

## 1. Context and main ideas

The spatial structure of cities plays a key role on their energy consumption levels and on their vulnerabilities to environmental hazards.

The type of urban growth that cities will experience in the next decades will therefore have major implications for climate change mitigation and adaptation.

### Objective

In our work, we study and model the mechanisms driving the urban expansion of cities. We analyze economic, environmental and social consequences of policies aiming at impacting urban sprawl.

### Approach

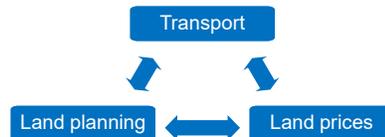
Urban shape is the result of 2 forces :

- State decisions : Land-use constraints, zoning, urbanism policies. . .
- Aggregation of multiple individual decisions taken by the inhabitants, and often reflected in a land market (these decisions can be influenced by policies, e.g. transport policies).

The second force (the market) can be analyzed through **economic models**. We use such a model to simulate prospective scenarios of city growth and to assess the consequences of various policies.

## 2. Model (NEDUM-2D)

Transport, land planning policies and real estate prices each interact with each other. Each of them impacts residential location choices of city inhabitants, which themselves act on land prices, and on transport demand.

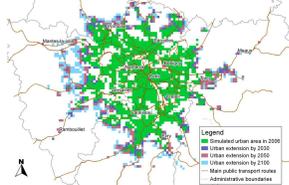


Using only the most fundamental economic principles from urban economics literature, NEDUM-2D model enables to model these interactions and to build scenarios on city conceivable future evolutions. It uses as inputs scenarios on the city's future demography, transport system and land use constraints.

This model is by nature an idealization of reality, but implementations on several cities on different continents have shown that it reproduces faithfully main characteristics of inhabitants residential choices, buildings construction and real estate prices across an urban area.

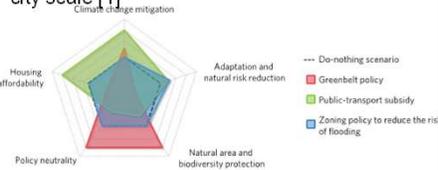
## 3. Applications

### Scenarios on cities future spatial expansion [6,8]



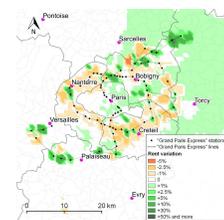
Example of a scenario for Paris metropolitan area expansion between 2010 and 2100 [8]

### Analysis of the trade-offs and synergies between mitigation and adaptation policies at city scale [1]



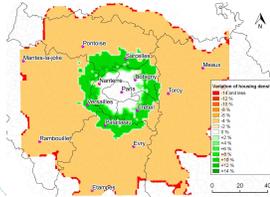
Example of analysis in Paris metropolitan area[1]

### Consequences of new transport infrastructures on urban development [9]



Simulated impact of Grand Paris express metro line construction on rents

### Taxation, building constraints and land planning policies consequences on real estate prices and urban development [2,4]

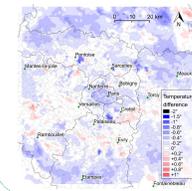


Example: simulation of potential impacts on population density of a novel construction tax in Paris region.



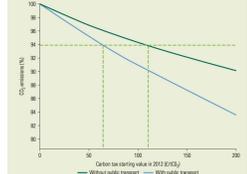
Main cities studied using NEDUM-2D model

### Implications of city growth scenarios in terms of greenhouse gases emissions, air pollution and natural hazards vulnerability [5,6,7]



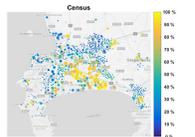
Example: simulation of air temperature change in case of heat wave, in a simulated scenario in which Paris region becomes less compact [5]

### Analysis of the consequences of delays in the implementation of emission reduction at city scale [3]



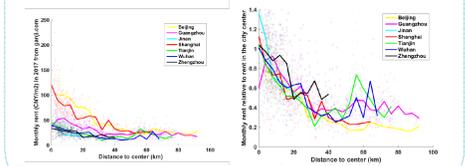
Relative impacts of carbon taxes on commuting-related emission levels in Paris region in 2020 for scenarios with and without public transport [3]

### Consequences of transport, land planning and economics policies on income repartition and slum development. (work in progress)



Simulation of the share of the households earning less than the median income in Cape Town, South Africa

### Comparison of the spatial configurations of cities, and of the link with transport/land planning policies. (work in progress)



Comparison of the spatial variation of rents in 7 Chinese cities

## 4. Summary

- Economic-based urban expansion models can inform decision making, and derive prospective scenarios about cities future expansion/structure modification
- Such models can be coupled with environmental modules (flooding-prone zones, urban micro-climate, air pollution emission and dispersion...)
- The model we have developed, NEDUM2D, is able to dynamically assess variations in real estate prices associated with public investments or changes of urban planning regulations.
- This model is relatively easy to calibrate, and is based on robust and verifiable assumptions : it allows the user to easily understand the mechanisms involved and to understand clearly the uncertainty and the validity of the results obtained.

## 5. References

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