

Can we mitigate climate change and sustainably feed the world ?

The links between energy and land-use in the long-term mitigation strategies



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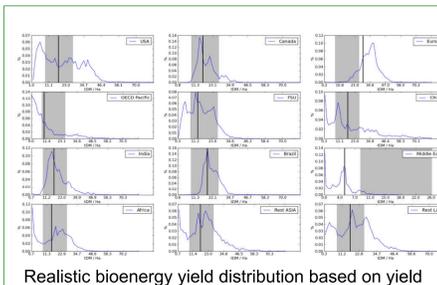
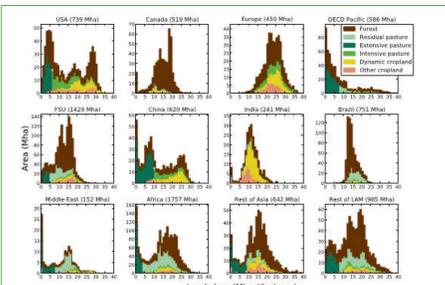
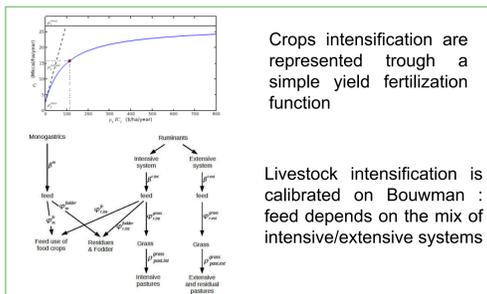
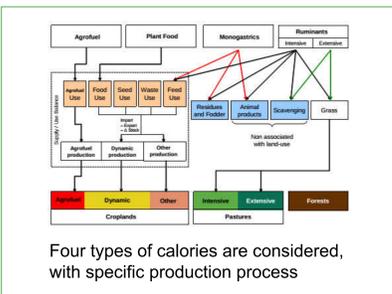
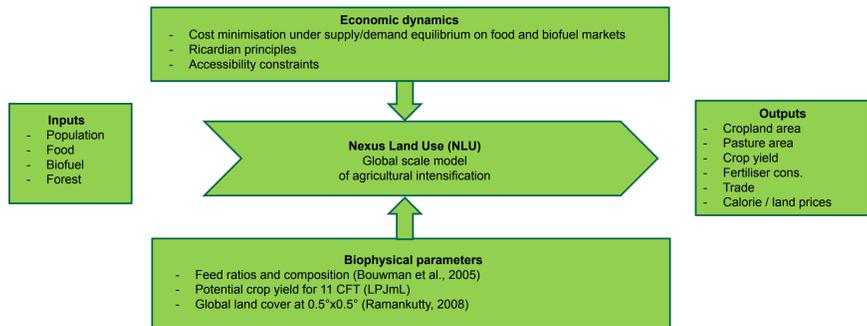
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1 Overview

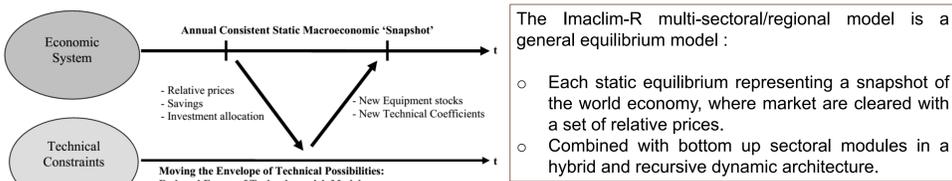
- Considering the AR5 scenarios conclusions : bioenergy reduced drastically mitigation costs, and is widely used whenever available
- As a next step : the EMF33 study try to assess more accurately the feasibility and sustainability of bioenergy
- In this context : CIRED has implemented the « hard linkage » of the the Nexus Land Use model into the E3 Imaclim-R model
- First results highlights :
 - The influence of food diet on land pressure, and the hedging potential of low food diets regarding the bioenergy pressure on land when mitigating climate change
 - Rent transfers between oil revenues and land owners
 - The efficiency of bioenergy as a mitigation option

2 The Nexus Land Use (NLU)

The Nexus land-use model takes as inputs a demand of biomass and computes variables of intensification through an economic and biophysical parametrization :

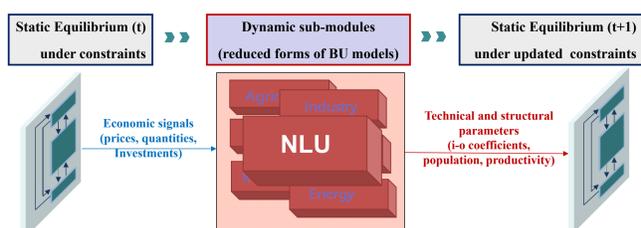


3 Bottom-up in the Imaclim-R framework



The representation of unused of the installed equipment stock creates market imperfection, which is captured through Markup pricing, though including :

- Capital costs
- Pure profits based on price and demand signal
- Rents



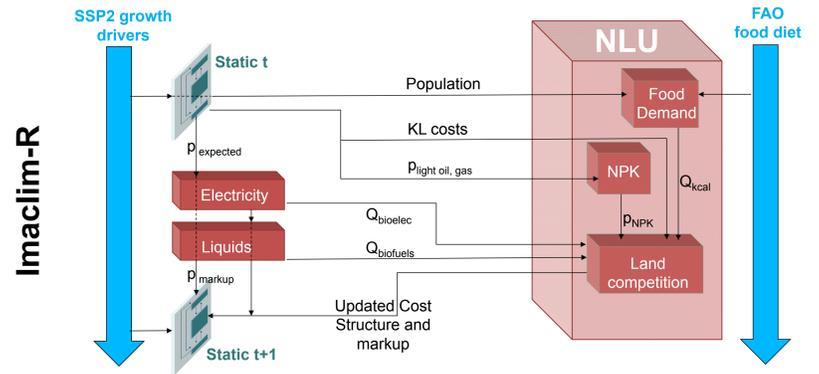
Disaggregation with NLU as a bottom-up module :

- Imaclim-R : agricultural and food processing in ones
- NLU : calorific content of the agri/food sector of Imaclim

NLU enables an external projection of the demand for food in quantity and the associated biophysical pressure :

- We assume that the calorific content of food is inelastic to price
- Imaclim-R add the value added corresponding to the quality of food and its transformation

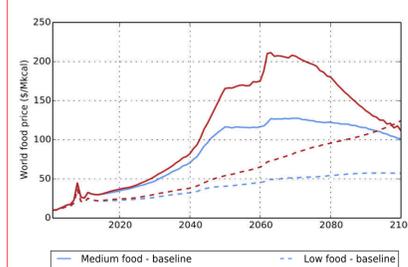
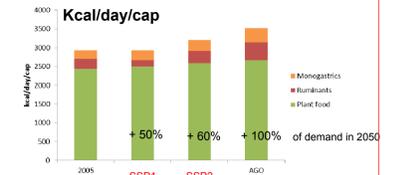
4 Linkages flows



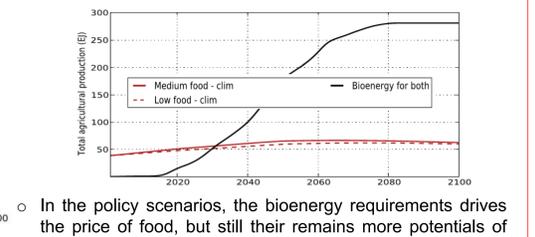
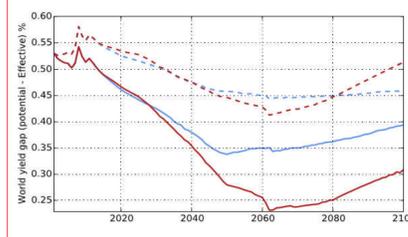
- NLU takes energy price signals and bioenergy demand from Imaclim-R :
 - Food demand is exogenous and driven by assumptions on population growth and food diet
 - Capital and labor costs of agriculture are Imaclim-R driven
 - Fertilizers price is driven by the light oil and gas price from Imaclim-R
- Demand for bioelectricity is driven by the electricity sectoral modules of Imaclim-R, which producers are price takers of the bioenergy price send back from the NLU.
- Demand for second generation biofuels competes with refined oil and coal to liquids. We compute a local supply curve with NLU and the final decision of biofuels producers depends on :
 - The endogenous price of bioenergy given by NLU
 - The anticipation of price response on the liquids market
- Imaclim-R account for NLU feedbacks :
 - Updated costs structure for electricity and liquids production
 - Agricultural price and land rent in the markup pricing
 - Energy content as feedstock for fertilizers production

5 First results

- Scenarios :
- Two food diets : Medium food (SSP2) and Low food (SSP1 - minimum of protein, share of vegetable protein)
 - Mitigation policy : exogenous carbon tax, exponential up to 2500\$/tCO₂ in 2100, only on fossil fuel
 - Bioenergy requirements are independent of the food diet : 150 EJ/yr in baseline, 280 EJ/yr in policy scenarios



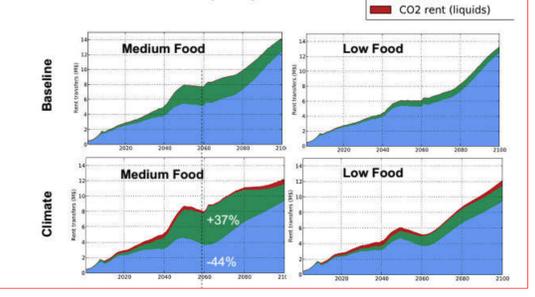
- Pastures are more constrained in the Medium Food scenario, so that the raising demand for food induces land competition which drive the price of food up.
- After a certain threshold, bioenergy crops are made on available pasture land. Part of the livestock demand then switch towards more intensified systems, raising the need for feeds (livestock is fed with less grass and more crops), raising the land rent.
- In the long-run, population decreases, biofuels requirement stagnate, so does the pressure on land.
- Independently of the food diet, the high carbon price in the long run raises the fertilizers price, leading to desintensification.



- In the policy scenarios, the bioenergy requirements drives the price of food, but still their remains more potentials of production in the Low Food case.

Rent transfers (M\$)

- The land rent is relatively small with a healthy diet
- Transportation patterns and lock-ins drive a high oil rent in the long-term
- BUT the climate policy shrinks the oil rent
- On the other hand, the policy do impacts the land rent mostly due to the price of fertilizers than bioenergy level requirements



6 References

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