Introduction to the Climate-Land-Energy-Water (CLEWs) modelling framework

and its use in the Nexus Assessment of the Drina River Basin

Day 1 – July 8th, 2021

Agenda

Time	Session	Presenter
9:30-10:00	Welcome and introductions	Tassos Krommydas (GWP), Francesco Gardumi (KTH)
10:00-10:30	Introduction to Nexus assessment methodologies and CLEWS	Francesco Gardumi
10:30-10:45	Break	
10:45-11:30	Climate-Water-Energy nexus issues in the Drina River Basin: what can be modelled?	Youssef Almulla
11:30-12:00	The water-energy model of the Drina River Basin: methodology	Emir Fejzic
12:00-12:45	Breakout group session: discussion on scenarios with the water-energy model of the Drina River Basin	All, facilitated by KTH
12:45-13:00	Wrap-up and end of session	Emir Fejzic

Day 1 – July 8th, 2021

Learning objectives

- Acquire general knowledge about the assessment of the water-energy-food nexus
- Understand the scope and characteristics of the CLEWs nexus methodology
- Understand the methodology underlying the water-energy model of the Drina River Basin
- Relate the scenario results of the water-energy model of the Drina river basin to key numerical assumptions and to the methodology

Introduction to Nexus assessment methodologies and CLEWS

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KTH Royal Institute of Technology

The problem

- Sustainable development means untangling a complex web of interwoven concerns and vested interests.
- Decisions can have far-reaching consequences outside the targeted area, sector, or jurisdiction.
- Impacts can be unintended and unforeseen.
- Cross-sectoral and cross-system impacts may be either positive or negative (or both).

A coordinated and integrated process to develop policies and measures with adequate attention given to cross-cutting aspects is needed to best manage synergies and trade-offs.

The nexus

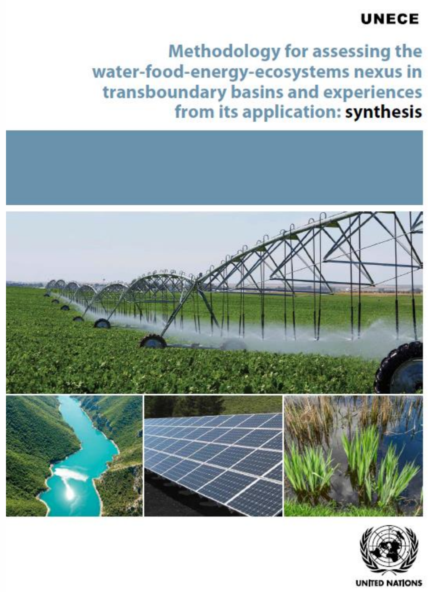
nexus

Interaction and interdependency between selected resource sectors/system/domains [in terms of trade-offs, conflicts, opportunities and synergies].

nexus approach

A systematic process of inquiry that accounts for water, land, energy, food and climate interactions (and/or other systems), in both quantitative and qualitative terms, with the aim of better understanding their dynamic relationships and inform planning and decision making in these domains.

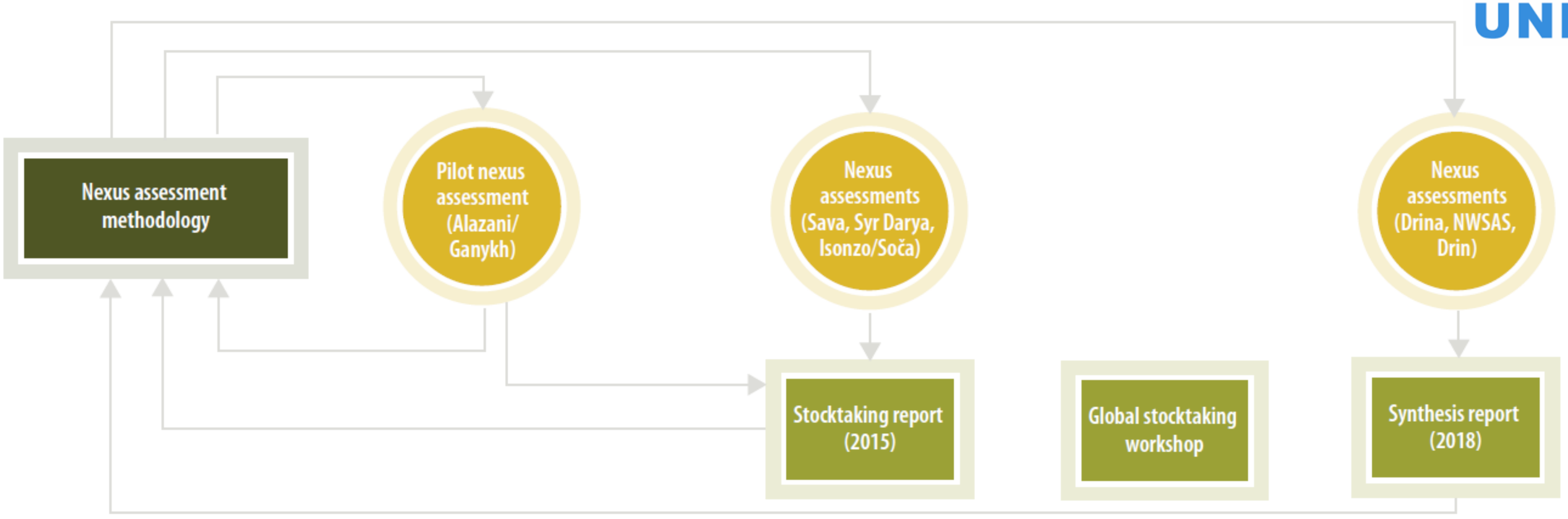
Nexus approach



UNECE, M. Roidt and L. De Strasser, *Methodology for assessing the water-food-energy-ecosystems nexus in transboundary basins and experiences from its application*, 2018

Programme of Work 2013-2015 under the UNECE Water Convention, adopted by the Parties

FIGURE 6
Phases of development of the TBNA methodology



Nexus approach

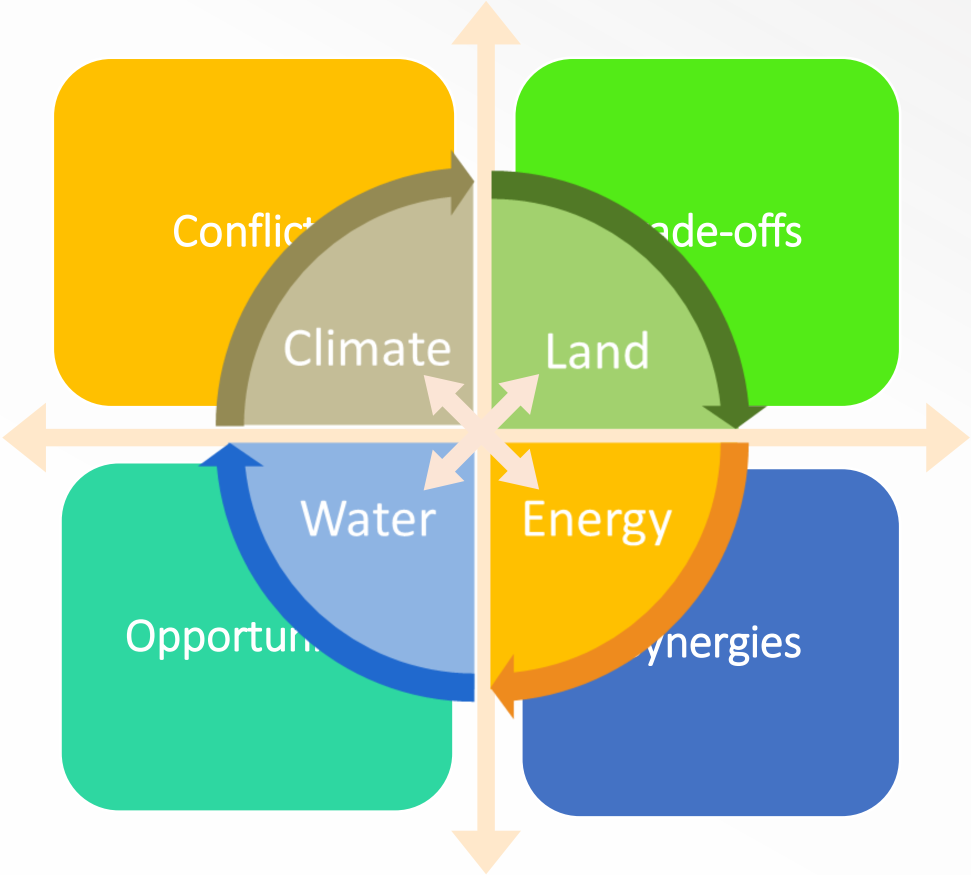
STEP		LOCATION	SECTORS
1	Identification of basin conditions, the socio economics	Desk study	General. Information normally used to underpin sectoral planning. Key elements include general socio-economic goals.
2	Identification of key sectors and stakeholders	Desk study	General. Requires expert judgment understanding of local context, governance.
3	Analysis of the key sectors	Desk study/ 1st Workshop	Individual sector experts and plans. Key elements include identifying resource flows and institutional mapping.
4	Identification of intersectoral issues	1st Workshop	Sectoral group discussion on interlinkages (input needs, impacts and trade-offs), and discussion on sectoral plans
5	Nexus dialogue and future developments	1st Workshop	Agreeing on a prioritization of main interlinkages. How the interlinkages are expected to change (development trends, key uncertainties and drivers)
6	Identification of opportunities for improvement	1st & 2nd Workshop/Desk study	Identification of solutions with multiple impacts between sectors, scales and boundaries

The CLEWs framework

What is the CLEWs framework?

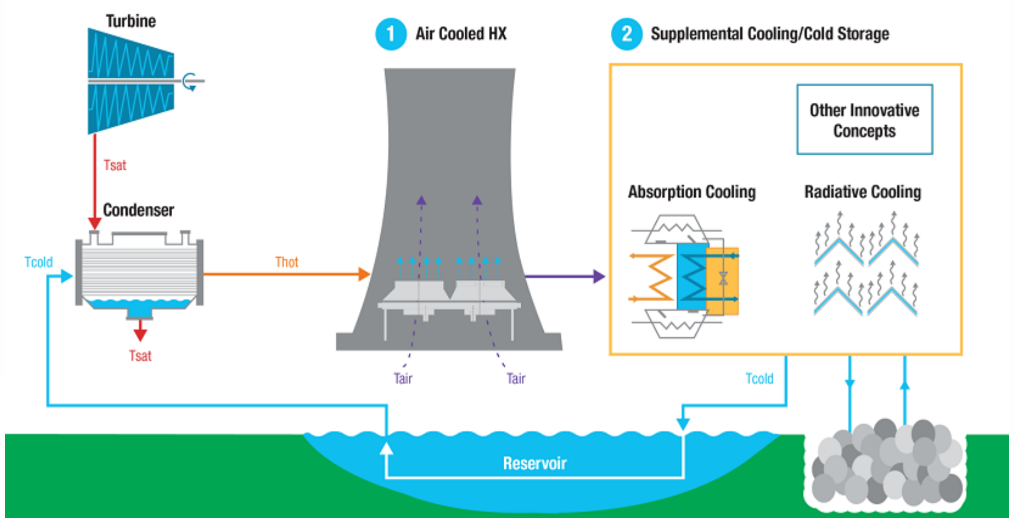
CLEWs stands for: **C**limate-**L**and-**E**nergy-**W**ater systems

Integrated analysis of resource systems' interactions and quantitative assessment of critical linkages using modelling tools.



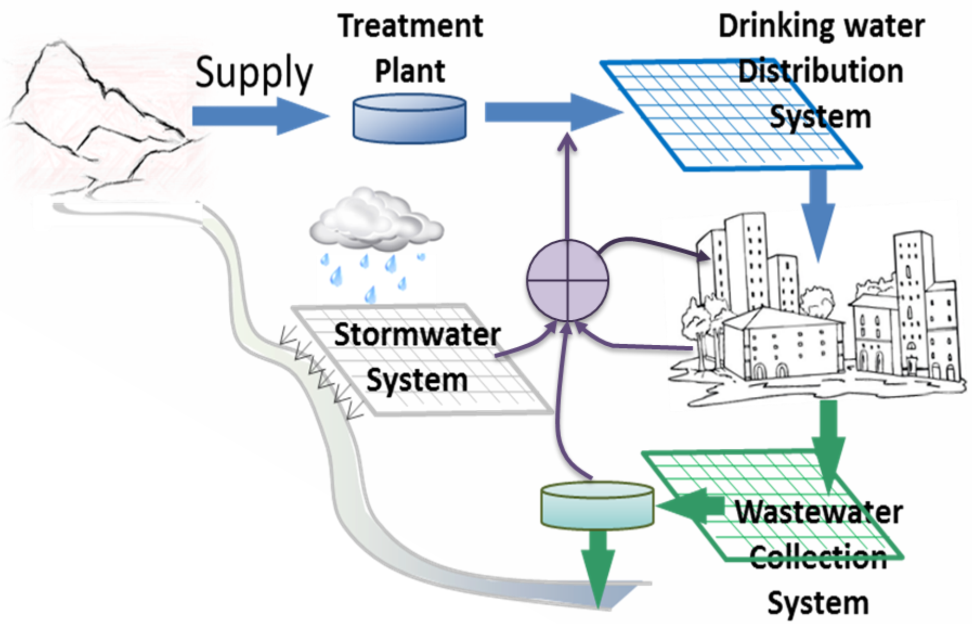
Water to Energy

- Fuel cycle
  - Fossil fuel extraction
  - Fuel processing
  - Biofuel cultivation and processing
- Energy conversion processes
  - Transport sector
  - Electricity generation
    - Hydropower
    - Thermal power
    - Non-hydro renewables



Source: https://arpa-e.energy.gov/?q=news-item/arpa-e-arid-program-advances-technologies-reduce-water-usage-power-plants

Energy to Water



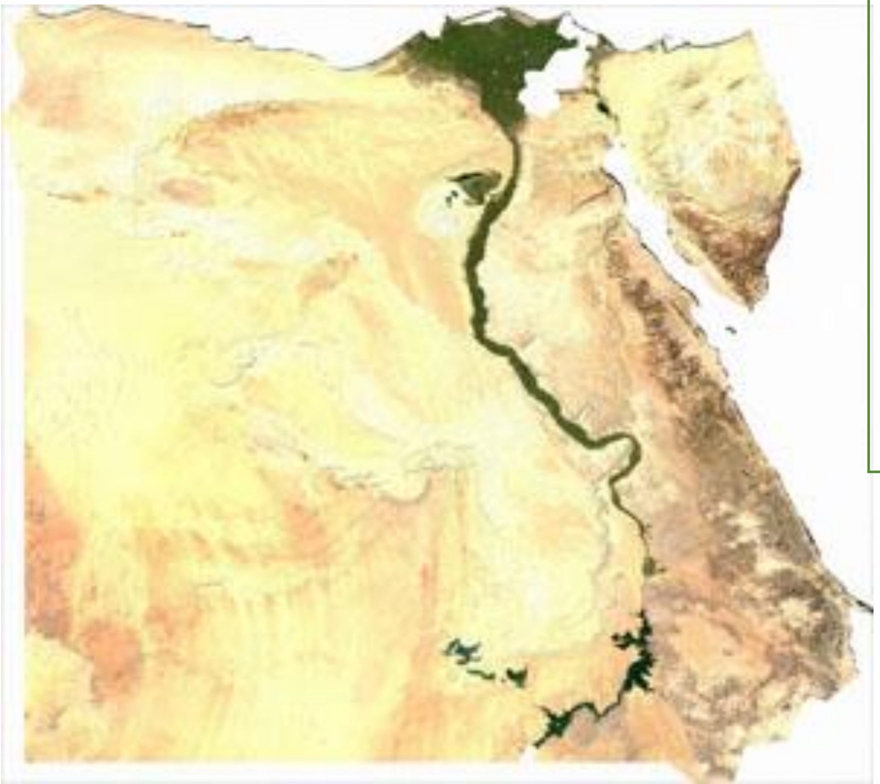
- Operation of water systems
  - pumping (extraction and distribution
  - water purification
  - wastewater treatment
  - non-conventional production of potable water
  - pump storage power plants
- Use of water
  - Water heating
  - Energy use and end use (e.g. washing machines)
- Energy for agriculture
  - Irrigation systems

Water to Land

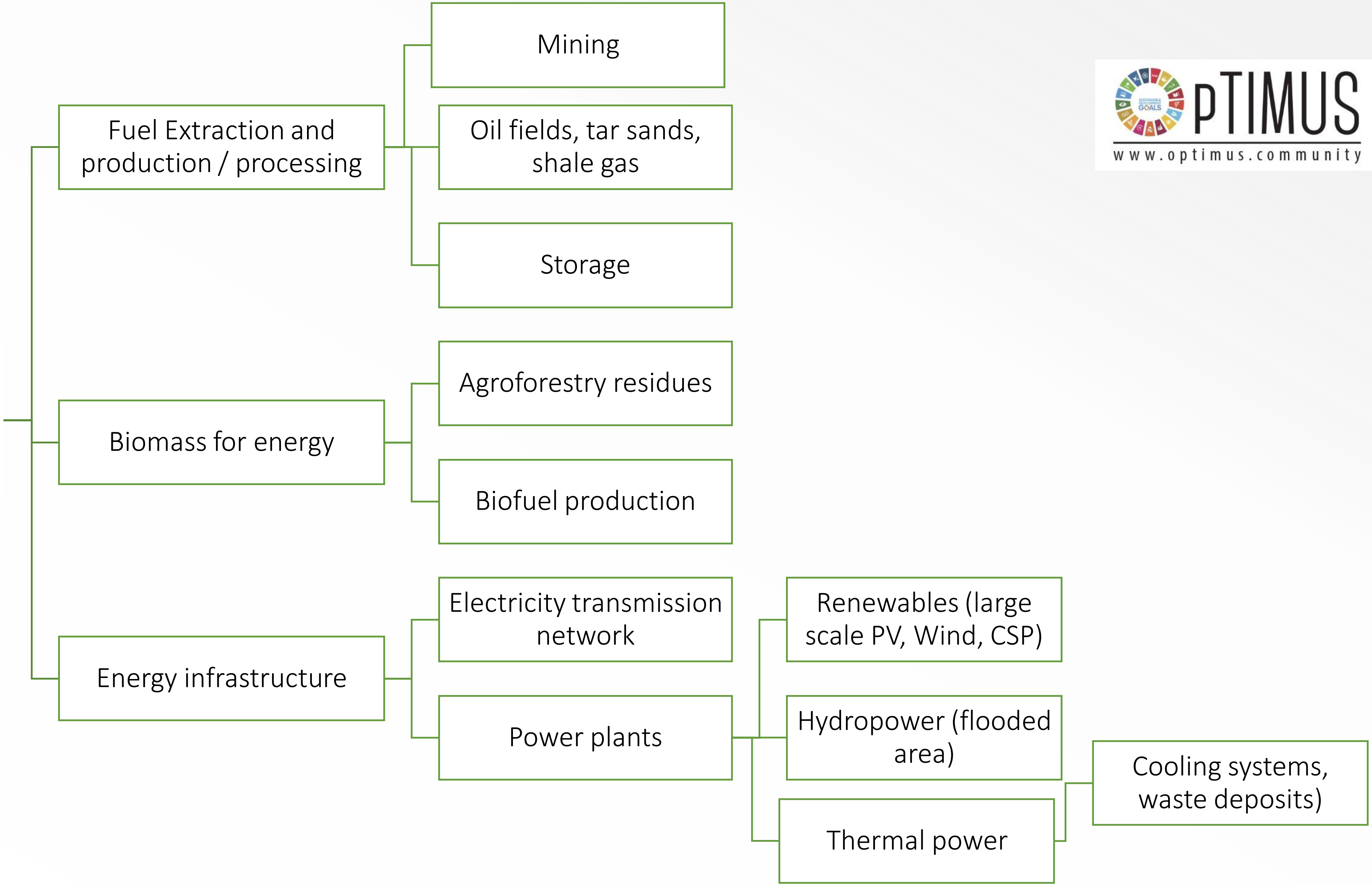
URBAN AREAS & PLANNING
- Population distribution and location of water resources

AGRICULTURE
- Crop suitability and yields
- Livestock

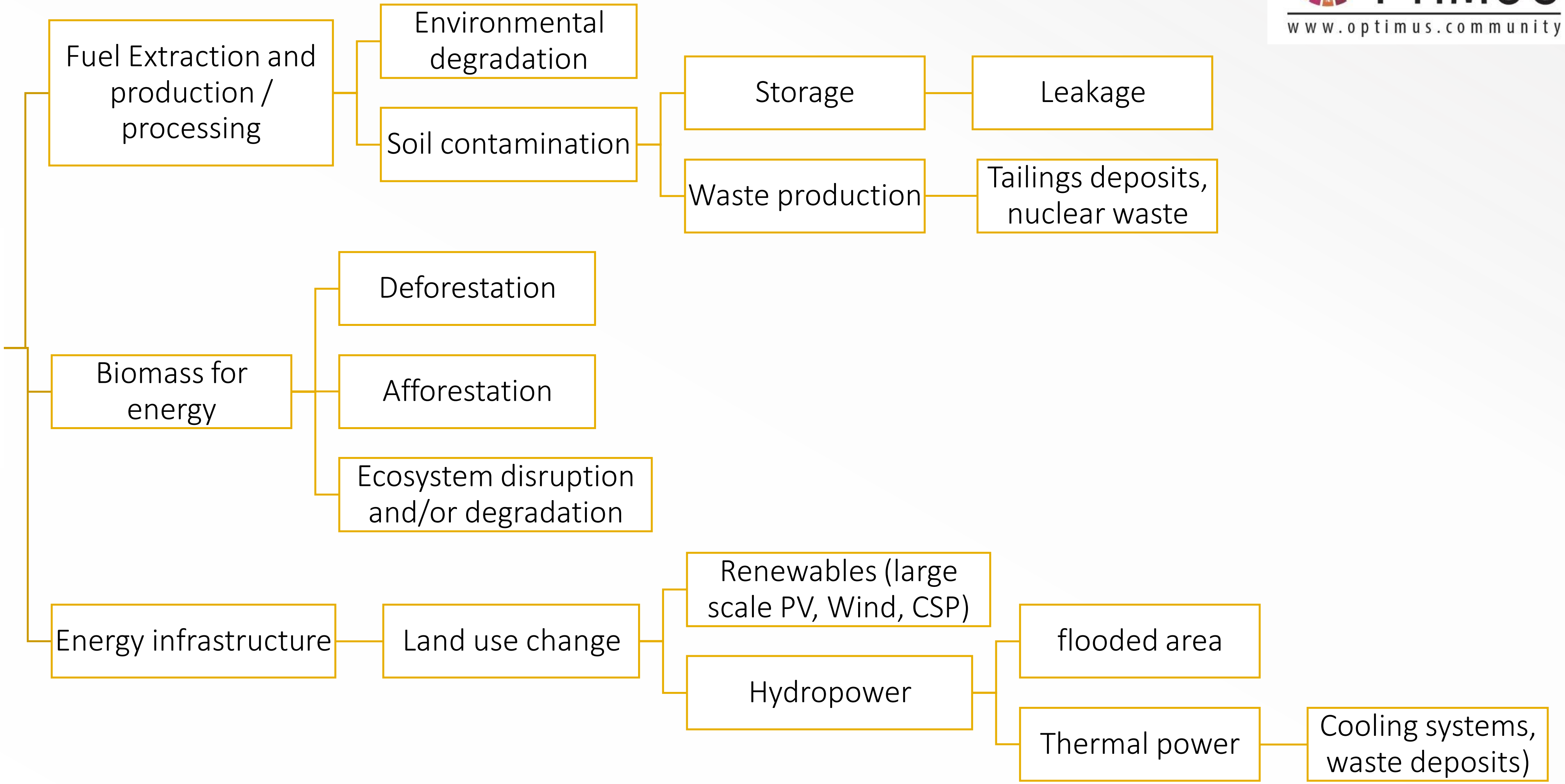
Natural cover
- Forests
- Wetlands
- Inland water



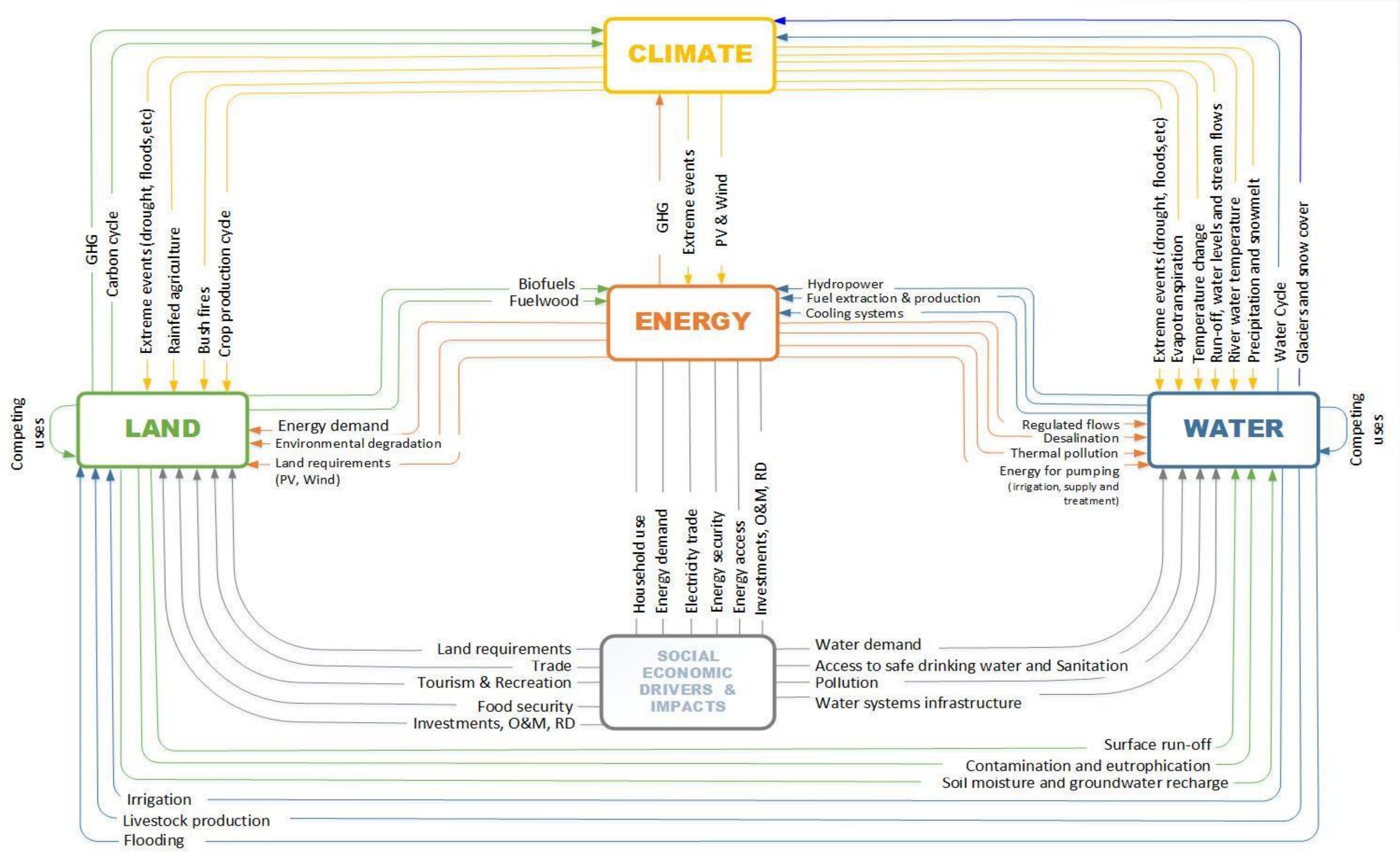
Land to Energy



Energy to Land



Mapping systems' interactions: the whole picture



Examples of CLEWs Modelling Tools

OSeMOSYS

Water
Evaluation
And
Planning

WEAP

GAEZ
Global Agro-Ecological Zones

LEAP

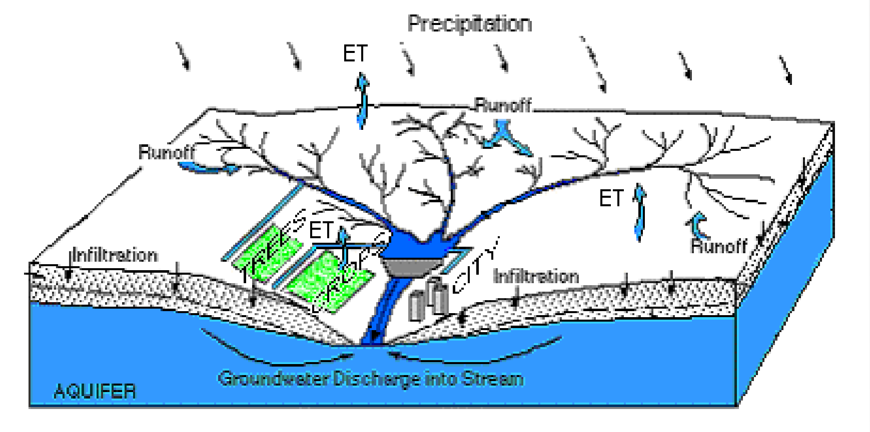
QGIS

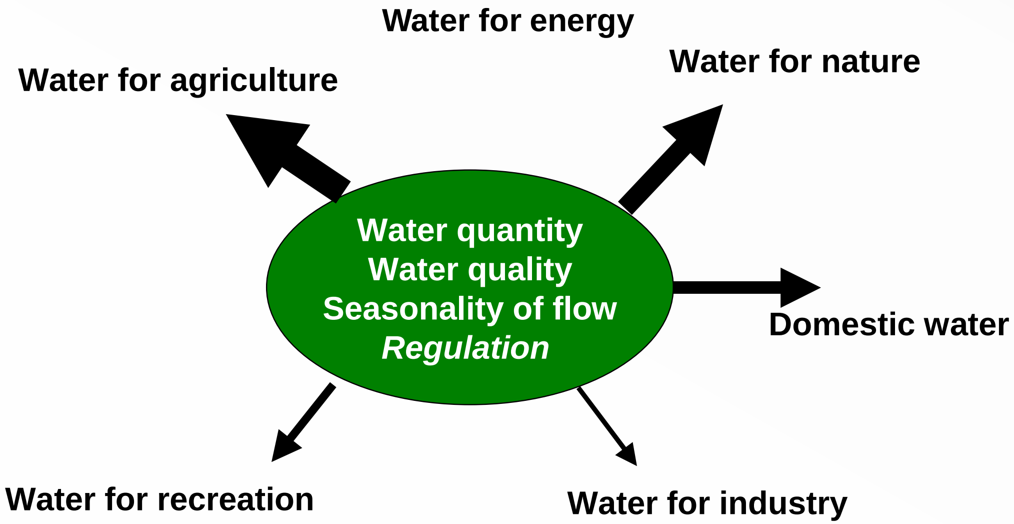
python™

Water Management modelling

Critical Questions

- How should water be allocated to various uses in time of shortage?
- How should infrastructure in the system (e.g., dams, diversion works) be operated to achieve maximum benefit?
- What is the demand for irrigated water and what are the associated energy requirements?

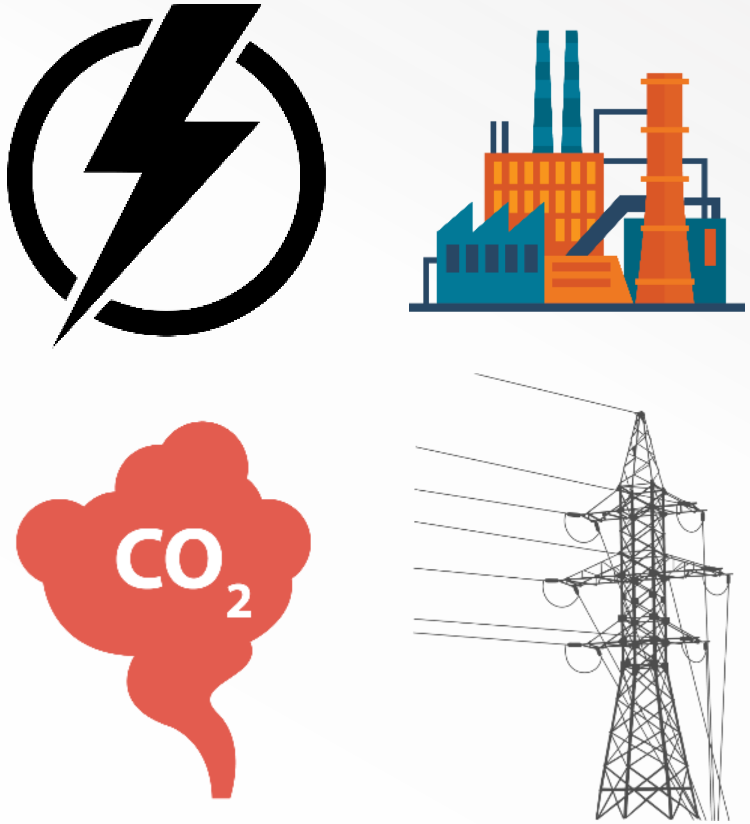




Energy system modelling

Critical questions

- What investments are needed in generation and network infrastructure to meet electricity demand and when?
- What technologies achieve the least-cost and most reliable energy mix?
- What are the associated impacts on land-use? E.g. from growing biofuels or from large-scale solar PV parks
- What are the associated water requirements for a specific energy mix? E.g. water for cooling, hydropower
- What pollutants are emitted and at what level?



Land use modelling

Critical questions

- What is the potential yield of a range of crops in each region?
- What are the water requirements for each crop?
- How do different climate scenarios affect crop yield?
- What are the energy requirements to ensure a certain yield?

Selected CLEWS Studies

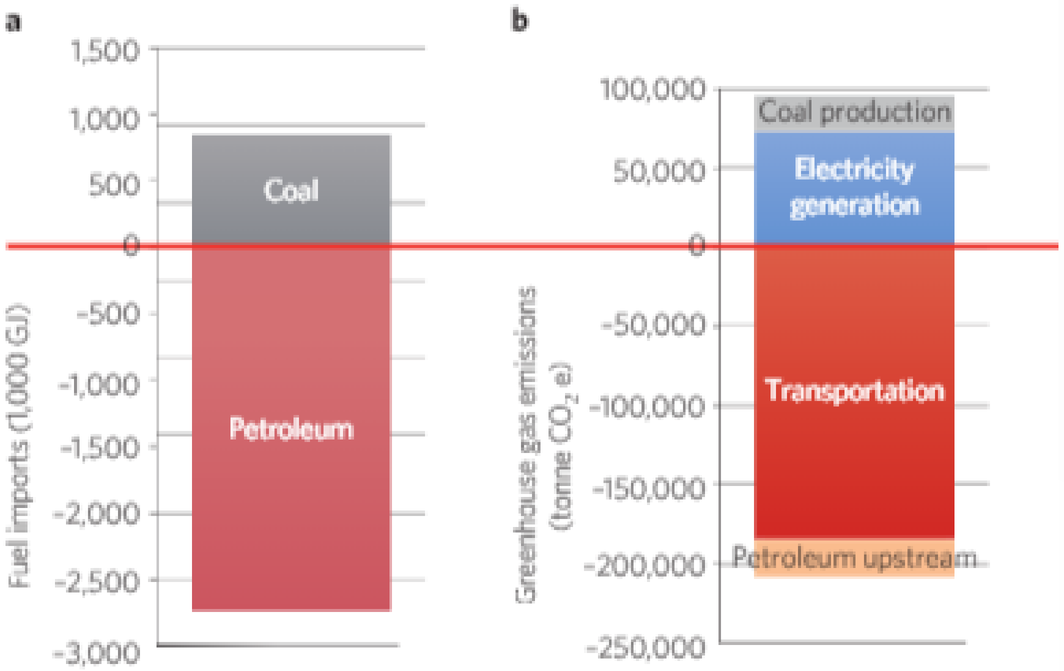
Mauritius – National CLEWs

- Main revenue has been tourism and sugar exports
  - Expiration of EU agreement and collapse of revenue from the latter.
- Diversification from sugar cane to food crops and vegetables
- Bagasse from refining – cogeneration of heat and electricity
  - Reduction in sugar prod. led to lower electricity generation from bagasse
- Consequent increase in fuel imports – coincided with increase in international fuel prices
- Irrigation requirements higher for food crops-vegetables than for sugar cane
  - Increased water demand

Mauritius – National CLEWs

Fuel imports (in 1,000 GJ)

GHG emissions (tonnes CO2 eq)



The impact of transforming two sugar-processing plants to produce second-generation ethanol in Mauritius (projections for 2030).

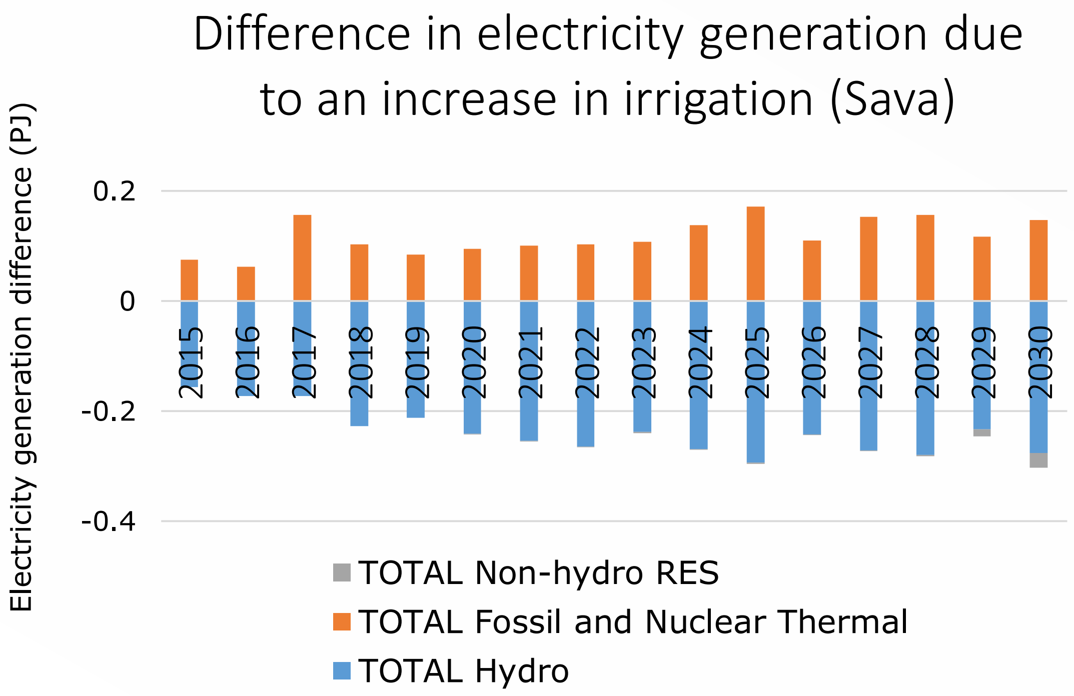
Sava and Drina River Basins

Aim: to assess water, energy and agriculture at a sub-regional level in a transboundary river basin context.

Main issues:

- Dependency between the basin water resources and the energy sector;
- Hydropower expansion vs climate change and competing irrigation demand;
- Water consumption in agriculture and for cooling systems;
- Relation between CO_2 emissions and water resources use in electricity generation.

Sava and Drina River Basins



Link: [Sava River Basin Nexus Assessment]

Link: [Drina River Basin Nexus Assessment]

Thank you!

Questions?

Changelog and Attribution

Date	Author	Reviewer	Reviser
2021-07-08	Sridharan, V., Ramos, E.P., Engström, R., Alfstad, T.	Gardumi, F.	Gardumi, F.

To correctly reference this work, please use the following:

Sridharan, V., Ramos, E.P., Engström, R., Alfstad, T., 2021. *Introduction to the Climate-Land-Energy-Water (CLEWs) modelling framework and its use in the Nexus Assessment of the Drin River Basin*, KTH-dES and OpTIMUS.community.