The Role of the Water-Energy-Food Nexus in Industrial Applications

Prof. Dr. Petra Schneider
Magdeburg-Stendal University of Applied Sciences, Germany

A Historical Perspective on Sustainability

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A Historical Perspective on Sustainability

concept of "*sustainable*" silviculture was introduced in 1713 by Hans Carl von Carlowitz in his book Sylvicultura oeconomica → responsible management of forest resources

First limits to growth and how they were overcome

- Growth is limited: decreasing marginal revenue
  - Limit: energy availability
  - Limit: land availability
  - Limit: water availability

Kasimir Geibel, 1896

- transport is limited: Land transport is associated with high energy costs

- use of renewable energy flows is a prerequisite for ecological sustainability

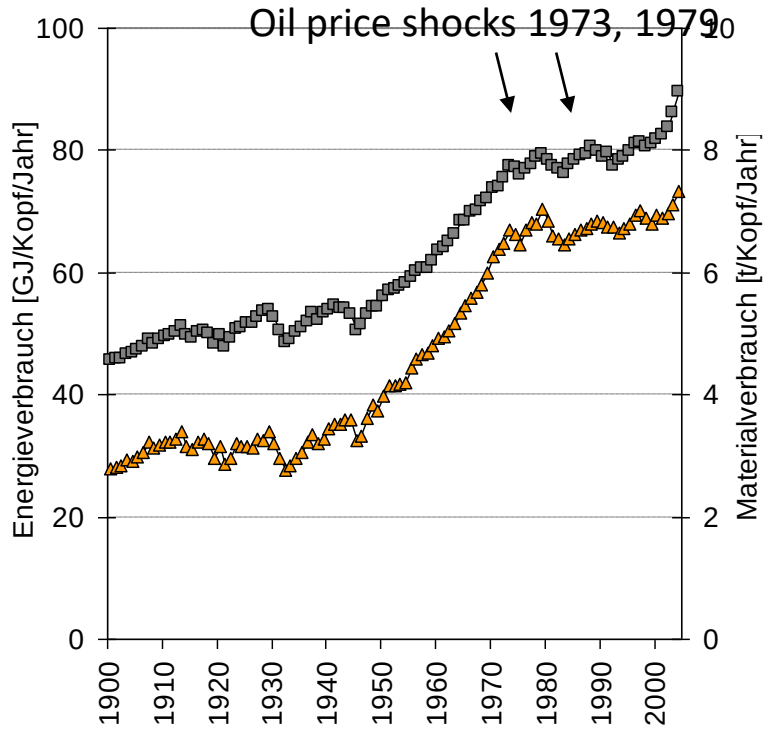
First limits to growth and how they were overcome

- 1st energy transition to overcome the limit
- Solar → coal … around 1700

- 2nd energy transition
- coal → oil … around 1900

→ **Ensuring energy security**

- **Preparation for 3rd energy transition**
- **oil – solar**



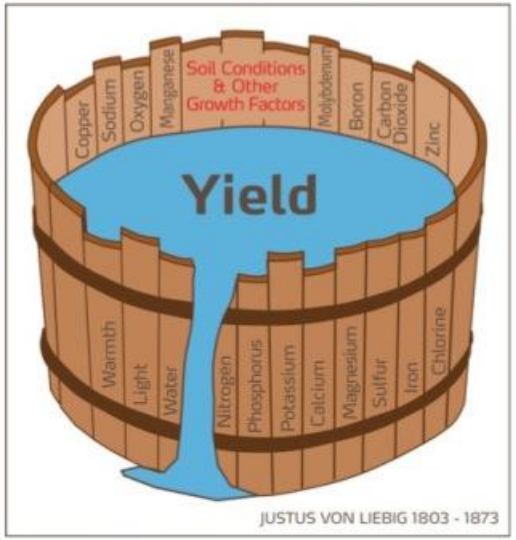
(Source: Krausmann, 2009)

First limits to growth and how they were overcome

- maintenance of soil fertility is a central sustainability problem
- Justus von Liebig developed artificial fertilizer, paving the way for a huge increase in the productivity of arable farmland

Justus von Liebig's "Law of the Minimum" published in 1873

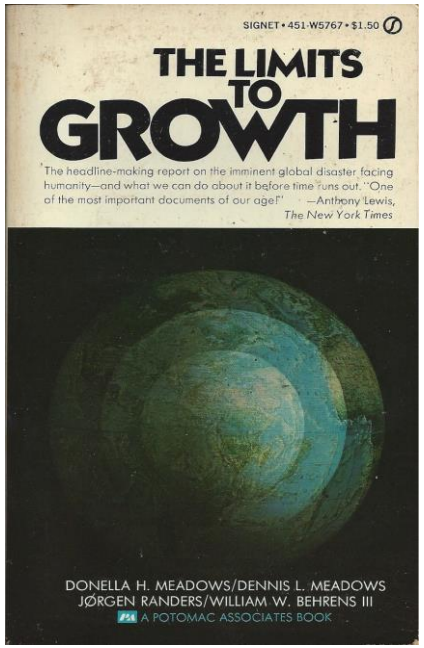
"If one growth factor/nutrient is deficient, plant growth is limited, even if all other vital factors/nutrients are adequate…plant growth is improved by increasing the supply of the deficient factor/nutrient"

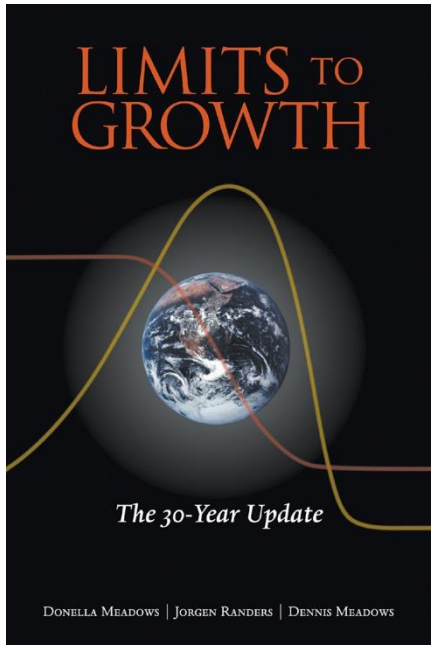


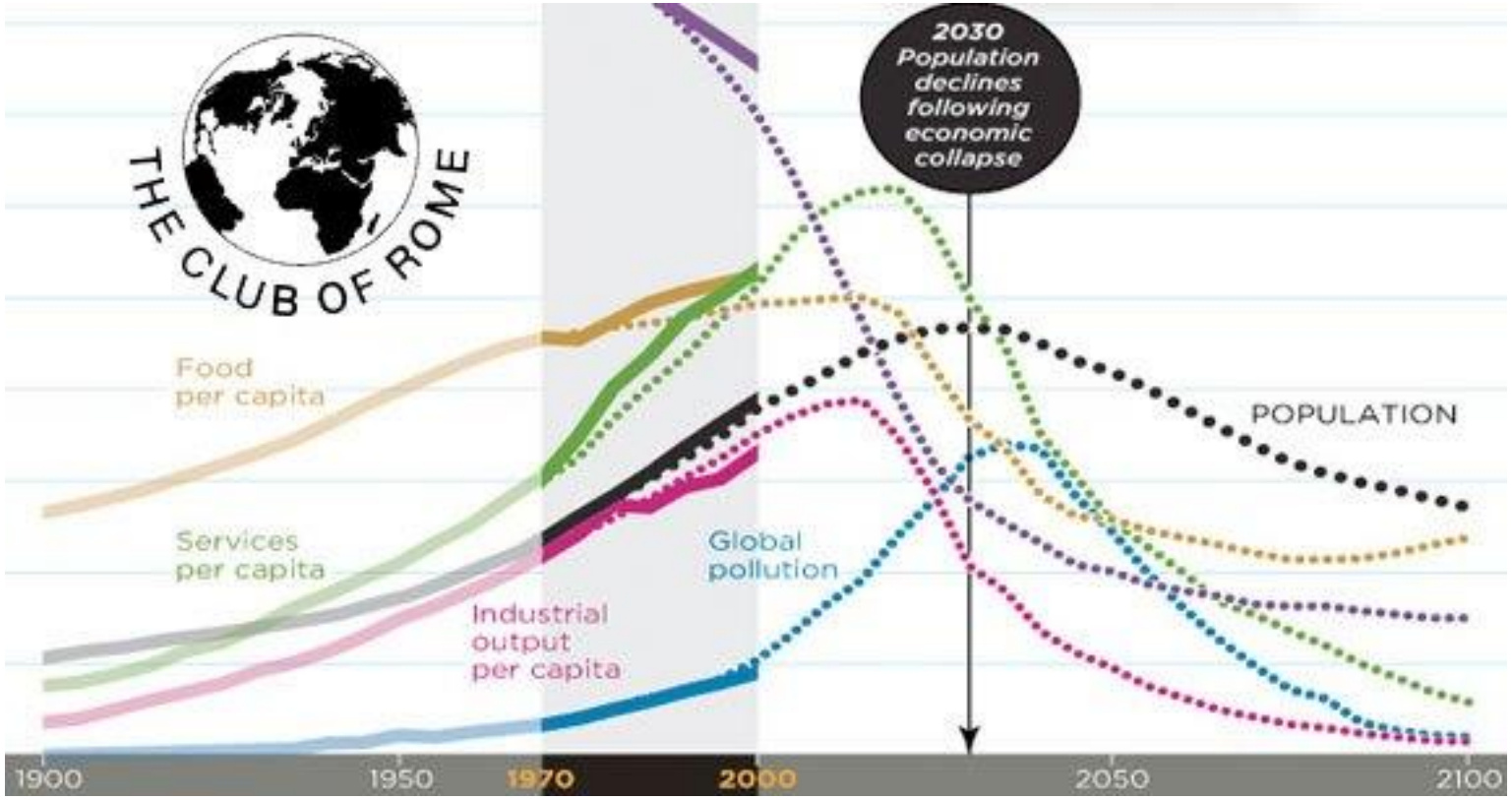
→ **Ensuring food security**

Current limits to growth

- Study of the Club of Rome 1972: The Limits to Growth
- A Synopsis: Limits to Growth: The 30-Year Update (2004, 2012)







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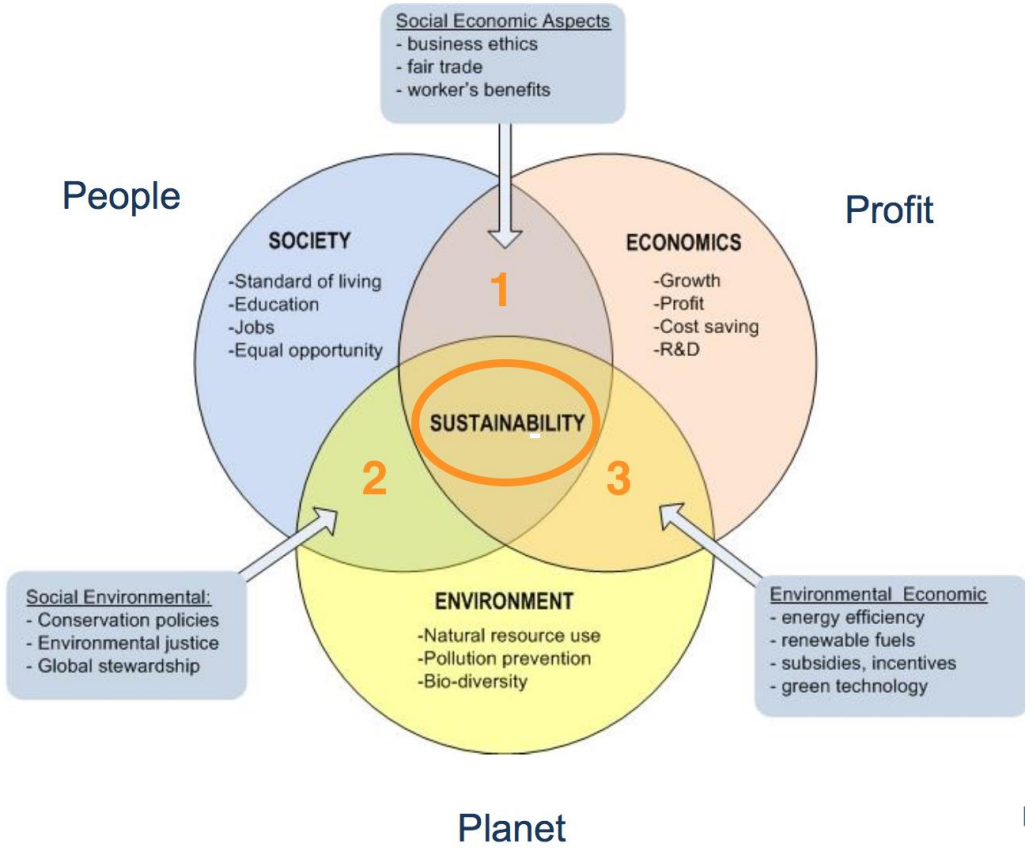
What is sustainability ?

The World Comission on Environment ans Development (Brundtland Comission)

- “Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs"
- Brundtland Commission “Our common future” 1987

What is sustainability ?

The „Triple Bottom Line“ – People – Profit - Planet



(Source: Elkington, 1997)

The „Quadruple Bottom Line“ – Adding Purpose to the Mix

(Source: source: www.npsp.sa.gov.au)

Resource Scarcity and the Need for Sustainable Use

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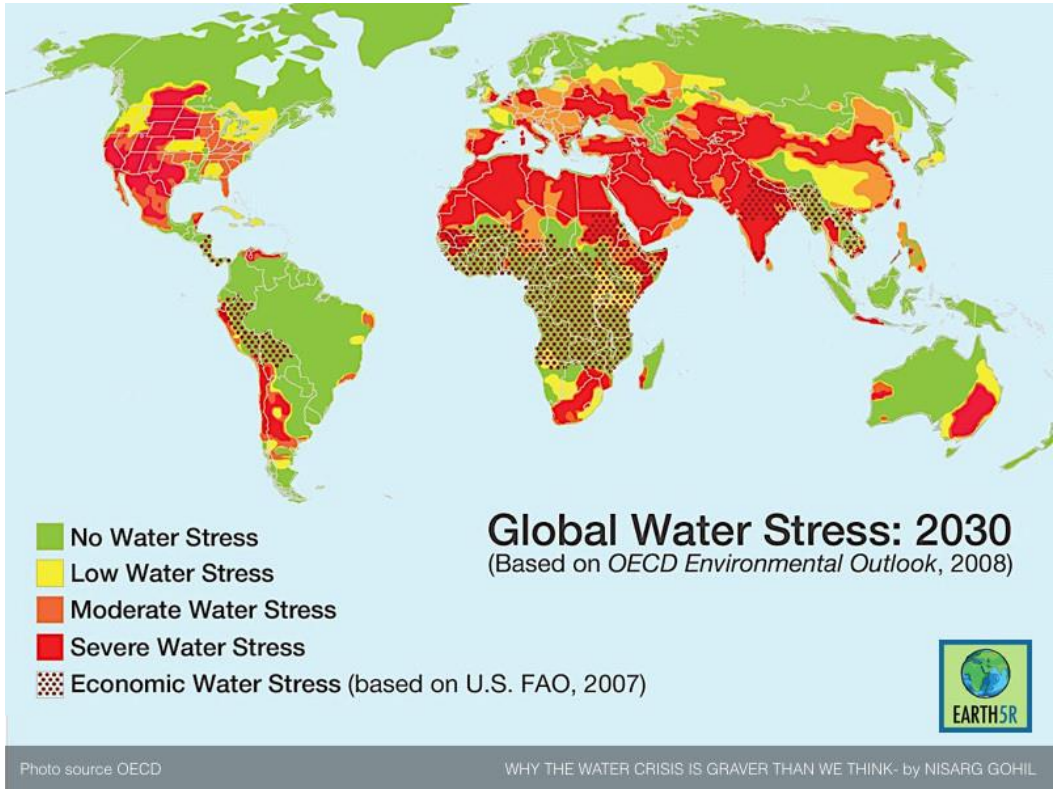
Water Security and Integrated Water Resources Management

Water security (UN-Water, 2013):

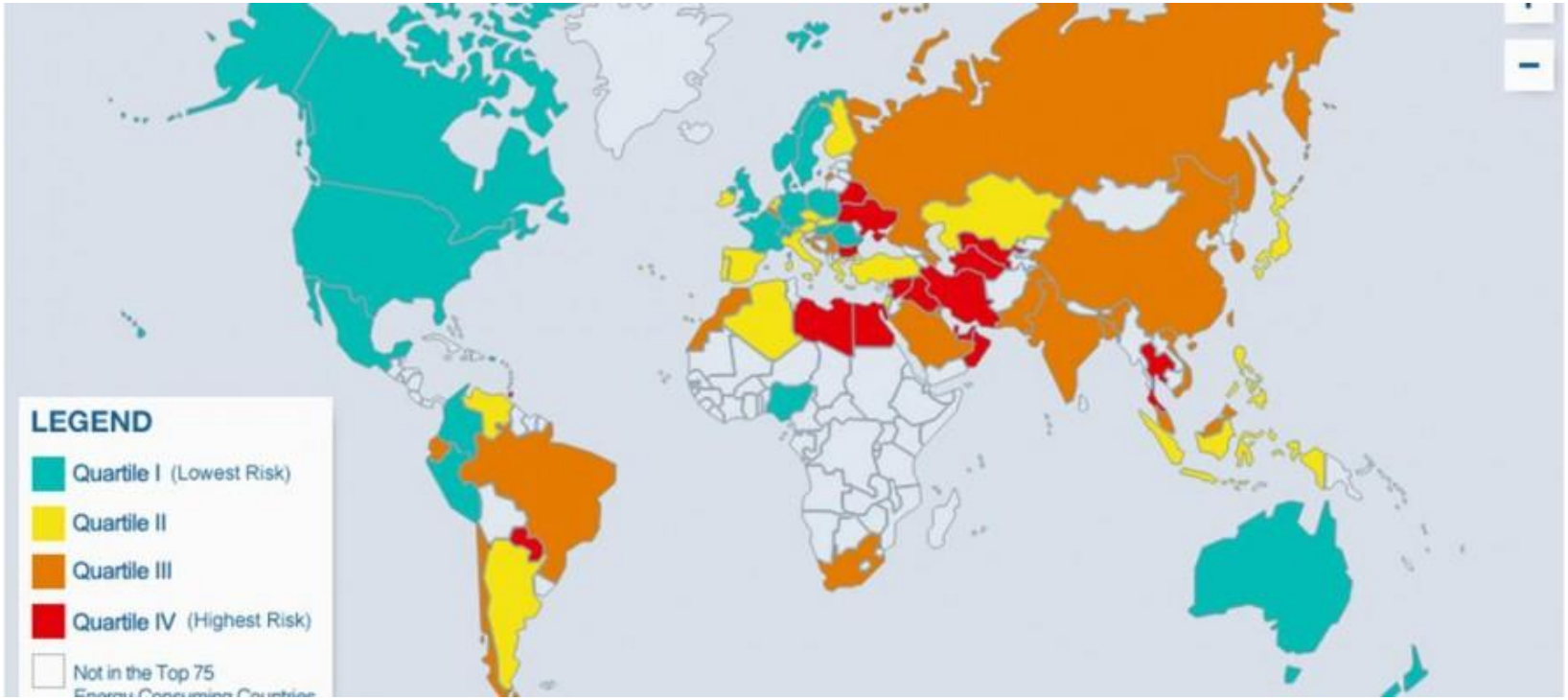
"The capacity of a population to safeguard sustainable access to adequate quantities of and acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development, for ensuring protection against water-borne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability"



Energy Security and Use of Renewable Energies

International Energy Agency (IEA) defines energy security as

uninterrupted availability of energy sources at an affordable price.

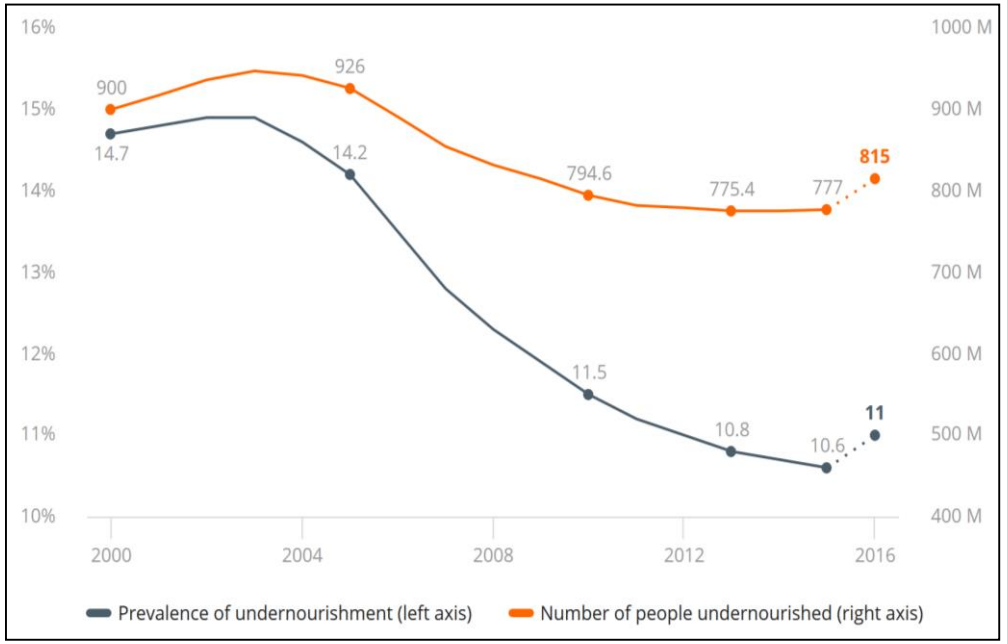


International Energy Security Risk Index

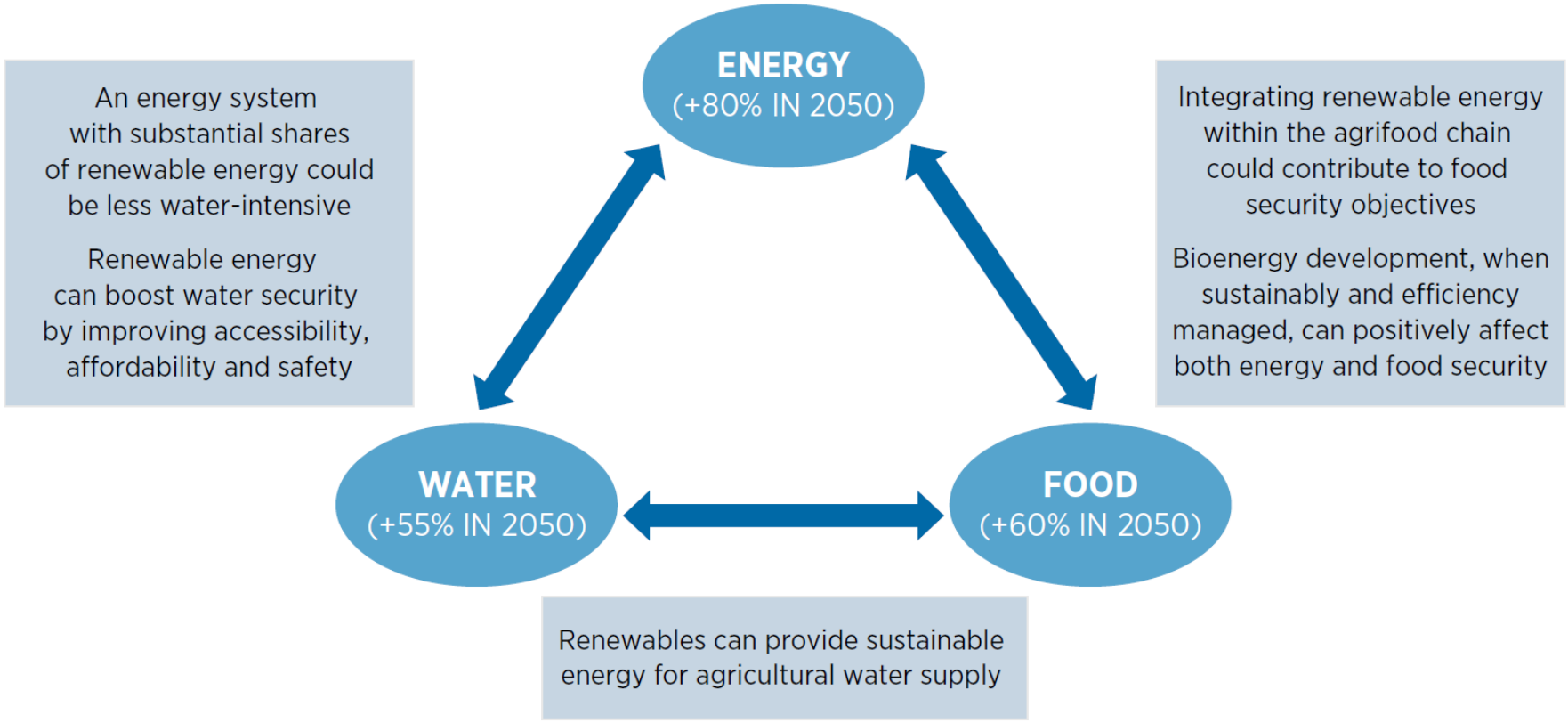
Food Security

- FAO World Food Summit (WFS) definition as of 1996, aimed at renewing the global commitment to fight world hunger:

- *"Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life"*



Forecast for the Development of Global Problems



Source: IRENA's Renewable Energy in the Water – Energy – Food Nexus

Nexus Approach to Sustainable Development

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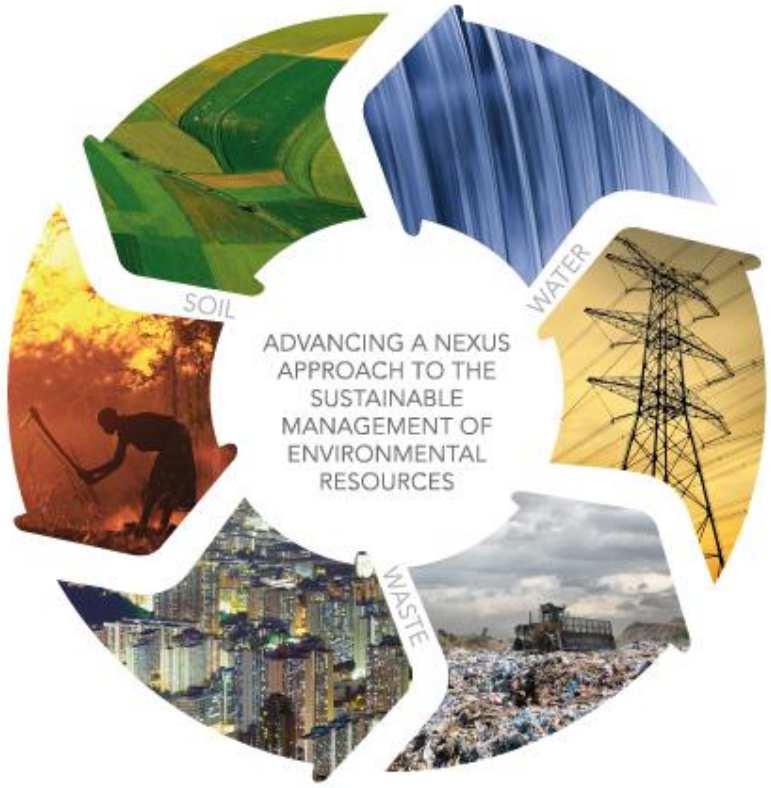
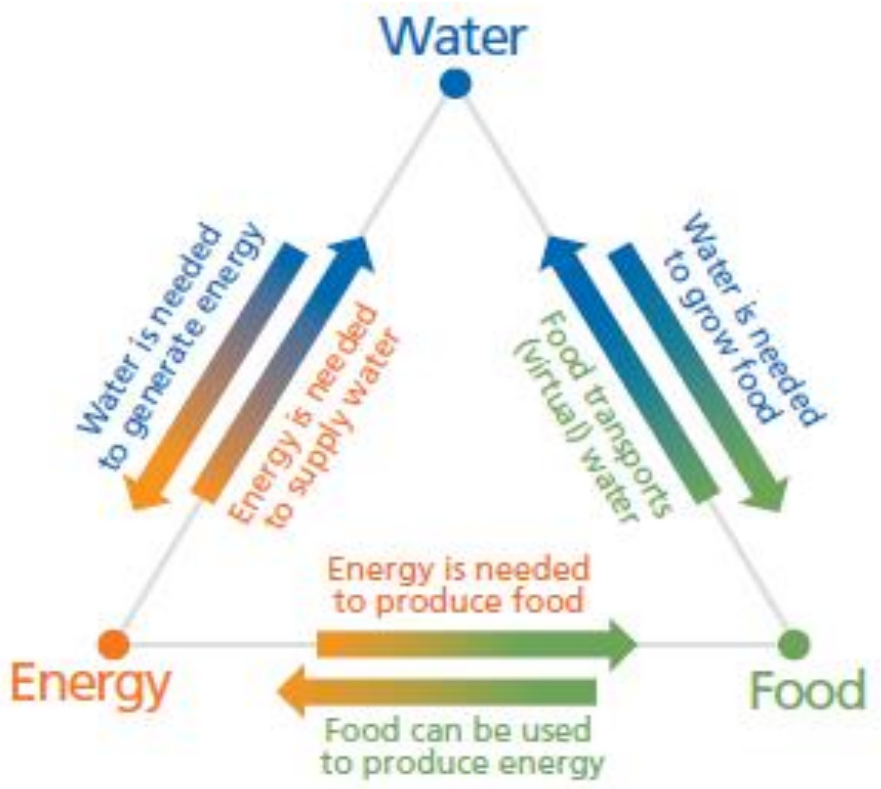
Nexus Approach

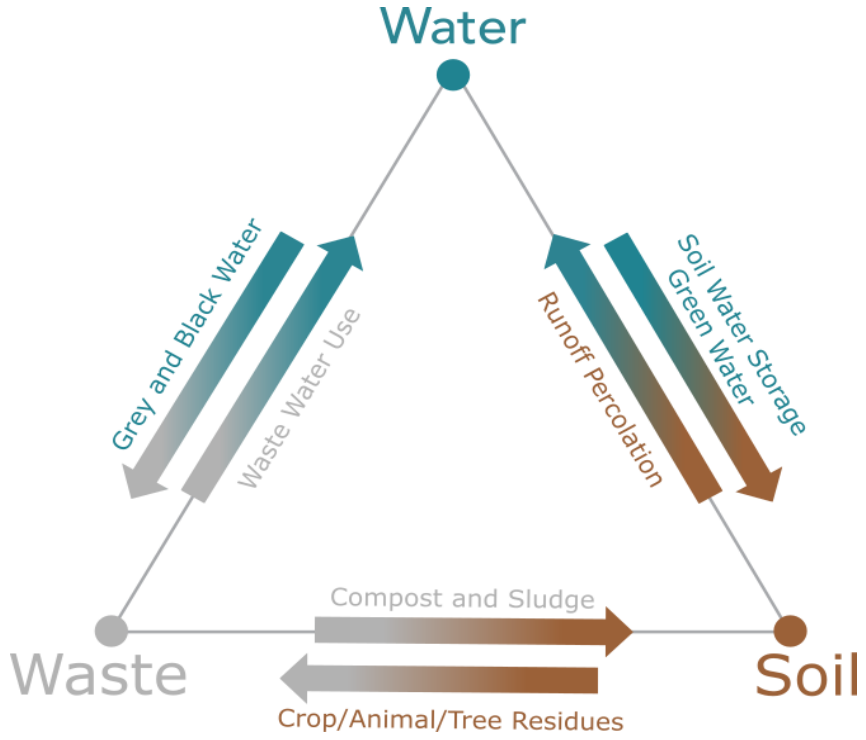
The Nexus Approach to environmental resources' management examines the **interrelatedness and interdependencies** of environmental resources and their **transitions and fluxes acros spatial scales and between compartments**.

UNU Institute for Integrated Management of Material Fluxes and of Resources (UNU FLORES, 2015)



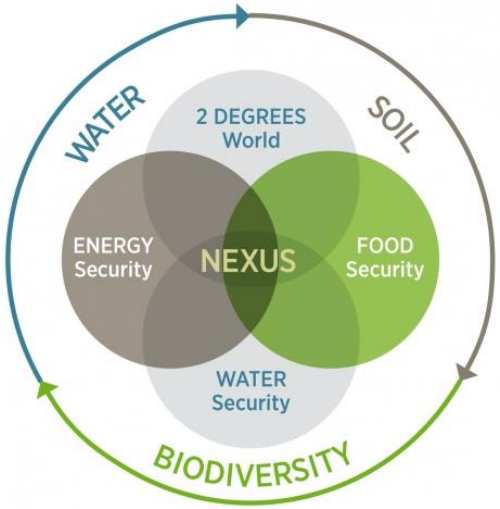
Water-Energy-Food Nexus vs. Water-Soil-Waste Nexus

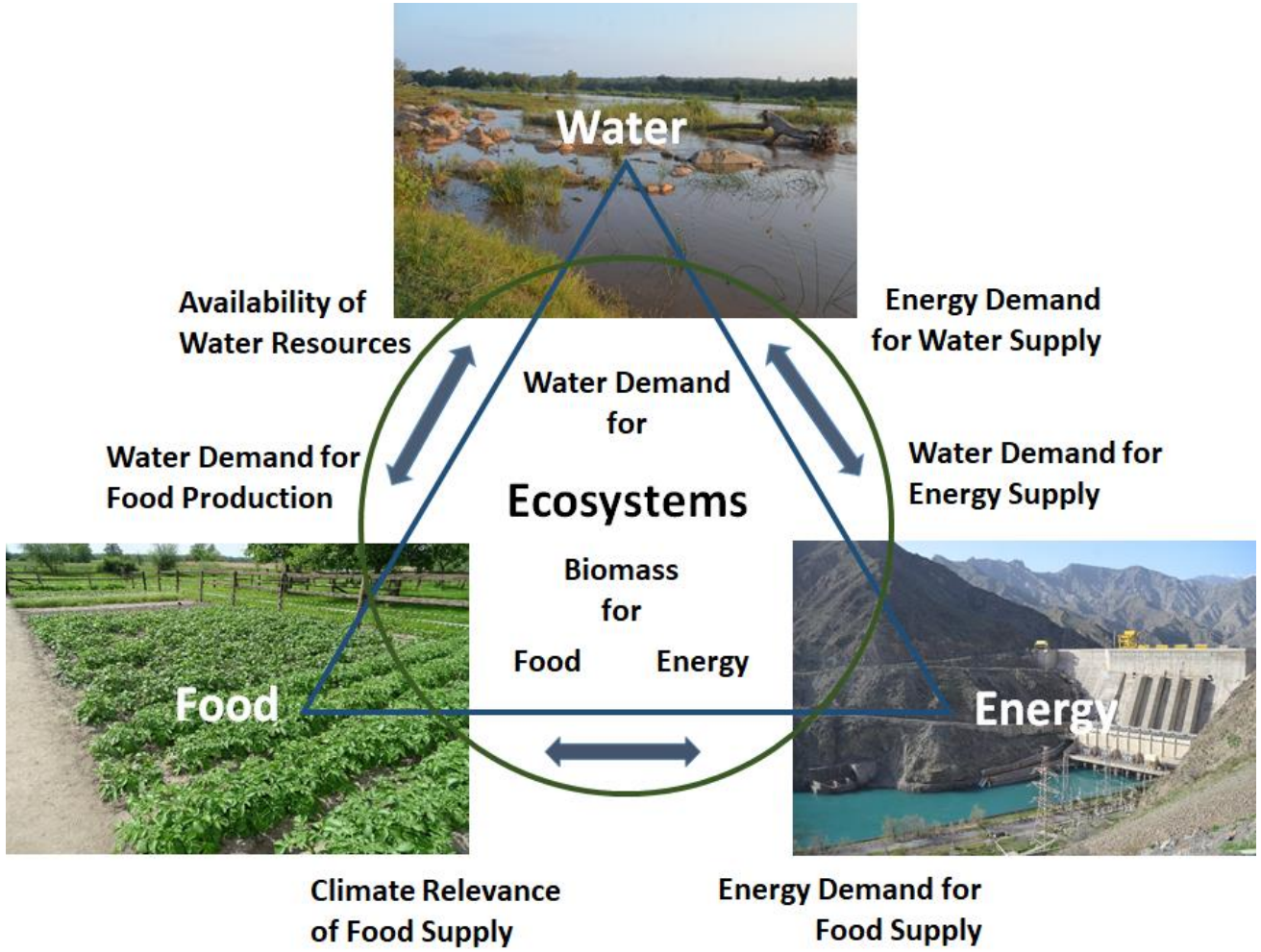




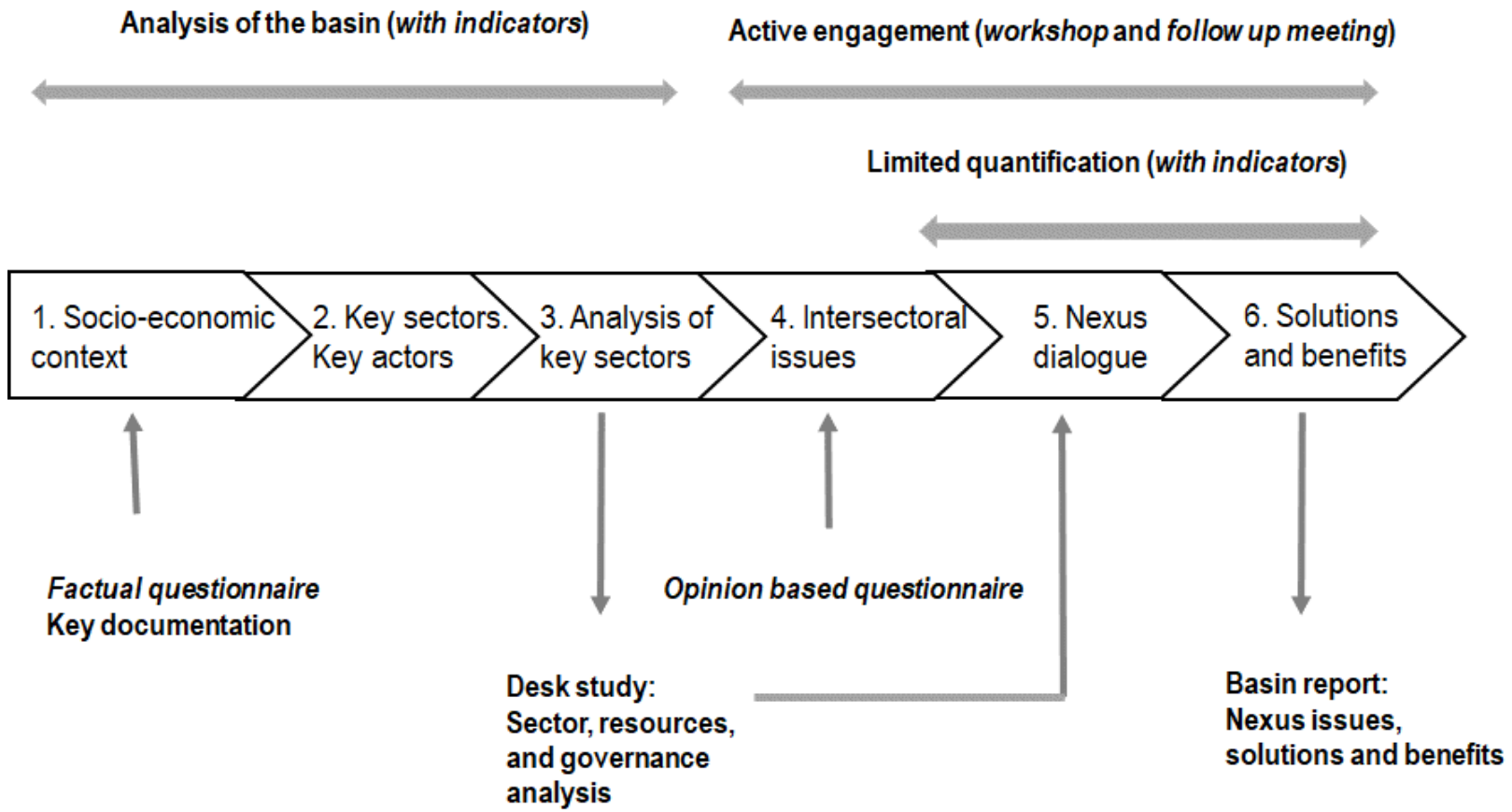
Source: UNU FLORES, 2015

Water-Energy-Food Nexus and Ecosystems





Balancing of Interests of Competing Uses: The Nexus Dialogue



(de Strasser et al. 2016)

Nexus Approach in Industrial Applications as part of Sharing Economy

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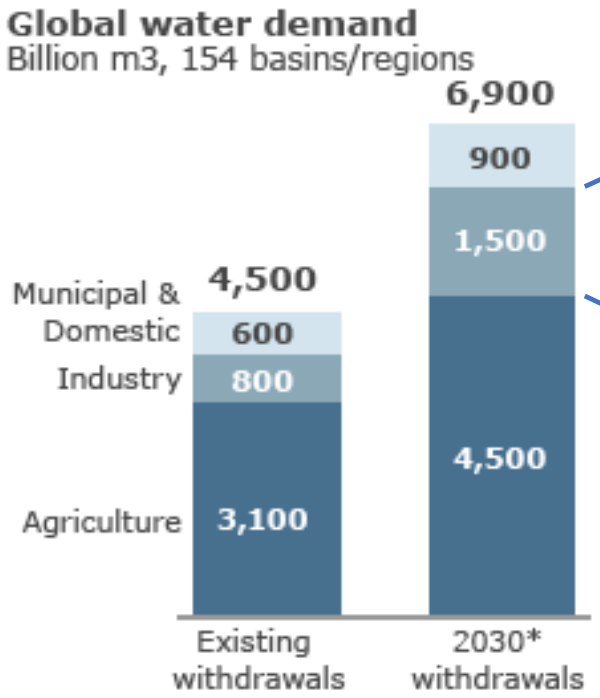
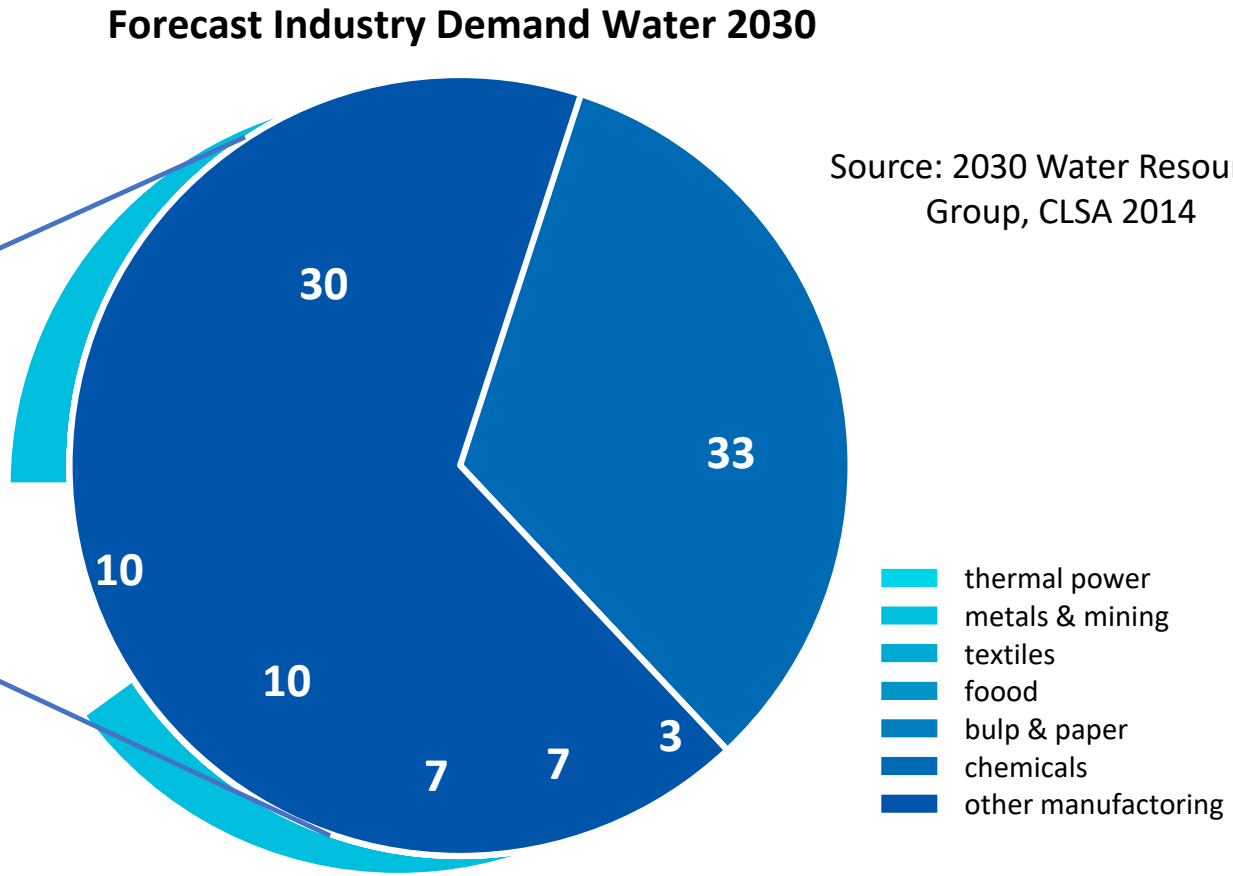
Future Demand of Water in Industries





Source: 2030 Water Resources Group, CLSA 2014

Nexus Approach in Industrial Applications ?

interrelatedness and interdependencies of environmental resources

→ mitigating fragmentation of material and energy cycles
→ closing the loops of environmental resources

their **transitions and fluxes across spatial scales and between compartments**

→ collaboration between sectors for responsible joint use of resources
→ benefiting from cascade effects to reduce / eliminate waste

Nexus Approach in industrial applications can be considered a form of sharing economy

Implementation of the Nexus Approach in Industrial Applications: Industrial Symbiosis

Sharing resources to increase resource productivity

→ foster circularity
→ increase products and resources life time across the value chain
→ propose Nexus dialogue as communication approach between sectors

Samples for Water-Soil-Waste Nexus as industrial symbiosis:

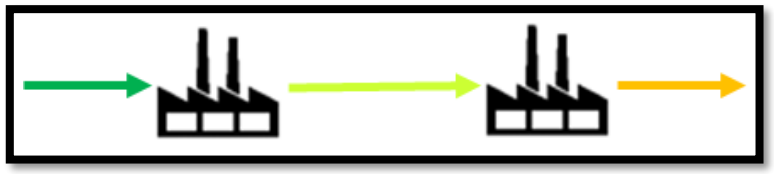
Industrial Symbiosis in Kalundborg, Denmark

Samples for Water-Energy-Food Nexus implementation approach as industrial symbiosis:

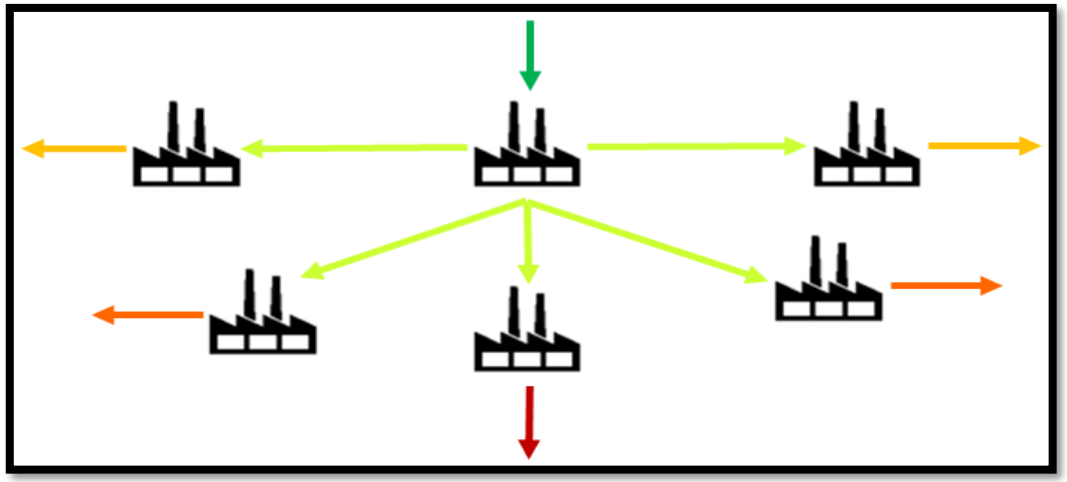
Industrial Symbiosis design in Zayandeh Rud River catchment, Iran

Sharing through Appropiate Linking

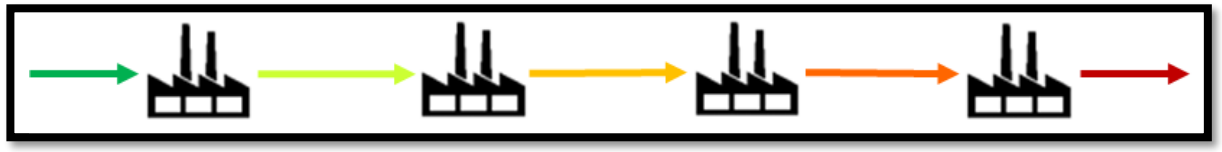
1. Bilateral principle



2. Nucleus principle

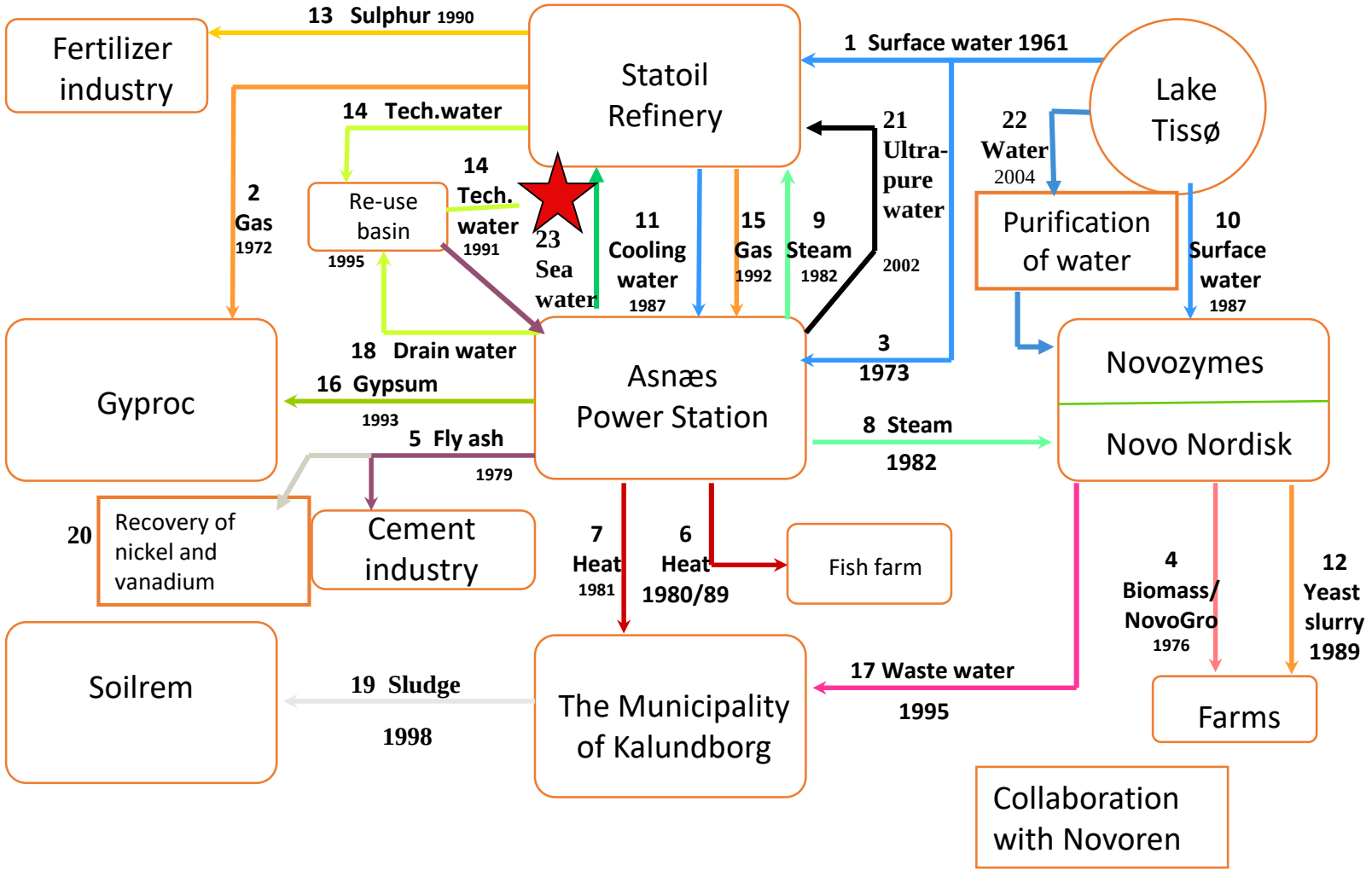


3. Cascade principle



Source: von Koerber, University of Applied Sciences Magdeburg-Stendal, 2016

Industrial Symbiosis in Kalundborg, Denmark



Source: Kalundborg Symbiose Centre, 2016

Annual resource savings in EIP Kalundborg

(35 affiliated business units):

- Fresh water 2.1 M m³/a
- Oil 19,000 t/a
- Coal 30,000 t/a

Other savings:

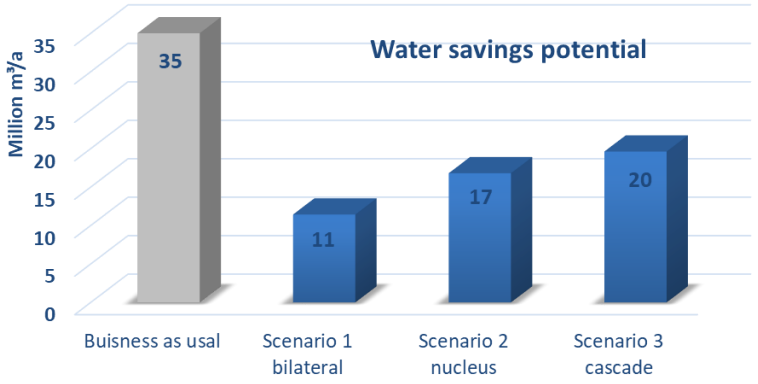
- Avoided emissions
  - CO_2 130.000 t/a
- Avoided consumption of raw materials
  - gypsum 80.000 t/a
- Avoided wastes
  - Waste water 1 M m³/a

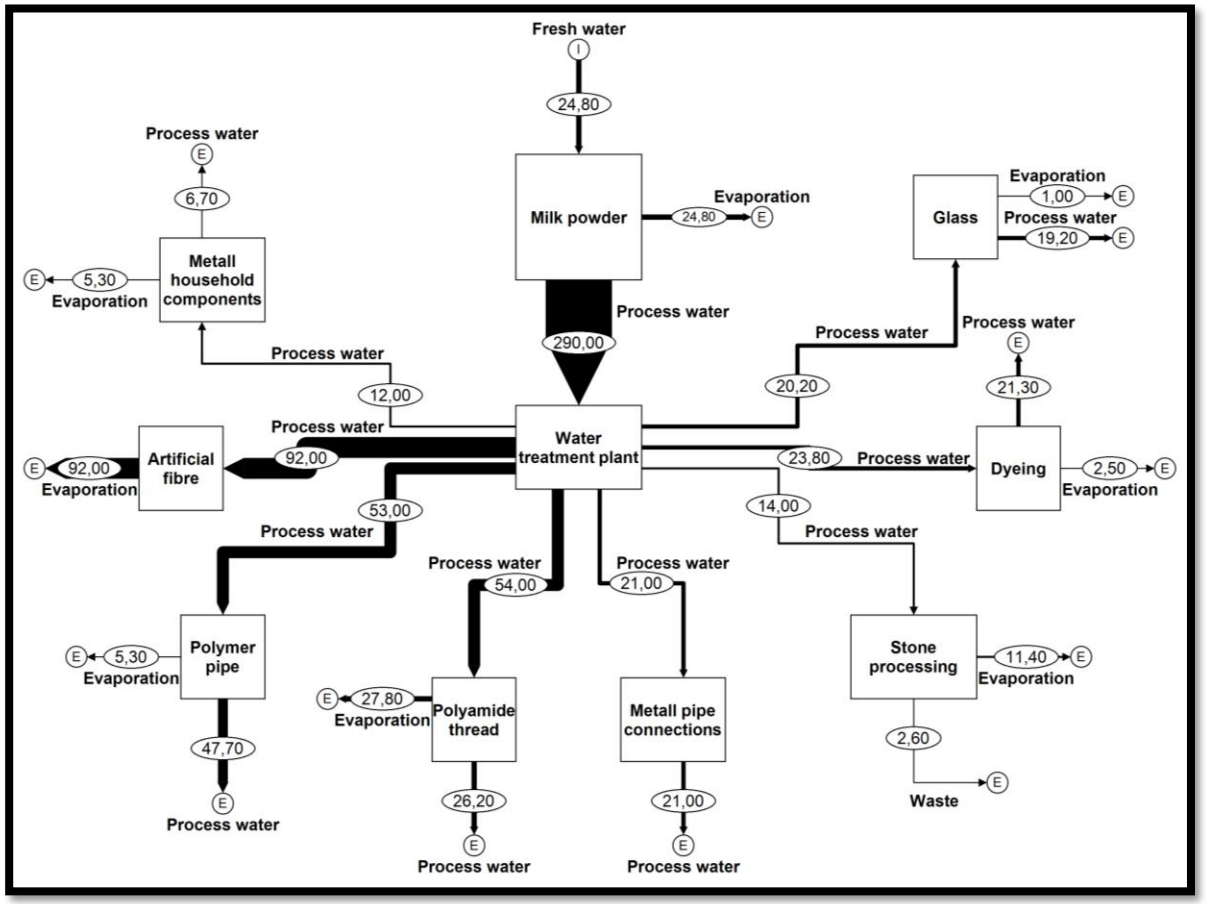
Source: Source: Ehrenfels&Gertler, 1997

Industrial Symbiosis design for Industrial Settlements in Zayandeh Rud River catchment, Iran

- Results IWRM Zayandeh Rud Project
  - Industrial settlements water consumption
    - Today 27 M m³/a
    - 2025 62 M m³/a

→ Growth of water consumption 35 M m³/a





Source: von Koerber, University of Applied Sciences Magdeburg-Stendal, 2016



Thanks for your attention ! Gracias !

Room for Discussion.