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

Holger Hoff
Stockholm Environment Institute (SEI)
Potsdam Institute for Climate Impact Research (PIK)

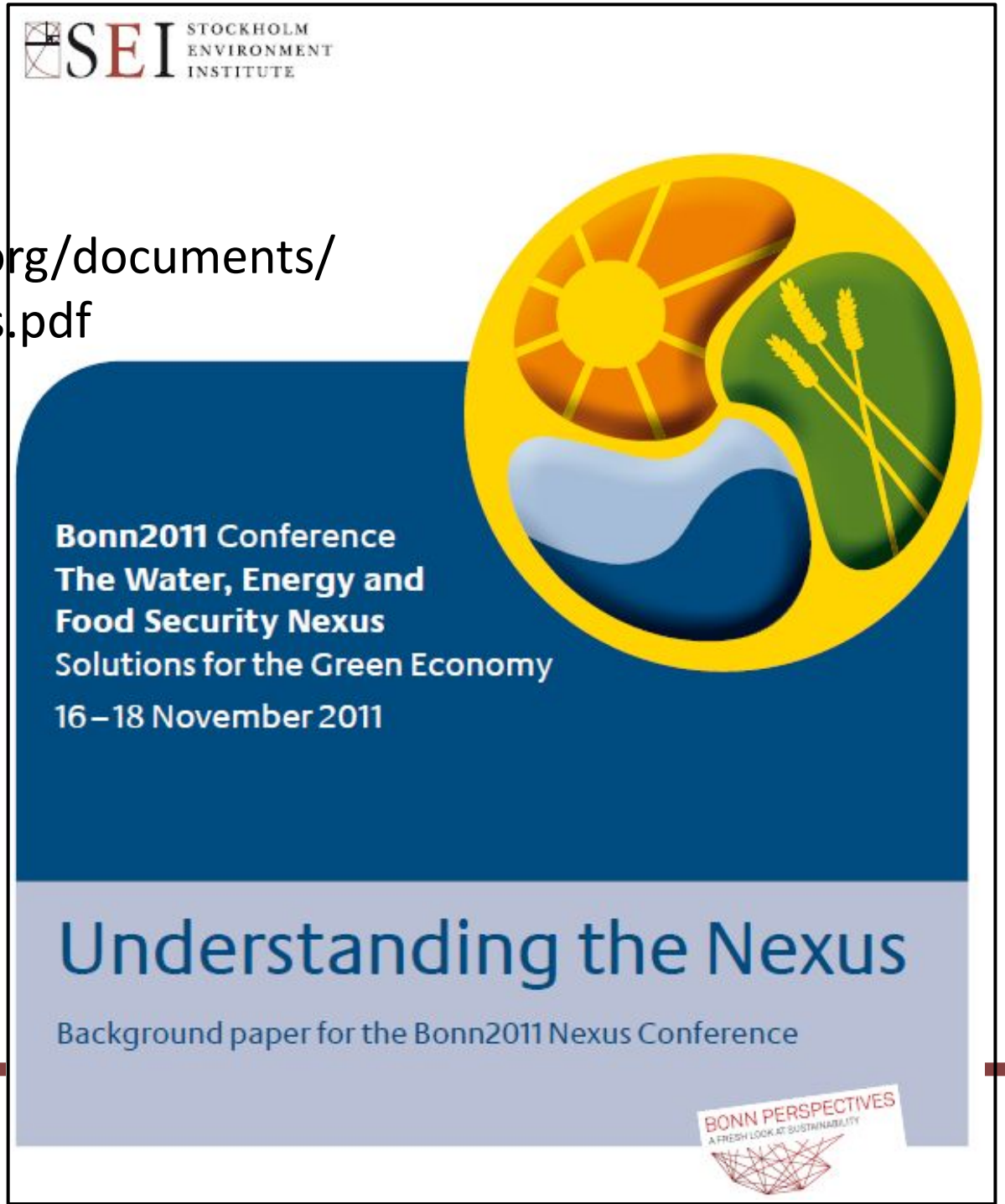
Lucia de Strasser
Royal Institute of Technology (KTH)

Bahir Dar, 27 March 2013

Nexus Background Paper

www.water-energy food.org/documents/
understanding_the_nexus.pdf

SEI, KTH,
FAO, IAEA, UNDESA…



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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

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

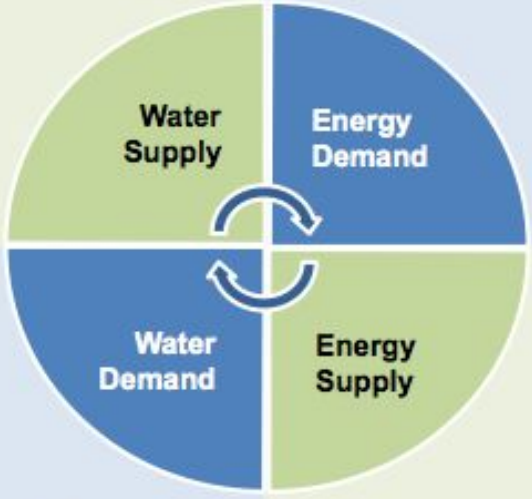
Increased energy requirements for desalination.

Electricity demand

Energy efficiency

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

Hydropower & fossil generation

Wind & solar, less water-intensive cooling

Hydropower energy & cooling water requirements

Reduced water demands

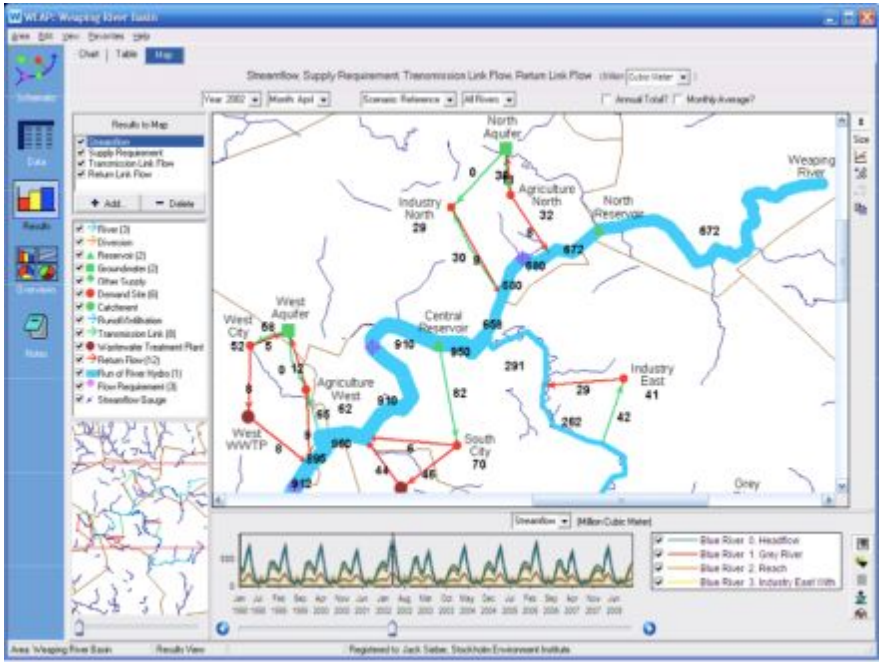
Fuel Use
GHGs
Local air pollution
Costs

(CLEW Integration, KTH)

WEAP Water Evaluation And Planning

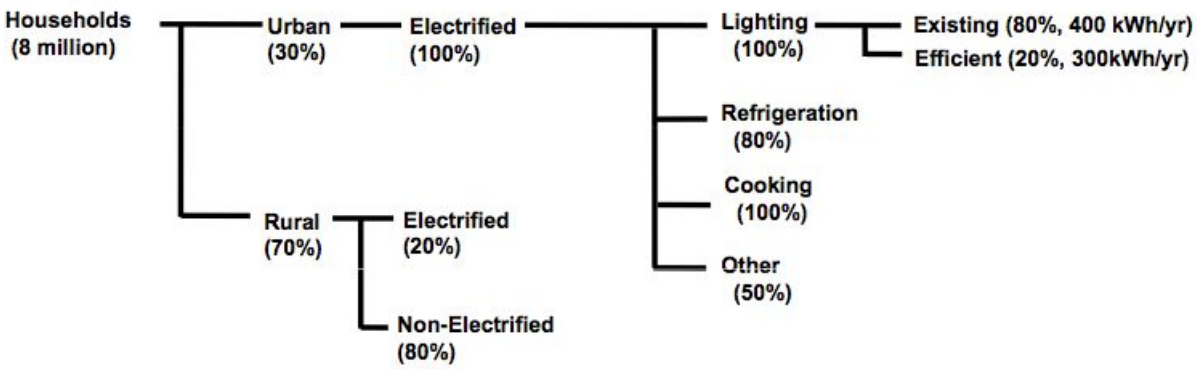
www.weap21.org

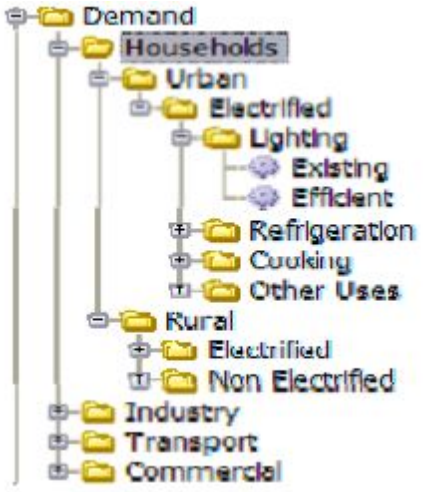
- Integrated watershed planning, matching demands and supplies
- GIS-based, graphical drag & drop interface
- Additional simulation modeling possible:
  land use effects,
  groundwater dynamics,
  crop water use,
  crop productivity,
  water quality,
  reservoir management & hydropower
  financial module



LEAP Long range Energy Alternatives Planning System

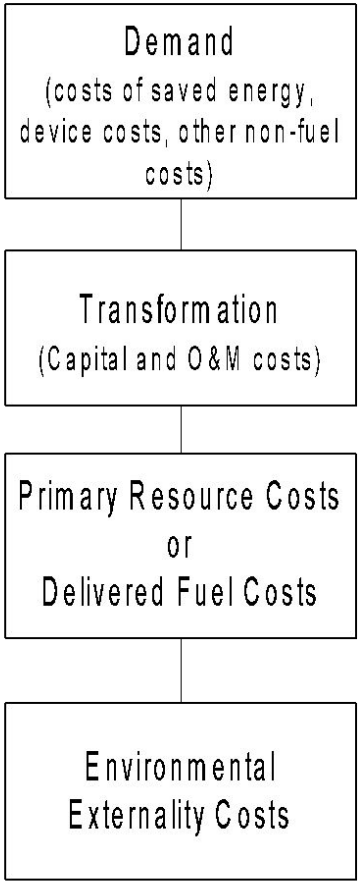
- Typically organized by sector, subsector, end-use and device.
- Users can edit the tree on-screen using standard editing functions (copy, paste, drag & drop)
- Structure can be detailed and end-use oriented, or aggregate (e.g. sector by fuel).



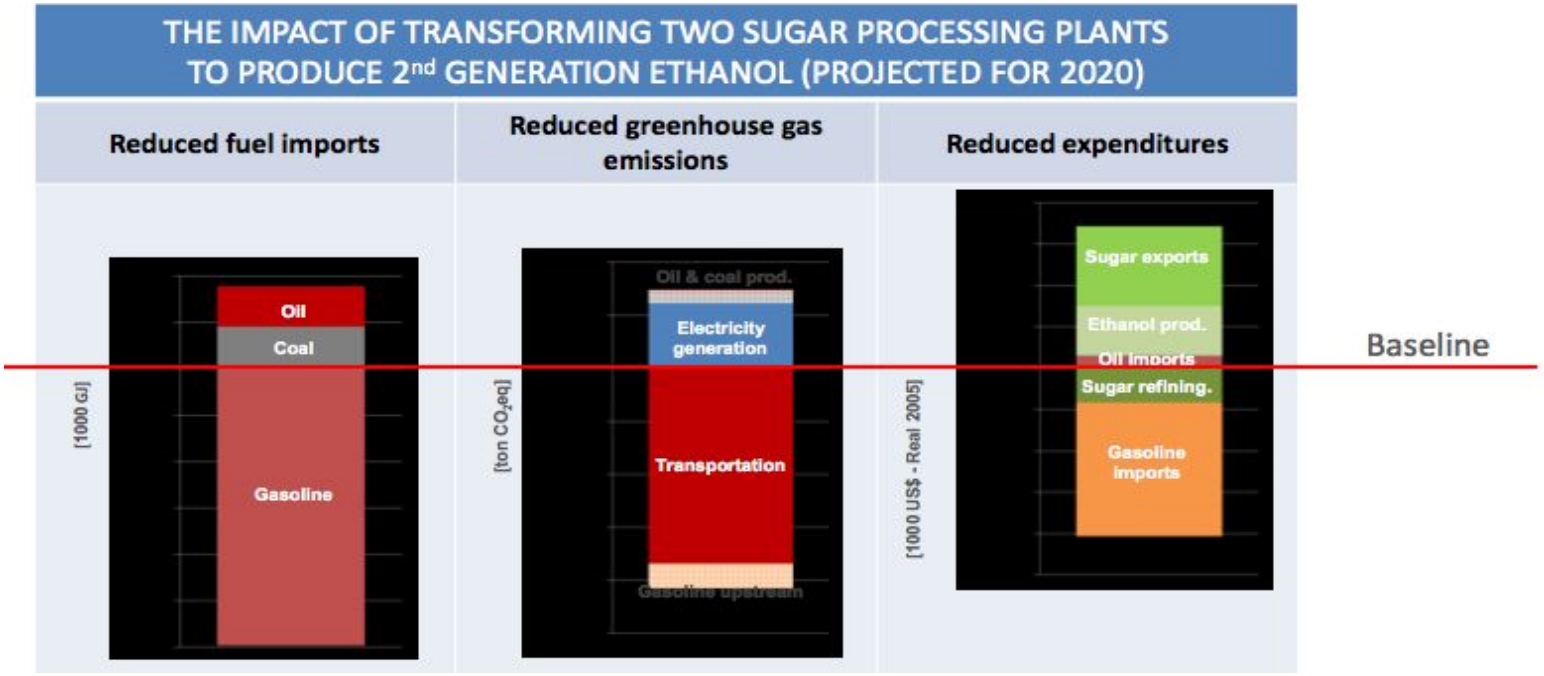


Cost-Benefit Analysis ("externalities") in (WEAP) LEAP

- 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.



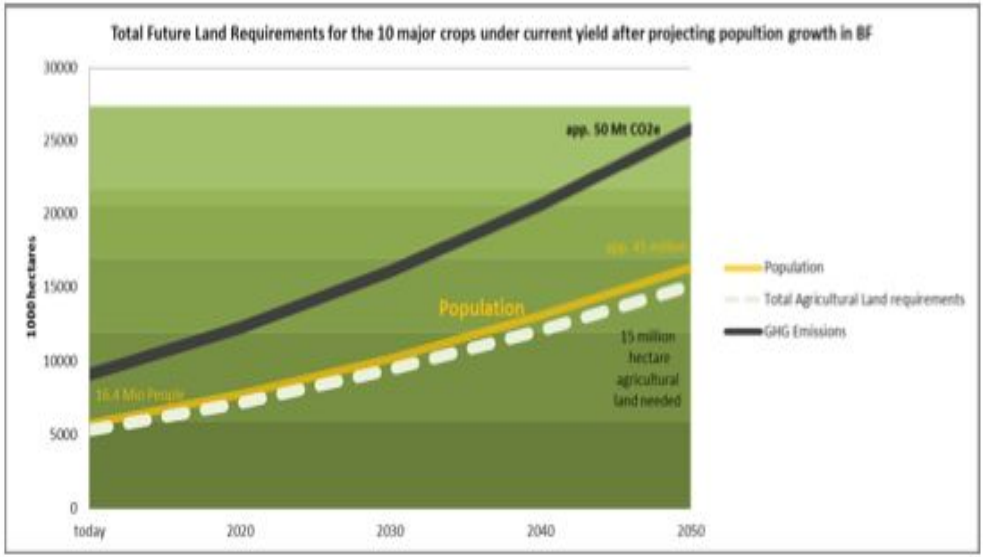
Previous case studies (KTH, SEI) **Mauritius**

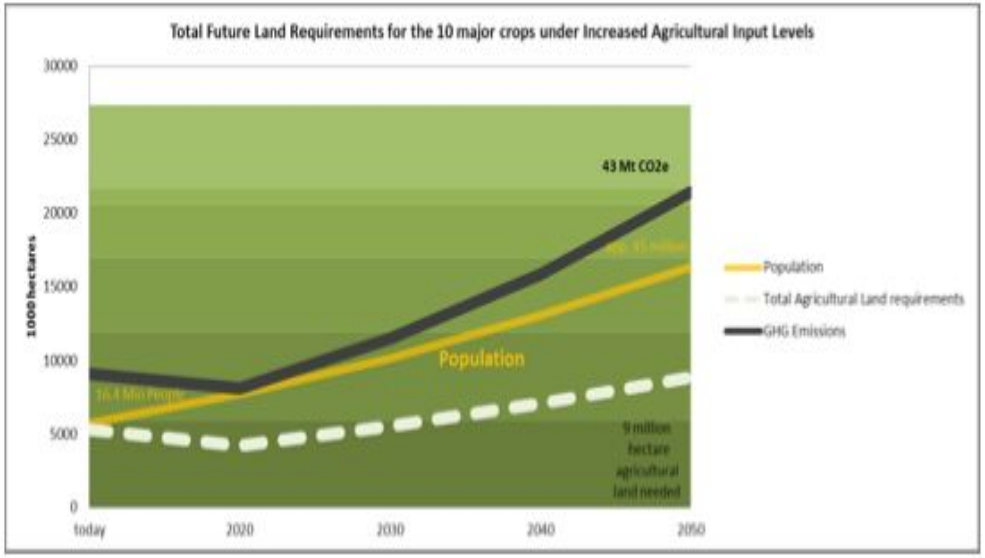


- Energy Security in changing Climate conditions
- Small island with clear boundaries- data availability
- Producer and exporter of sugar (occupying 80 % cultivated land area)
- Dependent on fuel imports for its energy requirement
- Highly vulnerable to climate change
- Nexus („CLEWs“) approach formally 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 suitalble land for food security, biofuel production and reduced emissions.





(CLEW Integration, KTH)

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)

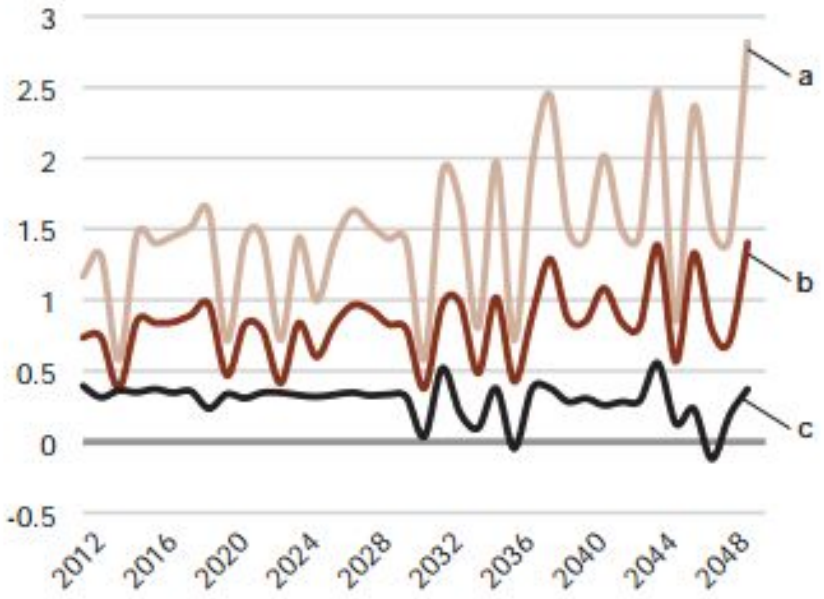


Figure 3. Changes in DESAL Scenario compared with BAU

a. Increase in water-sector electricity use (TWh)
b. Increase in water-sector GHG emissions (million tonnes CO_2e)
c. Reduction in water imports (billion m^3)

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

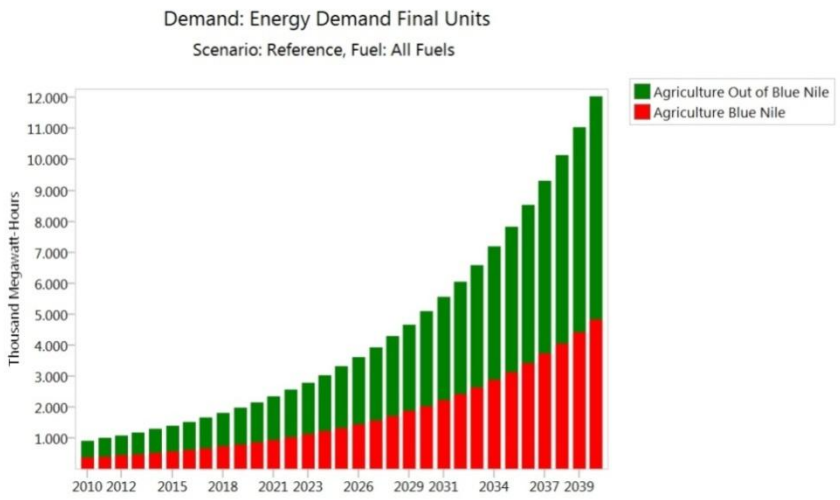
proposed focus on biomass production,
tradeoff analyses / testing different strategies, e.g.
small- vs. large-scale storage
water for hydropower vs. water for agriculture
water for biofuels vs. water for food production
energy for agricultural intensification

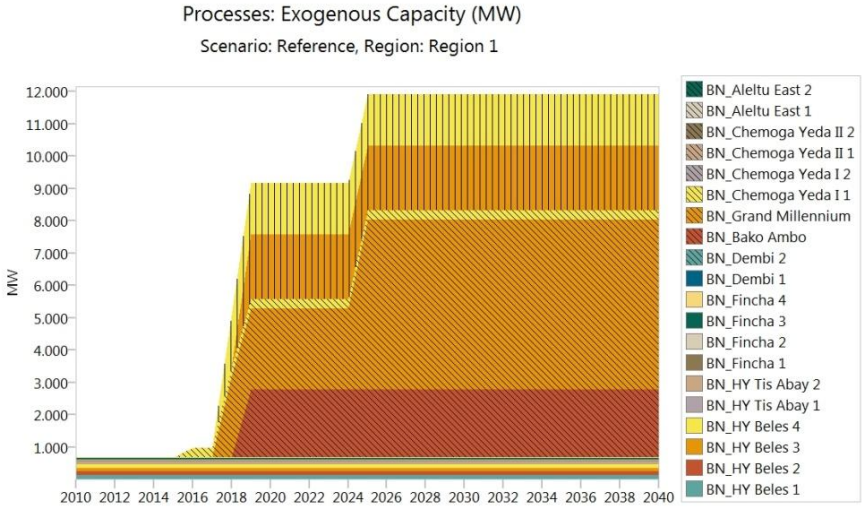
goal: „improved landscape configurations“ for resilience

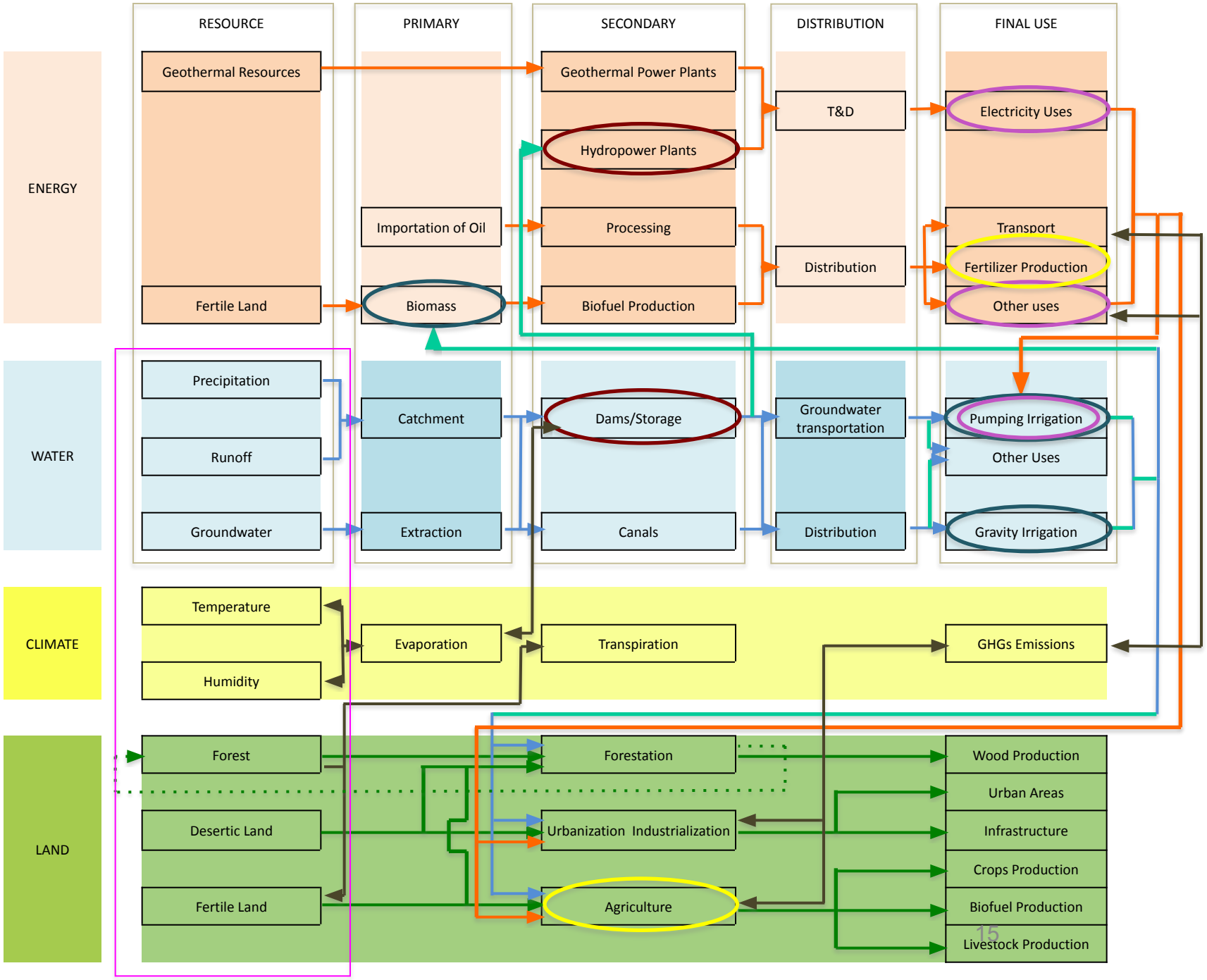
Initial LEAP model for Ethiopia / Blue Nile

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

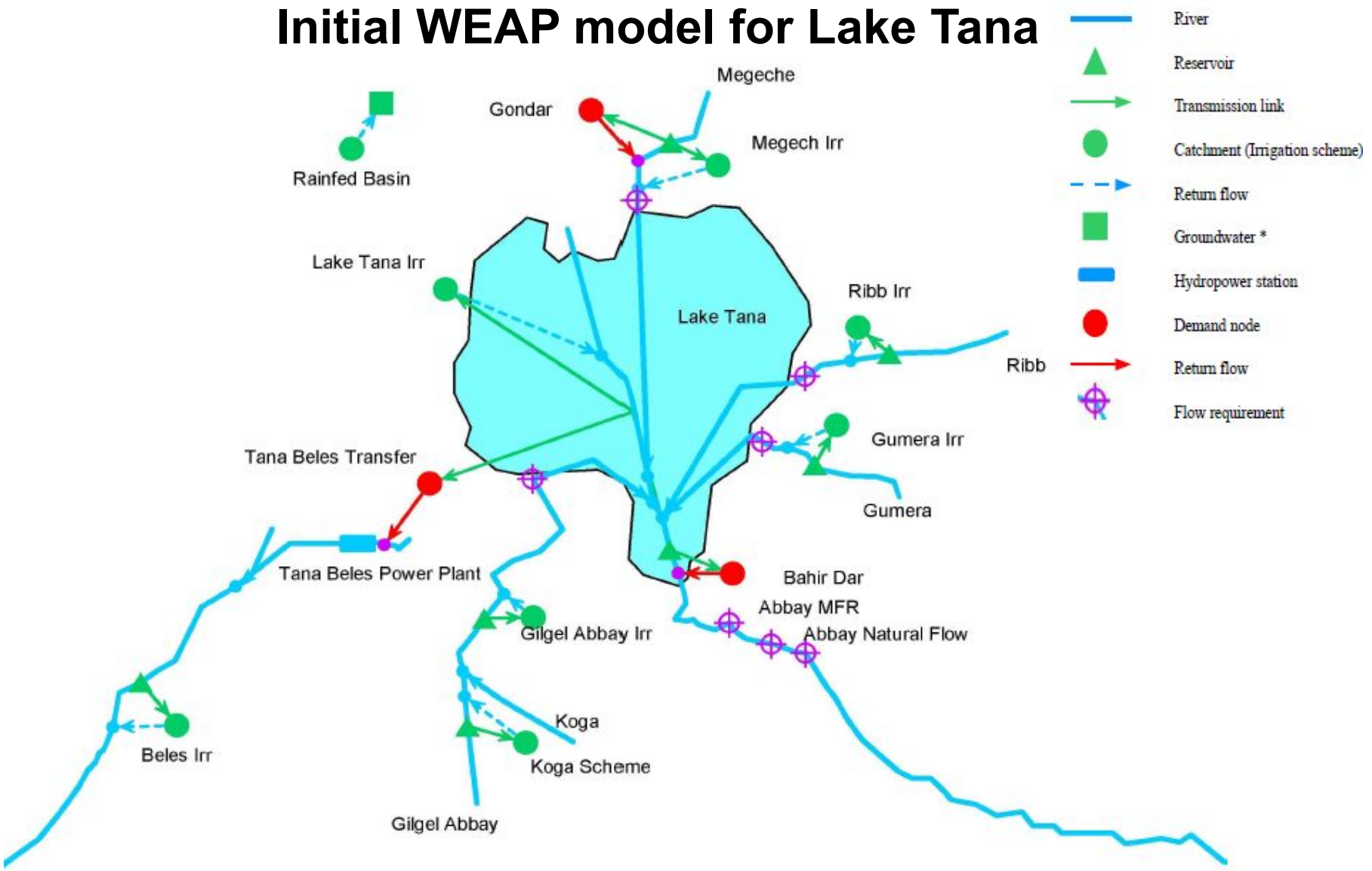
- Disaggregation of data from Blue Nile Region





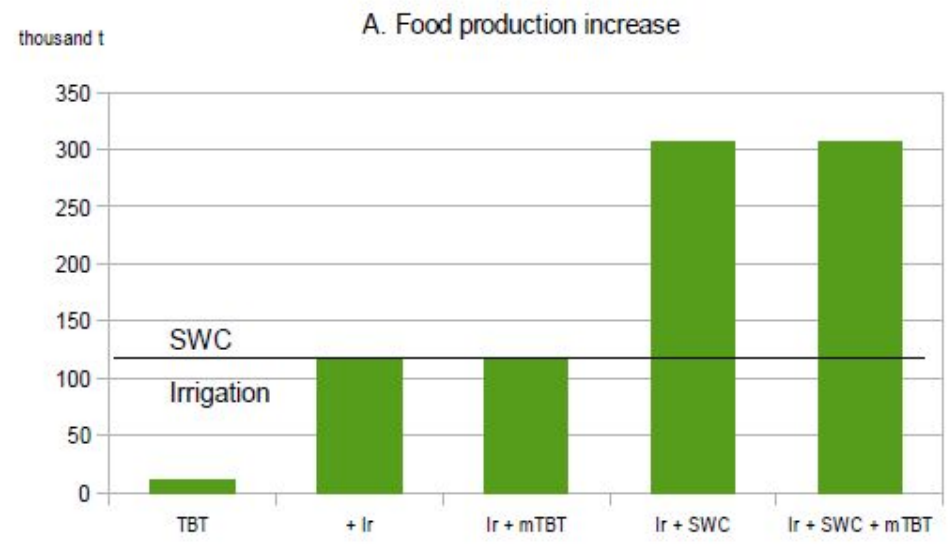

RESOURCE
PRIMARY
SECONDARY
DISTRIBUTION
FINAL USE
ENERGY
Geothermal Resources
Geothermal Power Plants
T&D
Electricity Uses
Hydropower Plants
Importation of Oil
Processing
Transport
Distribution
Fertilizer Production
Fertile Land
Biomass
Biofuel Production
Other uses
WATER
Precipitation
Catchment
Dams/Storage
Groundwater transportation
Pumping Irrigation
Runoff
Other Uses
Groundwater
Extraction
Canals
Distribution
Gravity Irrigation
CLIMATE
Temperature
Evaporation
Transpiration
GHGs Emissions
Humidity
LAND
Forest
Forestation
Wood Production
Urban Areas
Desertic Land
Urbanization Industrialization
Infrastructure
Crops Production
Fertile Land
Agriculture
Biofuel Production
Livestock Production

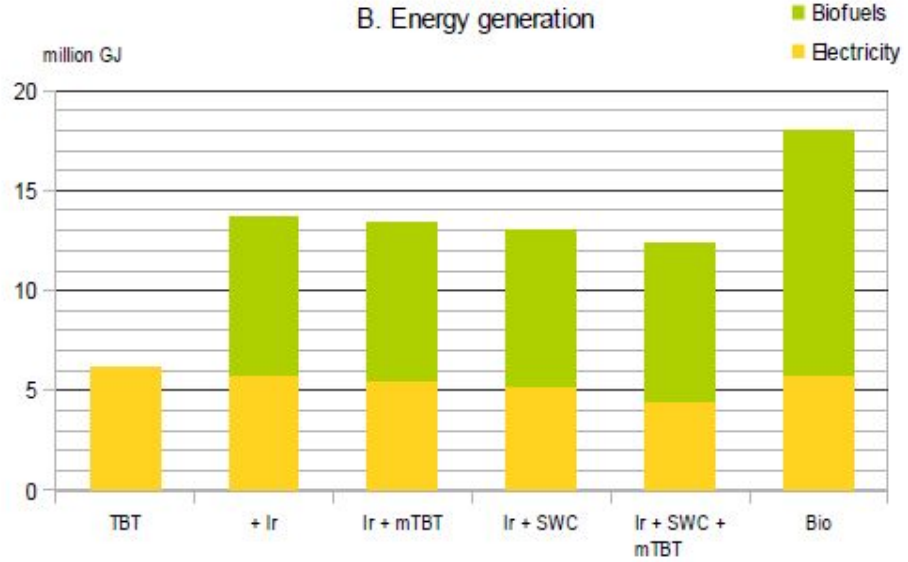
Initial WEAP model for Lake Tana

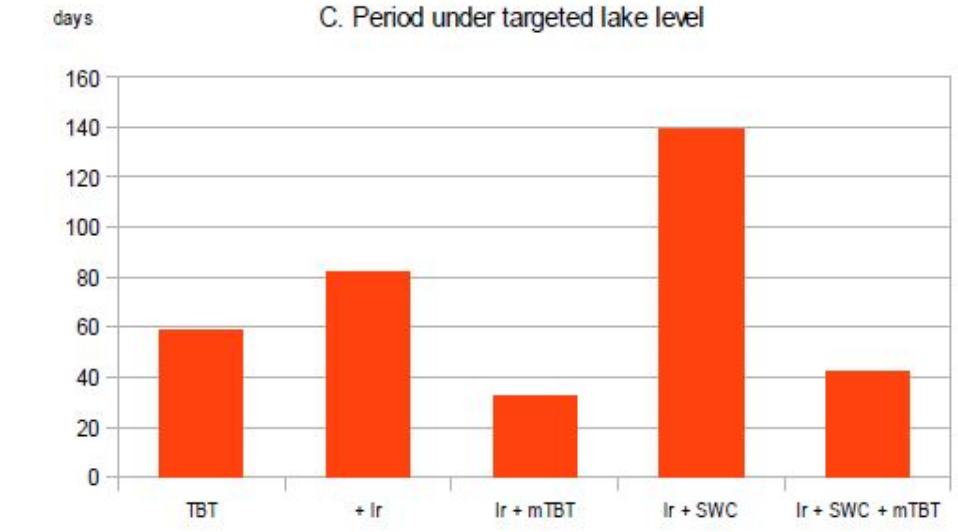


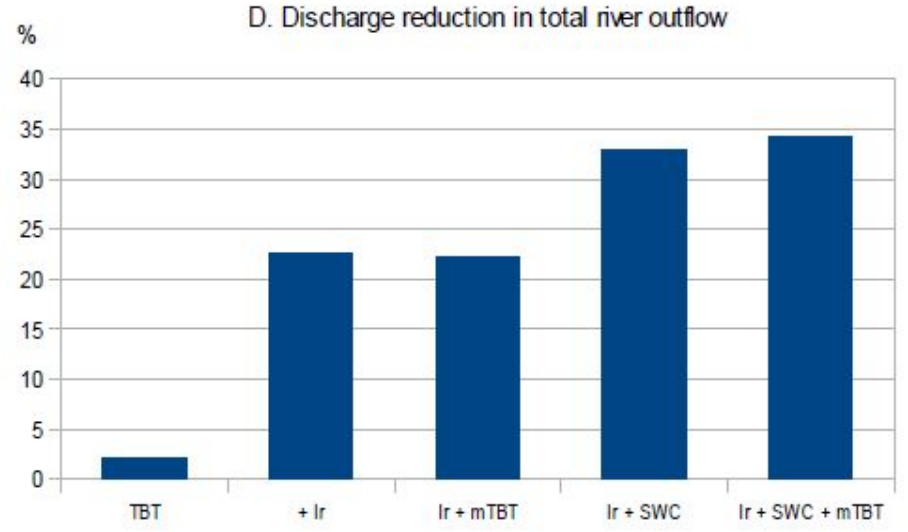
Initial WEAP model for Lake Tana

quantifying upstream <–> downstream effects and tradeoffs

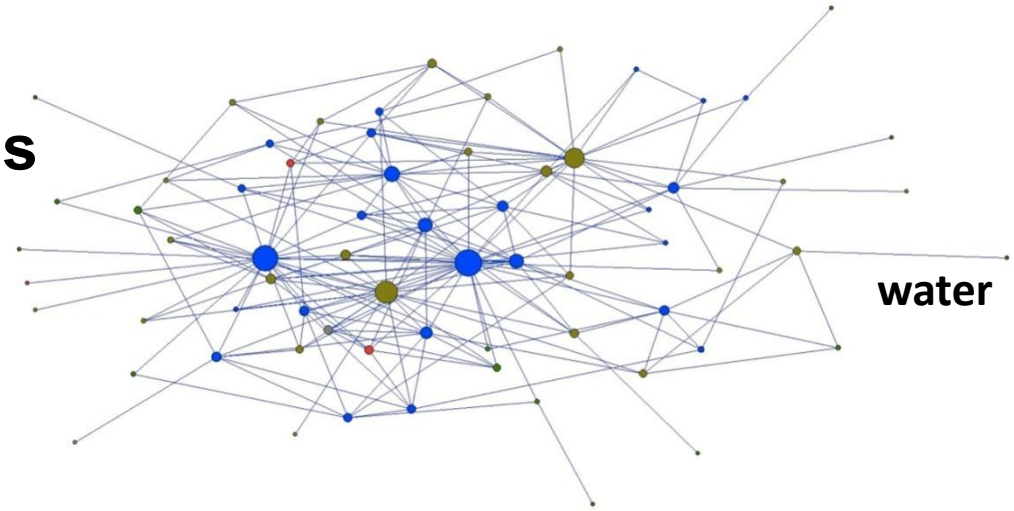




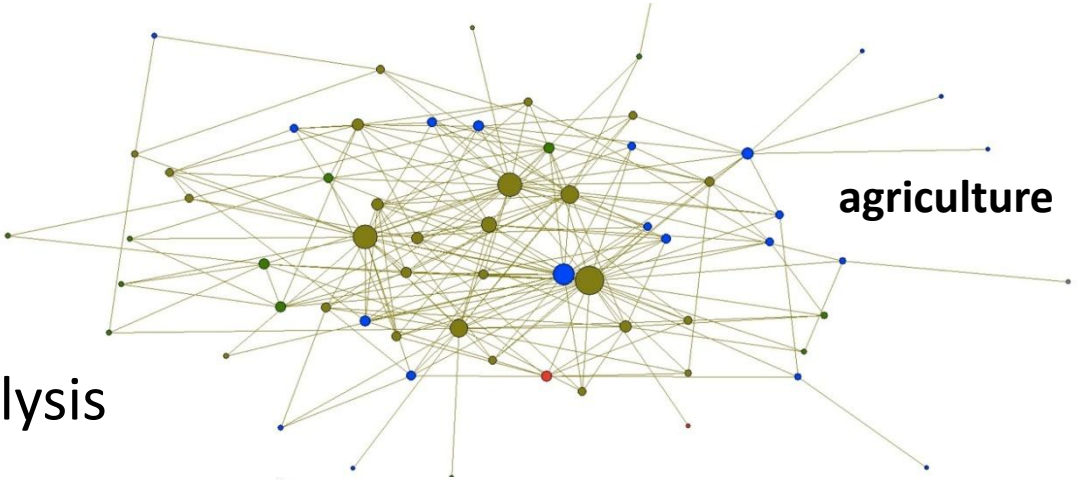




Implementing the nexus

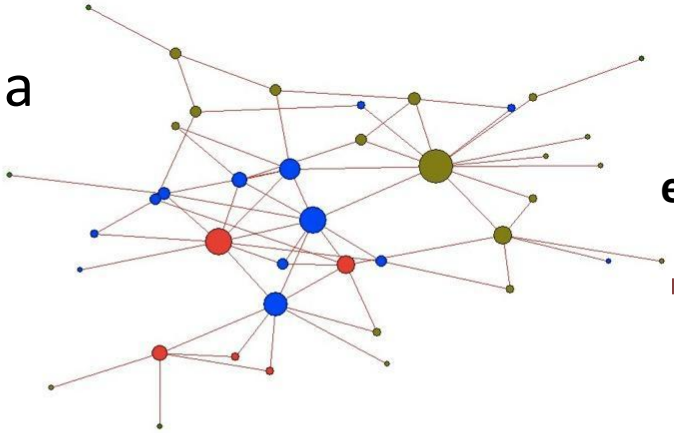


do sectors cooperate?

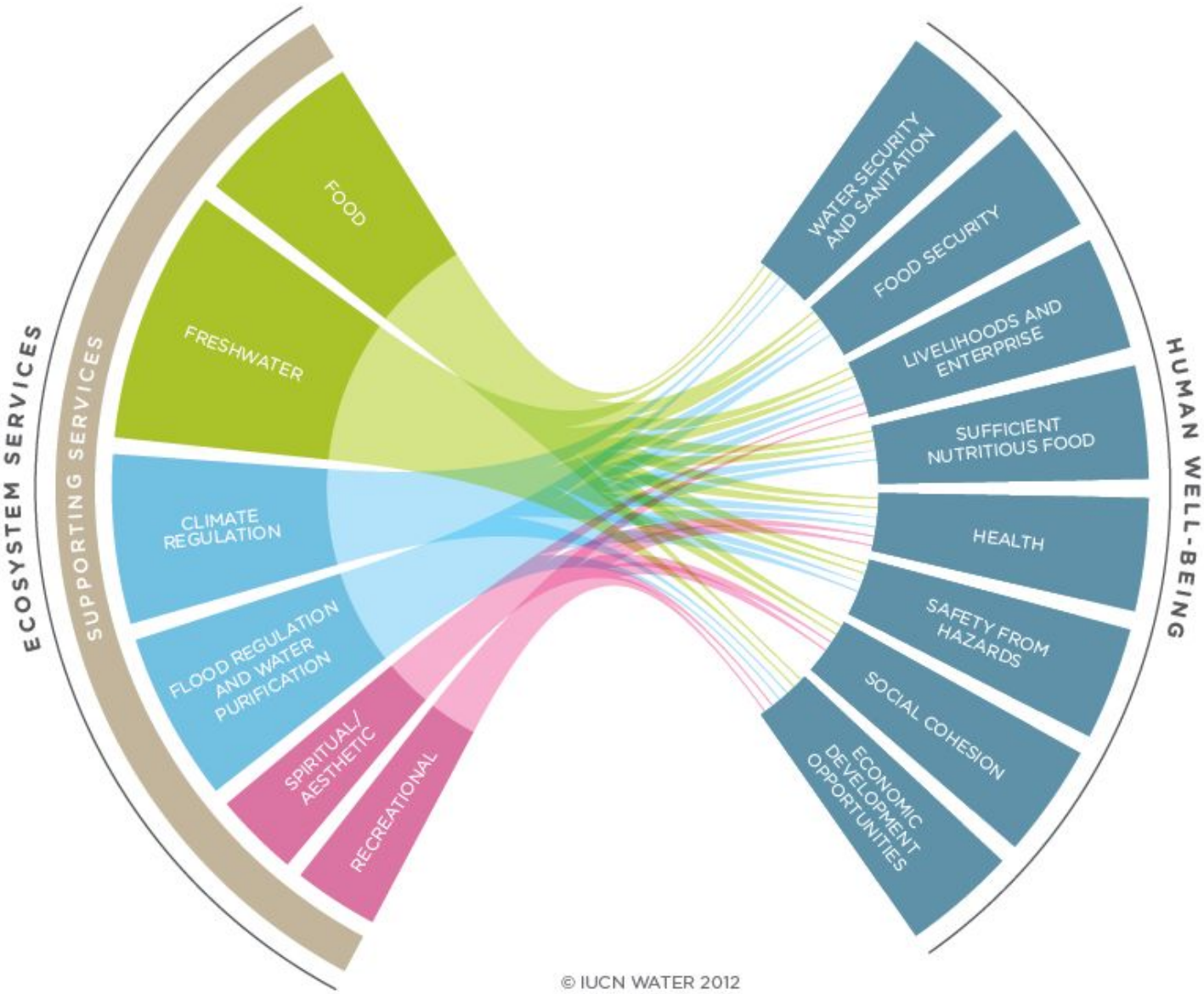


institutional network analysis

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



The nexus and (healthy) ecosystem services



SEI

The nexus and (degraded) ecosystem services