



CENTRE
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SUR L'ENVIRONNEMENT
ET LE DÉVELOPPEMENT



Modeling urban expansion

Downscaling urban scenarios under the shared socioeconomic pathways

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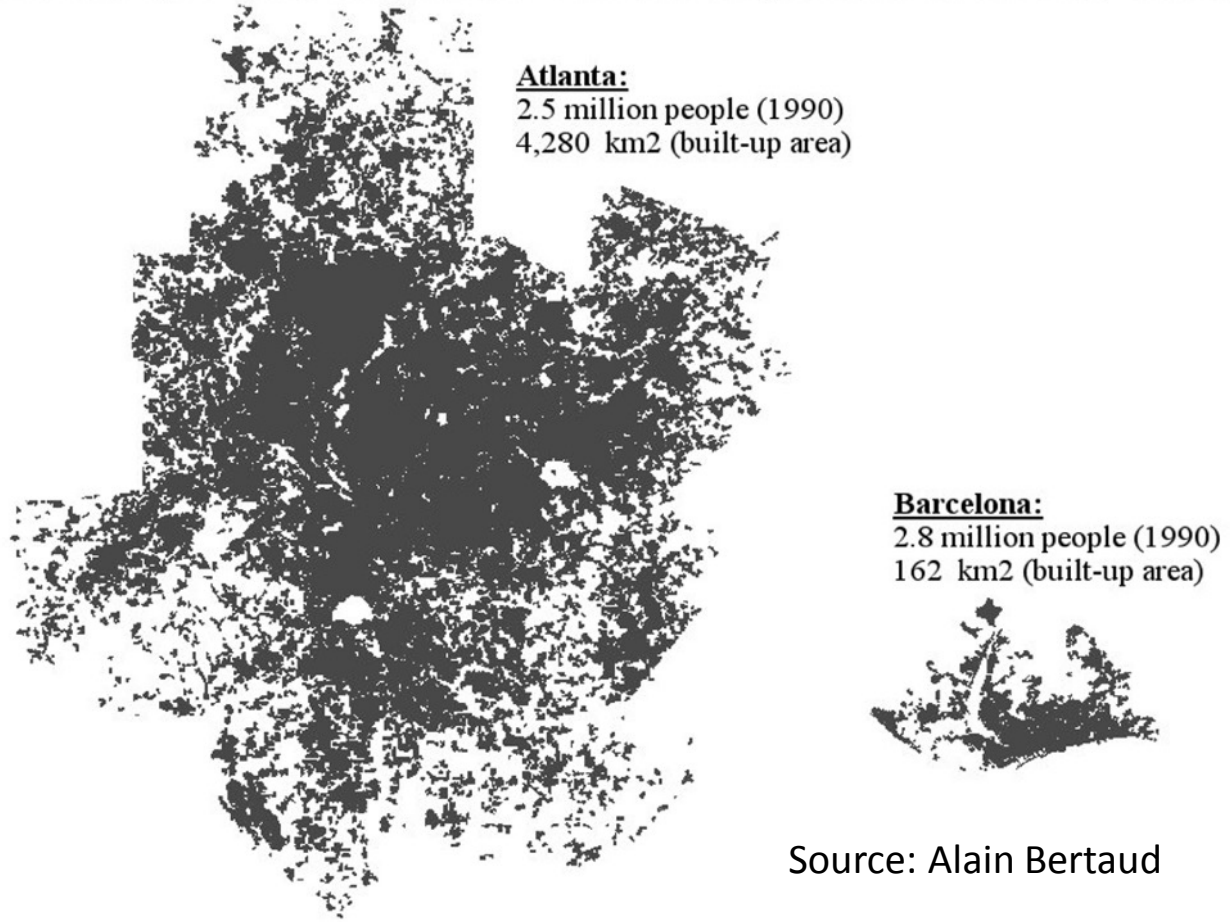
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Urban forms matter for greenhouse gas emissions...

The Built-up Area of Atlanta and Barcelona Represented at the Same Scale



Lower emissions in Barcelona because of:

1 - Shorter travel distance;

2 – Easier use of public transport:

Barcelona has 99 km of metro line.

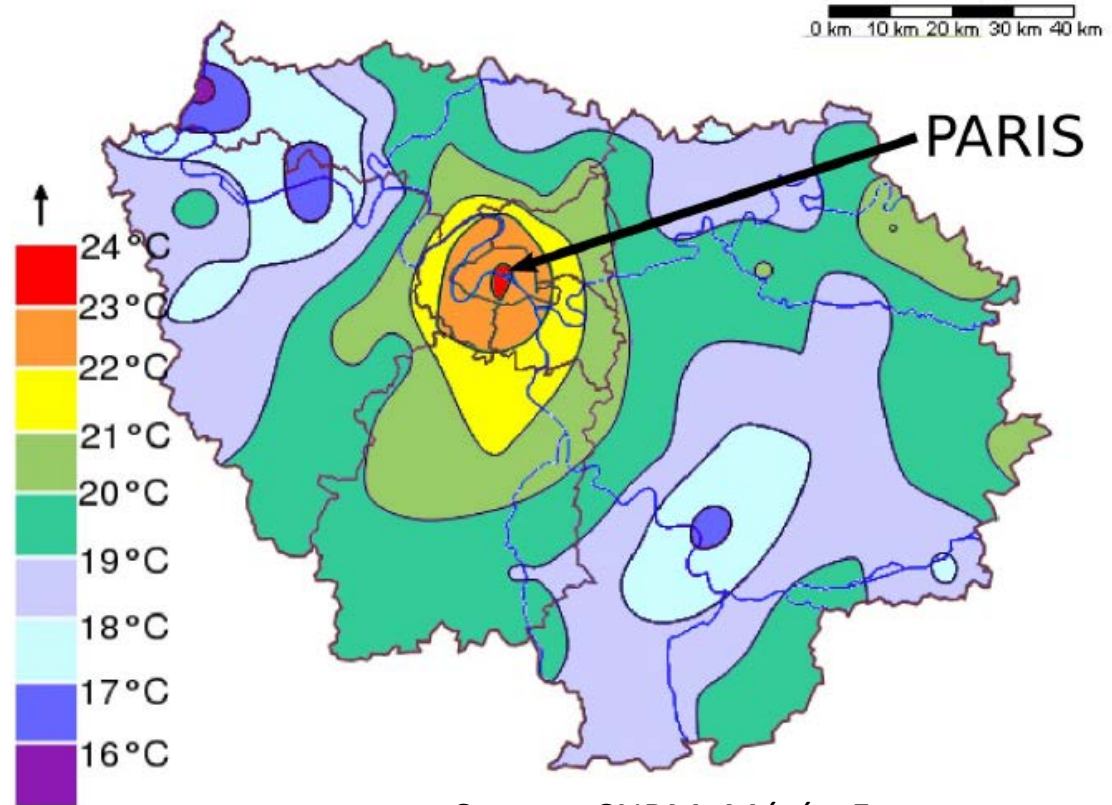
To provide the same accessibility to metro in Atlanta, 3400 km would be necessary.

Urban forms matter for climate-change vulnerability...

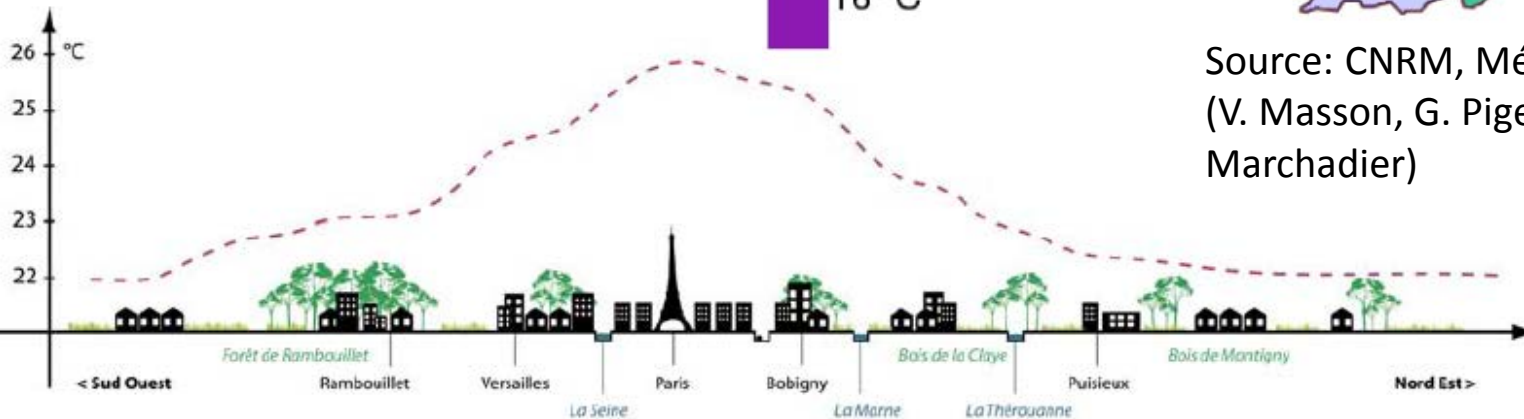
Urban Heat Island effect

Temperatures are higher in cities than in rural areas, especially at night.

Example of the 2003 heat wave.



Source: CNRM, Météo-France
(V. Masson, G. Pigeon, A. Lemonsu, C. Marchadier)



Adapting cities leads to specific issues

- **Urban forms matter for greenhouse gas emissions**
 - Transport, housing, ...
- **Urban forms matter for climate-change vulnerability**
 - Urban heat island
 - Urbanization in flooding prone areas...
- **Urban forms matter for many other policy objectives, e.g., related to social and spatial inequalities, competitiveness...**
- **Urban forms cannot change rapidly, so we already need to take into account current and future constraints**
 - Unprecedented need to anticipate future constraints and objectives and to act with no delay

How does urban shape evolve over time?

- **Urban shape is the result of 2 forces**
 - State decisions : Land-use constraints, zoning, urbanism policies...
 - Multiple decisions by the inhabitants/the market : Real-estate market and construction
 - It is indirectly influenced by policies, e.g. transport policies
- **The second force (the market) can be analyzed through economic models**



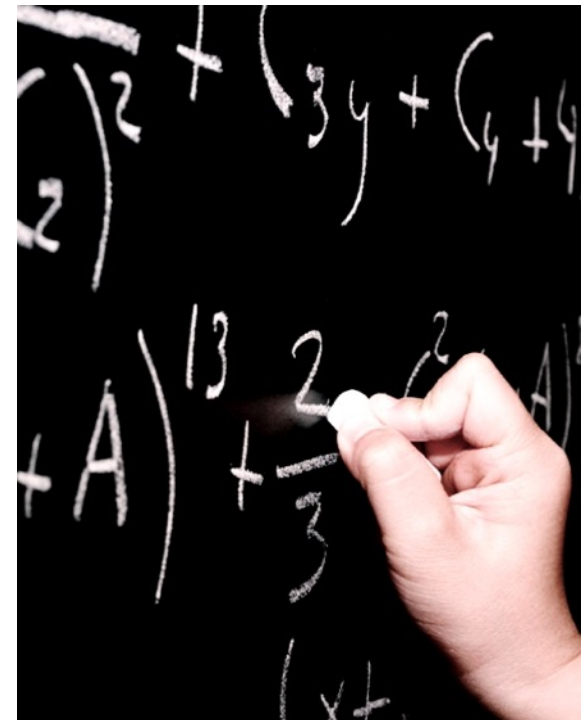
Standard urban economics modelling

■ 3 mechanisms :

1. Households' tradeoff:
 - Lower transportation costs and shorter commuting time when living close to the city center, and
 - Larger dwellings and lower rent in remote areas
2. Local amenities (e.g. a nice view) can locally modulate the rent
3. Investors optimize the housing density as a function of rents and construction costs

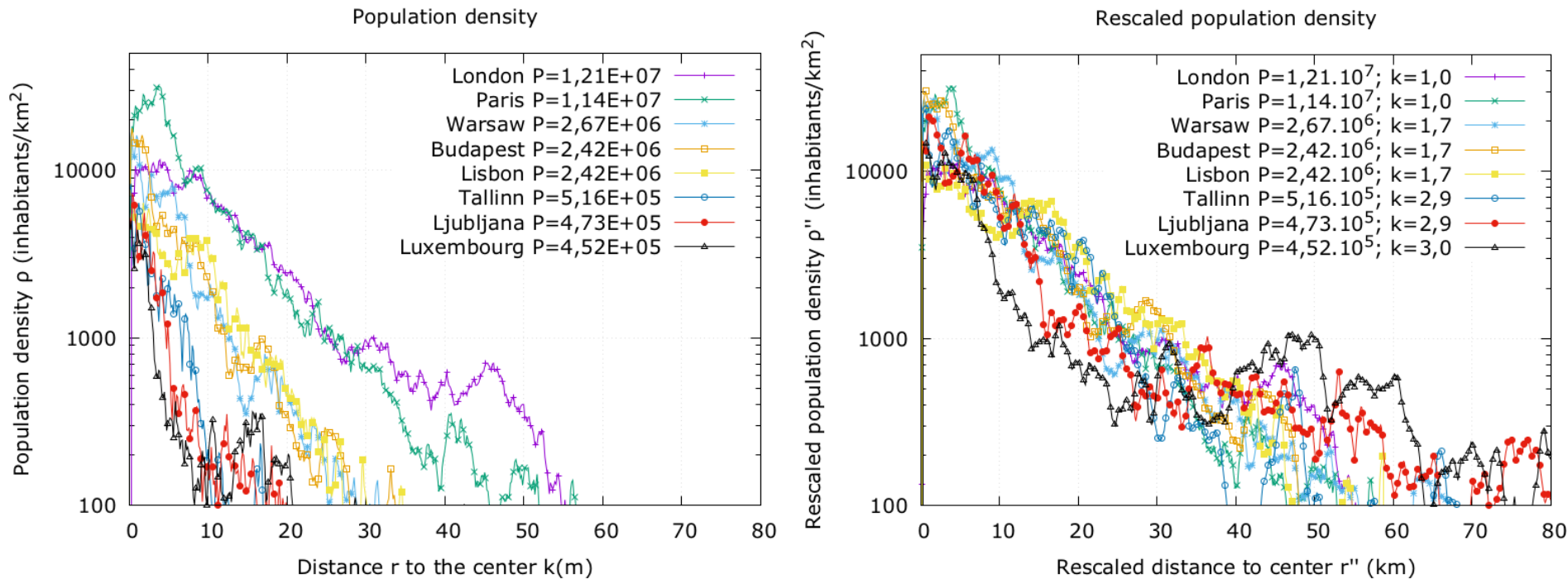
■ Key conclusions:

- If there is one major city center, rents will be maximum there, and decrease when moving away
- Same thing for population density



This theory coherent with many cities

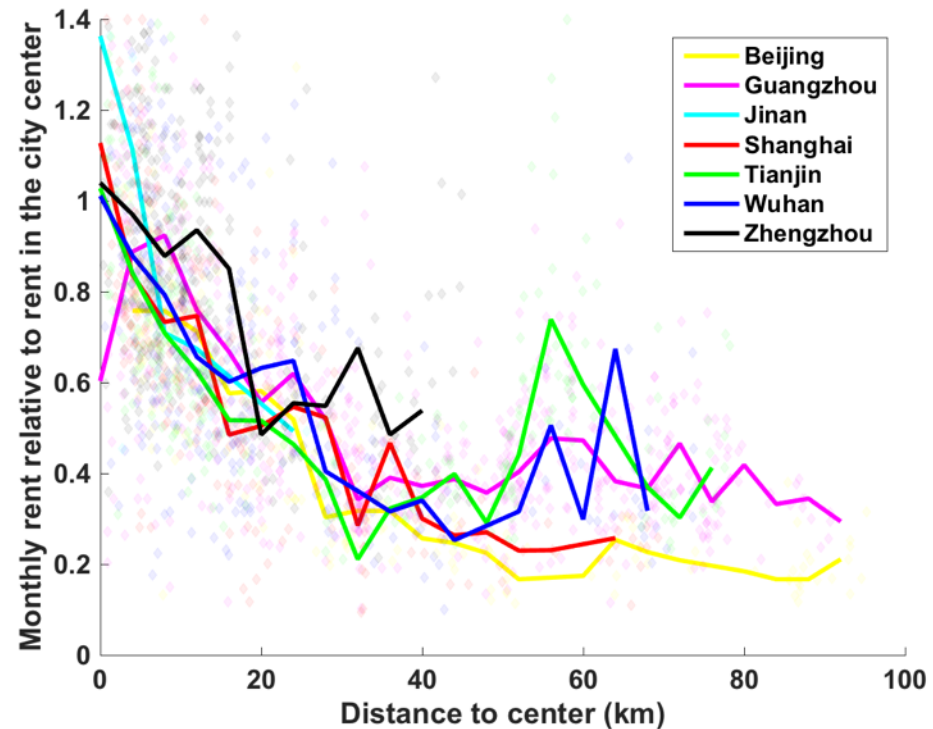
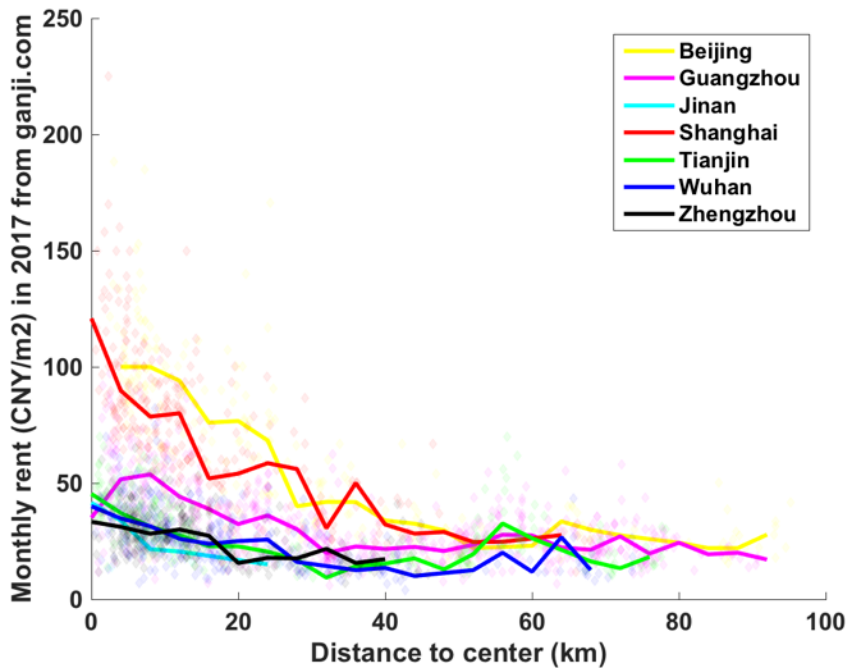
Population density



Source: Lemoy and Caruso (2017)

This theory coherent with many cities

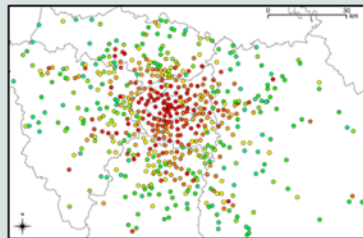
Rents



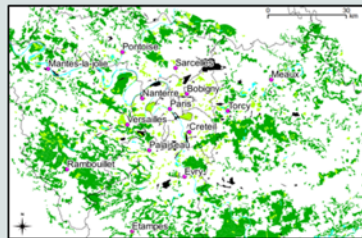
Source: Viguié and Lepetit (on going work)

NEDUM-2D model

INPUTS



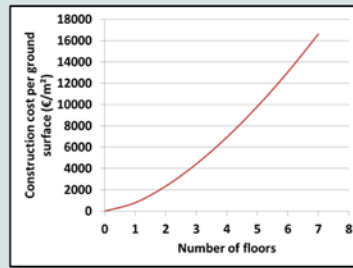
Employment centers and number of jobs and related households income



Land-use constraints

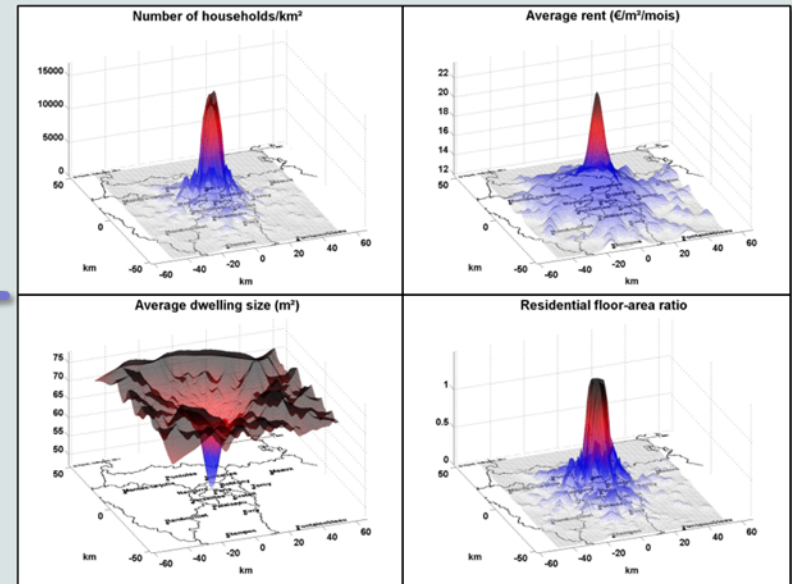


Transport times and costs



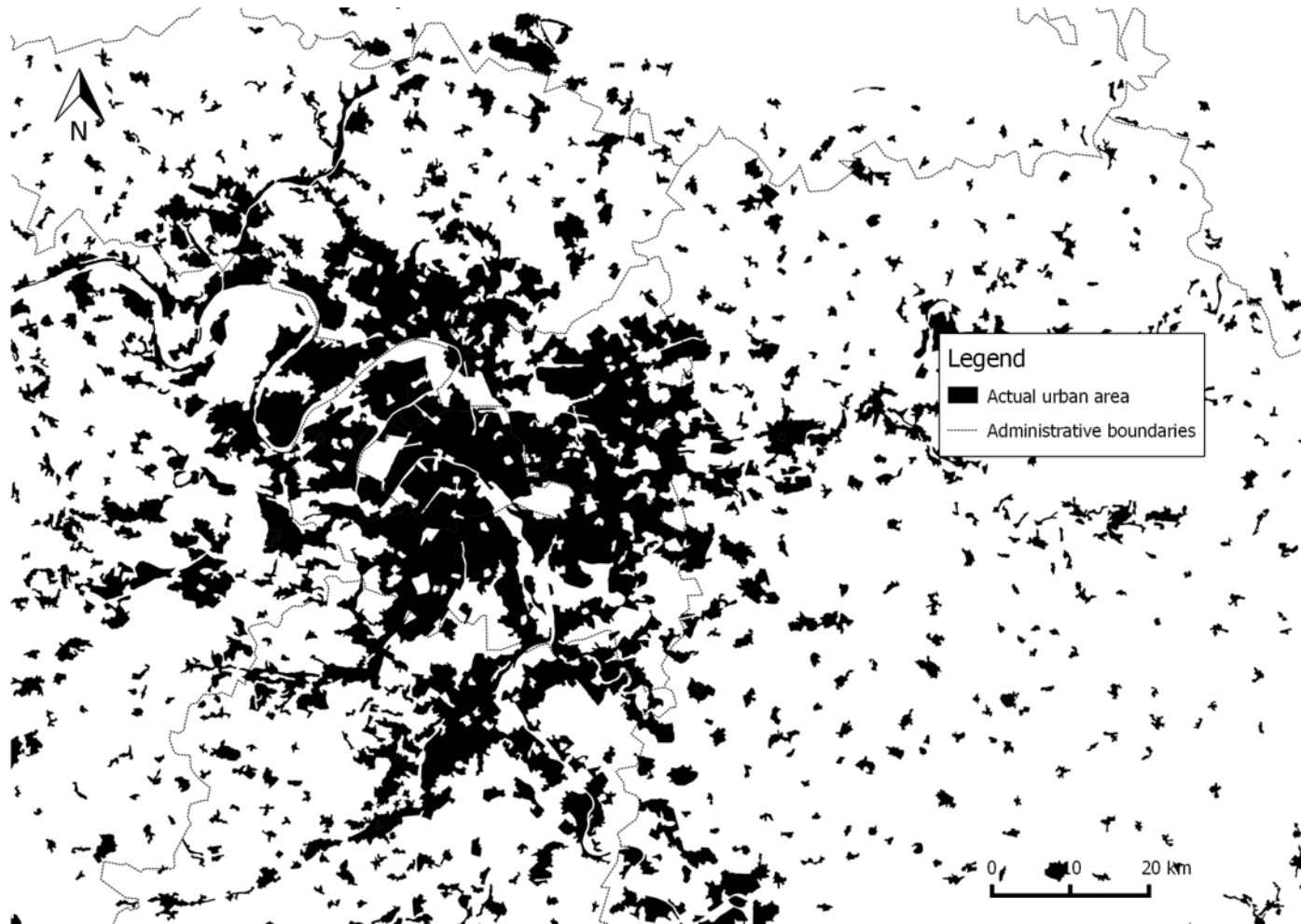
Construction costs

OUTPUTS

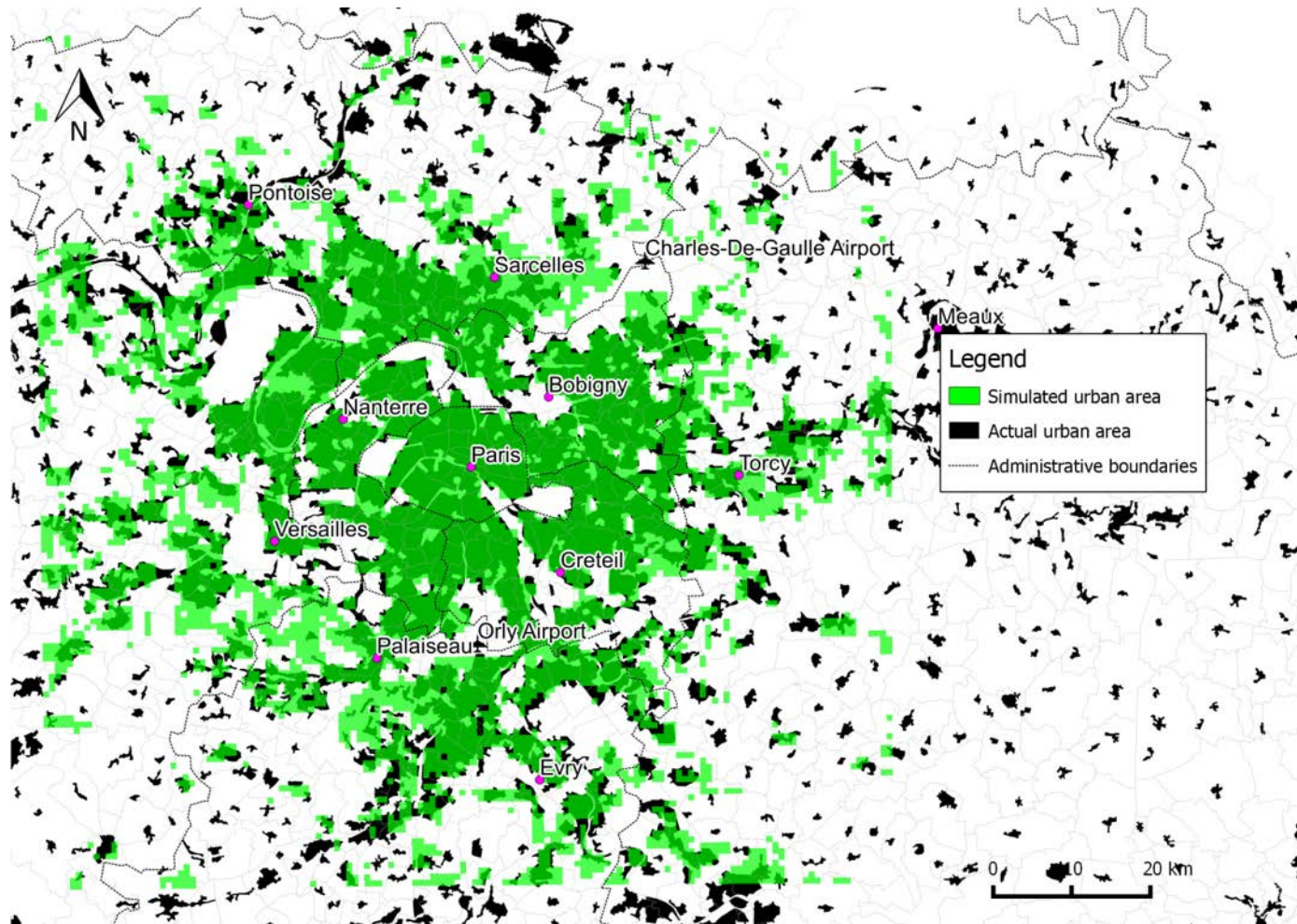


Rents, population density, floor-area ratio, and average dwelling size

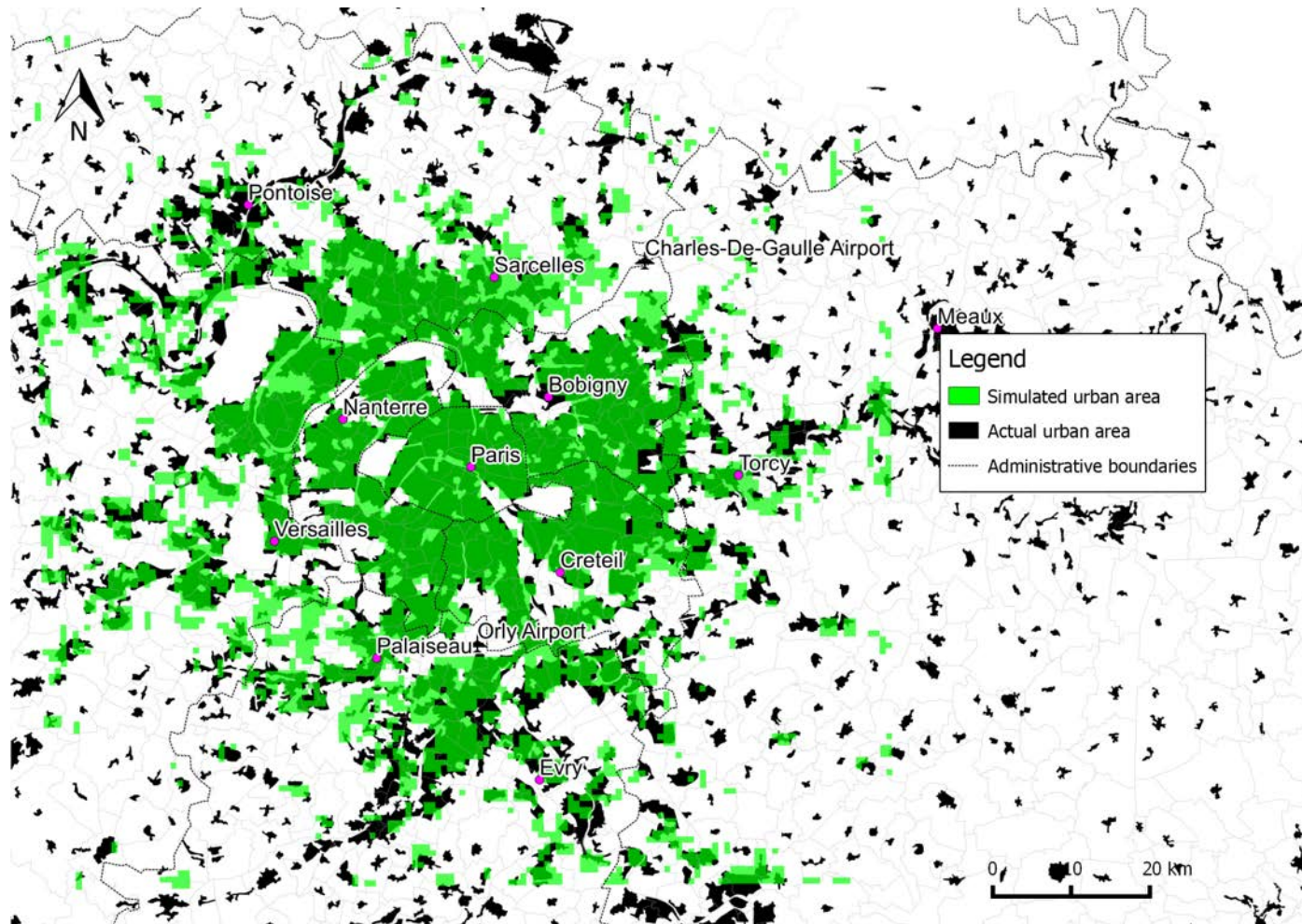
Paris, 2006



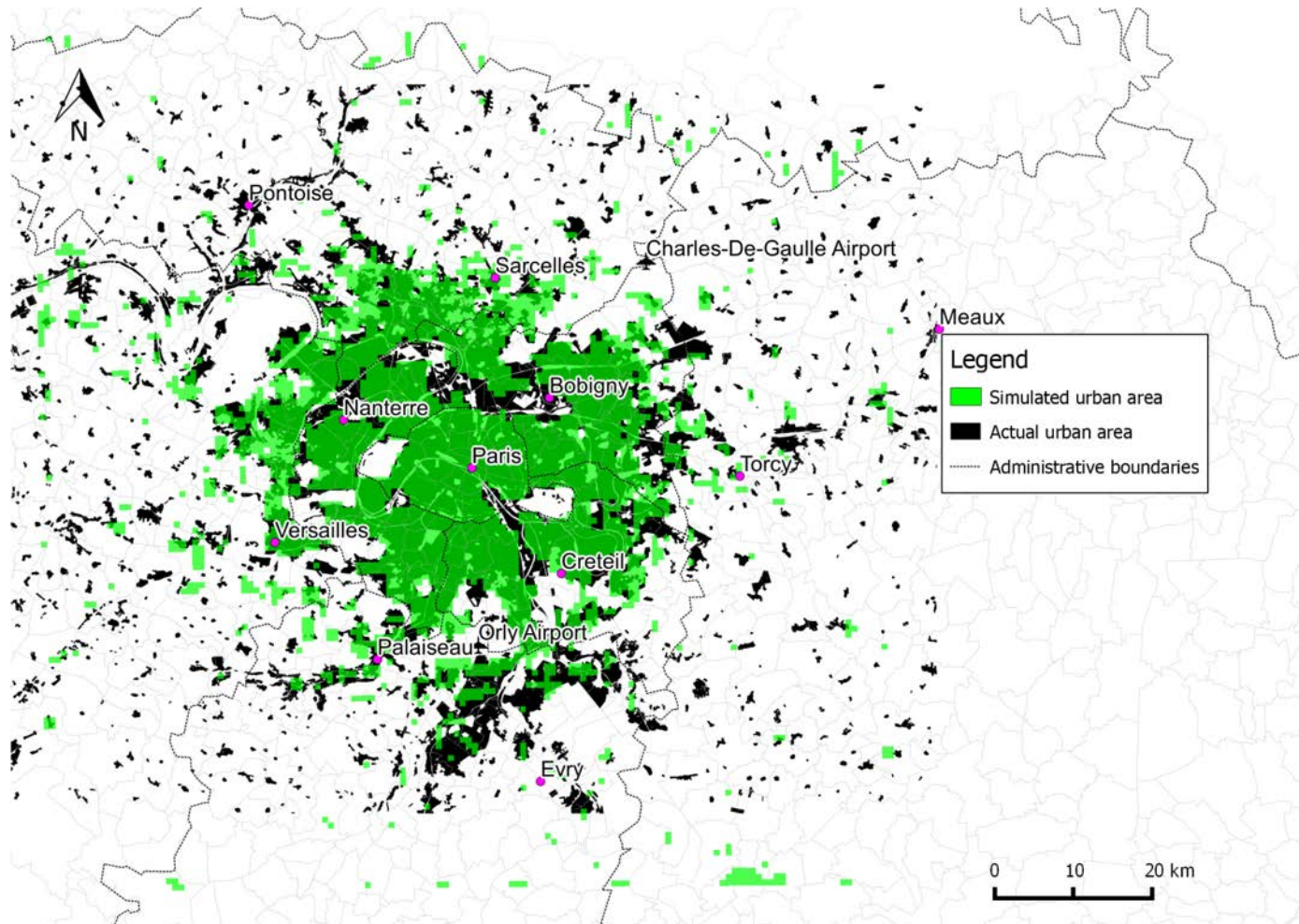
Paris, 2006



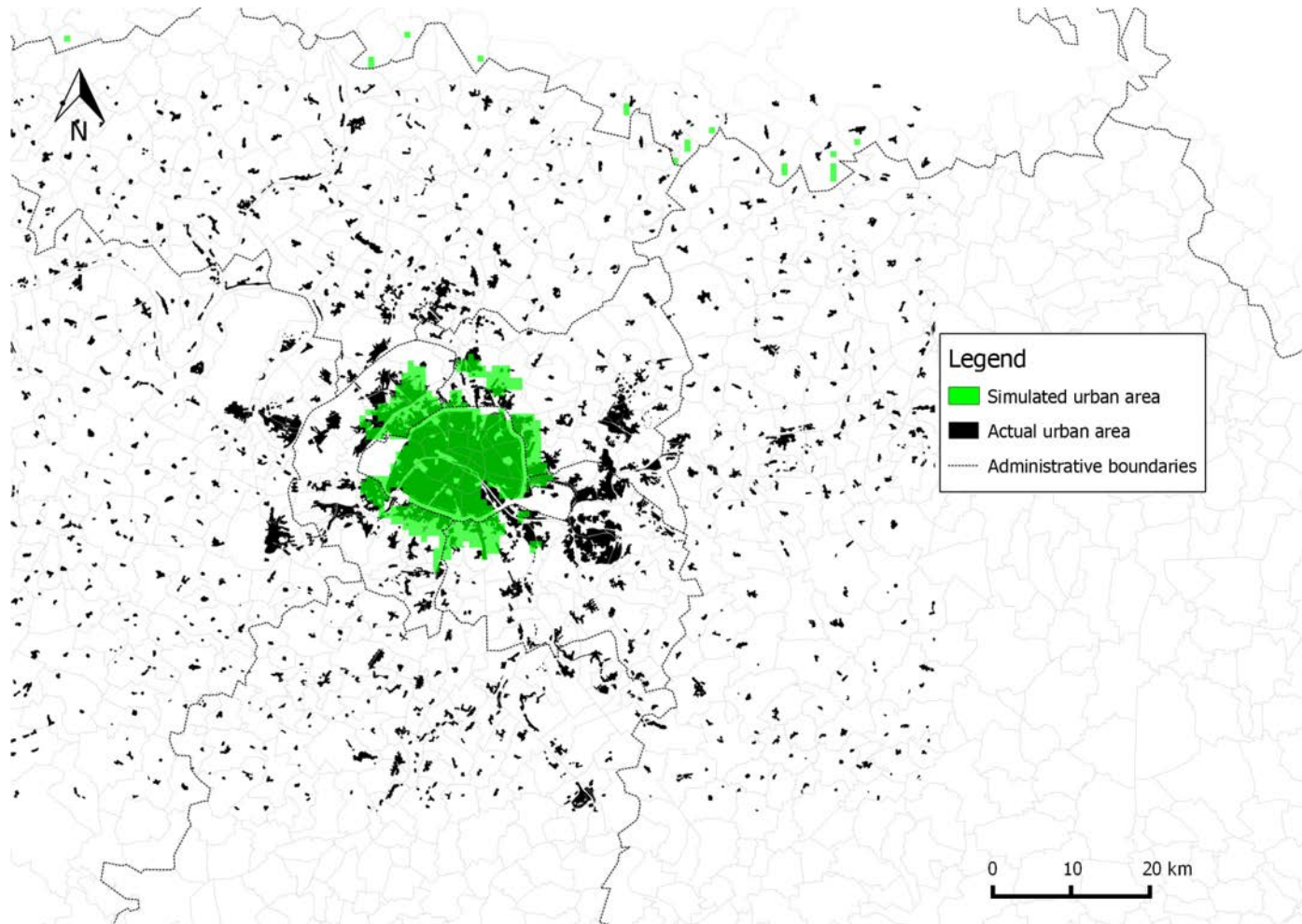
Paris, 1990



Paris, 1960

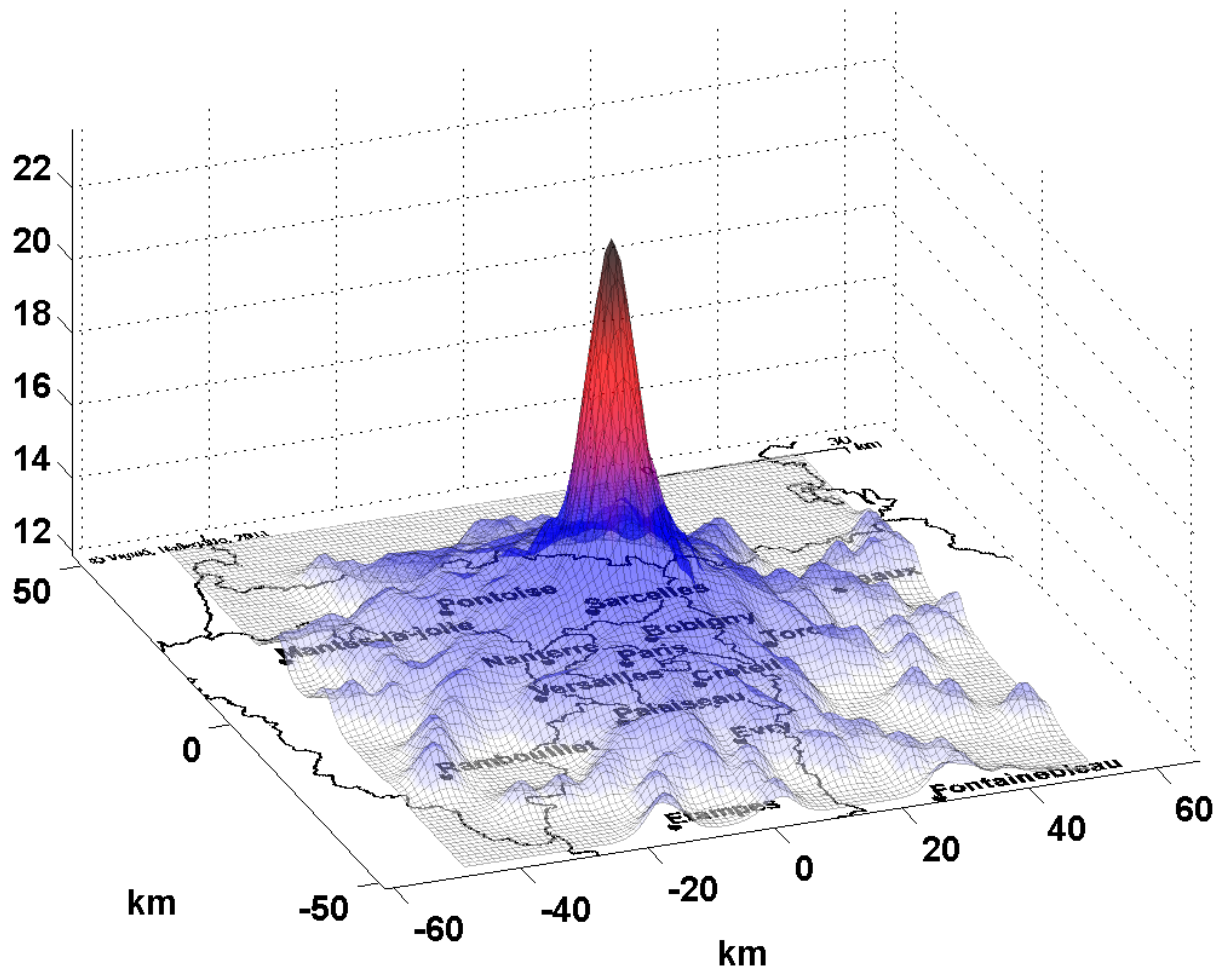


Paris, 1900

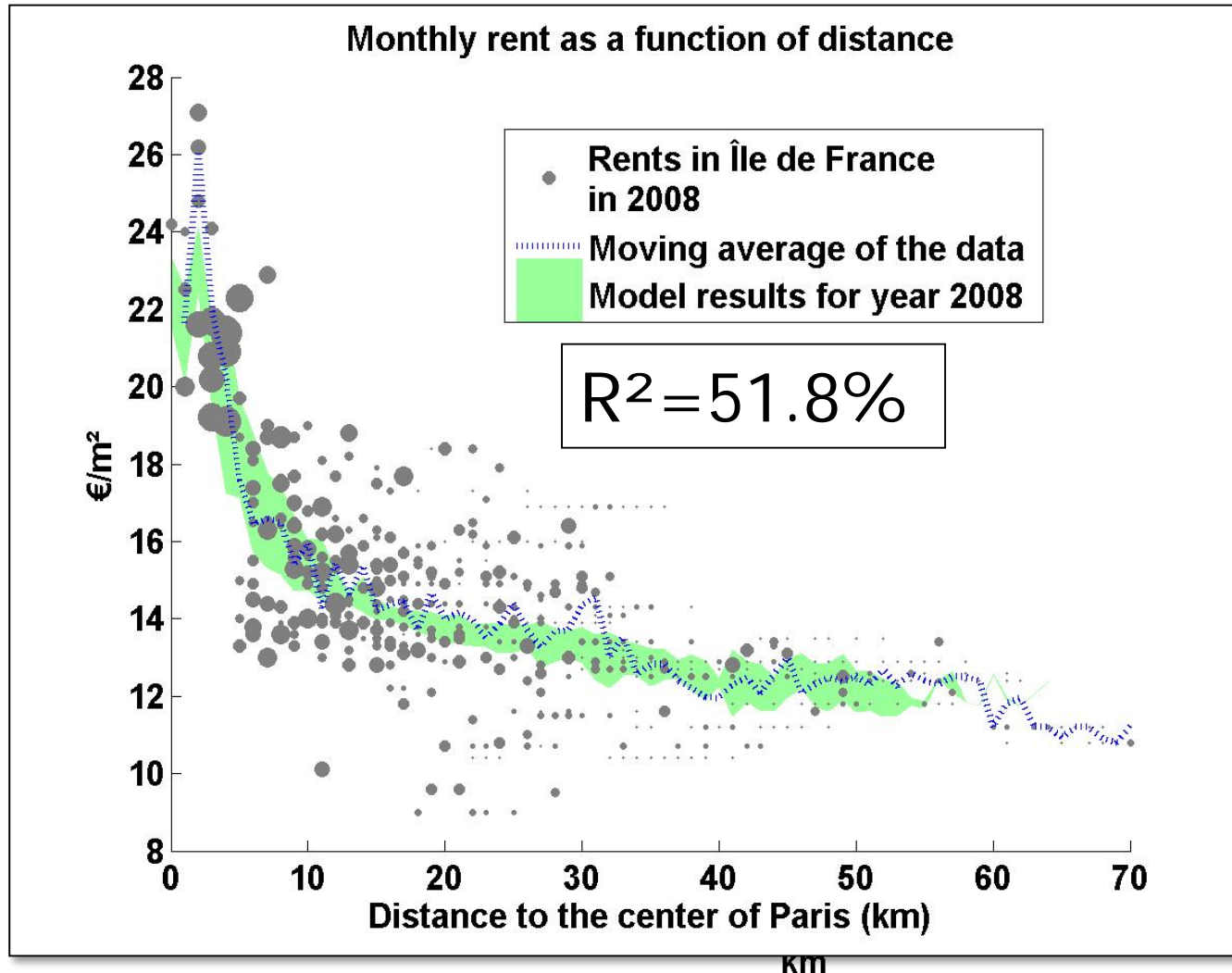


Model results: Rents (2008)

Average rent (€/m²/month)

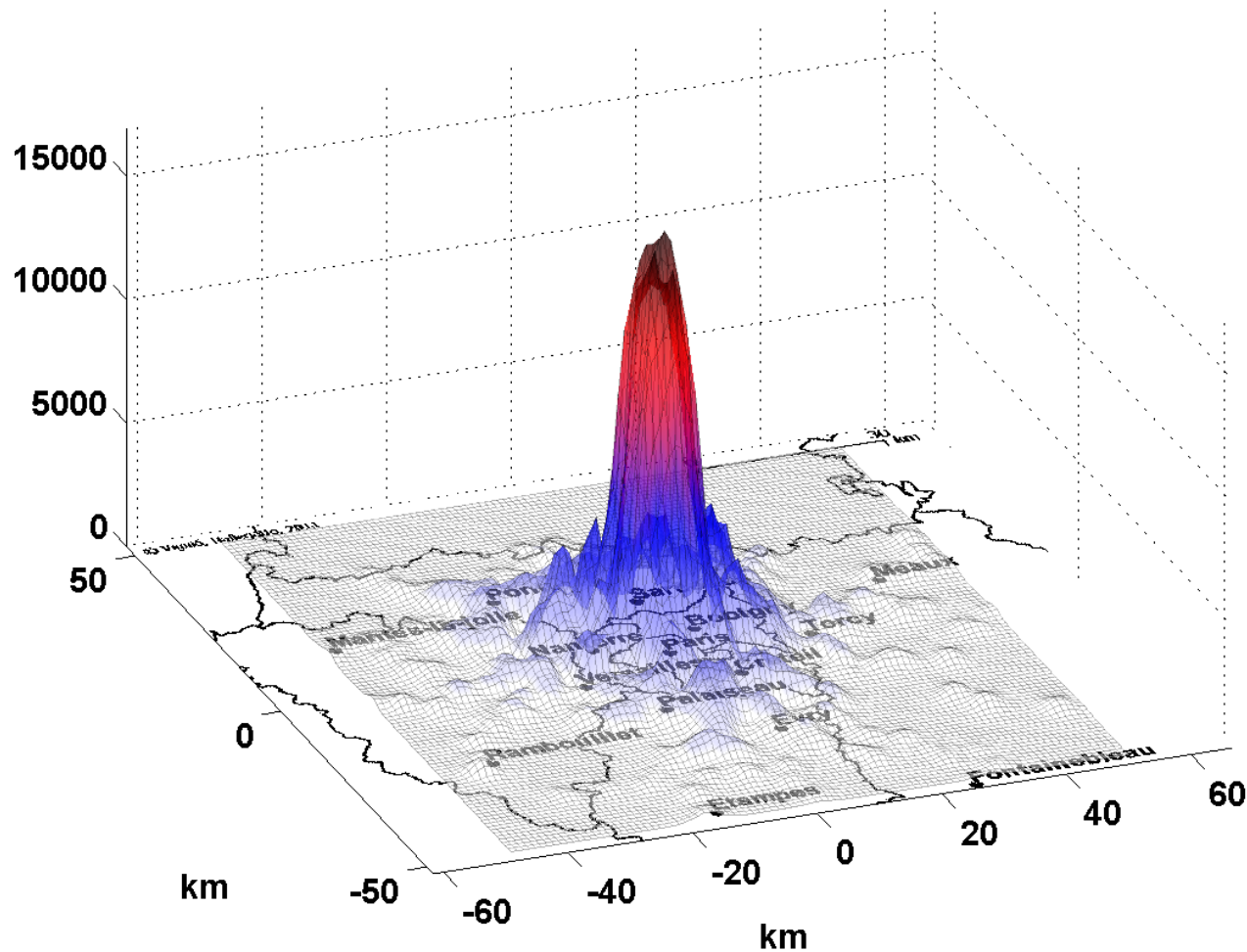


Model results: Rents (2008)

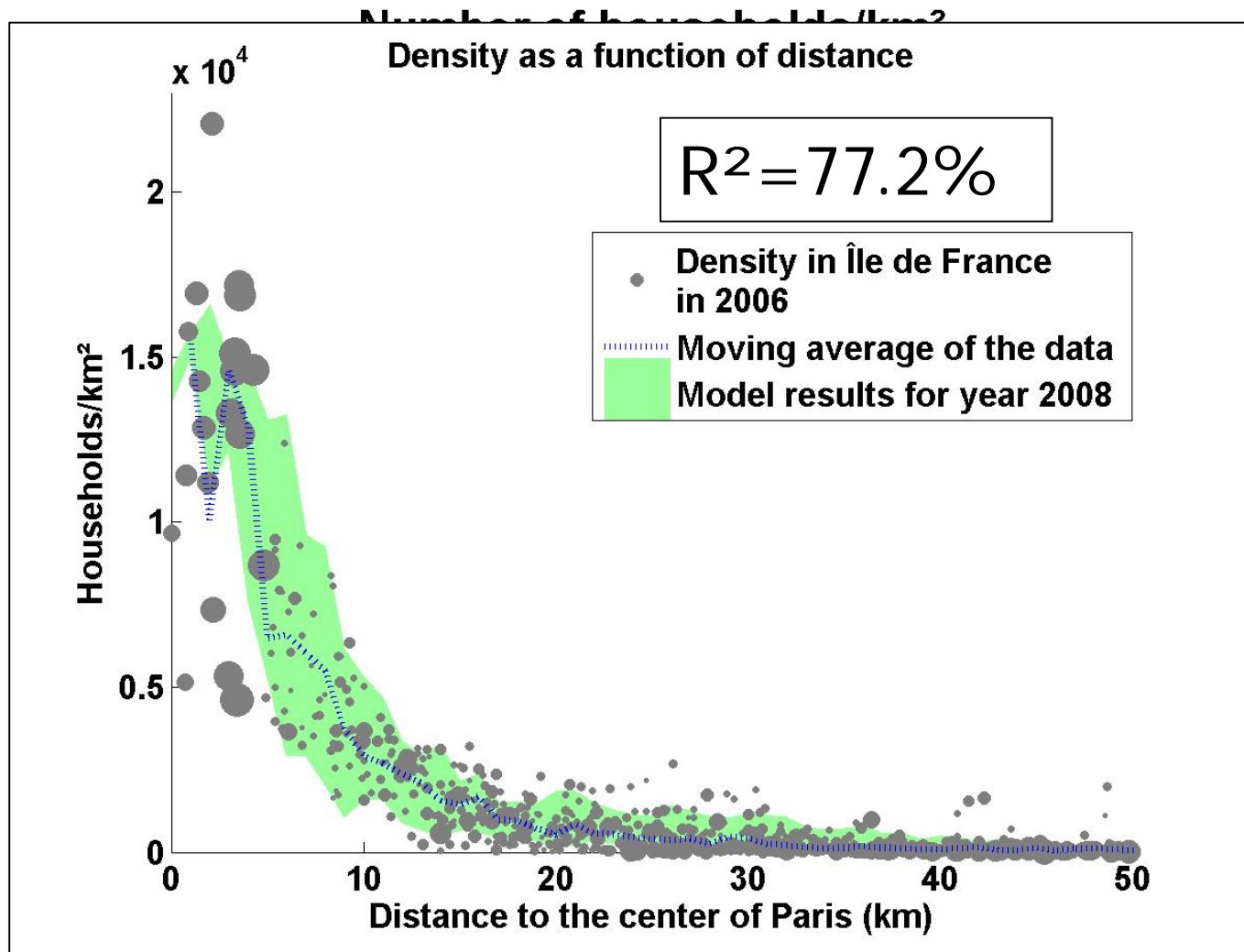


Model results: Population density (2006)

Number of households/km²



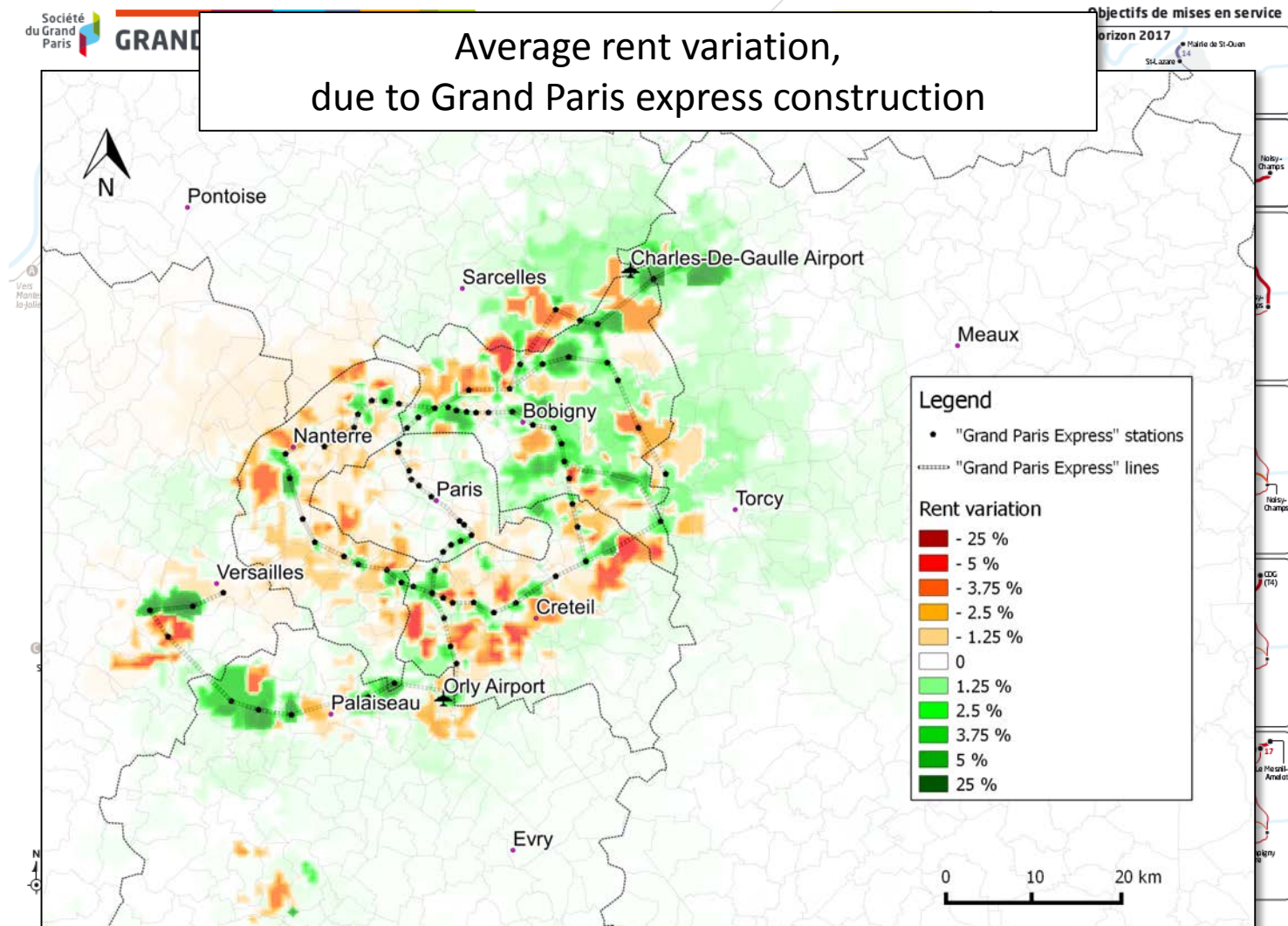
Model results: Population density (2006)



Main cities studied using NEDUM model

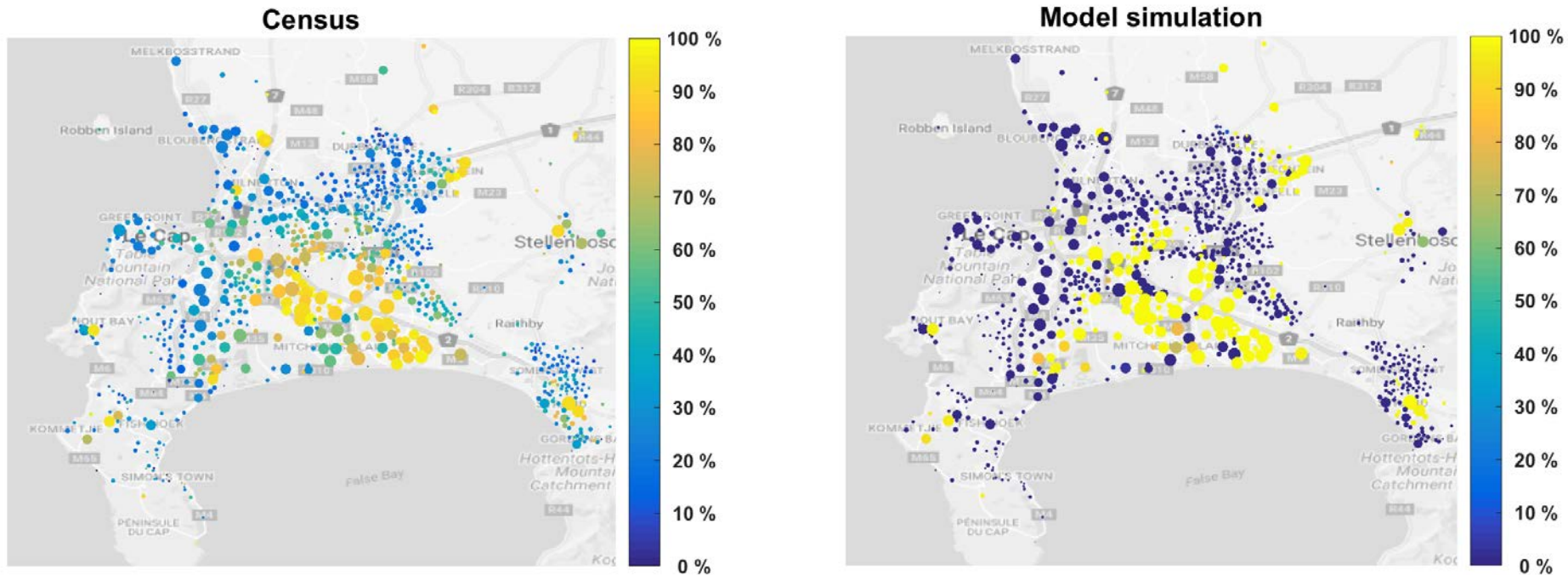


Example 1: Consequences of new transport infrastructures on housing prices



Example 2: Consequences of transport and land planning on income repartition and slum development

- Share of the households earning less than the median income



Conclusion

- **Urban shape plays a key role for environmental issues**
 - CO2 emissions
 - Adaptation to climate change impacts
 - Urban shape evolves slowly : we need to act now to prevent lock-ins

- **Economic models can inform decision making**
 - Prospective scenarios about cities expansion/structure modification
 - Costs and benefits of urban policies
 - Impacts of transport policies on rents etc.
 - Analysis of the city making
 - Role of land prices and finance (speculation)
 - Role of change in households preferences/behaviour
 - Role of changes in global trends (increase in oil prices etc.)

- **Many open questions**
 - Spatial repartition of income inequalities
 - Commuting choices
 - Etc.