



KTH Royal Institute of  
Technology



# Indicators for a Nexus Assessment in Transboundary Basins

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Second meeting of the Task Force on the Water-Food-Energy-Ecosystem Nexus

UNECE

Geneva, September 2014

# Indicators to understand..

## Use of resources

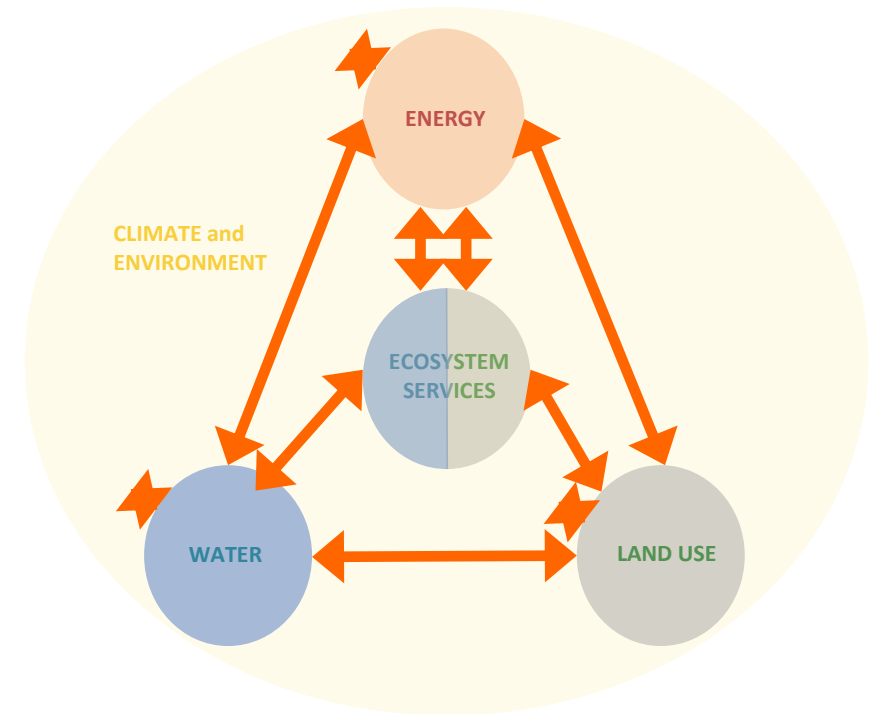
- What is the demand of resources by sector and the efficiency in their use?
- On the use of which resources the different sectors are depending and/or competing?

## Nexus security (water security, energy security, food security, environmental security)

- Which resources are scarce and where?
- How do interlinkages between sectors and resources affect these securities?

## Complementarity between countries

- What are the opportunities for reducing trade-offs in the basin by considering the differences in resources and needs between countries?



# Use of indicators

The use of indicators can support the nexus assessment in two ways:

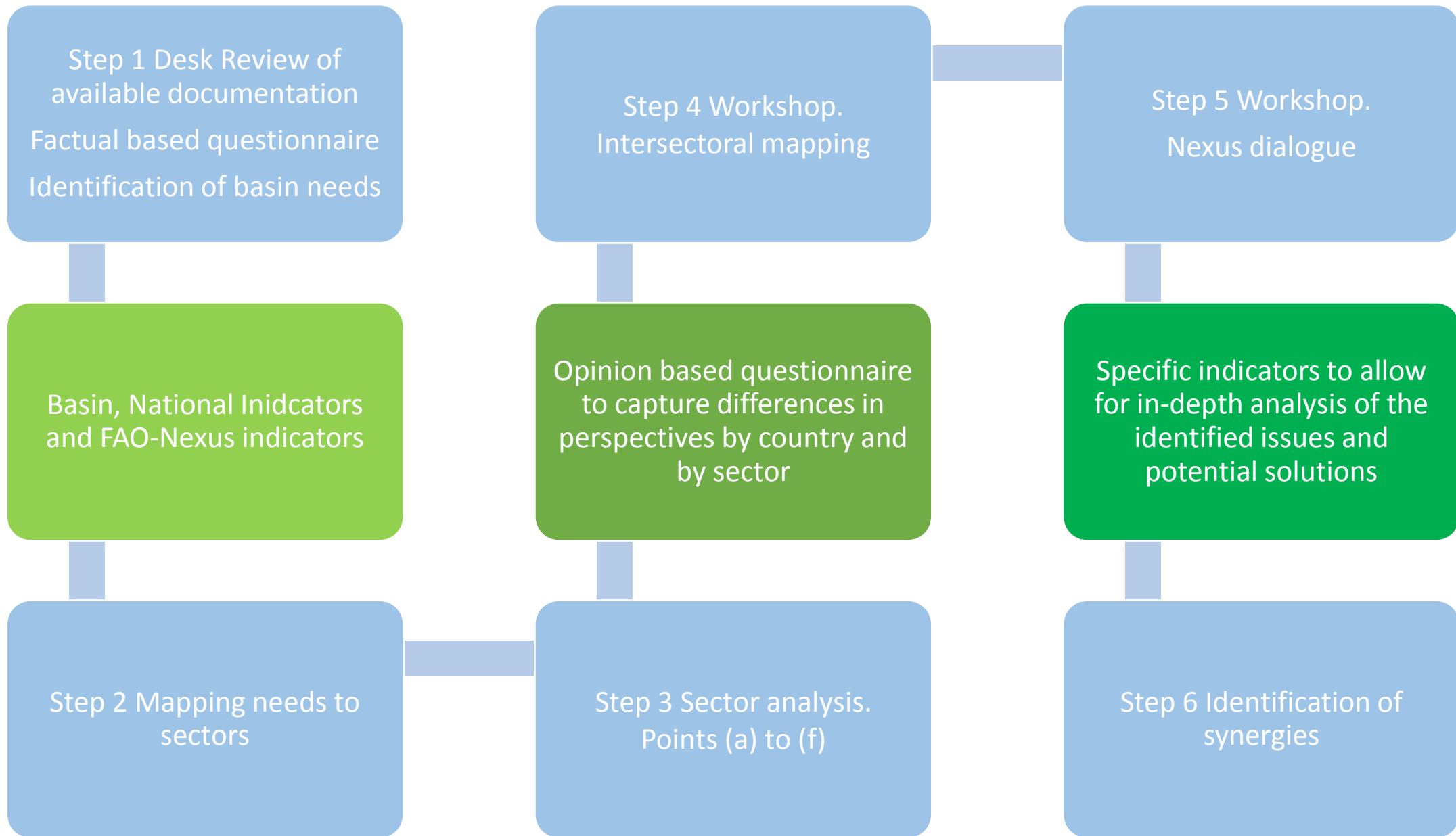
- 1) to substantiate the analysis of the basin
- 2) to quantify specific issues relative to the basin and the benefits of cooperation – guided by the input of stakeholders and their dialogue during the workshop

Special focus is given to:

- Inter-linkages between resources and sectors (nexus)
- Relations between riparian countries (transboundary dimension)

The indicators are NOT used to:

- Quantify every possible inter-linkage across the nexus
- Rank sectors, countries or basins in terms of natural resources management



# Groups of indicators

<b>Group</b>	<b>*National Indicators</b>	<b>*Basin Indicators (including GIS)</b>	<b>*Nexus-FAO Indicators</b>	<b>**Opinions of countries and sectors</b>	<b>***Specific indicators</b>
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Common principle: Use already available data as much as possible and specify trends/projections when relevant

- \* National and basin indicators as proxies? -> consistency check within direct consultative process
- \* GIS data to trigger discussion -> content to be refined with local stakeholders
- Nexus indicators for water-food-energy interlinkages - > in parallel with FAO
  
- \*\* Opinions to complement statistics with local knowledge - > differences across sectors and countries
- \*\*\* Specific indicators -> to investigate specific issues and explore proposed solutions

# The approach

## 1. Starting from an overview of the countries and the region:

- what are the socio-economic profiles of the riparian countries?
- what is the geography and the resource base in the basin? (GIS analysis)
- what issues have been identified in the basin/region in previous analysis?



Literature review

*Country, basin and FAO  
nexus indicators*

## 2. Zooming from regional to local:

- how is the economy of the basin relevant for national economies?
- how do national economies respond to local needs?



Literature review and  
Factual questionnaire

*Qualitative and semi-  
quantitative information*

# The approach (cont'd)

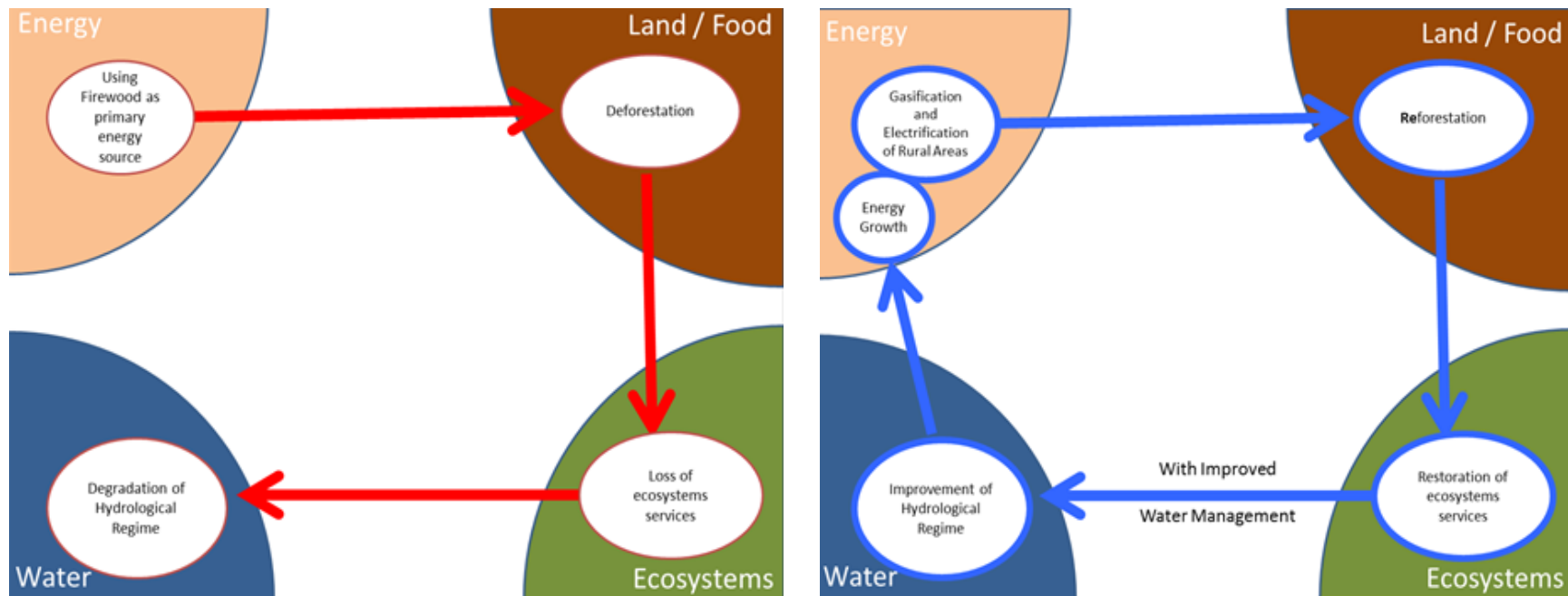
3. Focusing on basin-specific issues or topics of interest (jointly defined with local stakeholders and developing around policy lines)

- what are the main trends and scenarios to consider?
- how does inter-sectoral cooperation benefits tranboundary cooperation?



Workshop dialogue

*Opinions of countries and sectors*



Direct consultation

*Specific data*

# Indicators by source

## 1) Country experts

Preferred source

Best accuracy

A lot of information already collected in previous efforts

Used only for specific issues and solutions, when not already available

Source:

Direct consultation



# Indicators by source (cont'd)

## 2) Country and basin statistics

Aggregated by country, by basin, by sector

Used in a first stage of diagnosis of the region

Can be used as proxies for local indicators (but need validation)

Sources:

World Development Indicators - by country (World Bank database)

Progress towards MDGs, demography and society, environment, economy, states and markets

FAO-stat (Aquastat)

Water resources, water uses and agricultural management

UNECE Second Assessment of Transboundary Rivers, Lakes and Groundwaters – by basin

Water users and water quality

Water Risk Atlas - by basin (Water Resources Institute database)

Baseline water stress, interannual variability, seasonal variability, flood occurrence, and drought severity.

Nexus FAO database – by country and/or by basin

Interlinkages across Water, Energy and Food sectors

# Indicators by source (cont'd)

## 3) Spatial indicators (Geographic Information System - GIS)

Highlight geographic hotspots

Complement statistics with geographic information

Sources:

Roads (Natural Earth), Elevation (CGIAR-CSI GeoPortal), Population density (NASA SEDAC)

Boundaries (Global Administrative Areas)

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# Indicators by source (cont'd)

## - Spatial indicators

### Water related activities

- Lakes and wetlands (Global Lakes and Wetlands Database)
- River catchments (European Environment Agency)
- Industrial Activities location (hydropower etc) (GRID ARENDAL)
- Urban areas (Global Rural-Urban Mapping Project, GRUMP - NASA/Columbia University)

### Energy related activities

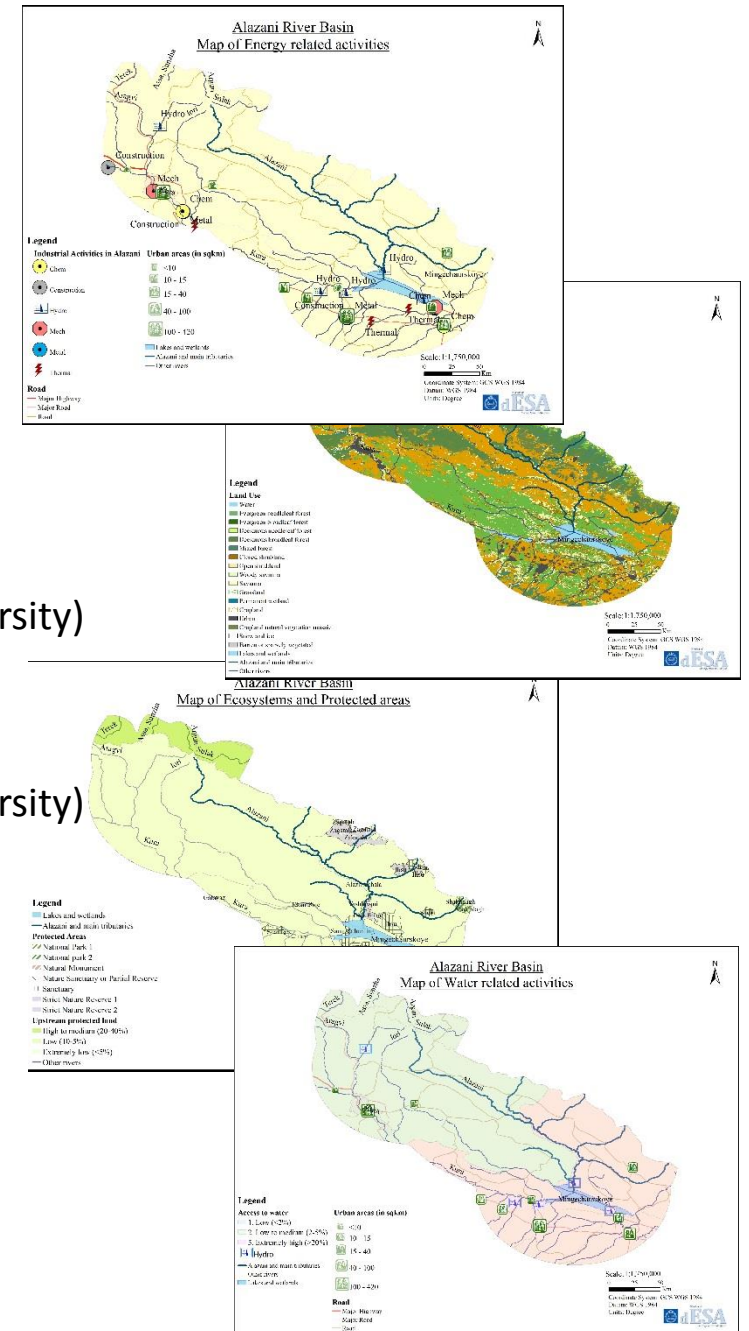
- Industrial Activities (power plants and heavy industry) (GRID ARENDAL)
- Urban areas (Global Rural-Urban Mapping Project, GRUMP - NASA/Columbia University)
- Deforestation/Reforestation (Global Forest change, Hansen et al.)
- Nighttime light (National Geophysical Datacenter – US Department of Commerce)

### Land Use related activities

- Land Use and Land cover data (FAO's and JRC's databases)

### Ecosystem related activities

- Protected areas and Ecosystems (World Database on Protected Areas)
- Access to water and upstream protected land (FAO, AQUEDUCT Global Maps)



# Indicators by source (cont'd)

## 4) Opinions of countries and sectors representatives

Ranking natural resources availability, quality and management (good to bad, high to low)

Highlight differences in perspectives, by country and by area of expertise (W, E, L, Eco)

Complement statistics with social context

Source:

Opinion based questionnaire

# Indicators by source (cont'd)

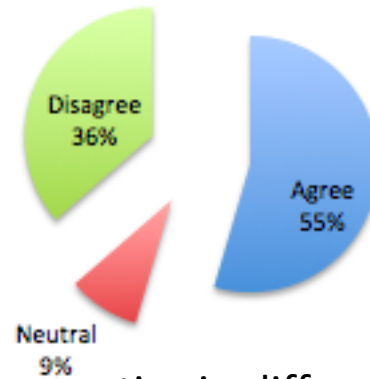
## - Use of opinions from questionnaire

DIFFERENCE  
Georgia - Azerbaijan

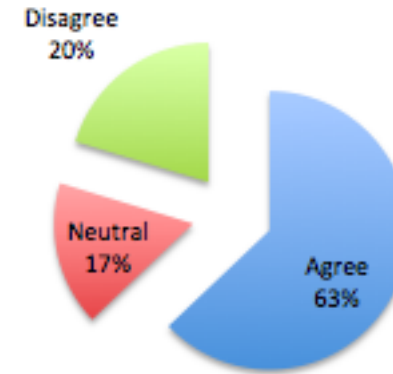
7.05%	-7.69%	0.64%
13.29%	-0.70%	-12.59%
8.33%	0.00%	-8.33%
-1.92%	8.97%	-7.05%
-13.64%	7.79%	5.84%
0.00%	0.00%	0.00%
0.00%	0.00%	0.00%
-25.64%	8.97%	16.67%
-23.78%	2.80%	20.98%
0.00%	0.00%	0.00%
-41.67%	50.00%	-8.33%
8.44%	12.99%	-21.43%
-17.53%	-12.34%	29.87%
-10.71%	9.52%	1.19%

Chart Area

Energy

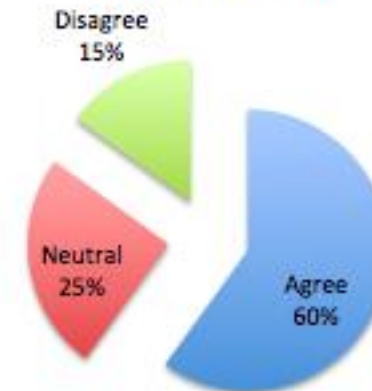


Energy



Same area of expertise in different countries or same country but different area of expertise

Environment



Environment

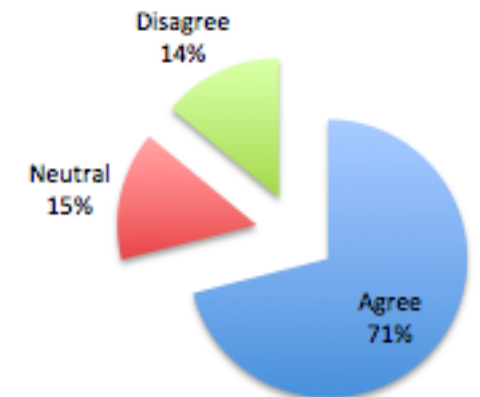


Chart Area

# Use of GIS (two examples)

If there is risk of flooding:

Areas at risk of flooding and areas of droughts (GIS) + current and planned agricultural land (GIS)

→ Where is agricultural land damaged (causing yields loss) because of extreme events and/or lack of adequate infrastructure?

+ planned infrastructure → Is it located where needed?

If energy production is a significant water use:

Map of power plants (hydro, thermal, nuclear) (GIS) and their water needs (technology related) + projected change in runoff in the river and tributaries (climatic analysis result)

→ Is the energy sector resilient to changes in water availability?

+ agricultural areas with their water needs → will there be a competition?

# Example from the Alazani

## Problems definition

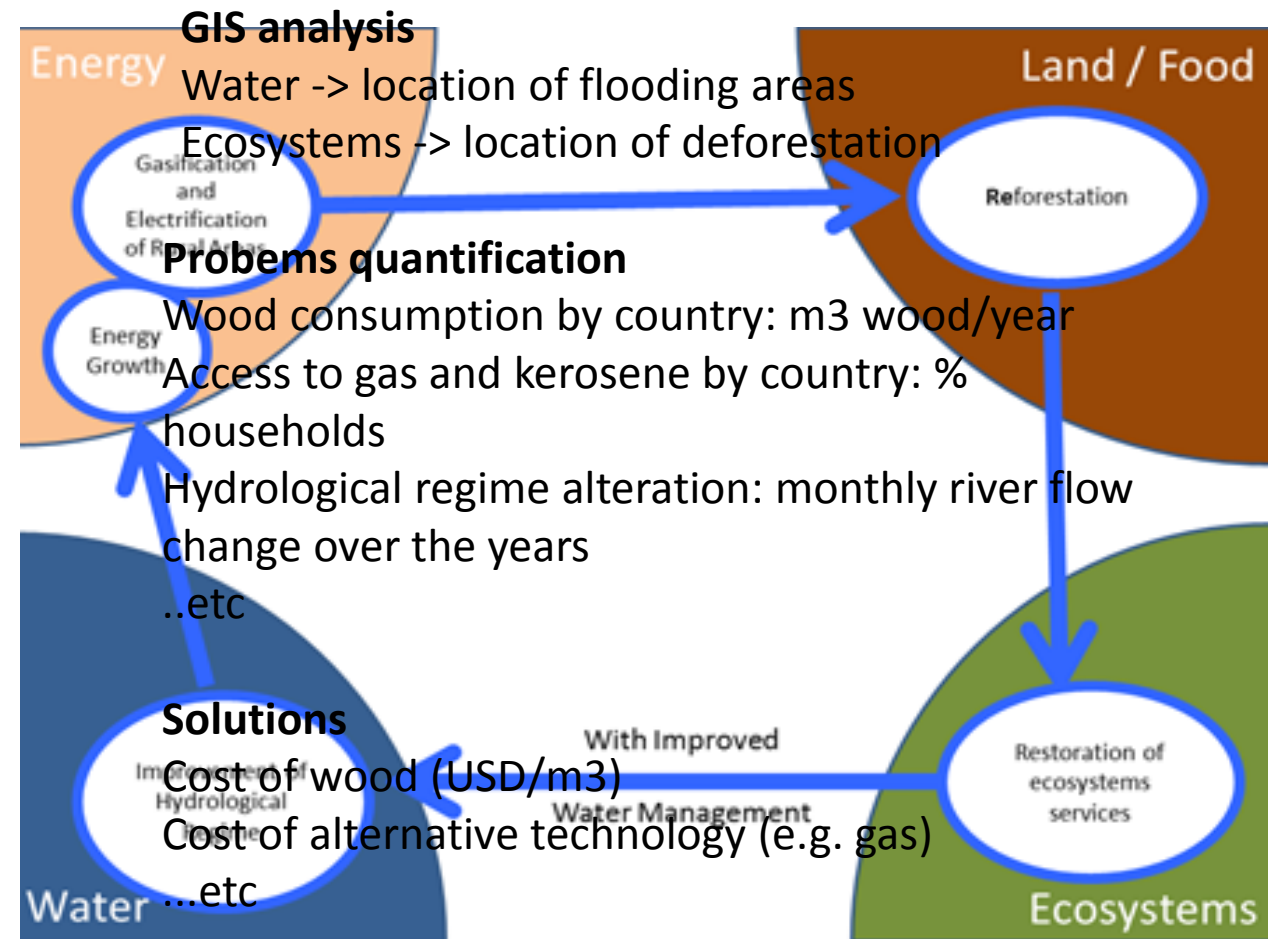
*i. lack of access to safe water in rural areas, ii. polluting household biomass fuel burning, iii. expensive modern fuels, iv. Water quality degradation and salinization, v. hydropower growth potential, vi. agricultural growth potential, vii. deforestation, viii. land degradation, ix. flood protection etc.*

## GIS maps support for discussion

Energy, Water, Land Use, Ecosystems

## Understanding the entity of the problems

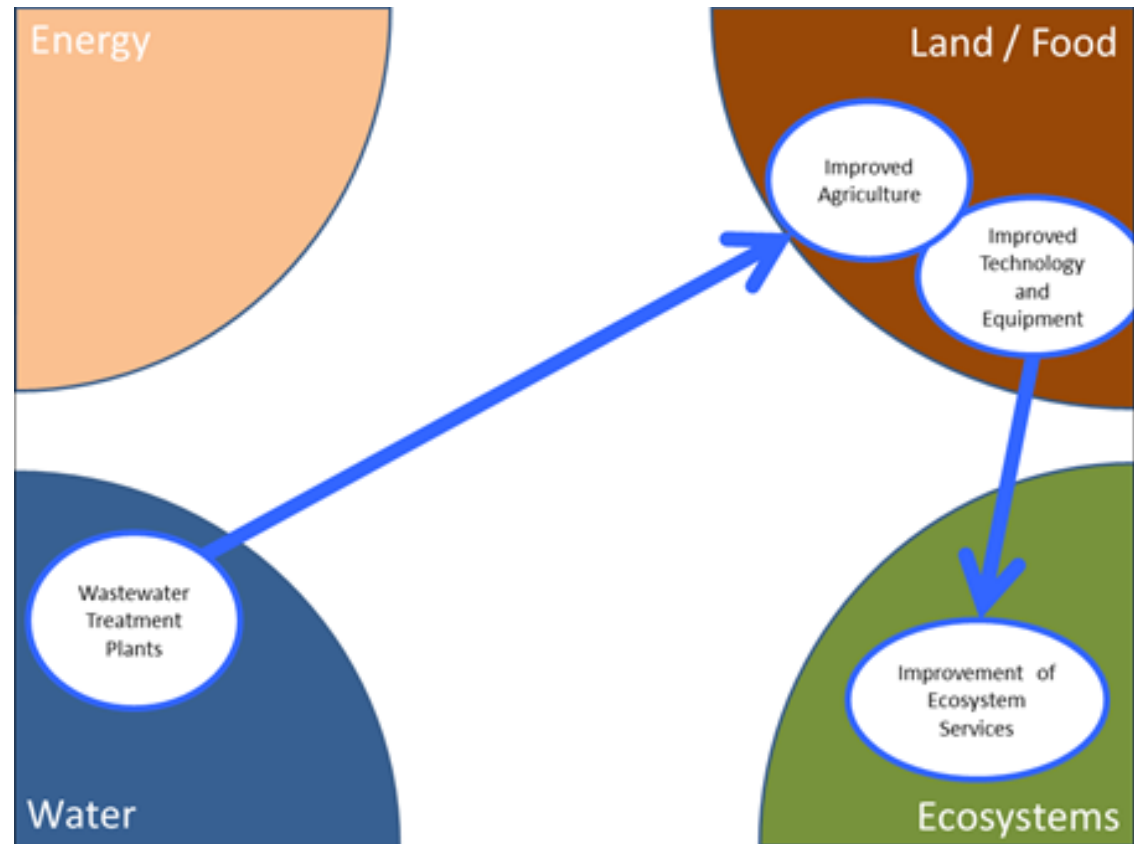
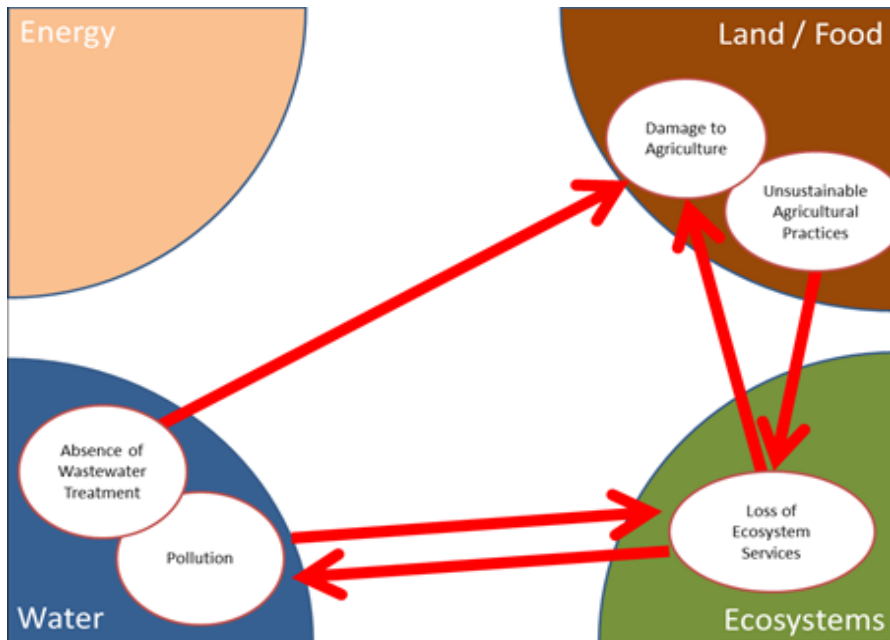
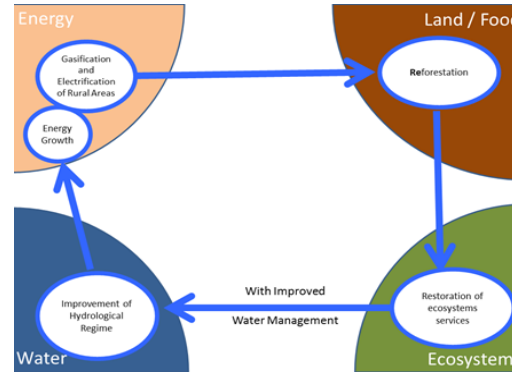
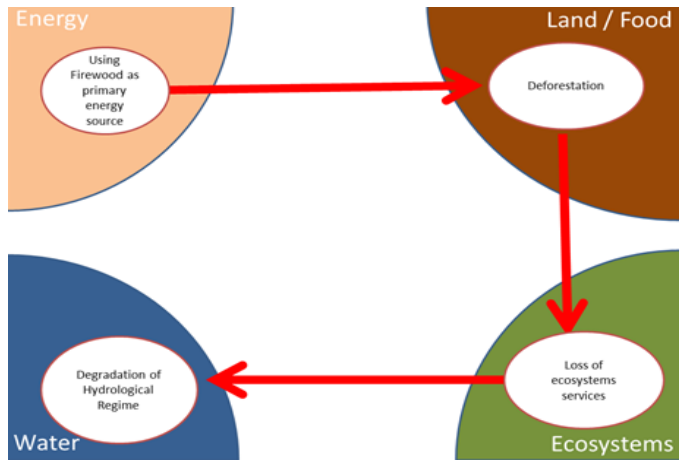
Deforestation: forest loss/year  
Price of fuels, by country  
Access to electricity, access to gas: % of population (proxies for local)  
...etc



Thank you!



Group	*National Indicators	*Basin Indicators (including GIS)	*Nexus-FAO Indicators	**Opinions of countries and sectors	***Specific indicators
Type	<p>Socio-economy and use of resources at country level.</p> <p>World Development Indicators: Progress towards MDGs, demography and society, environment, economy, states and markets</p>	<p>Indicators on resources availability, quality and uses at basin level.</p> <p>Water risk indicators: baseline water stress, interannual variability, seasonal variability, flood occurrence, and drought severity</p>	<p>Indicators on the inter-linkages across WEF sectors (WE; WF, EF)</p>	<p>Entity of issues related to energy, water, land use and environment according to local authorities (who have good knowledge of the basin)</p>	<p>Indicators to substantiate the in-depth analysis of the identified issues and solutions (including 'secondary feedbacks')</p>
Use	<p>Such indicators are used in the initial phases of the assessment. If needed, they can be validated or adjusted via expert consultations.</p> <p>In a final stage of the assessment, if better data is missing, they can be used as proxies for potential calculations.</p>	<p>Such indicators are used in the initial phases of the assessment. If needed, they can be validated or adjusted via expert consultations.</p> <p>At basin level, data available can differ very much in levels of aggregation, accuracy, reliability, etc.</p> <p>Qualitative and semi-quantitative</p>	<p>These indicators specifically quantify interlinkages across sectors. [Lucie to add something?]</p> <p>They are used for consultation or comiled in parallel to the nexus assessment, according to the specificity of the case.</p>	<p>Such indicators are used to appreciate the differences in perspective by country and by sector (or area of expertise)</p> <p>The opinions are ranked in the questionnaire itself in terms of intensity or importance.</p>	<p>Such indicators are used to substantiate the in-depth analysis of the identified issues and solutions (including 'secondary feedbacks' (C))</p> <p>Wherever possible, their quantification can help determining the entity of major issues across sectors and the</p>



- It was observed that households, especially in winter, harvest and burn fuelwood in order to heat their homes. People spend hours collecting fuelwood and become sick as they are exposed to high indoor pollution levels. As incomes can be low, the alternatives, such as electricity or LPG is either not distributed or expensive. The Aazani basin has significant hydro-power potential. However this potential is limited as flash floods and sedimentation reduce potential generation (and increase production costs).
- Forests are important providers of fuel wood and are a carbon sink. If they are harvested faster than they are re-grown, the quantity of forest covered land is decreased.
- Many important ecosystem services are supplied by the forests. As they grow, they capture carbon dioxide turning it into wood and roots. (This makes them valuable economically as CO<sub>2</sub> is traded on the global market). Forests also provide protection against erosion and retards the rapid run off that otherwise occurs during heavy rain.
- The region is plagued by flash floods. With limited forest cover this results in flash floods and top soil erosion. The loss of top-soil diminishes the fertility of the land and silts rivers.
- **The problem**
- Households are gathering and burning more fuel wood than can be grown by the forests. The resulting deforestation diminishes a carbon sink and is no longer a buffer against flash floods and soil erosion. Flash floods increase in severity and the rivers silt. The damage caused includes: erosion, loss of land productivity, lower electricity generation, infrastructure damage and others.
- The solution is to increase the use of alternative fuels for heating and cooking. This may be done in three ways. Making alternatives more accessible and cheaper, increasing the wealth of fuelwood users (so they can afford alternatives) or improving fuel burning efficiency. This will allow for a more effective reforestation that is needed also to overcome the desertification caused by climate change. Specific measures to better manage water flows and sustain the ecosystems are also suggested. The beneficial effects that ultimately these actions may have on the hydropower sector represent also an occasion to create energy growth.