Introduction to CLEWs

Hands-on lecture 11: Climate change and policies

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Tags: CLEWs; Climate; Land; Energy; Water; Systems Modelling; Integrated; Policy Coherence; Climate Change; Policy; Hands-on; Climate Compatible Growth; Open Source; Teaching Kit;

Useful links:

1) Discussion forum for CLEWs
2) Results from this Hands-on

Pre-requisites:

1) Successful completion of all the activities under Hands-on lecture 9

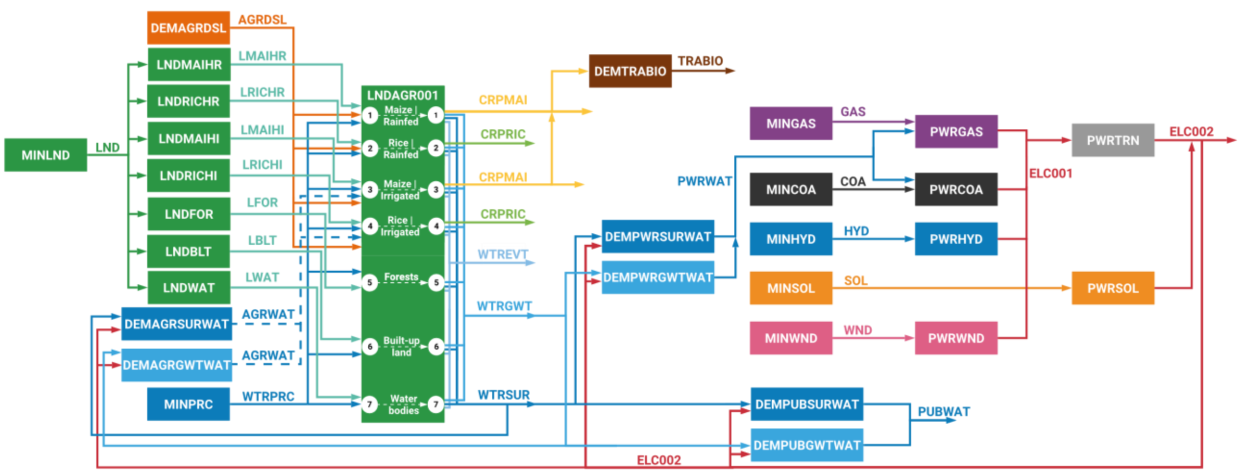
Learning outcomes

By the end of this exercise, you will be able to:

1) Reflect on the impacts of different decarbonisation policies on the CLEW systems
2) Explore climate change impacts on the CLEW systems

Overview

Previous activities focused on building an integrated model that captures the biophysical characterstics of energy, water, land, and climate systems. This provides a useful foundation to then explore the impacts of different approaches to achieve user-defined objectives.



Activity 1 – Emission reduction policies

Before starting this activity, remember to copy the model from the previous hands-on.

This activity will focus on the use of CLEWs models to explore the impact of setting emission reduction targets on different sectors. It introduces the parameter '**ModelPeriodEmissionLimit**', which can be used to set a limit on the total emissions over the entire model period for a specific type of emission. This approach can be used to represent carbon budgets, for instance.

Before setting this in the model, we need to slightly alter the model structure. The current structure of negative emissions for **LNDFOR** gives the model an 'out'. With a carbon cap, this will allow the model to create fake forests and 'offset' carbon emissions. Therefore, this needs to be switched to **LNDAGR001** in **mode 5** (which represents forests). This is a crucial concept to understand.

To do this, move the values for '**EmissionActivityRatio**' for **LNDFOR** (in mode 1) to **LNDAGR001** (in mode 5). You will need you add a C02eq emission type to the LNDAGR001 technology first at your model homepage before you can do this.

After this, add the total **ModelPeriodEmissionLimit** of 160 MtCO2.

Effectively, you are adding a constraint to your model, i.e. your model must optimise its CLEWs strategy without surpassing this emission threshold over the 4 years your model is active. If your constraint was too strict, e.g. a limit of 100 Mtons of carbon, the model would run as 'infeasible' as it would not be possible to achieve this target based on the current assets the model has.

Now, run your model.

Activity 2 – Renewable energy policy

In this activity, we introduce a plan to invest in **1GW** of wind power in each of the four years, from 2019 – 2022. This can be done by using the parameter '**TotalAnnualMinCapacityInvestment**'.

After this change, run the model and check the results.

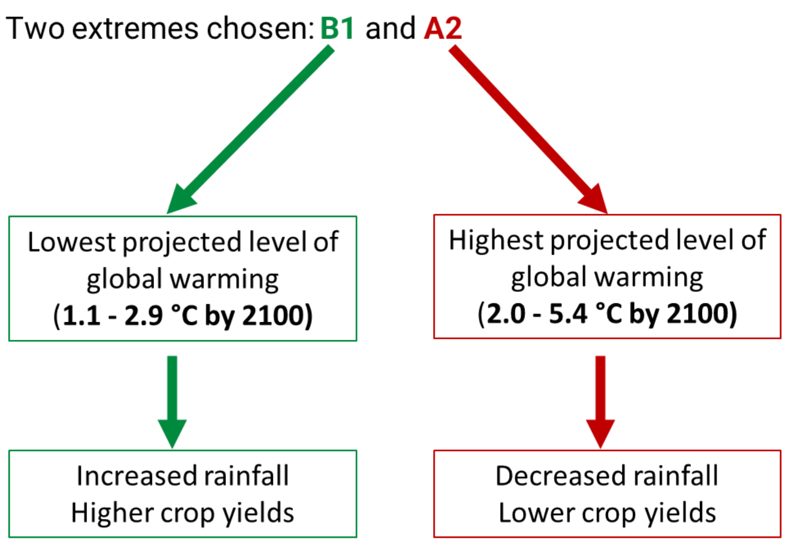
Own reflection

Optional (no deliverable needed)

- Reflect on the scenarios you ran in these two activities and the types of policies you looked at. How do the results change? Does introducing these policies in the model give any important insights? Can you think of other policies that you would like to introduce?

Activity 3 and 4 – Climate change scenarios

Next, we look at how climate change impacts can be represented in a CLEWs model. Here this is done by considering two of the IPCC's climate change scenarios: B1 and A2. These two scenarios represent two extremes of potential climate futures. In particular, they represent different future rainfall patterns and attainable crop yields.



This is done by creating **two different clones** of the previous version of the model. Each one will be modified to represent a different climate scenario. In one you will introduce data for the climate scenario B1 and in the other you will introduce data for the climate scenario A2. The data to be updated for each of the climate scenarios is shown below.

Depending on whether a commodity is an input or output, the InputActivityRatio or OutputActivityRatio for that commodity should be updated respectively.

CLIMATE SCENARIO B1

Technology	Value	Parameter
LNDAGR001	1 unit of land (1000 sq. km) produces 0.9 million tonnes of **CRPMAI in mode 1**	**OutputActivityRatio**

LNDAGR001	1 unit of land (1000 sq. km) produces 0.3 million tonnes of **CRPRIC in mode 2**	**OutputActivityRatio**
LNDAGR001	1 unit of land (1000 sq. km) produces 1.1 million tonnes of **CRPMAI in mode 3**	**OutputActivityRatio**
LNDAGR001	1 unit of land (1000 sq. km) produces 0.5 million tonnes of **CRPRIC in mode 4**	**OutputActivityRatio**

Input water commodities		Mode	Output water commodities		
WTRPRC	**AGRWAT**		**WTREVT**	**WTRGWT**	**WTRSUR**
1.4		**1 (Maize, Rain-fed)**	**0.47**	**0.09**	**0.84**
1.4		**2 (Rice, Rain-fed)**	**0.7**	**0.07**	**0.63**
1.4	**0.1**	**3 (Maize, Irrigated)**	**0.5**	**0.10**	**0.90**
1.4	**0.25**	**4 (Rice, Irrigated)**	**0.75**	**0.09**	**0.81**
1.4		**5 (Forests)**	**0.99**	**0.04**	**0.37**
1.4		**6 (Built-up land)**	**0.88**	**0.05**	**0.48**
1.4		**7 (Water bodies)**	**0.47**	**0.09**	**0.84**

Note that the values in the above table are for the technology LNDAGR001 and they are in Billion m^3 per 1000 sq.km (i.e. units of water supply per units of land).

CLIMATE SCENARIO A2

Technology	Value	Parameter
LNDAGR001	1 unit of land produces 0.6 million tonnes of CRPMAI in mode 1	OutputActivityRatio
LNDAGR001	1 unit of land produces 0.1 million tonnes of CRPRIC in mode 2	OutputActivityRatio
LNDAGR001	1 unit of land produces 0.8 million tonnes of CRPMAI in mode 3	OutputActivityRatio
LNDAGR001	1 unit of land produces 0.3 million tonnes of CRPRIC in mode 4	OutputActivityRatio

Input water commodities		Mode	Output water commodities		
WTRPRC	AGRWAT		WTREVT	WTRGWT	WTRSUR
1.0		1 (Maize, Rain-fed)	0.33	0.07	0.60
1.0		2 (Rice, Rain-fed)	0.5	0.05	0.45
1.0	0.5	3 (Maize, Irrigated)	0.5	0.10	0.90
1.0	0.65	4 (Rice, Irrigated)	0.75	0.09	0.81
1.0		5 (Forests)	0.71	0.03	0.27
1.0		6 (Built-up land)	0.63	0.03	0.34
1.0		7 (Water bodies)	0.33	0.07	0.60

Note that the values in the above table are for the technology LNDAGR001 and they are in Billion m^3 per 1000 sq.km (i.e. units of water supply per units of land).

After entering all these values, run the two models separately.

If you have done everything correctly, you will notice that scenario A2 is infeasible! This is because the systems are not able to meet the strict decarbonisation target with such severe climatic changes. Increase the **ModelPeriodEmissionLimit** of scenario A2 to **220 Mton**. Then run the model again and check the results.

Own reflection

Optional (no deliverable needed)

- Reflect on the way you represented climate change effects in your model. Is it a comprehensive representation, or does it have limitations, in your opinion?
- Looking at the results of the two scenarios in your model, think of the effects that climate change seems to have in the sample region. Include numbers. Are the effects felt in all the systems? Where are they most intense? How could policies minimise the potential harmful effects of climate change across all the CLEW systems (and not only in one of them)? Could there be policy innovations that produce benefits across the CLEW systems?