The Climate, Land, Energy, Water (CLEW) and Ecosystem Nexus

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Open Tools
Integrated Modelling and Upskilling for Sustainable-Development
Agenda 2030 for sustainable development

• A plan of action for people, planet and prosperity
• Provides a powerful aspiration for improving our world – laying out where we collectively need to go and how to get there
• The SDGs are not 17 separate ambitions, but highly interlinked challenges that require coordinated action
The CLEWs framework and interlinkages ....
CLEWs and the SDGs

**Increased income, energy use & material consumption**

**Demand for food**

**Demand & source of energy**

**Industrial production**

**Assess alternative technologies & consumption patterns**

**Deforestation & land use**

**Accounts for Carbon emissions**

**Technology and investment options**

**Housing (rural & urban)**

**Growth scenarios**

**Demand for clean water**

**CLEWs and the SDGs**

**Sustainable cities and communities**

**No poverty**

**Zero hunger**

**Affordable and clean energy**

**Industry, innovation and infrastructure**

**Responsible consumption and production**

**Clean water and sanitation**

**Partnerships for the goals**

**Life on land**

**Climate action**

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**Climate action**
GLOBAL CLIMATE, LAND, ENERGY & WATER STRATEGIES

Water, energy and land-use are intimately interlinked and all affect the climate. Therefore, issues related to water, energy or land use cannot be dealt with in isolation and cannot be met sustainably without trade-offs between them. The CLEWS Model provides an integrated interdisciplinary framework supporting a clear understanding of those relationships.

The original model was developed by researchers from the Royal Institute of Technology (KTH) in Sweden in cooperation with the United Nations Division for Sustainable Development. For more information please visit UN DESA.
Comparing A BAU with a Carbon Tax

COMPARE CLIMATE SCENARIOS
Use the dropdown menus to compare the emissions and energy produced by various industries under different scenarios from 2010 to 2050. All scenarios follow current assumptions for energy supply and renewable energy generation potentials.

CHOOSE SCENARIO: Baseline Scenario

This is the business-as-usual scenario. Greenhouse gas emissions are expected to increase average temperature to between 4°C and 6°C. Consumption and production grow according to trend and no new environmental regulations are considered.

CHOOSE SCENARIO: Carbon Tax Scenario

This scenario does not impose any limit on the use of fossil fuels but incorporates a global carbon tax increasing from US $1 per ton CO₂ eq. in 2016 to US $25 in 2050.

CUMULATIVE AMOUNTS, 2010 TO 2050

- How much water is consumed?
  - 1,850 km³
  - Annual average is 142% of 2010 values

- How much CO₂ is produced?
  - 1,552 CO₂ eq
  - Annual average is 123% of 2010 values

- What is the total investment in energy and material production?
  - $228,071 billion 2010 USD
  - Annual average is 8.1% of global GDP

- How much water is consumed?
  - 1,879 km³
  - Annual average is 144% of 2010 values

- How much CO₂ is produced?
  - 1,452 CO₂ eq
  - Annual average is 115% of 2010 values

- What is the total investment in energy and material production?
  - $233,864 billion 2010 USD
  - Annual average is 8.3% of global GDP
Comparing A BAU with a 2°C Target
Technology and Water ...

COMPARE CLIMATE SCENARIOS

Use the dropdown menus to compare the emissions and energy produced by various industries under different scenarios from 2010 to 2050. All scenarios follow current assumptions for energy supply and renewable energy generation potentials.

CHOOSE SCENARIO: Baseline Scenario

This is the business-as-usual scenario. Greenhouse gas emissions are expected to increase average temperature to between 4°C and 6°C. Consumption and production grow according to trend and no new environmental regulations are considered.

CHOOSE SCENARIO: 2 degrees Scenario

This scenario poses a limit on use of fossil fuels such that average global temperature does not increase above 2°C.

CO₂ Emissions

Water Use
Transboundary assessments
### SAVA BASIN

**River length**: 615 km
**River basin area**: 87,713 km²
**Water use**: 4,686 million m³/year

#### SLOVENIA
- **Total renewable freshwater sources**: 223 million m³/year
  - Surface waters: 32 million m³/year
  - Water withdrawals: 191 million m³/year
  - Agricultural: 9% (17.2 million m³/year)
  - Industrial: 8% (15.2 million m³/year)
  - Municipal: 8% (14.4 million m³/year)

#### CROATIA
- **Installation capacity**: 4.2 million kW
  - Hydroelectric: 3.2 million kW
  - Thermal: 0.1 million kW

#### BOSNIA AND HERZEGOVINA
- **Agricultural land**: 21,500 km²
  - in use: 21,500 km²

#### SERBIA
- **Gross domestic product**: $40,000 million USD

#### MONTENEGRO
- **Population**: 340,000
  - of which: 210,000 people in Sava basin (60%)
Aim: to quantify the resilience of large scale hydro expansion using a CLEWS assessment.

How: by assessing global climate change, regional power expansion and local demands a “CLEWS approach” may provide new insight.

Why: Hydro investments need to be undertaken in the context of local water and regional power needs

- Ethiopia is expanding its hydro system rapidly, potentially stranding Uganda’s expansion and trade potential
- Climate change (with associated water withdrawals) may change production potential
- Local water requirements may grow in the future
Uganda

Resilience of Africa Energy infrastructure to Climate Change: Uganda as part of the East African Power Pool
Mauritius

• Main revenue has been tourism and sugar exports
  • Expiration of EU agreement and collapse of revenue from the latter.
• Diversification away from sugar cane to food crops and vegetables
• Sugar cane production and refining – staple industry
• Bagasse from refining – cogeneration of heat and electricity
  • Reduction in sugar production 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
Impact of shifting two major sugar refineries to produce 2nd generation ethanol

<table>
<thead>
<tr>
<th>Reduced fuel imports</th>
<th>Reduced greenhouse gas emissions</th>
<th>Reduced expenditures</th>
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</thead>
<tbody>
<tr>
<td>Overall energy import dependence decreases: Gasoline imports are reduced as ethanol replaces gasoline as a motor fuel. Some bagasse is diverted from electricity generation to ethanol production and needs to be substituted by higher imports of coal and distillate oil.</td>
<td>Total greenhouse gas emissions are reduced: Tailpipe and upstream emissions are reduced as gasoline is replaced by ethanol. The increased use of coal and distillate oil (in place of bagasse) for electricity generation results in smaller additional emissions. [1) Indirect emissions</td>
<td>Domestic ethanol production has economic benefits: As some of the sugar is converted to ethanol, the expenditures for sugar refining and gasoline imports are reduced. This outweighs the reduced sugar export earnings and the costs associated with ethanol production and the increases in oil and coal imports.</td>
</tr>
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Impact of climate change in a CLEWs framework
Punjab, India

Punjab has only 1.5% of India’s land, but its rice and wheat production accounts for 50% of the grain the government purchases and distributes to feed more than 400 million poor Indians.

- Groundwater is being withdrawn faster than it can be replenished
  - No restriction on landowners’ rights to pump water on their own land.
  - Government-set prices incentivises planting of water-intensive crops
  - Electricity is provided for free to farmers

- Water levels drop and increased pumping is putting additional stress on an already fragile and overtaxed electricity grid.
  - Excessive pumping not only leads to over-exploitation of aquifers it also leads to high electricity demand.
  - Irrigation accounts for about 15–20% of India’s total electricity use.
Urban CLEWs
– New York City: pilot CLEWs city study
Numerical results: economics of interventions

intervention’s payback times with (5% discount rate)

- Toilets
- Showers (GasWH)
- Showers (SolarWH)
- Washing Machine (GasWH)
- Washing Machine (SolarWH)
- Green Roofs
- Light bulbs
- Rain barrels

Legend:
- Blue: With only local (energy) costs
- Green: With local and systems (water + energy) costs
- Teal: With water, energy and CO₂e costs
- Red: Estimated payback period of the 2012 International Energy Conservation Code for NY home owners (3.2 years)
- Dashed: Estimated lifetime of efficient appliances in each intervention
Capacity building and communication ....
Considering the energy, water and food nexus: Towards an integrated modelling approach


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A B S T R A C T

The areas of energy, water and food policy have numerous interwoven concerns ranging from ensuring access to services, to environmental impacts to price volatility. These issues manifest in very different ways in each of the three "spheres", but often the impacts are closely related. Identifying these interrelationships is of great importance to help target synergies and avoid potential tensions. Systems thinking is required to address such a wide swath of possible topics. This paper briefly describes some of the linkages at a high-level of aggregation – primarily from a developing country the nexus. To use the nexus, environmental and energy policies need to be linked

Integrated analysis of climate change, land-use, energy and water strategies


Land, energy and water are our most precious resources, but the manner and extent to which they are exploited contributes to climate change. Meanwhile, the systems that provide these resources are themselves highly vulnerable to changes in climate. Efficient resource management is therefore of great importance, both for mitigation and for adaptation purposes. We postulate that the lack of integration in resource assessments and policy-making leads to inconsistent strategies and inefficient use of resources. We present CLEWS (climate, land-use, energy and water strategies), a new paradigm for resource assessments that we believe can help to remedy some of these shortcomings.