SIMUTEC

An Agent-based platform of decision support for urban climate policy development

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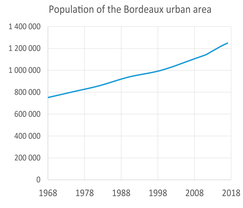
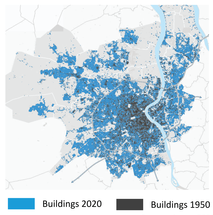
simutec-climate.com

SIMUTEC is a modelling and simulation platform that aims to evaluate the intersectoral effects of different public policies (transport, housing, planning, etc.) on the climate/air/energy triptych at the scale of urban territories. This platform is part of a prospective approach to decision support, to report and discuss the possible "trajectories" of territories from the point of view of sustainability criteria and spatial inequalities, starting from the choice of a public policy and with regard to its intersectoral systemic effects.
SIMUTEC operates on the scale of a urban area. The platform is composed of 3 modules:
1/ MUST-B, a model that simulates the interaction of the population through its residential choices with the location of jobs, but also with different modes of transport to satisfy daily mobility. 2/ M-CLIMATE, coupled with MUST-B, allows to determine the quantities of energy consumed, atmospheric pollutants and GHG emitted by the different sectors characterizing the urban metabolism such as daily mobility, housing, urban services/networks and economic/commercial activities. M-3D is the 3D graphical interface that allows to visualize the results produced by MUST-B (urban forms, location of households/jobs, travel flows, congestion, real estate prices, ...) and by M-CLIMATE (energy consumed, pollutants emitted, GHG, territorial/social inequalities, land artificialization, ...).

Context: Attractiveness, Sprawl, Housing pressure



Population increase over time
↗ +1%/year

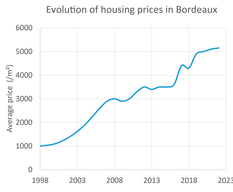


Source : A'urba 2020

Sprawl of the Bordeaux agglomeration

Source : INSEE 2013

Bordeaux Urban Area (AUB)
6th in population of France
2nd in land use of France



Source : MeilleursAgents et données publiques (Notaires, INSEE)

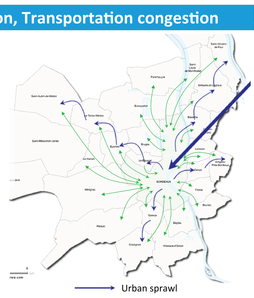
Increase of housing price
↗ +7,5%/year (highest increase in France)

Consequences: Residential relocation, Transportation congestion

- Increase housing price
  - Eviction of households (relocation)
  - Urban sprawl (⟶)
- Jobs and services remain in the urban center
  - The center remains the main area of attraction
  - Movement flows (⟷)
- Increased congestion during peak hours
  - Bordeaux : 3rd most congested city

France rank	City	Level of congestion
1	Paris	39 %
2	Marseille	34 %
3	Bordeaux	32 %
4	Grenoble	32 %
5	Nice	31 %
6	Lyon	30 %
7	Toulon	28 %

Source : TomTom 2019



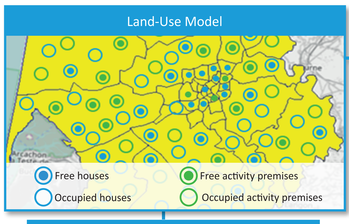
Challenges & Prospects

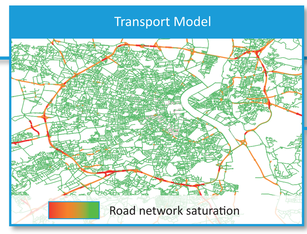
❑ **Reporting a complex issue:**
- articulated on interdependent issues: land use for activities and housing, mobilities, ecological and economic transition
- able to identify the possible "trajectories" of territories according to the systemic intersectoral effects of public policies.

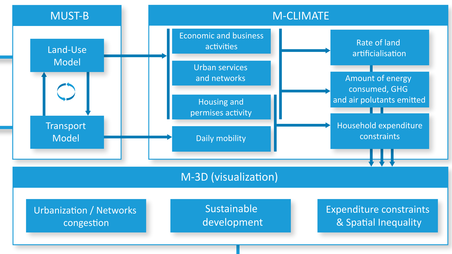
❑ **Requiring a multidisciplinary approach to characterize the mechanisms of :**
- formation of real estate and land prices
- location of households, jobs and services
- consumption of building land
- operation of public and individual transport networks
- greenhouse gas emissions and air pollutants

❑ **And enabling reporting and decision support on :**
- transition and public policy choices and the associated possible trajectories of the territories
- planning tools (PCAET, ...) and all sectoral interactions

SIMUTEC







Two types of agents in competition

Households
- Size [1-5]
- CSP [+/-]
- Household size [1-5]
- Household type [Private/Social]
- Zone [1-42]
- Utility (wellness)

Maximizing utility

Real estate and land markets

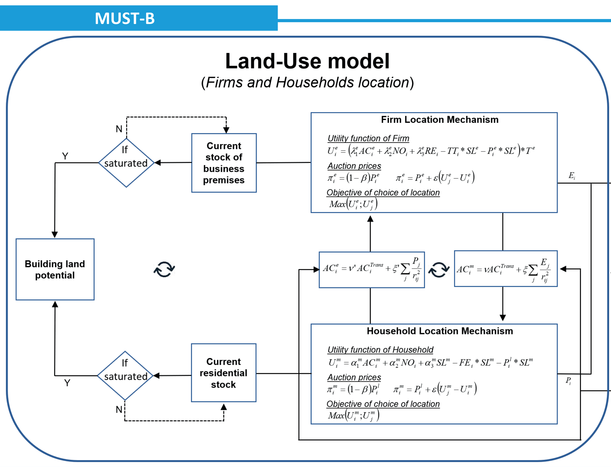
Firms
- Size [3-750]
- Activity
- Zone [1-42]
- Utility (profit)

$$U_i^m = \underbrace{\alpha_1^m AC_i^m}_{\text{Jobs accessibility}} + \underbrace{\alpha_2^m NO_i}_{\text{Notoriety}} + \underbrace{\alpha_3^m SL^m}_{\text{Desired surface area}} - \underbrace{FE_i * SL^m}_{\text{Energy bill}} - \underbrace{P_i^l * SL^m}_{\text{Price of housing}}$$

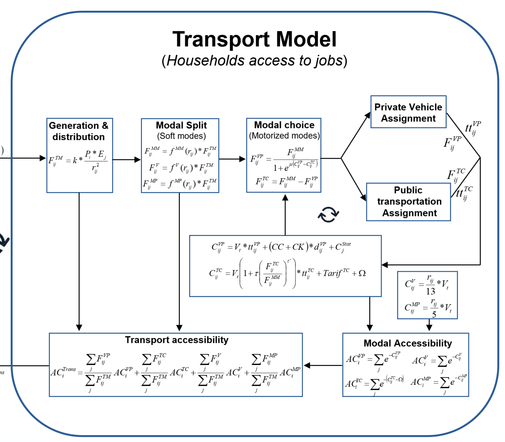
$$U_i^e = (\underbrace{\lambda_1^e AC_i^e}_{\text{Accessibility to workforce}} + \underbrace{\lambda_2^e NO_i}_{\text{Notoriety}} + \underbrace{\lambda_3^e RE_i}_{\text{Agglomeration effect}} - \underbrace{TT_i * SL^e}_{\text{Taxes}} - \underbrace{P_i^e * SL^e}_{\text{Price of activity permises}}) * T^e$$

MUST-B

Land-Use model
(Firms and Households location)



Transport Model
(Households access to jobs)



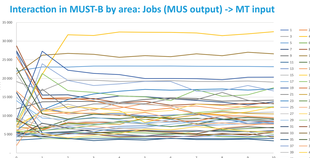
Some results

Summary of simulated scenario	Energy consumption (TWh/year)	CO2 emission (Million tons/year)	Emissions of air pollutants (Tons/year) NOx	CO	HC	SOx	PM
Daily mobility	2,8	0,8	1284	4576	464		192
Home - Work	*1,21*	*0,32*	546	1947	198		82
Other reasons	*1,63*	*0,43*	738	2629	267		110
Housing and permises activity	9,4	1,4					
Residential	*5,66*	*0,89*					
Activities	*3,77*	*0,53*					
Urban services and networks	0,4	0,1	393			1,39	9
Public lighting	*0,08*	*0*					
Sanitation	*0,05*	*0,01*					
Drinking water	*0,09*	*0,01*					
Household waste	*0,16*	*0,04*	393			1,39	9
Economic and business activities	2,1	0,2	197			0,69	5
Shops	*1,66*	*0,18*					
Catering & Hospitality	*0,11*	*0,01*					
Sports & Leisure Facilities	*0,21*	*0,02*					
Urban freight	*0,08*	*0,02*	197			0,69	5
TOTAL URBAN AREA	14,7	2,5	1874	4576	464	2,08	206

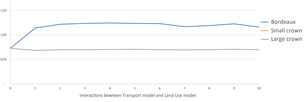
Energy consumption

CO2 emission

Interaction in MUST-B by area: Jobs (MUS output) -> MT input



Interaction in MUST-B: Accessibility (MT output) -> MUS input



Originality & perspectives

❑ **Interdisciplinarity in the design and development of SIMUTEC**
- An original and determining characteristic to simulate the urban metabolism
- The association of multidisciplinary researchers (economics, urban planning, geography, development, transport, computer science) makes it possible to integrate into the platform the specificities of the functioning of various sectors (mobility, housing/building, urban engineering, etc.).
- And to report and analyze the interdependencies between sectors in order to help public policy decisions with regard to sustainability criteria and socio-spatial inequalities.

❑ **Agent-based modeling and simulation has enabled:**
- To understand the complexity of the city based on individual behaviors,
- To bring to light emerging phenomena that are difficult to access by intuition or by analytical calculation
- To build and simulate scenarios to help local authorities reflect on the impact of the actions they wish to implement and the associated territorial trajectories

❑ **Perspectives**
- To underline the stakes of the ecological transition challenge for communities in their planning documents, their choices of public policies
- Integration of new issues on urban territories such as health crises like COVID-19

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