

# The Water - (Land-) Energy – Ecosystem Nexus in the Blue Nile / Ethiopia

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## Nexus Background Paper

[www.water-energy-food.org/documents/understanding\\_the\\_nexus.pdf](http://www.water-energy-food.org/documents/understanding_the_nexus.pdf)



SEI, KTH,  
FAO, IAEA, UNDESA...

A large circular graphic with a yellow border, divided into three sections: a sun in orange, a body of water in blue, and wheat stalks in green.

**Bonn2011 Conference**  
**The Water, Energy and**  
**Food Security Nexus**  
Solutions for the Green Economy  
16 – 18 November 2011

# Understanding the Nexus

Background paper for the Bonn2011 Nexus Conference

## What is „the nexus“ ?

an integrated approach promoting “systemic thinking”  
e.g. externalities, tradeoffs, synergies

## Why do we need it ?

increasing demand for natural resources,  
for food, energy and other human securities,  
threatens environmental sustainability , ecosystem services  
-> need for sustainable intensification  
-> need for coherent policies across scales  
-> to be supported by multi-scale, cross-sectoral analyses

## How to implement it?

mostly through case studies:

Burkina Faso (food-biofuel) , Mauritius (sugarcane for biofuel),  
MENA (climate adaptation – mitigation), California, Blue Nile

# **Tool box for nexus tradeoff analysis, integrated scenarios, policy and investment support**

## **WEAP / LEAP (AEZ)**

- simulating long-term resource allocations,
- integrated network-based demand and supply analysis,
- transparent, flexible, user-friendly, low initial data requirements,
- similar user interfaces and terminologies,
- widely used in ministries, authorities, bureaus, NGOs, universities etc:  
100s of users worldwide.
- for free to non-profit developing country institutions
- frequent trainings in Sweden, but also in various regions  
(plus online tutorials and handbooks)

to be developed jointly with stakeholders and scientists

# Linking Water and Energy Issues

Groundwater depletion  
Water quality  
Unmet ecological flows  
Costs

Insufficient water for hydro and cooling, even with increased groundwater pumping.

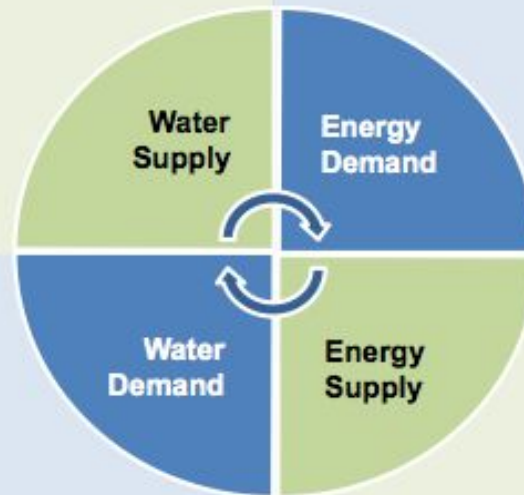
Still insufficient water--further enhance supply with desalination.



Water requirements for hydropower & thermal cooling  
Water conservation

Limited hydropower & cooling water, increased energy requirements for pumping.

Increased energy requirements for desalination.



Hydropower energy & cooling water requirements  
Reduced water demands

Electricity demand  
Energy efficiency



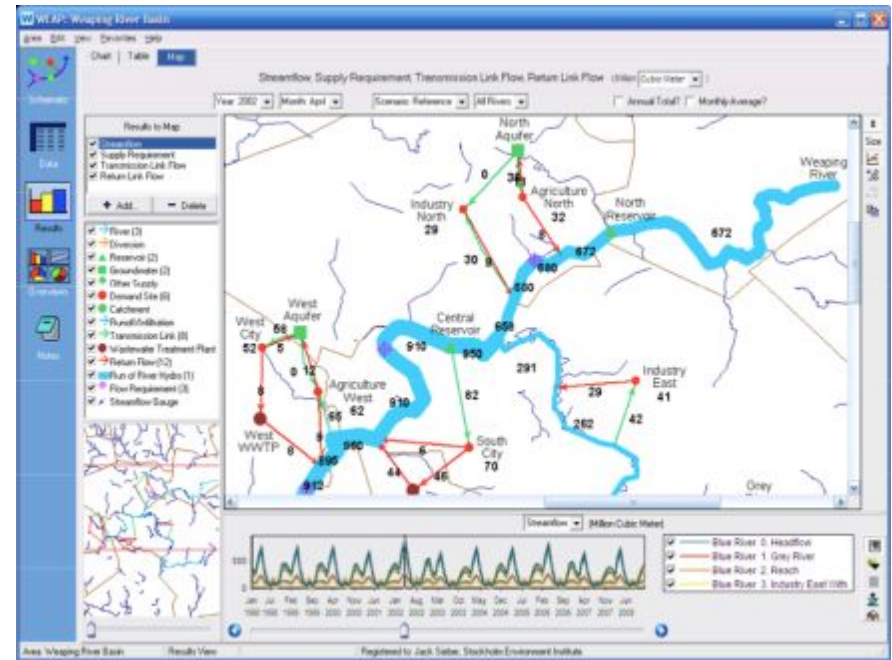
Hydropower & fossil generation  
Wind & solar, less water-intensive cooling

Fuel Use  
GHGs  
Local air pollution  
Costs

# WEAP Water Evaluation And Planning

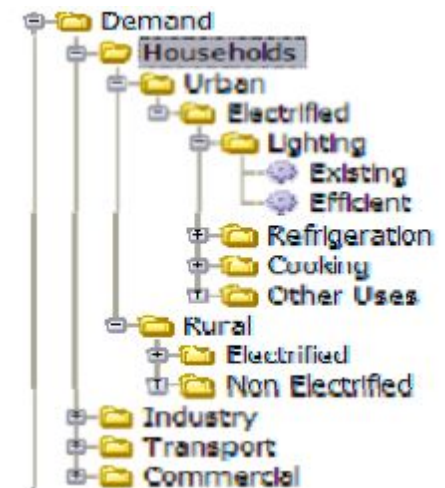
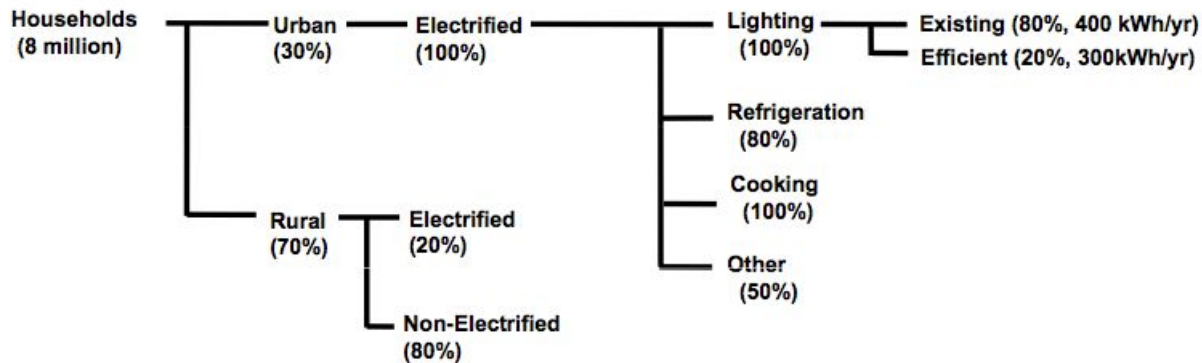
[www.weap21.org](http://www.weap21.org)

- Integrated watershed planning, matching demands and supplies
- GIS-based, graphical drag & drop interface
- Additional simulation modeling possible:  
land use effects,  
groundwater dynamics,  
crop water use,  
crop productivity,  
water quality,  
reservoir management &  
hydropower  
financial module



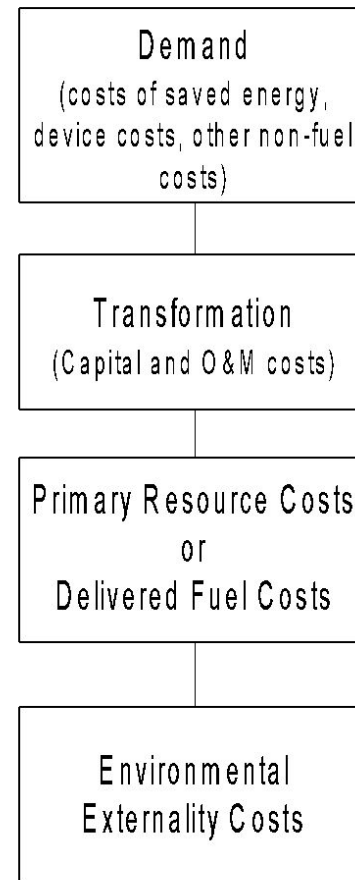
# LEAP Long range Energy Alternatives Planning System

- Typically organized by sector, subsector, end-use and device.
- Users can edit the tree on-screen using standard editing functions (copy, paste, drag & drop)
- Structure can be detailed and end-use oriented, or aggregate (e.g. sector by fuel).



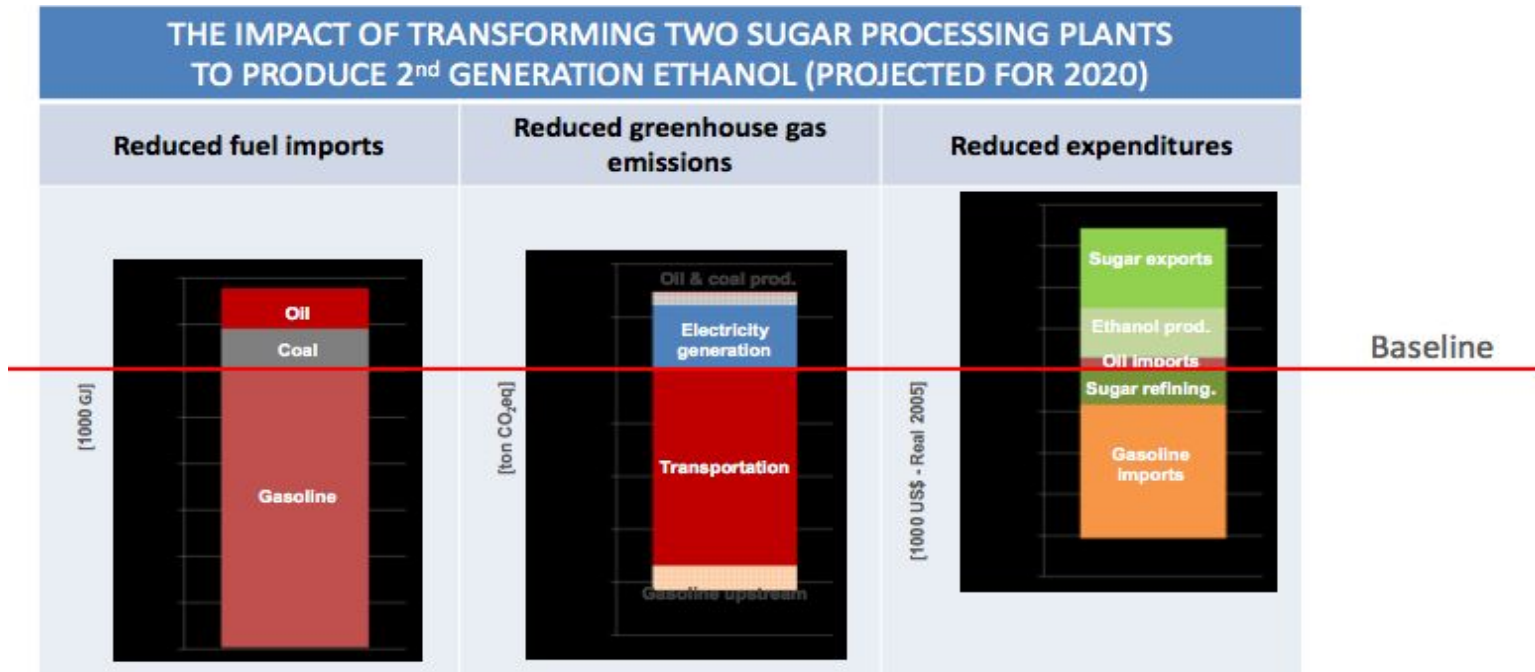
# Cost-Benefit Analysis ("externalities") in (WEAP) LEAP

- Societal perspective of costs and benefits (i.e. economic not financial analysis).
- User specifies boundaries
- Cost-benefit analysis calculates the Net Present Value (NPV) of the differences in costs between scenarios.





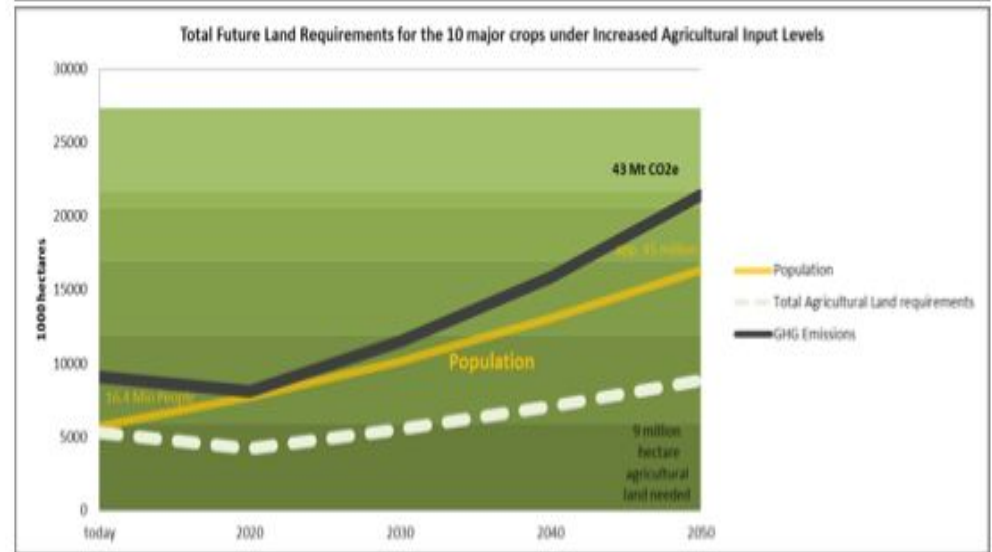
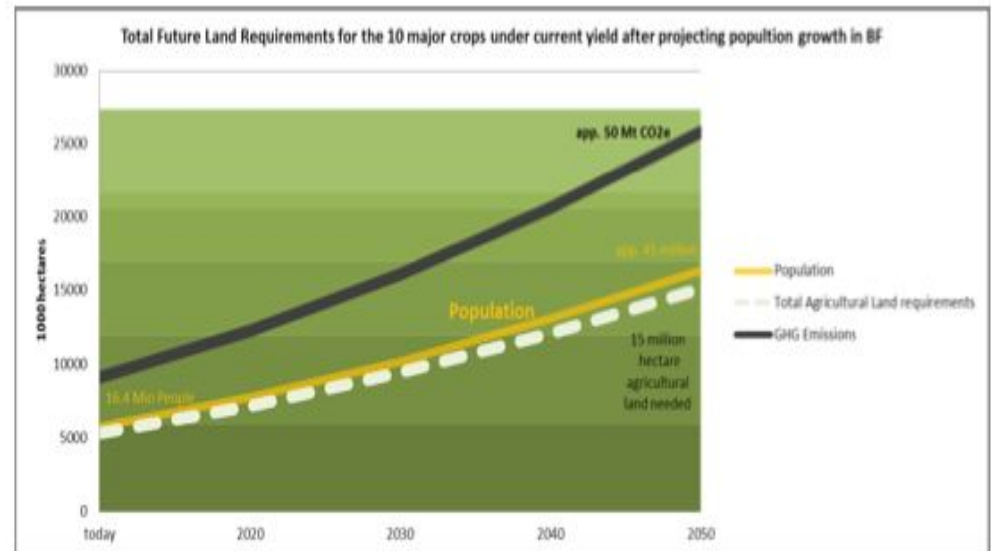
# Previous case studies (KTH, SEI) Mauritius



- Energy Security in changing Climate conditions
- Small island with clear boundaries- data availability
- Producer and exporter of sugar (occupying 80 % cultivated land area)
- Dependent on fuel imports for its energy requirement
- Highly vulnerable to climate change
- Nexus („CLEWs“) approach formally adopted for national policies by the government

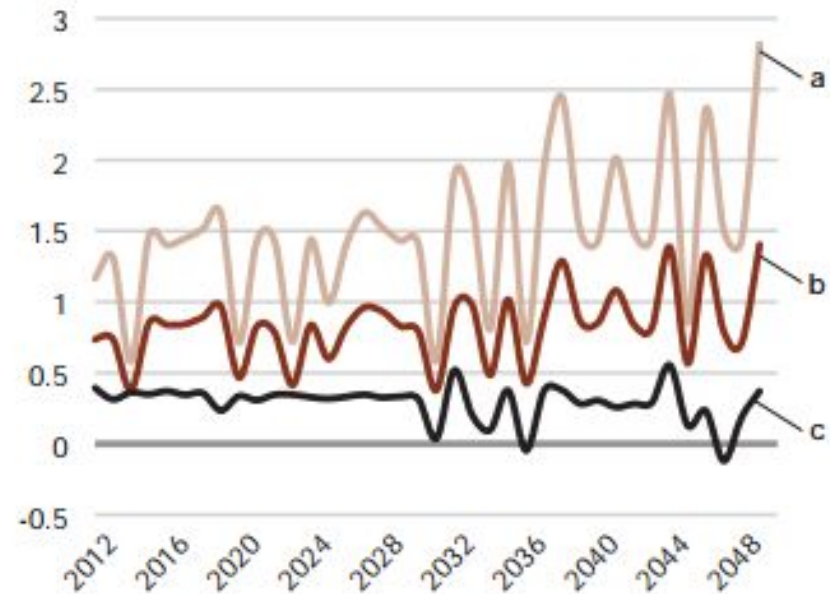
# Previous case studies (KTH, SEI) Burkina Faso

- Increasing Population (water demand, energy access, food security)
- Land locked country
- Population increase and urbanization (centralized demand)
- Dependence on one main export crop (cotton)
- Continuous deforestation
- No own fuel resource – Dependence on wood for as energy source
- Agricultural intensification on suitable land for food security, biofuel production and reduced emissions.



# Previous case studies (KTH, SEI) California

- Water for Energy and Energy for Water
- The water sector accounts for 19% of California's electricity consumption
- Importation of water from North to South California
- Proposed scenario: introduce a share of water supply (5%) from desalination of sea water
- Result: quantified tradeoff: increased energy consumption vs water saved (not imported)



**Figure 3. Changes in DESAL Scenario compared with BAU**

- a. Increase in water-sector electricity use (TWh)
- b. Increase in water-sector GHG emissions (million tonnes CO<sub>2</sub>e)
- c. Reduction in water imports (billion m<sup>3</sup>)

# Application of the nexus concept to the Ethiopian Blue Nile

Supporting ongoing activities, plans and strategies

e.g. GTP & CRGE:

agricultural intensification / commercialization / irrigation,  
renewables / hydropower / bioenergy crops

Identifying pathway to achieve goals such as:

- improved water use efficiency (GTP)
- avoiding further cropland expansion (CRGE)

For discussion: how are the national goals broken down into Blue Nile planning and management?

# Application of the nexus concept to the Ethiopian Blue Nile

proposed focus on biomass production,  
tradeoff analyses / testing different strategies, e.g.

small- vs. large-scale storage

water for hydropower vs. water for agriculture

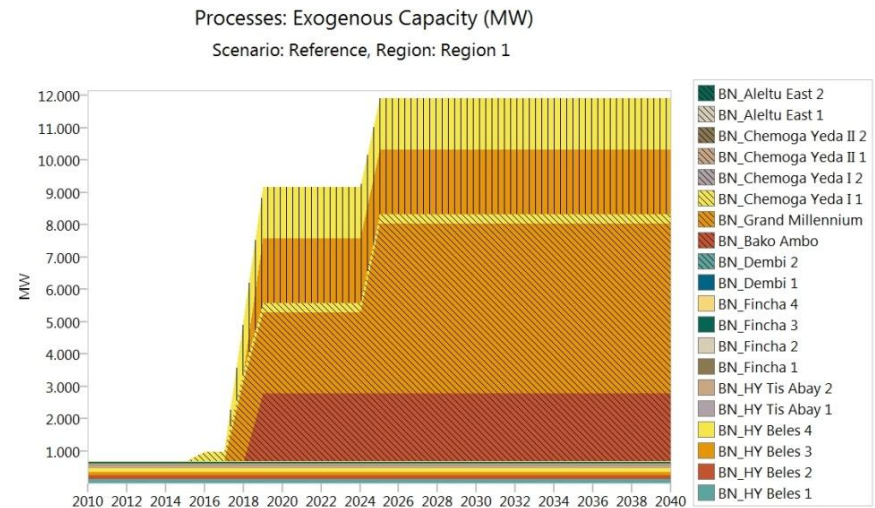
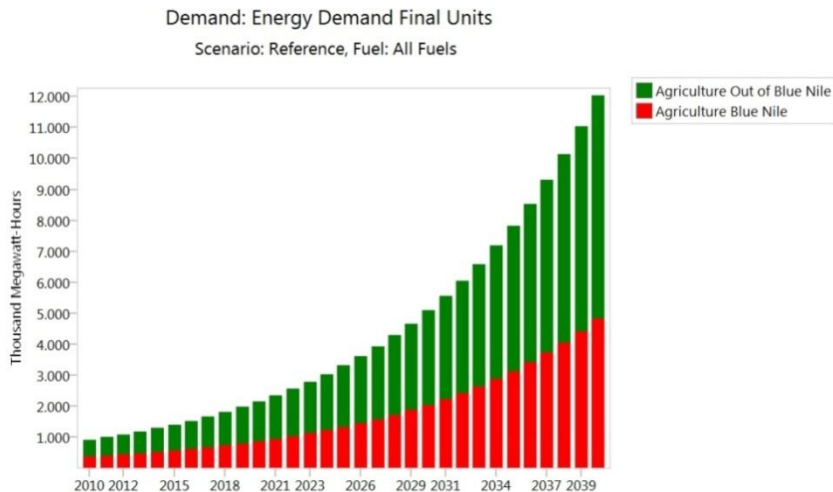
water for biofuels vs. water for food production

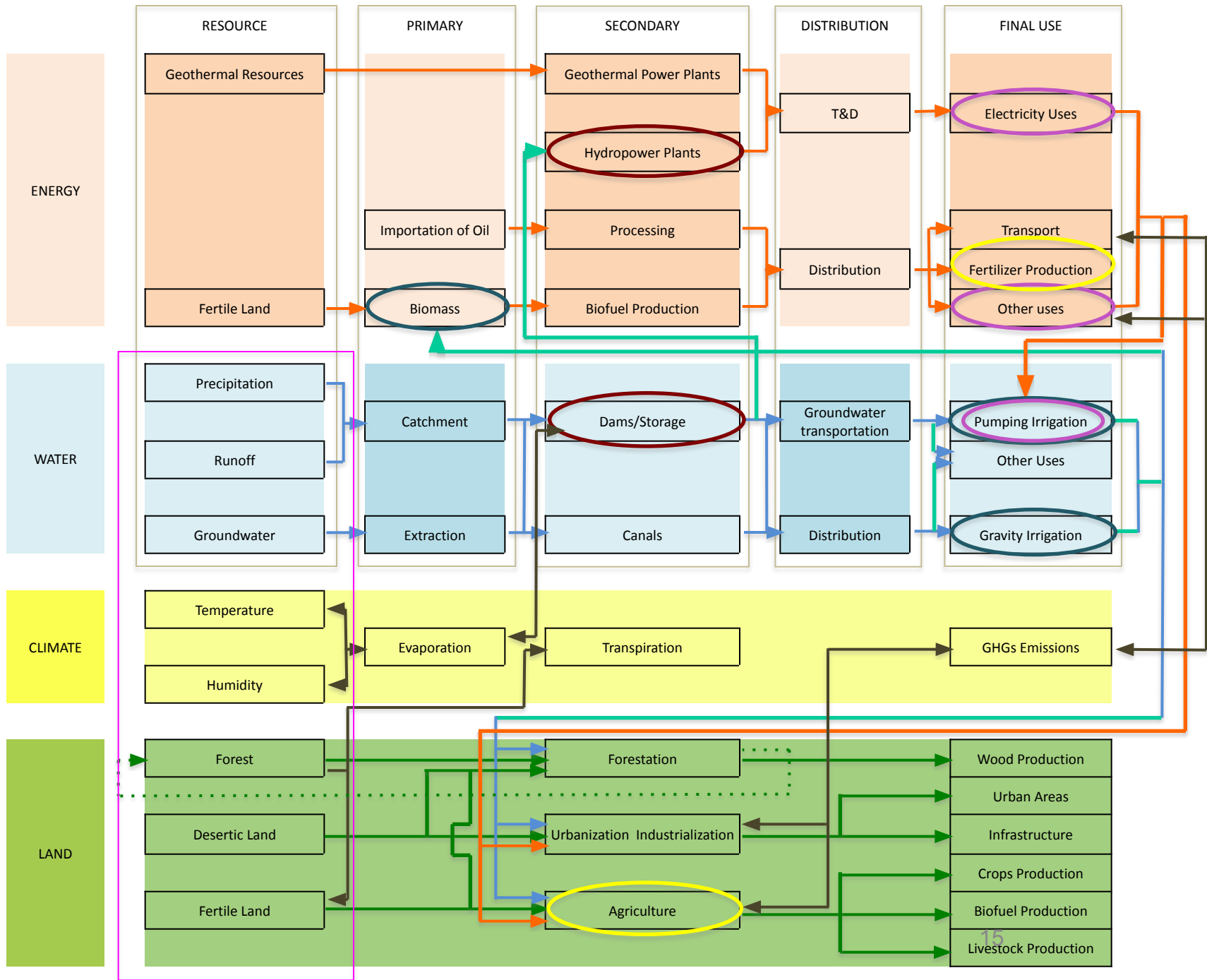
energy for agricultural intensification

goal: „improved landscape configurations“ for resilience

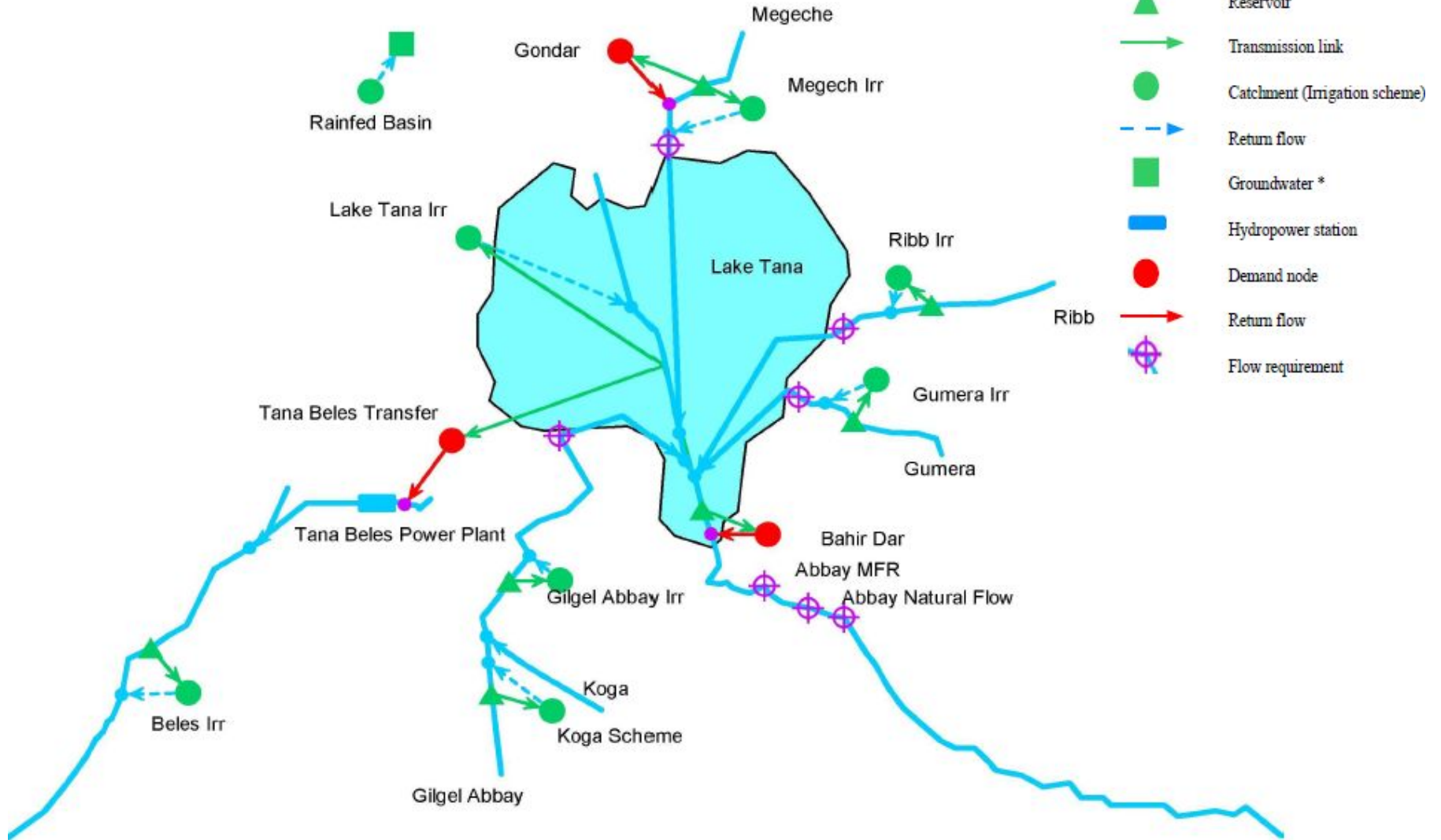
# Initial LEAP model for Ethiopia / Blue Nile

- National Model on LEAP (to be linked with Blue Nile Basin Model on WEAP and eventually with Land Use using GAEZ)
- Disaggregation of data from Blue Nile Region





# Initial WEAP model for Lake Tana

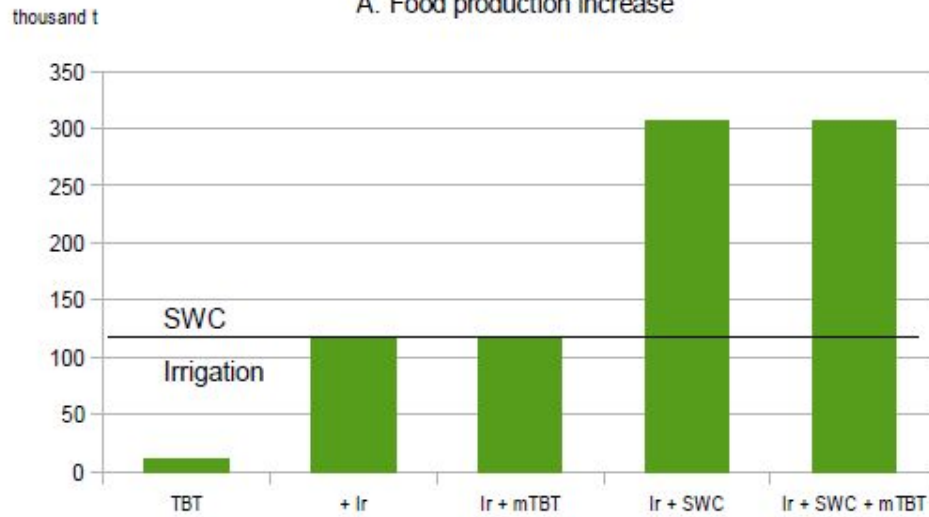




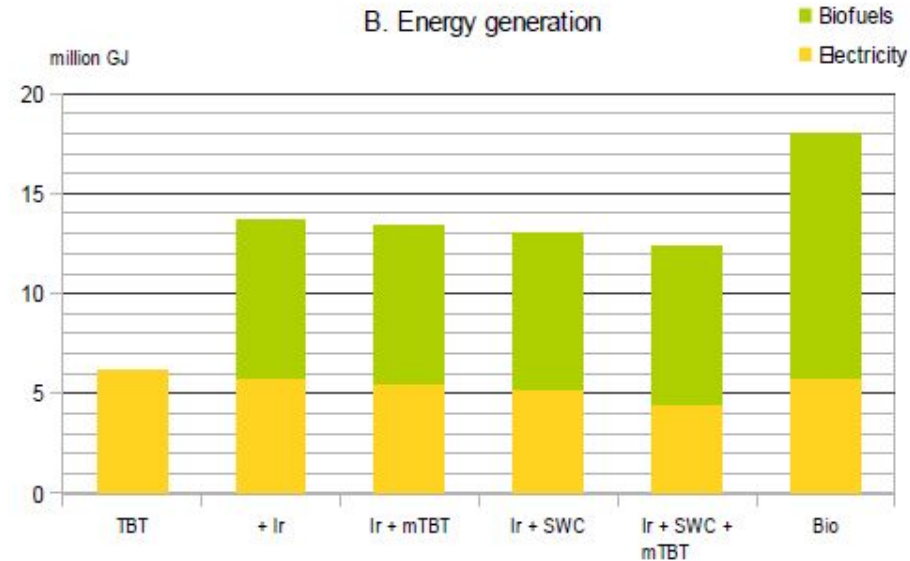
# Initial WEAP model for Lake Tana

quantifying upstream  $\leftrightarrow$  downstream effects and tradeoffs

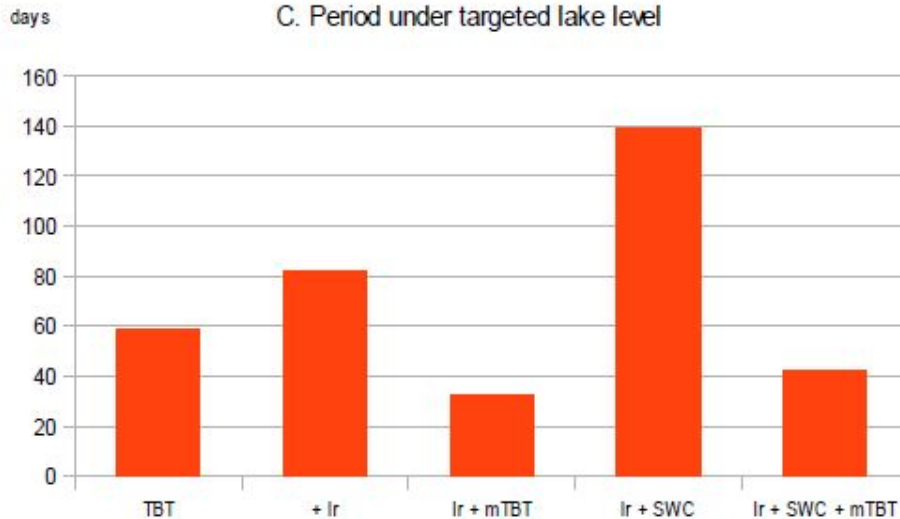
A. Food production increase



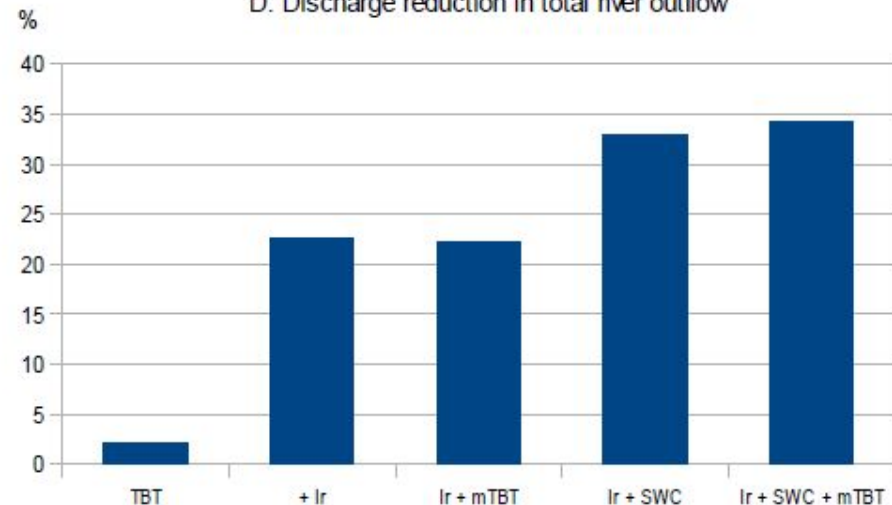
B. Energy generation



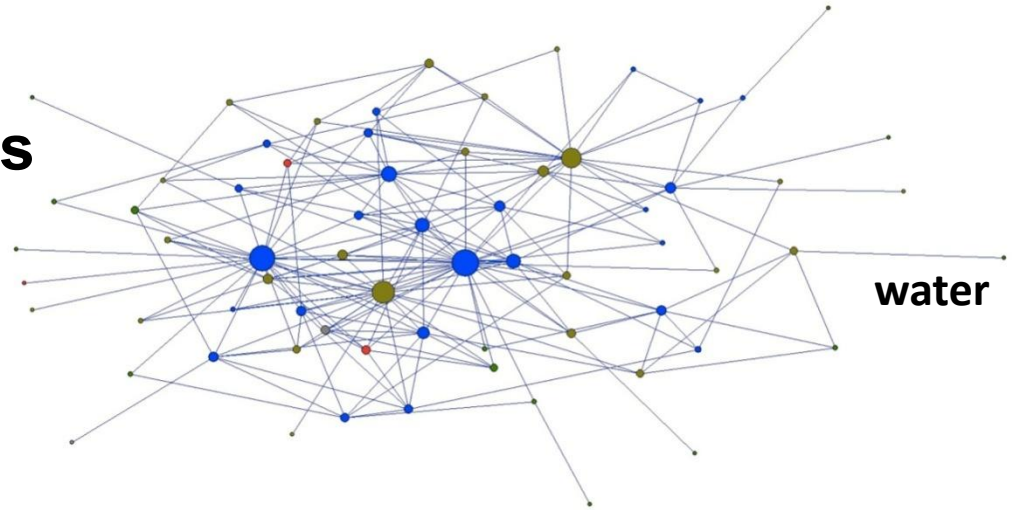
C. Period under targeted lake level



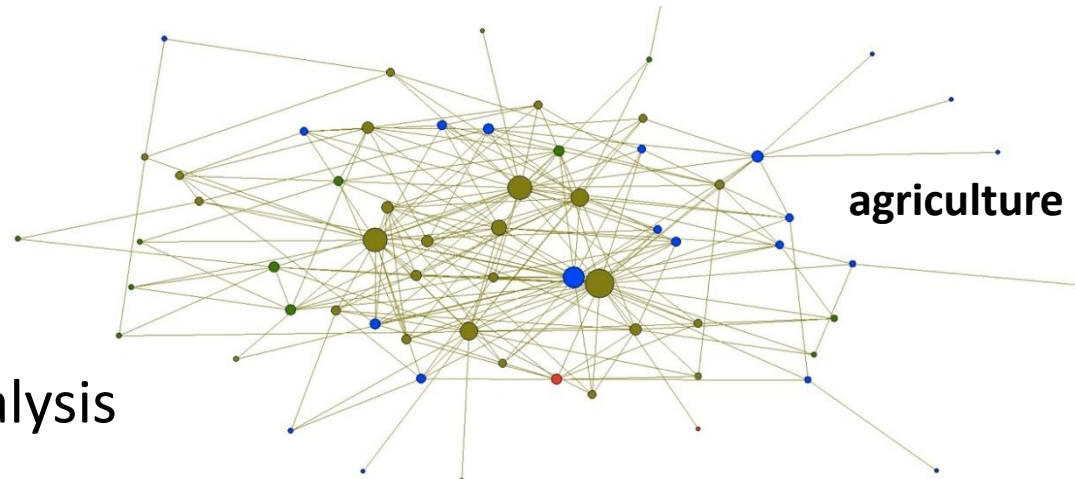
D. Discharge reduction in total river outflow



# Implementing the nexus

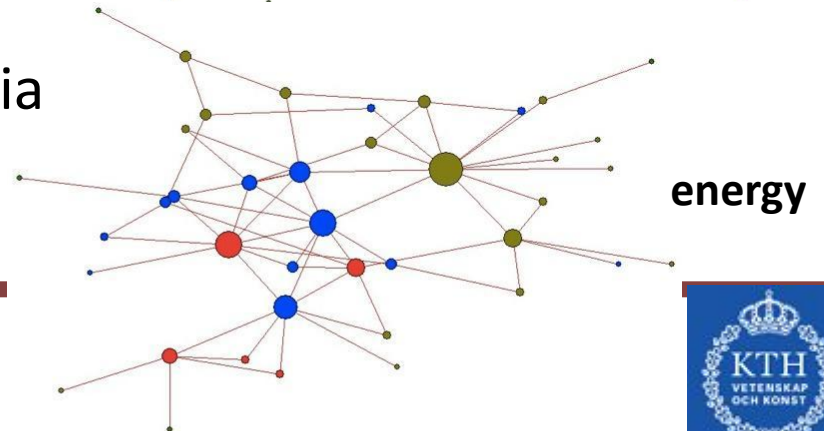


do sectors cooperate?

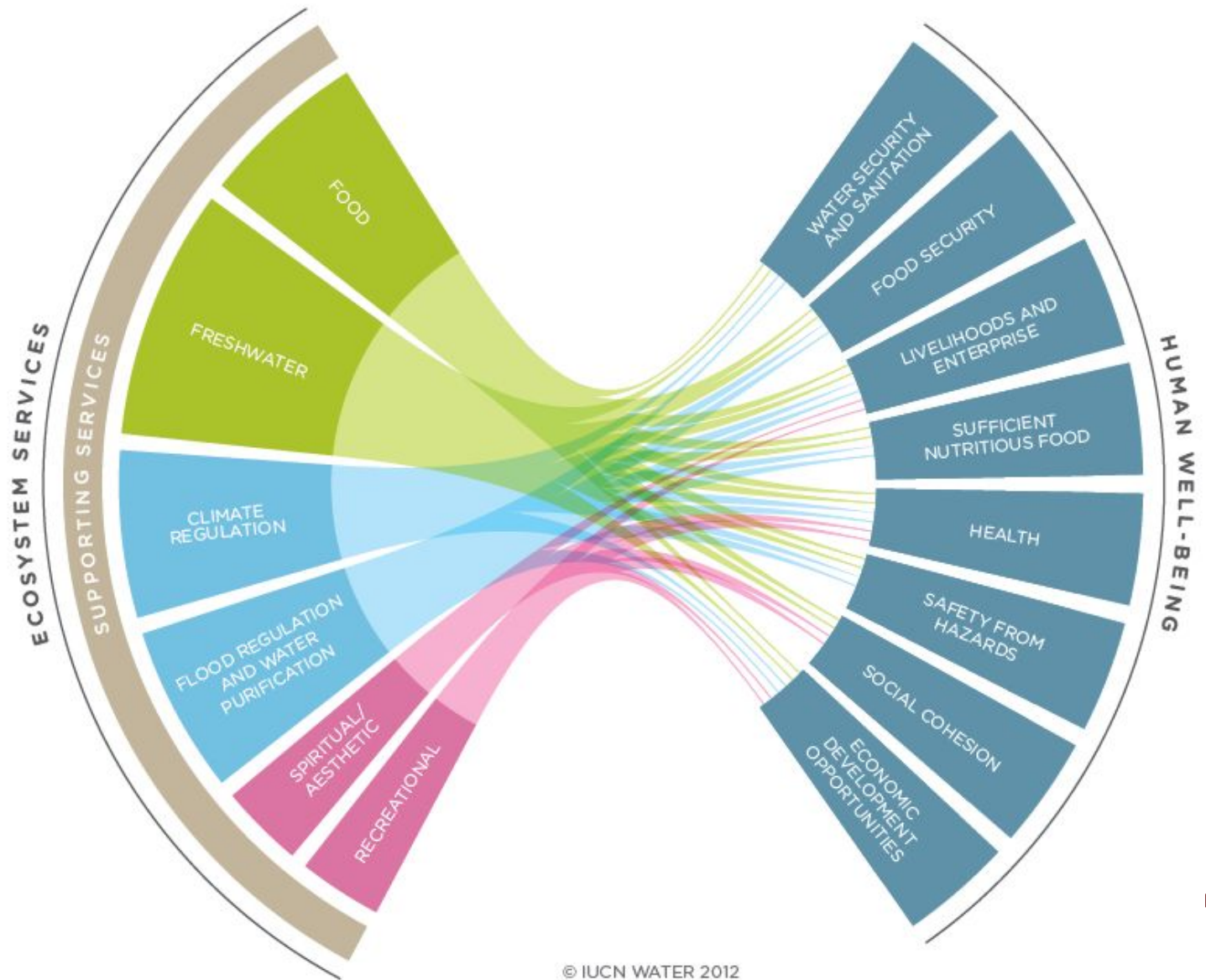


institutional network analysis

inter-agency coordination, e.g. via  
interministerial steering group  
(CRGE)



# The nexus and (healthy) ecosystem services



# The nexus and (degraded) ecosystem services

