negligible - 4,3 m3/ MWh Photovoltaics low range values- (CSP) high range values	Negligible - 100 m3/ MWh (0-209 m3/MWh is an IPCC est. but with stated uncertainties)	Negligible

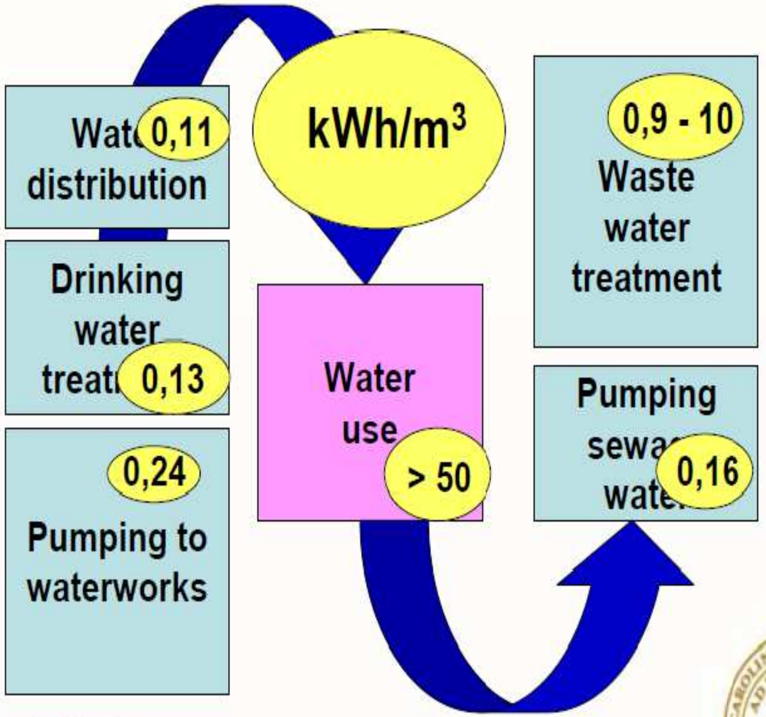
Granit and Lindström 2011: Based on Glennie et.al, 2010; Maheu et.al, 2009; IPCC 2011, WEF 2008

Energy related pressures on water resources

- water requires energy

Industrial Electrical Engineering and Automation

Electric power consumption - Sweden



Gustaf Olsson, Lund, Sweden

Stockholm World Water Week Aug. 2011

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Industrial Electrical Engineering and Automation

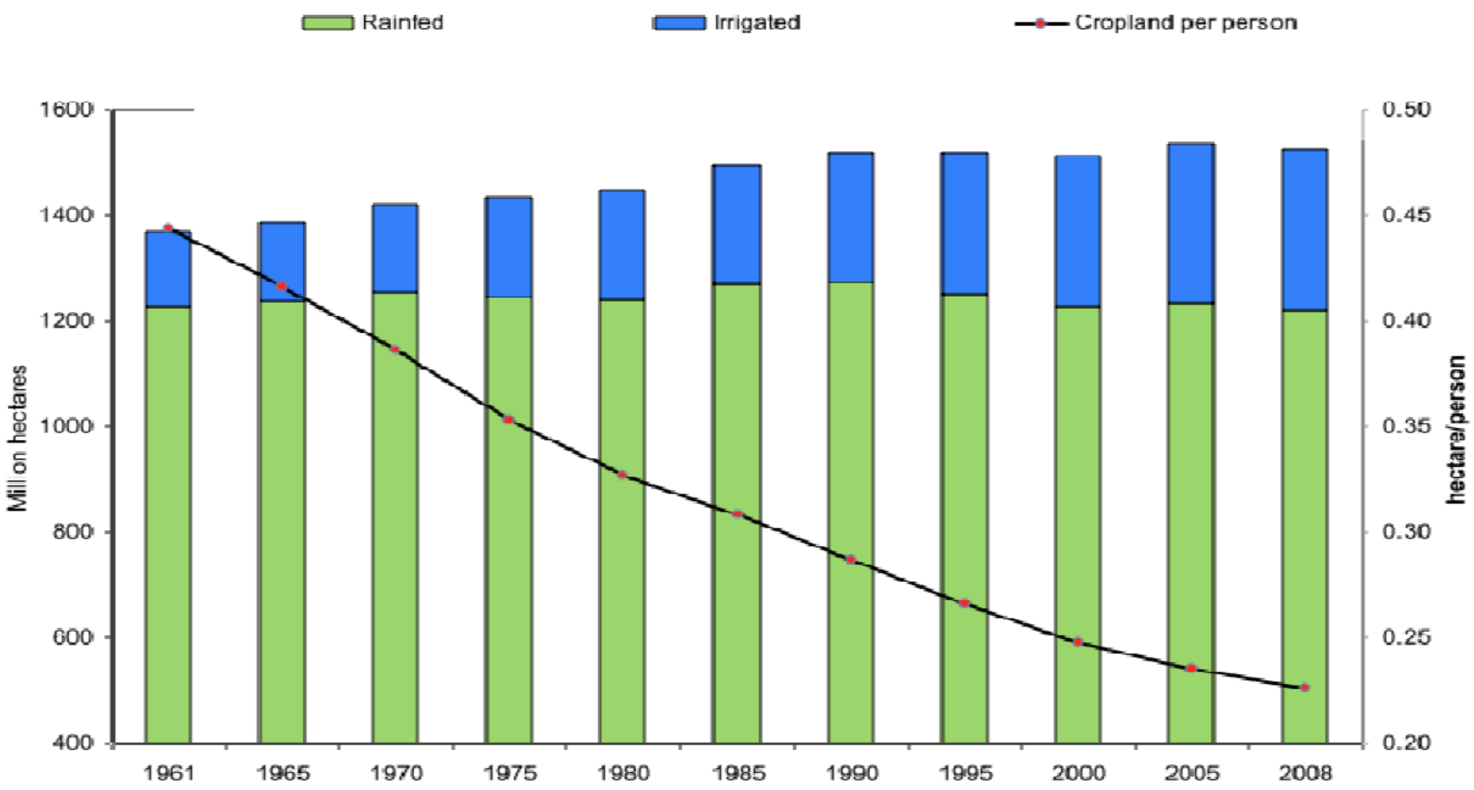
Water leakages

- World: 25 – 50% of treated water is lost
- Chicago: up to 60%
- London: large leakages
  - 900,000 *m3* per day → 670,000
- Malaysia: about 36%

Lost water = lost energy

Global trends and drivers

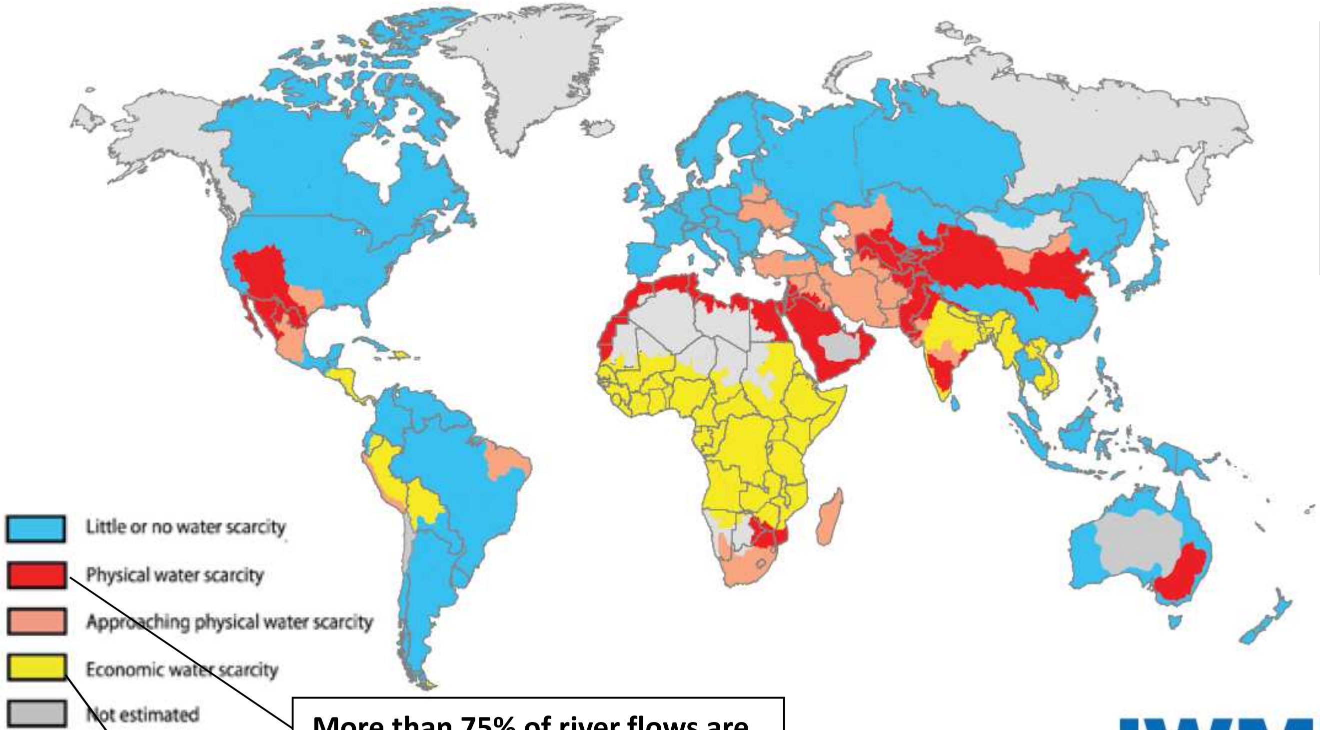
- Increasing food demand – available land area for agriculture is reducing



FAO, 2011

Global trends and drivers

- Water scarcity: Aggregated global water supply gap, estimated to be 40% by 2030 assuming no efficiency gains



Increased climate variability intensifies existing problems

More than 75% of river flows are allocated to agriculture, industries or domestic purposes

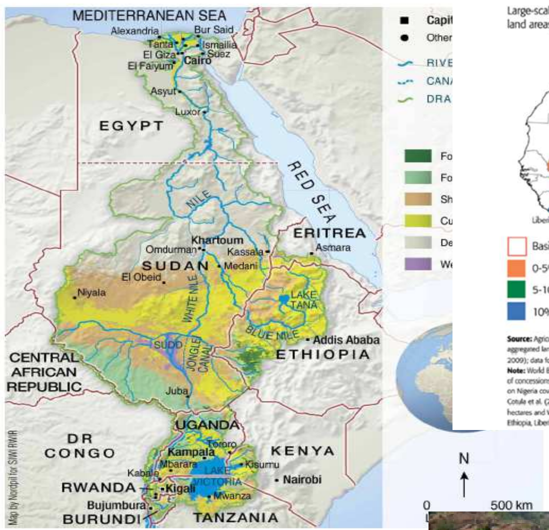
Water resources can be abundant but lack of investment makes them unavailable for exploitation

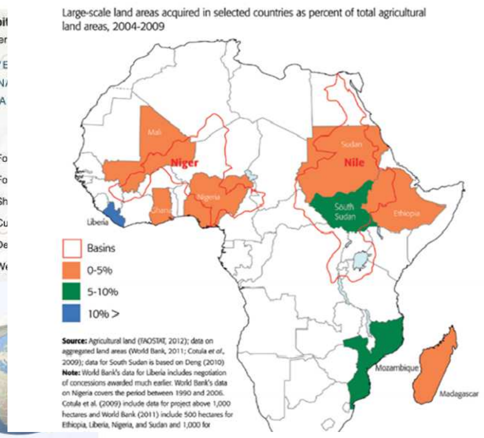
IWMI International Water Management Institute

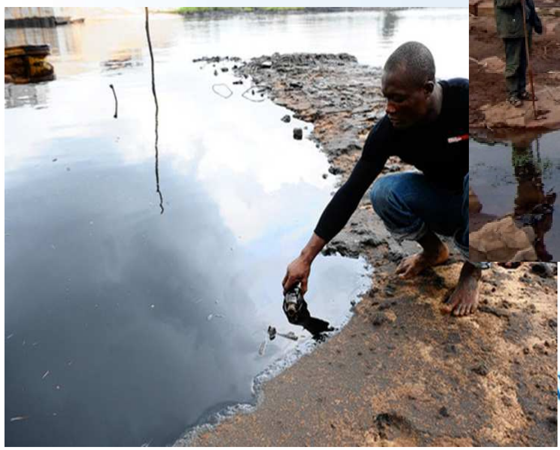
Different manifestations of WEF impacts- in context

WEF Nexus consequenses

Figure 1. Map of the Nile Basin







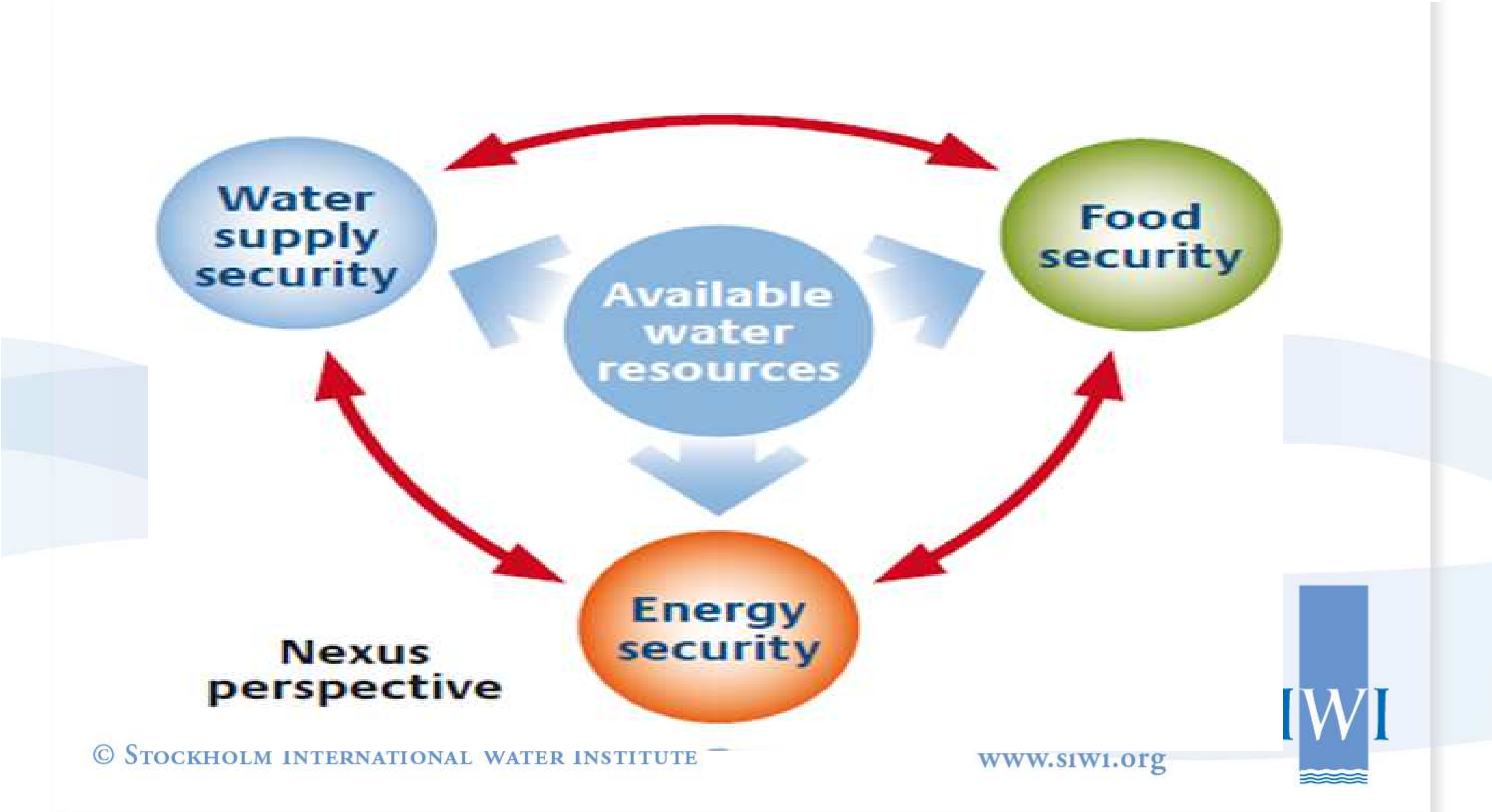
- Water food and energy security in conflict? Nile basin
- ”Securing” land and **<u>WATER</u>** resources outside own national borders
  - Growing private sector interest in bio crop production
- Impacts on water resources from energy production

The WEF nexus as an analytical framework

A nexus approach:

”an approach that observes, accounts for and suggests most strategic and sustainable development options and paths in connected water, energy and land management systems at different scales and contexts”

The nexus Water Energy Food Nexus



A nexus approach

Plans, Policies, Laws, Technology choices, Institutional arrangements etc

Outcomes

- **<u>Identify the desired change to be achieved through intervention</u>**
  - Baseline to desired state
  - Active nexus components?
  - Barriers to change?
  - Beneficiaries?

Unit

- **<u>Identify appropriate scale/unit of intervention</u>**
- Local/basin, national, micro-region/transboundary basin, macro region, global
- Best vehicle of change for unit? (basin org.? Power pool? Devt. Community? Global compact?

Data/information

- **<u>Type of information needed and available</u>**
- Qualitative and/or quantitative approach?
  - Data intensity

Information available and generally accepted among stakeholders at scale

Assessment tools

- **<u>Options for information handling</u>**
- TBO analyses
- Hydroeconomic modelling
- Integrated WEAP/LEAP

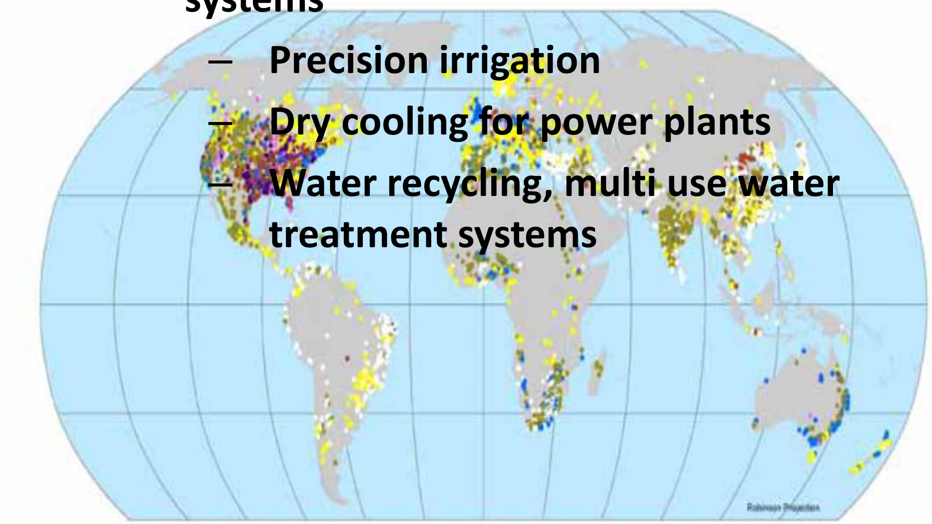
Type of assessment and available information

Key issues- challenges to opportunities

Key issues

Closing the demand/supply gap

- **Short to mid term- closing efficiency gaps sector by sector**
  - Reduce wasteful water and energy generation consumption
    - Water supply infra structure
    - Irrigation
- **Deploy energy and water efficient supply systems**
  - **Precision irrigation**
  - **Dry cooling for power plants**
  - **Water recycling, multi use water treatment systems**

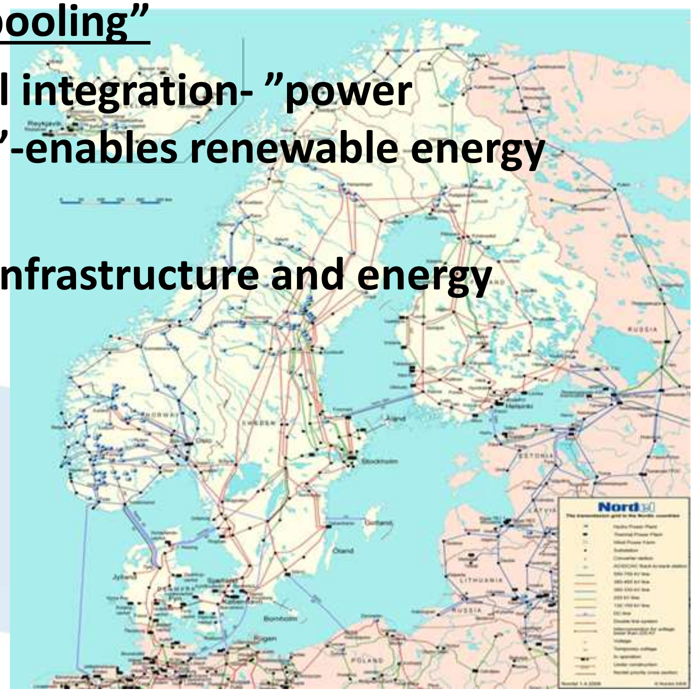


Water storage globally

- Drinking water, energy, irrigation, flood control, etc
- At different scales, natural/ contructed

“Resource pooling”

- **Regional integration- ”power pooling”-enables renewable energy growth**
- **Shared infrastructure and energy markets**



Regional approaches

- SIWI Projects

South-Eastern-Baltic Sea Region
A micro-region defined by its transboundary waters lacking cooperative frameworks

Cooperative tracks identified for further development in the Neman region by riparian governments & civil society

- **Political track - dialogue & trust**
  - Re-start dialogue on joint Commission
  - Working group/round tables

- **Technical track**
  - Joint modelling approaches, sharing data and validation
  - Regulatory framework mapping and harmonization
  - Nexus analysis
    - Water resources management plan: nutrient management, environmental flows, risk assessment, fisheries management, water supply
    - Energy: Regulating power for renewable energy generation, energy efficency, renewable energy scenarios, climate change, feed in tariffs, support development of wind, solar and energy, energy mix and how it impact natural resources, NPP and electricity import / power market development
- **Investment track**
  - Joint coordinated surface and groundwater monitoring system
  - Joint early flood & drough warning system, adaptation measures
  - Cross border power system planning

Conclusion – Nexus Value Add

- Increases the understanding of dynamic systems taking multiple sector objectives into account
  - Analytical approaches that are scale and context specific
  - From qualitative to quantitative analysis
  - Linkages/challenges/options
- Contributes to assess governing options at different scales
  - Norms, institutional structures and options
  - Policy coherence
- Identifies management options & innovation needs
  - Resource planning
  - Operational aspects, synergies & tradeoffs
  - Solution oriented