M2 Internship: Critical Energy Transitions in Spatial Land-use Models

Laboratory Name: Laboratoire d'Hydrodynamique, LadHyX
CNRS Identification Code: UMR CNRS 7646
Internship Location: Ecole Polytechnique, Palaiseau
Thesis possibility after internship: YES
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A steadily growing human population requires a steadily increasing food production system to sustain itself. Simultaneously, expanding agricultural land is one of the leading risks to ecosystems due to habitat destruction. Bengochea Paz et al. (2022) build one of the first spatially-explicit models linking these two issues, and setting the stage for further analysis (see Lanz et al., 2017, for a non-explcit approach). In particular, a feasible long-term agricultural system should be net energy positive: it should provide more energy (i.e. in food terms) than it consumes (e.g. in terms of labor, fertilizer, or other energy forms). To assess this requires an integrated multi-scale assessment (e.g. see Serrano-Tovar & Giampietro, 2014). The aim of this project is to combine these two streams of analysis in light of the suggestions that the current agricultural practices are net energy negative (Marshall & Brockway, 2020).

The aim of this project is twofold. First, within the model presented to establish a channel to integrate with the MuSIASEM approach, and thus have an estimation and dynamic on the energy uses involved in intensification (e.g. fertilizer usage, machine usage, and labor intensity) in comparison to low-intensity agriculture and how the costs of these products may affect the dynamics of land-use in the model. Second, we are interested in expanding the scope of the model to address other forms of land-use such as settlement as well as production and the extraction of resources. The aim of these extensions is to study how the geographic system interrelates with the energy consumption patters of society and affects a transition to a ecologically balanced world with renewable forms of energy.

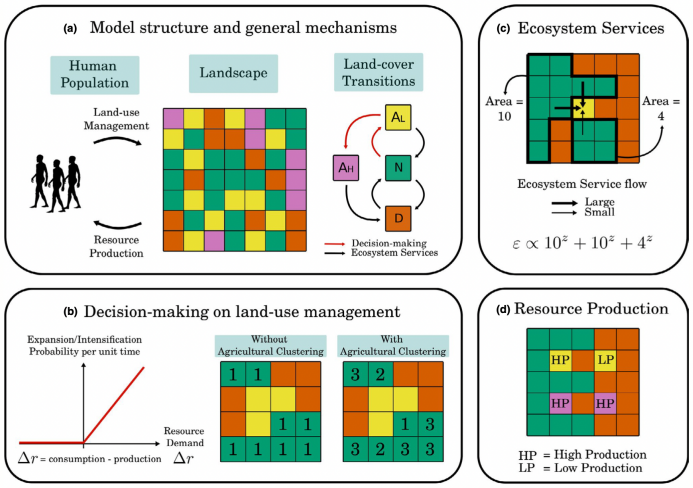

Figure 1: Conceptual diagram of the socio-ecological model proposed by Bengochea Paz et al. (2022)

References

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undermines sustainability in social-ecological agricultural systems. *Ecology Letters*, *25*. doi: 10.1111/ele.13914

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