O.D.D. description

of the LUCAS_GEMMES model

Projet: GEMMES
https://www.afd.fr/vi/phan-tich-tac-dong-kinh-te-xa-hoi-cua-bien-doi-khi-hau-o-viet-nam-va-cac-chien-luoc-thich-ung/
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We describe in this document the LUCAS_GEMMES model using the standard O.D.D. protocol[1]

Overview

Purpose

In (Truong et al., 2021), a first version of the model called LUCAS was introduced; farmers play the key role, basically driving all the dynamics of the model by individually selecting appropriate land-use types for their plot. This first version aimed to reproduce the distribution of land-use in the Mekong Delta, and to understand the impact of various climate scenarios (e.g. changes in temperature and rainfall) on this distribution. The provinces were represented as agents in the model, but their role was limited to providing, or restricting, funding for farmers' adaptation strategies.
The extension of LUCAS (named LUCAS-GEMMES) presented and explored in this chapter reinforces the economic dimension of the model, by allowing farmers to take out loans to invest in land-use changes beyond their initial financial capacity. More importantly, it strengthens the ability of provinces to influence individual adaptation strategies, according to the agro-ecological zone for which they are responsible and the level of subsidence measured: policies available to provinces can include prohibiting certain land-uses in order to limit or even prevent water pumping. The subsidence thresholds at which these policies are triggered, and the coordination between provinces

[1] Grimm V, Berger U, DeAngelis DL, Polhill JG, Giske J, Railsback SF. The ODD protocol: A review and first update. Ecological Modelling. 2010 Nov 24;221(23):2760–8.

in choosing these thresholds, are among the elements whose importance and relevance we wish to measure in order to provide concrete recommendations

Entities, state variables, and scales

Scales

The simulations are executed at the scale of the Vietnam Mekong Delta (VMD, ~ 40.577 km²). The smallest considered spatial units are 500mx500m cells.

The simulations are not launched from a specific starting date, but rather from the introduction of the first infected cases in the population and will run until the end of the epidemic. The simulation step is set to 1 hour. As a consequence, given the simulated area, movements from one activity place to another one are not simulated: individuals are always located in an activity place (that can be a close building or even an outdoor park). The underlying assumption is that no infection cannot occur during the move time.

Entities

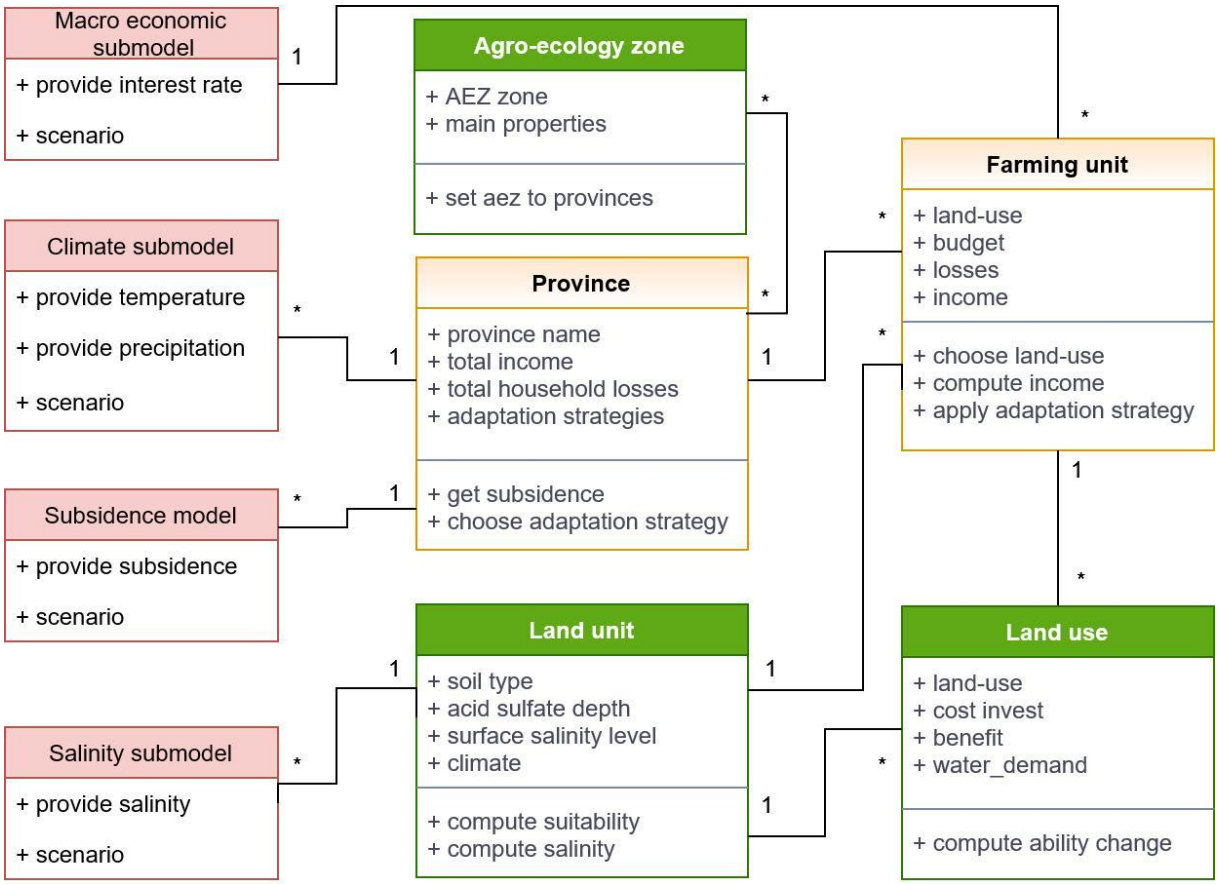

Figure: Main entities of the LUCAS-GEMMES model

Process overview and scheduling

Design Concepts

Basic principles

Emergence

Adaptation

Sensing

Interaction

Stochasticity

Collectives

Observation

Details

Initialization

Submodels

Table: Agent actions in land-use adaptation.

Action	Input	Output	Function
Agro-ecology zone (AEZ)			
Set AEZ to provinces	List of provinces.	List of AEZ that province is located.	Each AEZ asks the provinces that intersect with the AEZ to set the list of AEZ.
Province			
choose adaptation strategy	- Salinity level. - Subsidence cumulative threshold to react. - AEZ regions where the province is located.	- Provincial adaptation profiles. Set of land-use types allowed for each selected profile.	Select a list of adaptation profiles. Each province can have many adaptation profiles based on the AEZ and the threshold of land subsidence that provinces react with.
Get subsidence	- AEZ regions of the province. - the list subsidence maps.	Land subsidence regions each 10 years (this period of time depends on the subsidence dataset).	Update the list of subsidence regions in the province.
Farming unit (F.U)			
choose land-use	- List of provincial adaptation profiles. - macroeconomic cut-off, F.U budget. - land suitability - Benefit and cost of land-use candidates.	A selected land-use type for the current farming unit.	Select the land-use for the year with the multicriteria selection based on factors: land suitability, profit, ability to convert land use type, influence of the other farmers (neighboring).
Compute income	- Benefit of LUTs per hectare	- Benefit of the year.	Calculate the benefit of the current

	- Land suitability of land-use.. - Macro variable: interest rate.	- Losses by impact of climate change.	land-use. Update the loose if this cell is damaged by climate constraints.
Apply adaptation strategy	Provincial adaptation profile in the AEZ and subsidence region.	Land-use type for current farming unit.	Apply multicriteria selection only on the supported LUT of adaptation strategy (to avoid risk).
Land unit			
Compute suitability	- Properties of land unit - List of land-use candidates. - Salinity levels.	Suitability level of the land-use candidates.	Evaluate for suitability levels.
Compute salinity	Salinity maps.	Salinity levels impact land suitability of land-use type.	Classify the salinity level for the cells.
World - global entity			
Providing climate data	- Climate dataset. - Climate station at district level.	Climate data (temperature and precipitation) of the stations, assigned to the districts within the province	Update the list of climate data per year for the stations in the provinces.
Providing salinity	- Salinity maps - Scenarios (4.5RCP; 8.5RCP)	Salinity maps for 2030 and 2050	Provide salinity map, updated for 2030 and 2050 (The period depends on available salinity data)
Providing macro-economic	Macro economic dataset from GEMMES model	Interest rate each year	Provide an interest rate each year for calculating the investment and losses.
Vulnerability analysis	- List of farming unit cells at risk.	- Vulnerable cells for 3-rice crops and shrimp	Estimate vulnerable maps for rice and shrimp based on the

		- Vulnerable area for rice and shrimp per year.	tolerance of rice and shrimp under impact of temperature and precipitation, salinity by climate change.
Estimating water use	- List of farming units. - List of water demand of land-use type.	Amount of fresh water demand for each year.	Estimate the amount of fresh water demand, corresponding with the land-use type every year.
Estimating benefit and losses	- List of farming units. - List of farming units that were impacted by climate and salinity.	- The total benefit per year. - The total accumulated losses by risk.	- Calculate the total benefit of agricultural activities per year. - Calculate the accumulated losses for rice and shrimp cultivation by climate constraints.