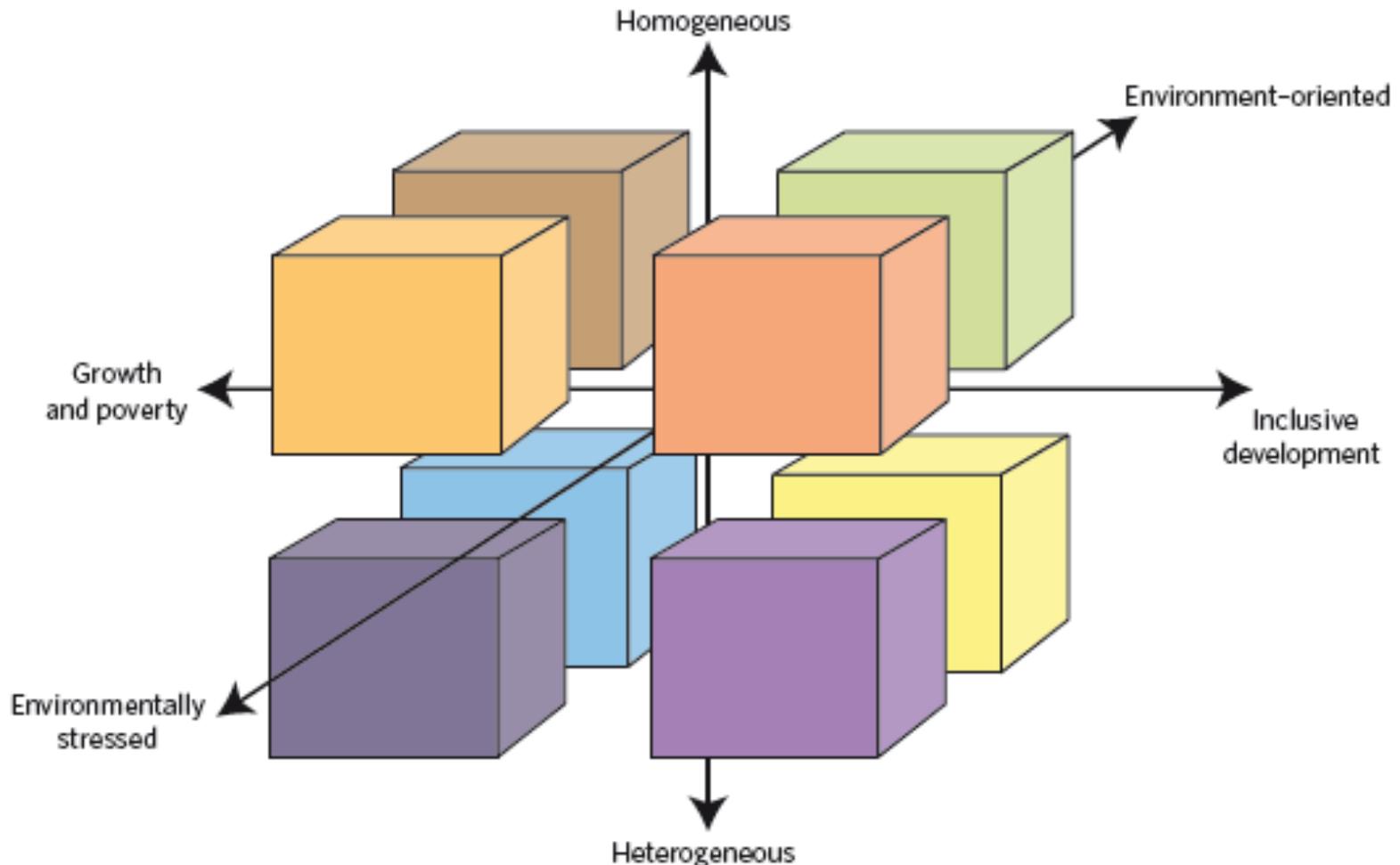

Urban scenarios to inform climate policies: a case study on Paris urban area

Vincent Viguié, [Stéphane Hallegatte](#), Julie Rozenberg

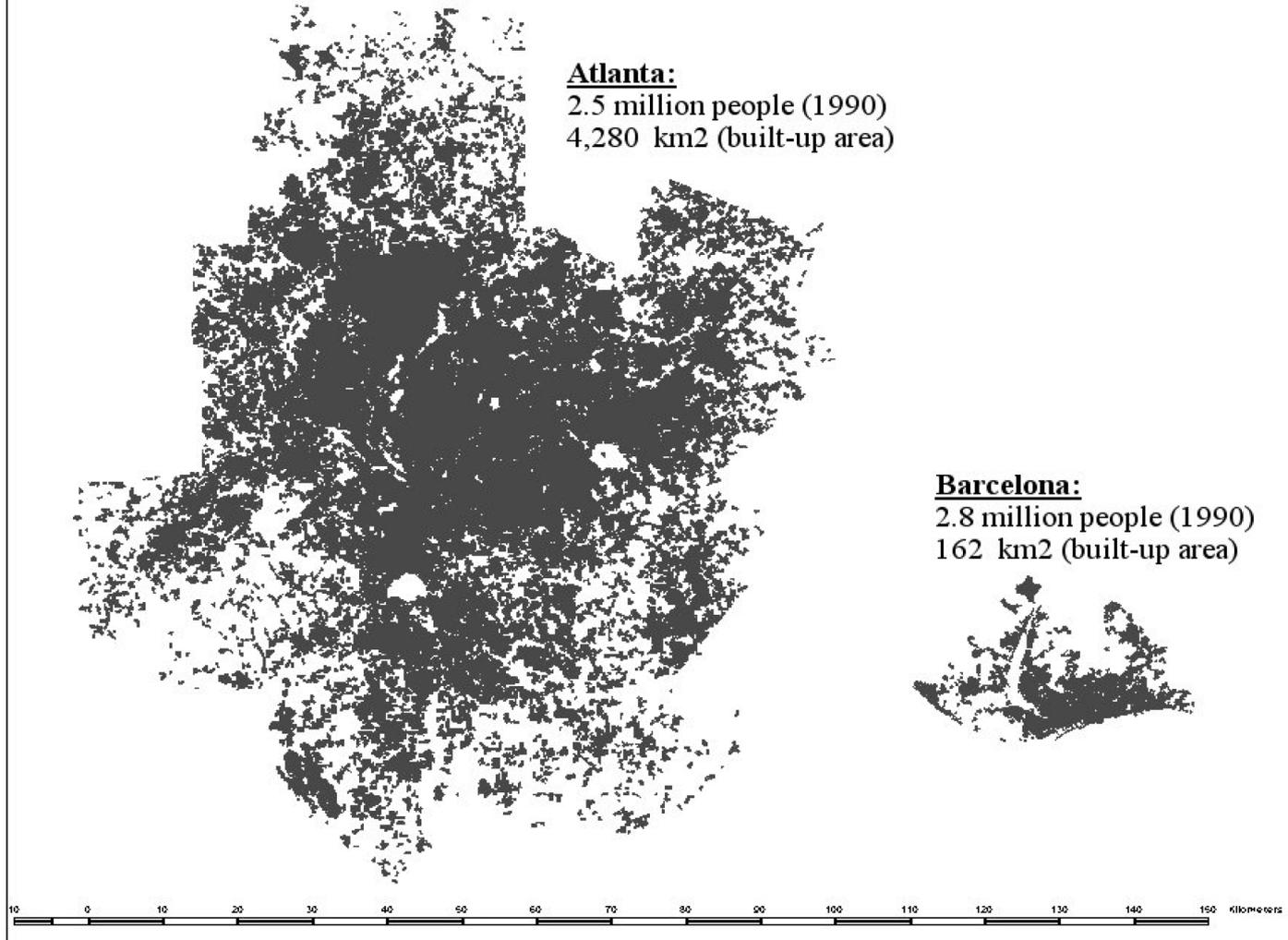
Building world narratives for climate change impact, adaptation and vulnerability analyses



Hallegatte, Przulski, Vogt-Schilb, Nature Climate Change, June 2011

Need for local scenarios: Urban forms matter for greenhouse gas emissions...

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



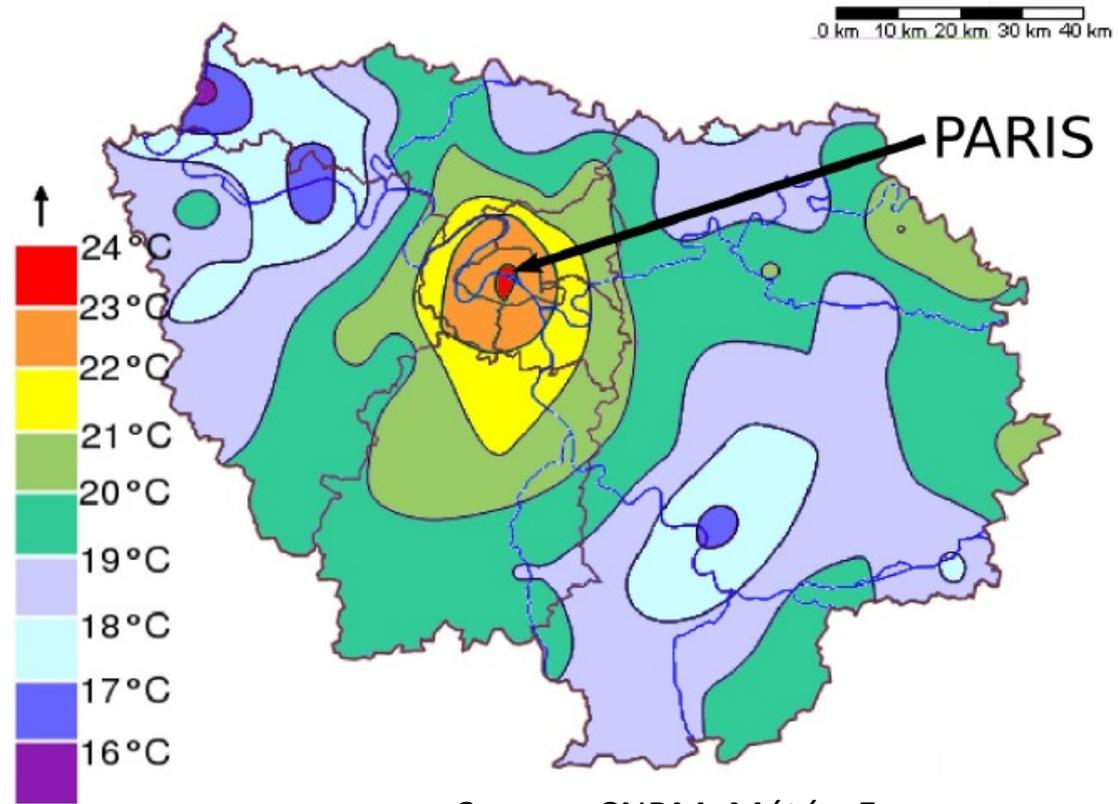
Source: Alain Bertaud

Need for local scenarios: Urban forms matter for climate-change vulnerability...

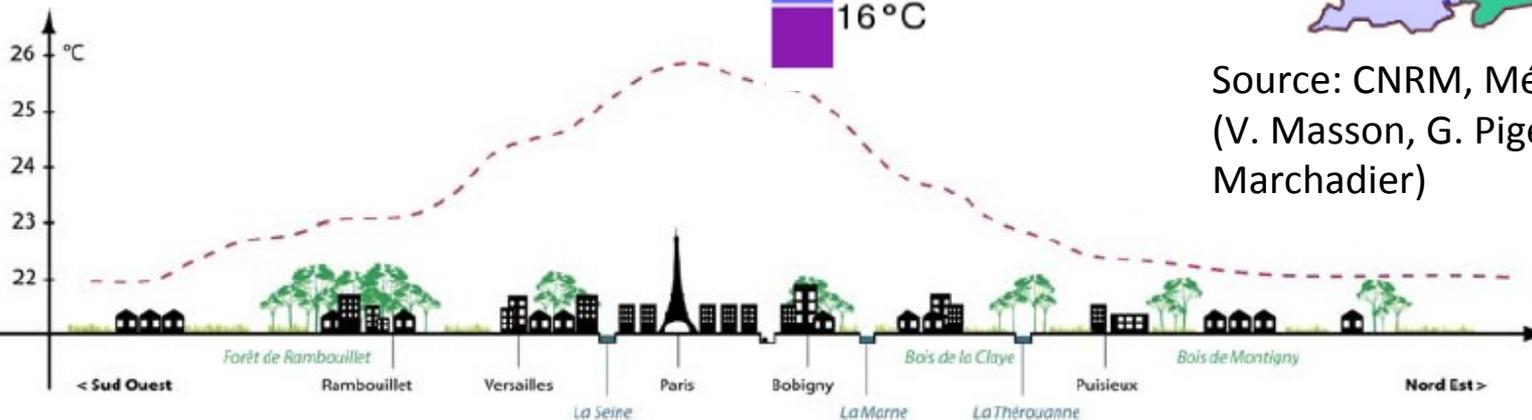
Temperatures are higher in cities than in rural areas, especially at night.

Example of the 2003 heat wave.

This effect depends on urban forms (density, parks, etc.)



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



Modelling urban form over the very long term?

- Standard urban economics modelling (*Alonso 1964, Mills 1967, Muth 1969*)

- **Three mechanisms :**
 1. Household tradeoff:
 - Lower transportation costs and shorter commuting time when living close to the city center; and
 - Larger dwellings and lower rent per square meter in remote areas
 2. Investors optimize housing density as a function of rents and construction costs.
 3. Different evolution timescales for rents, population density, buildings etc.

- Simplifying hypotheses :
 - All households have the same income;
 - One trip per day towards the city center;
 - One city center.

VALIDATION ON 1900-2010

July 11, 2011

Paris built area, 2006

© Viguié, Halleгатte, 2011

0 30 km

Validation process

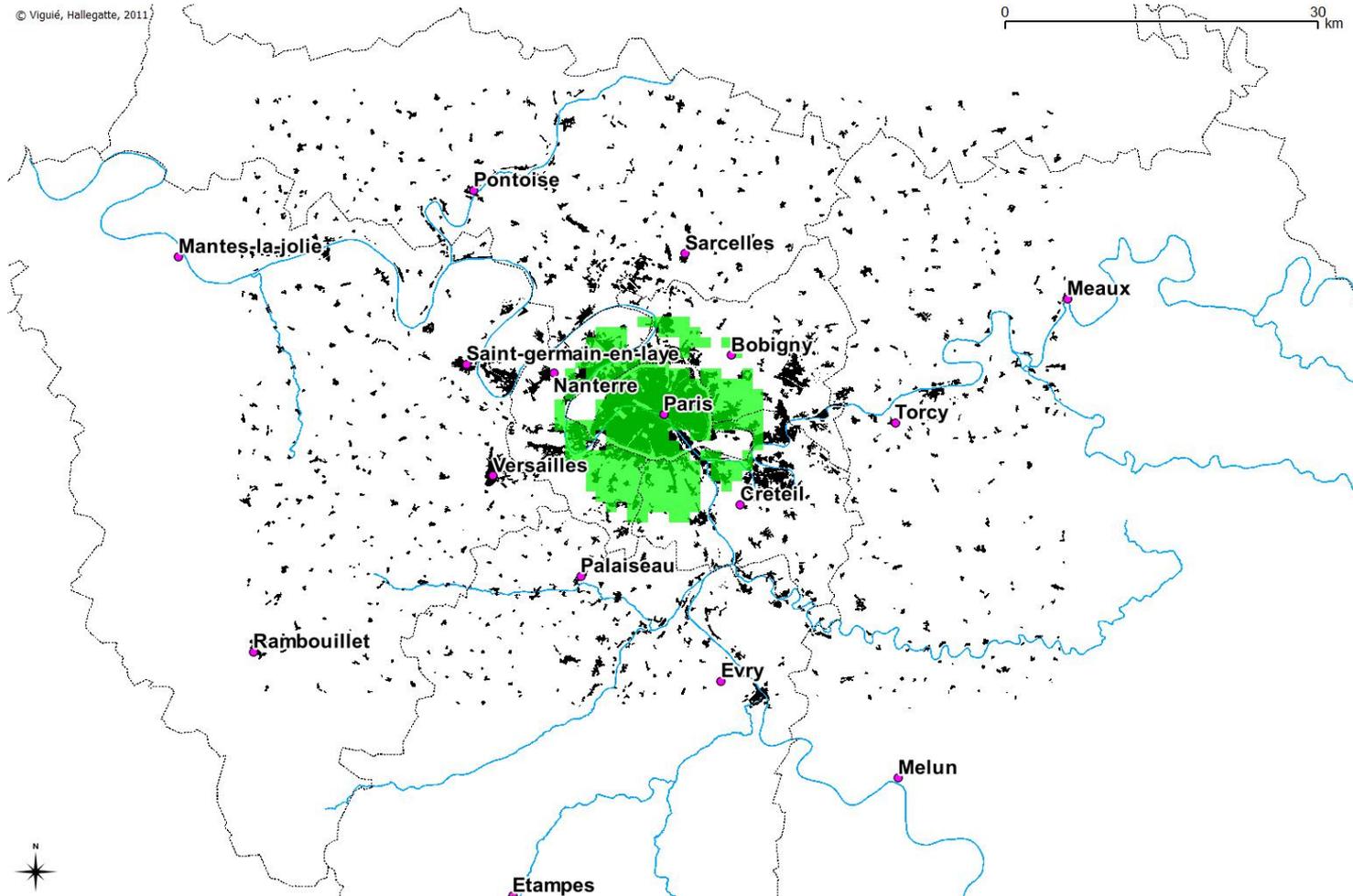
We run the model from 1900 to 2010 using:

- Data on population;
- Data on average income;
- Data on transportation cost, speed, and localization;
- Construction costs change like income.



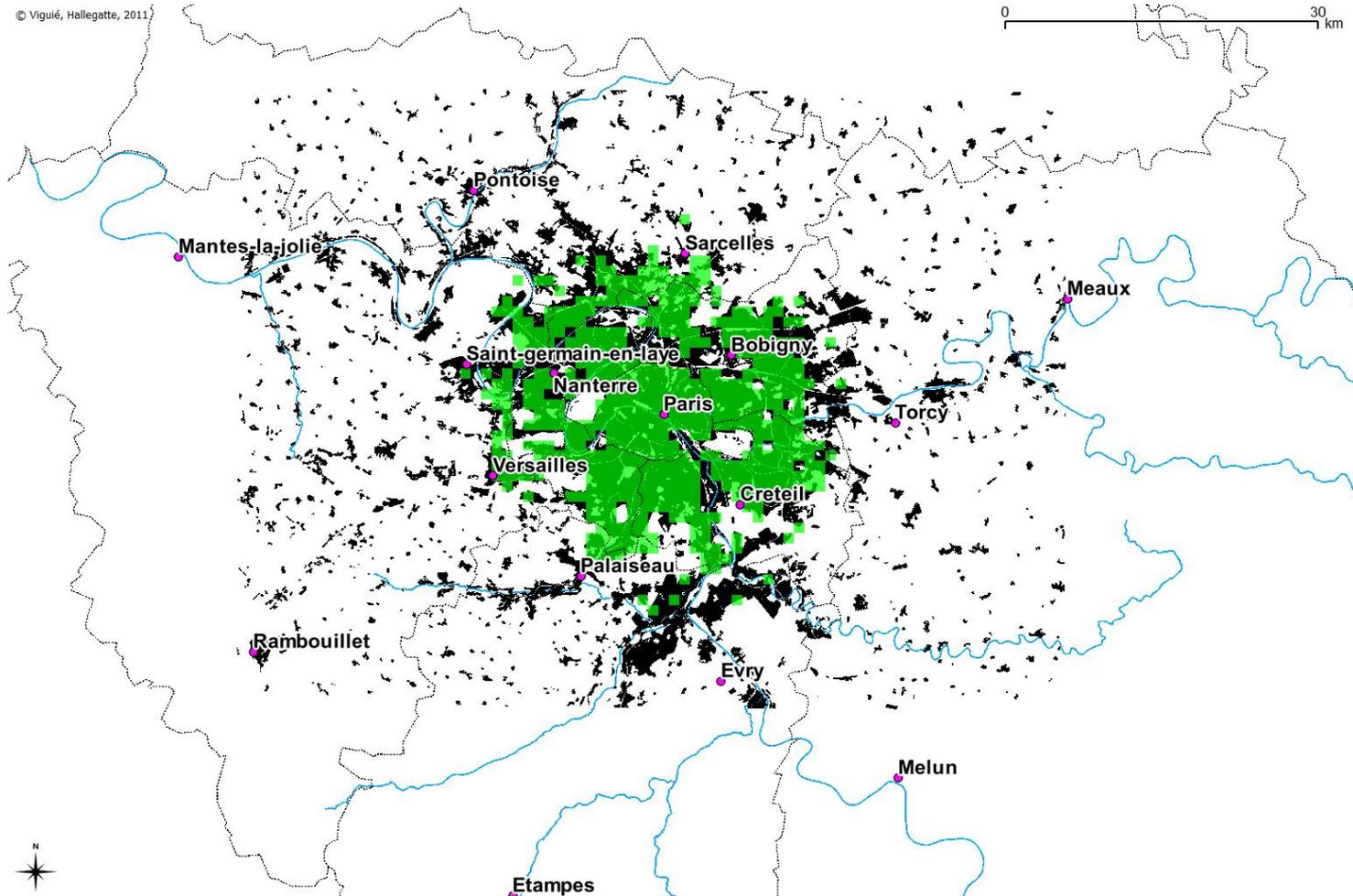
July 11, 2011

Model dynamics validation on the built area, 1900



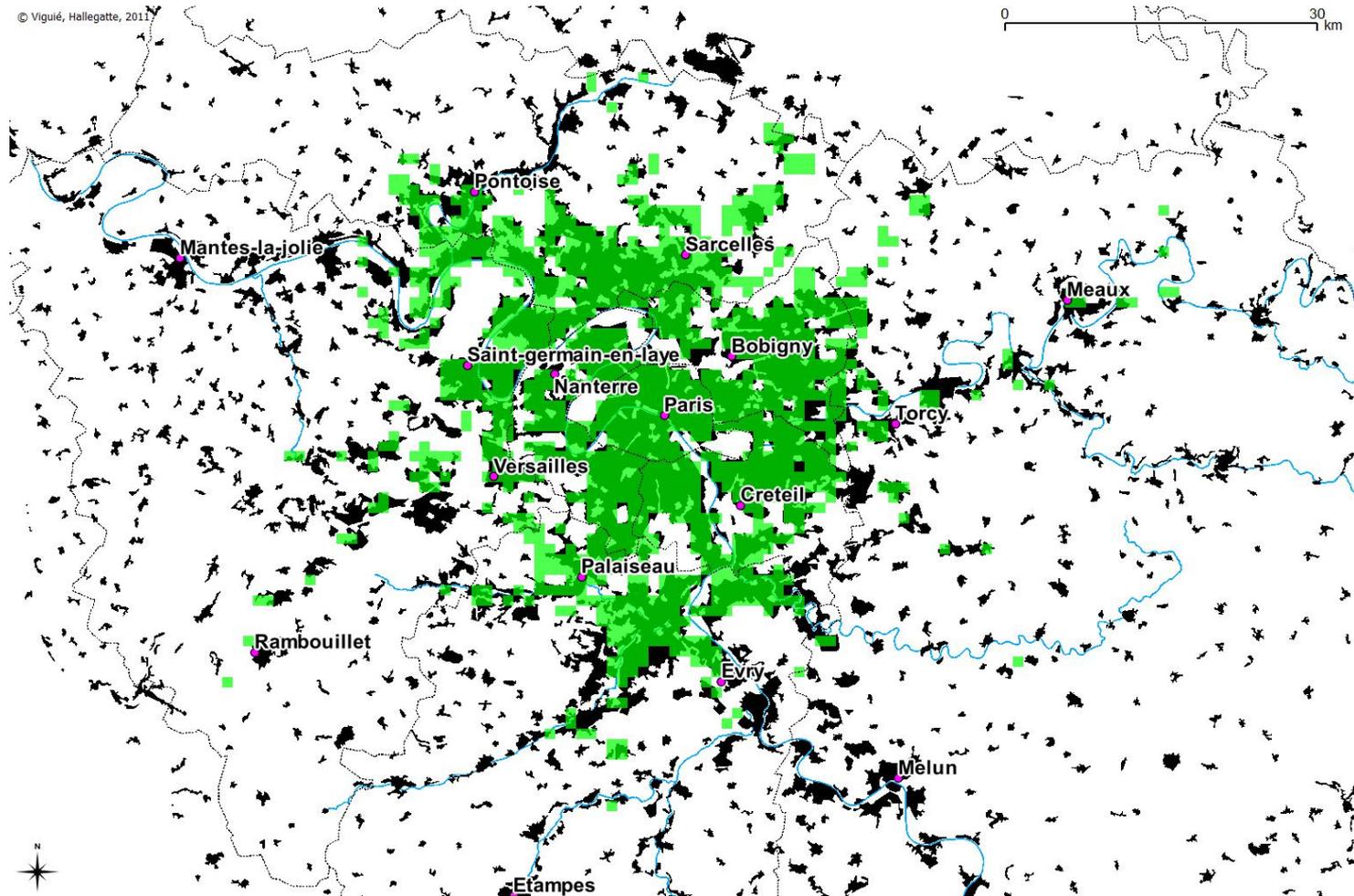
July 11, 2011

Model dynamics validation on the built area, 1960



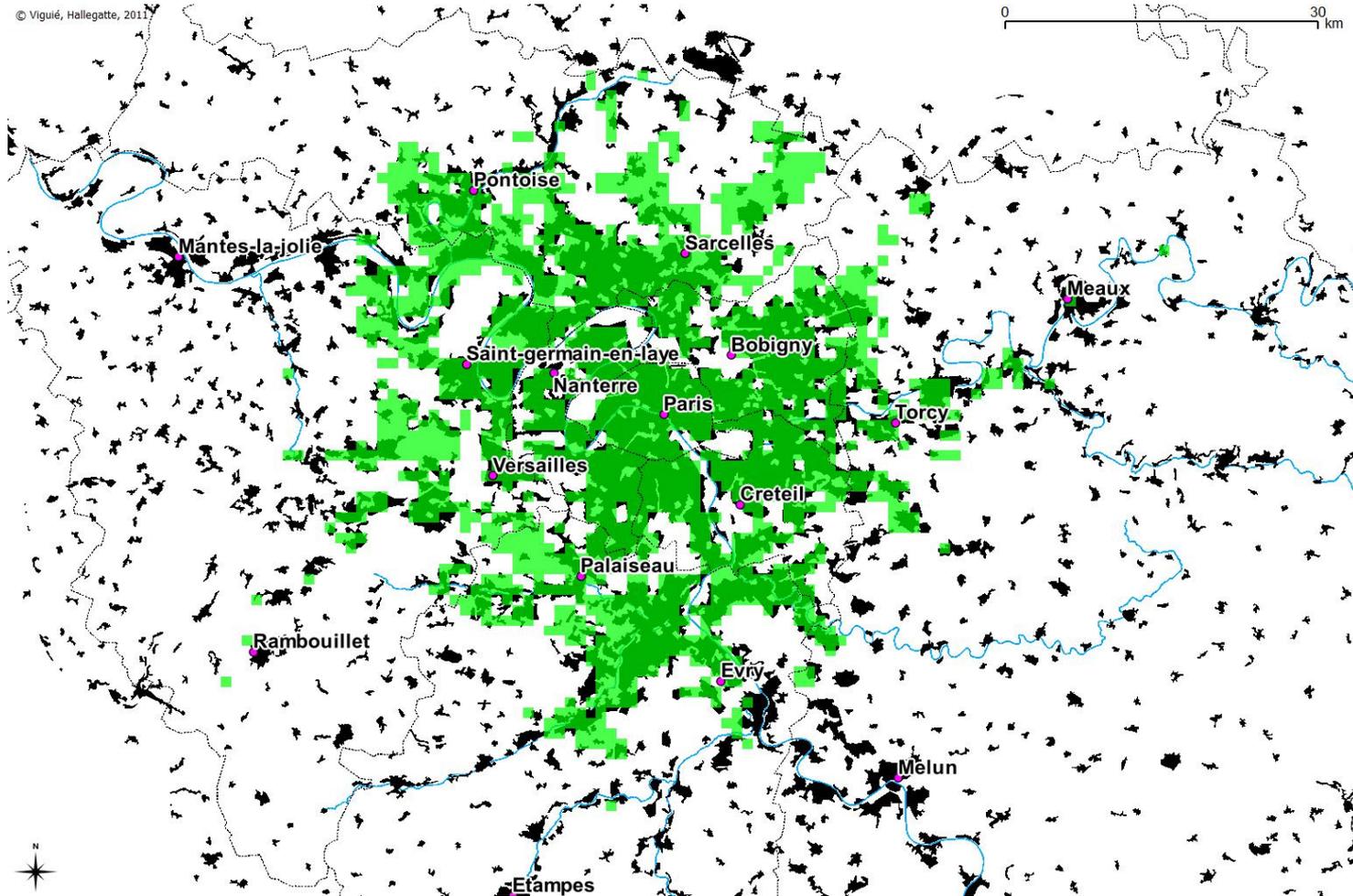
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Model dynamics validation on the built area, 1990



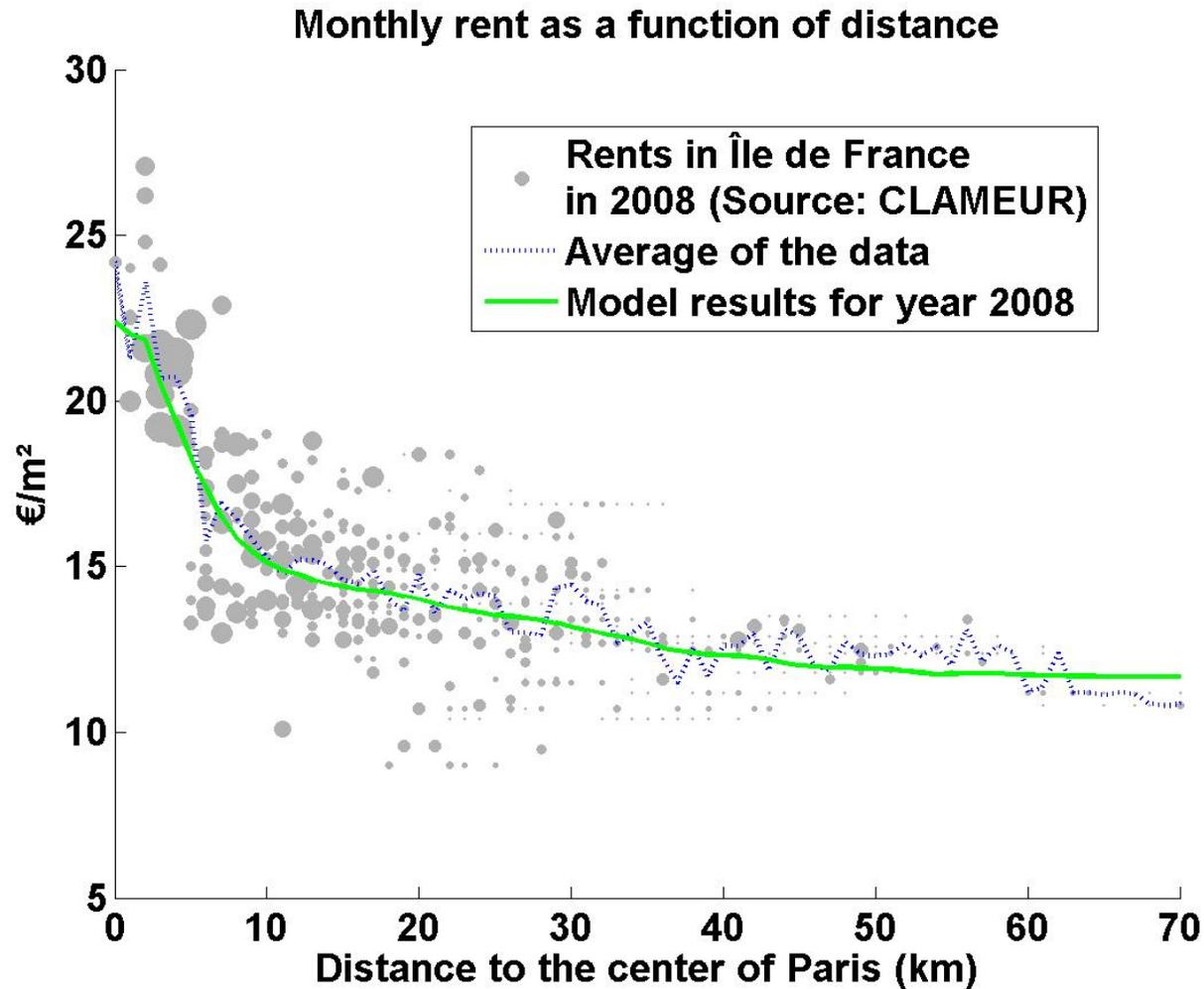
July 11, 2011

Model dynamics validation on the built area, 2006

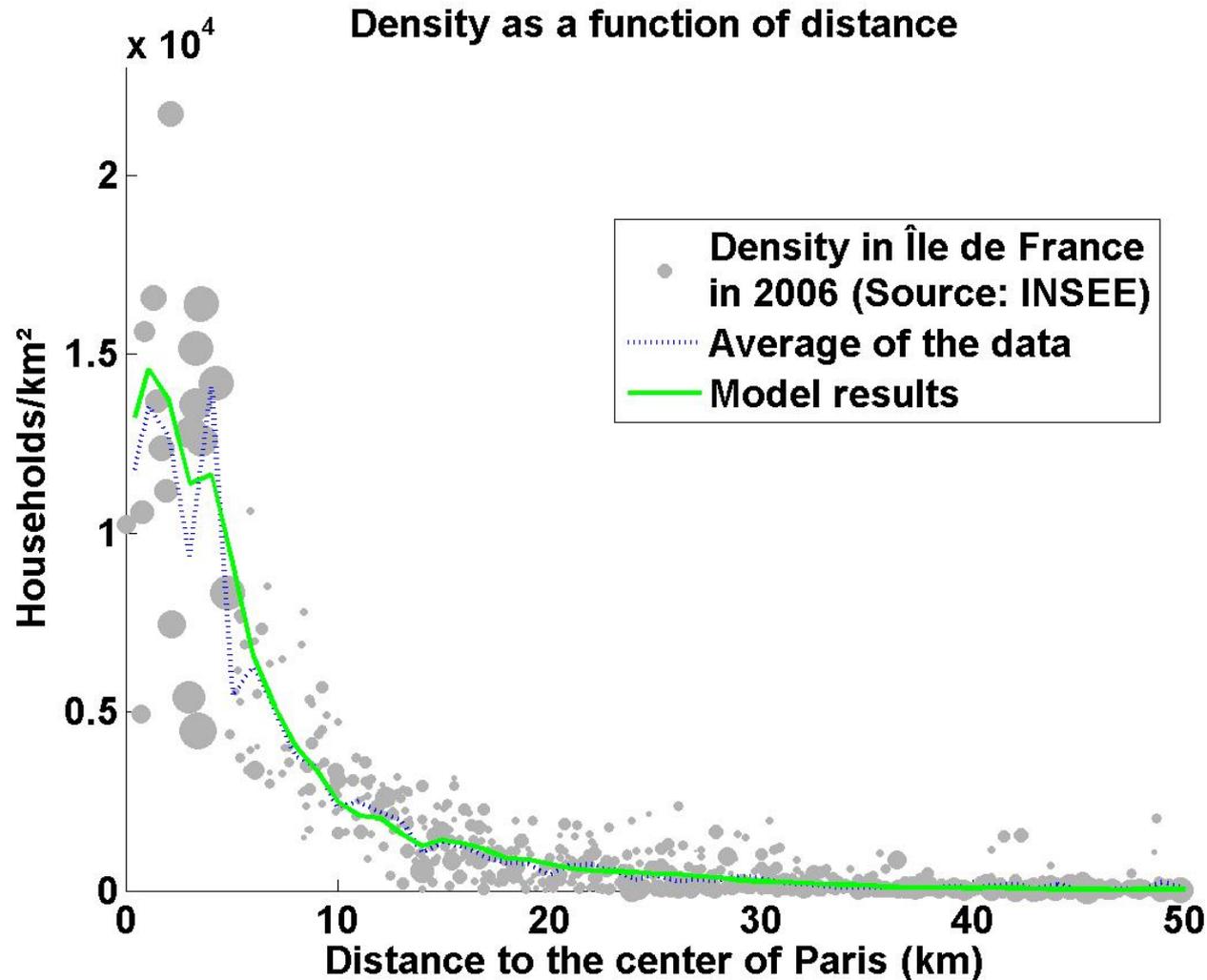


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Validation on local rents



Validation on local density

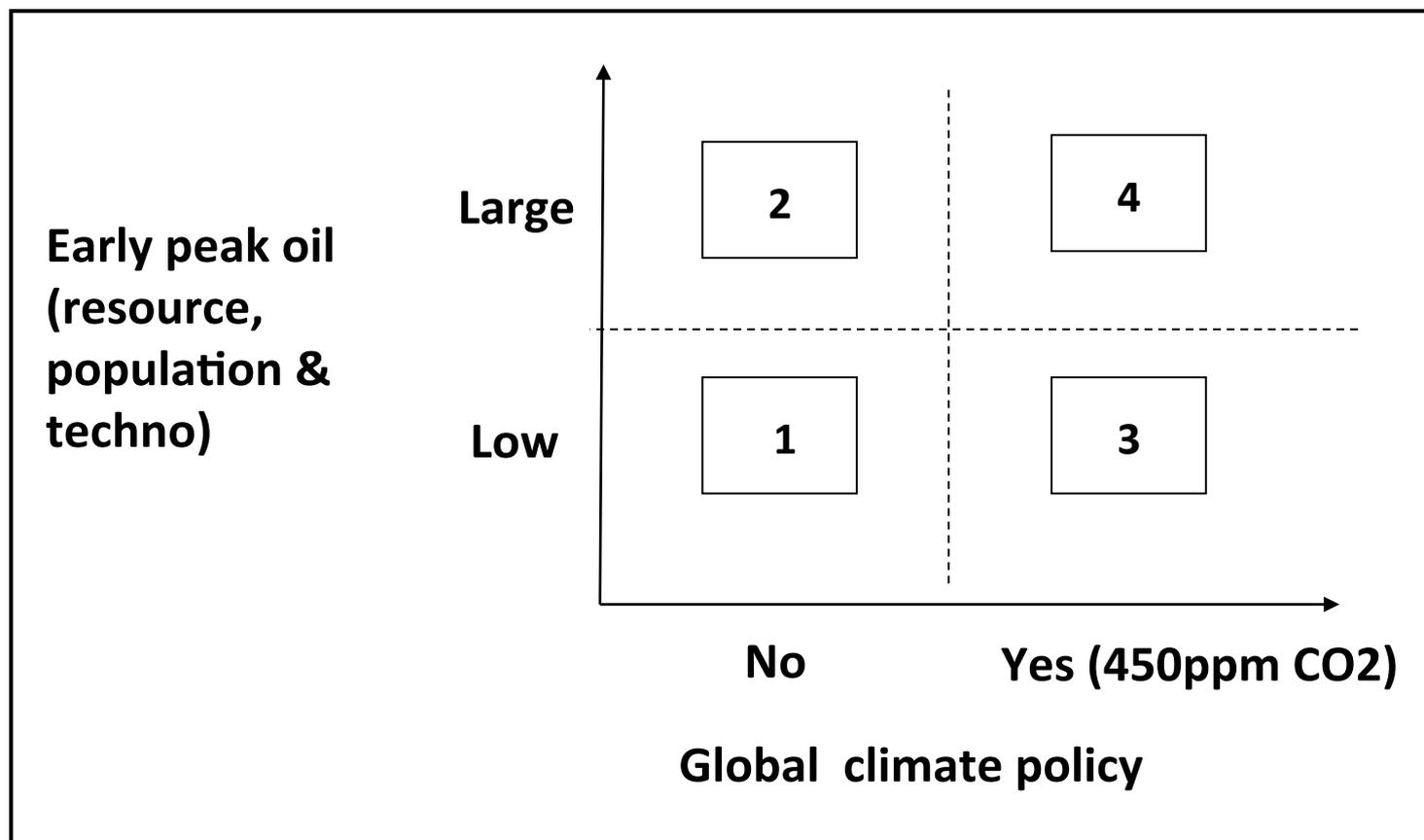


2010-2100 SCENARIOS

July 11, 2011

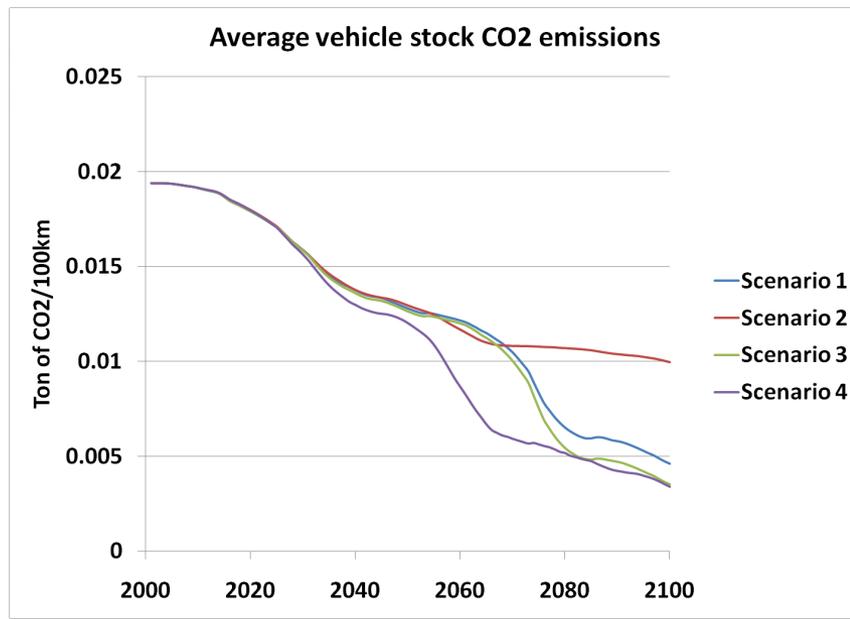
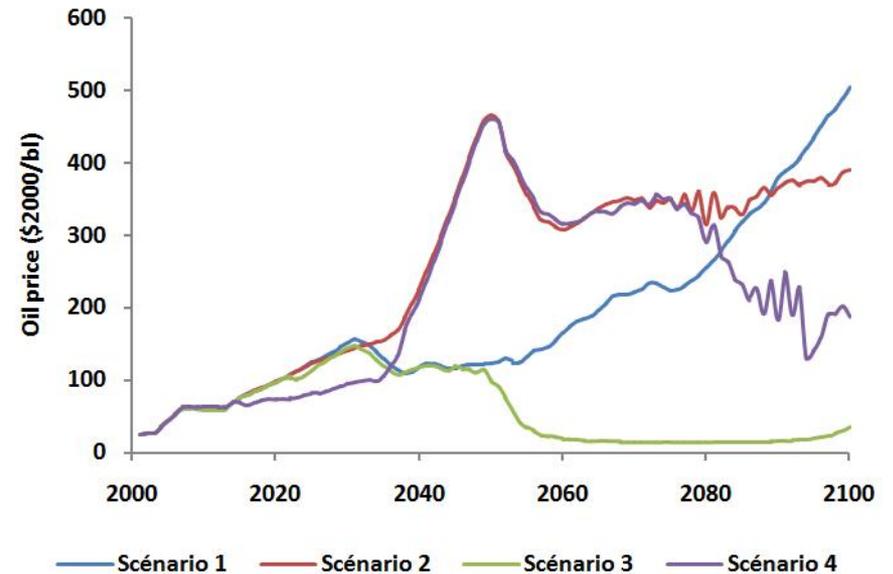
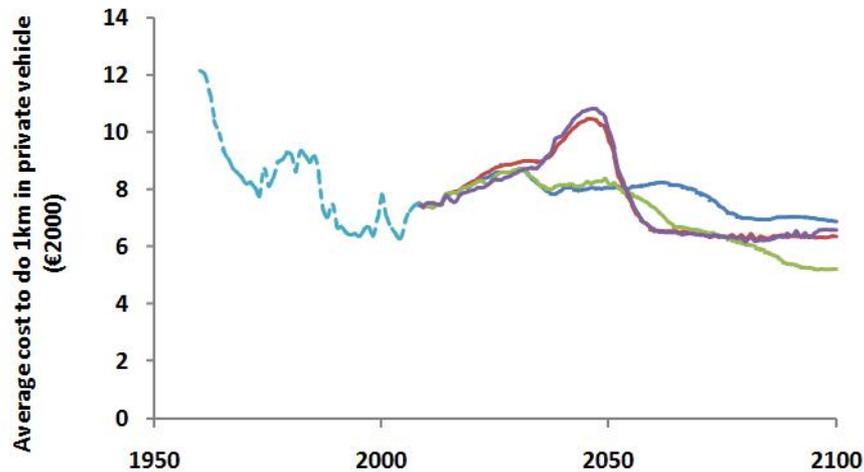
Main hypotheses

- 4 world scenarios with two dimensions:
 - Tensions on fossil fuel markets (resources, population, technology)
 - Ambitions of world climate policies.



Techo-economic scenario from the ImaclimR model

Exemple: private vehicle cost and oil prices

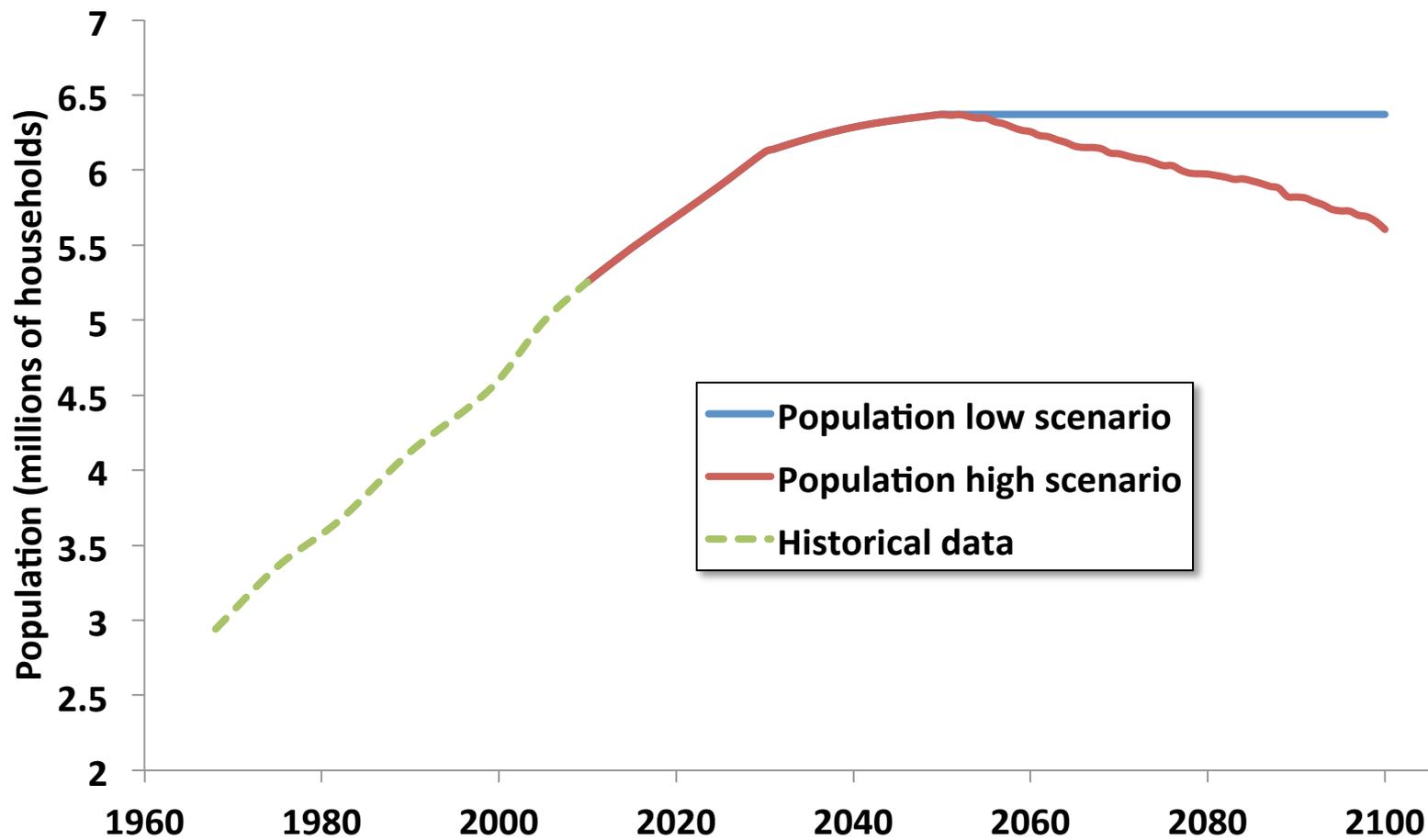


Main hypotheses

- 4 world scenarios with two dimensions:
 - Tensions on fossil fuel markets (resources, population, technology)
 - Ambitions of world climate policies.

- High or low demographic scenarios for Paris urban area population

Paris urban area population : 2 scenarios

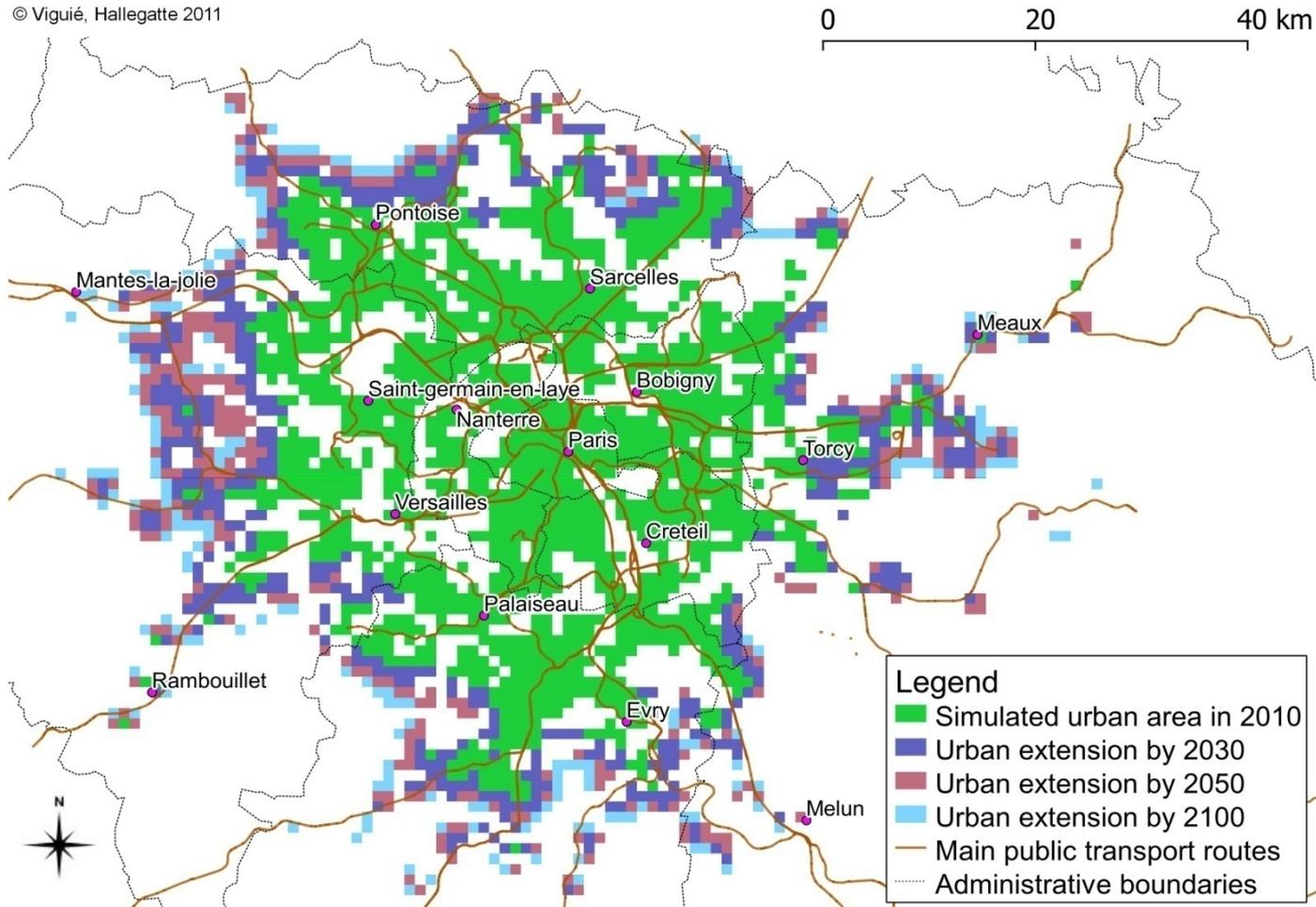


Main hypotheses

- 4 world scenarios with two dimensions:
 - Tensions on fossil fuel markets (resources, population, technology)
 - Ambitions of world climate policies.
- High or low demographic scenarios for Paris urban area population
- Simple scenarios for local policies :
 - Infrastructure remains unchanged between 2010 and 2100
 - Congestion on roads and public transport remains at current levels
 - No active urbanism policy

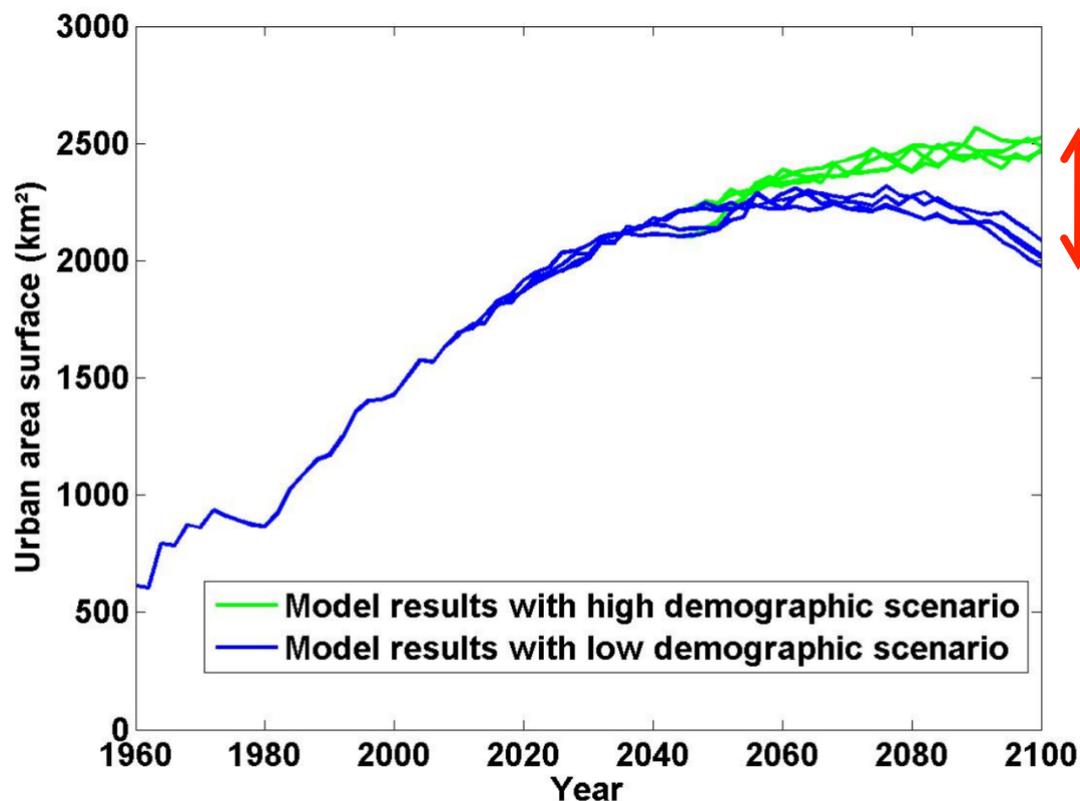
→ Autonomous or “potential” urbanization

Example of Paris urban area extension prospective scenario (high demographic scenario + scenario 1)



July 11, 2011

Paris built area extension – Urban sprawl



Urbanized area extension continues if the population keeps growing

Slow decrease in the other case

Small impact of technology and fuel prices scenarios.
Only local policies can control urban sprawl (e.g., a green belt).

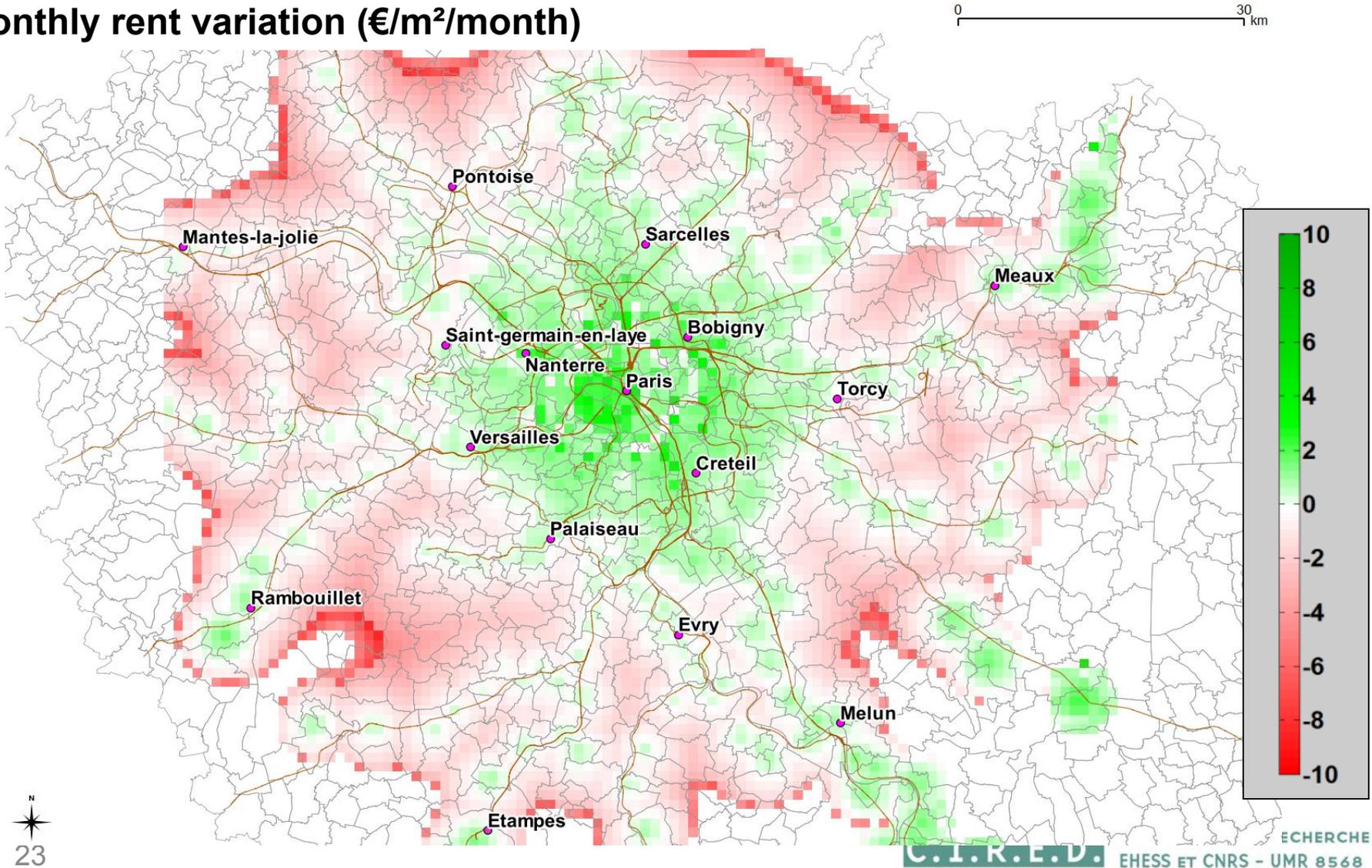
Input for mitigation policy analysis:

Example: impact of a €100/tC carbon tax

- **Higher density and shorter distances:**
 - Household average distance to the center decreases by 1.7 %.
 - Total urbanized surface decreases by 2.7 %
- **Modal transfer:**
 - 10% of all km travelled in private vehicles shift to public transport.
- **But what is the “cost” ?**
- **What is the distributional effect?**
 - Difference between tenants and landowners
 - Difference between suburbs and city center

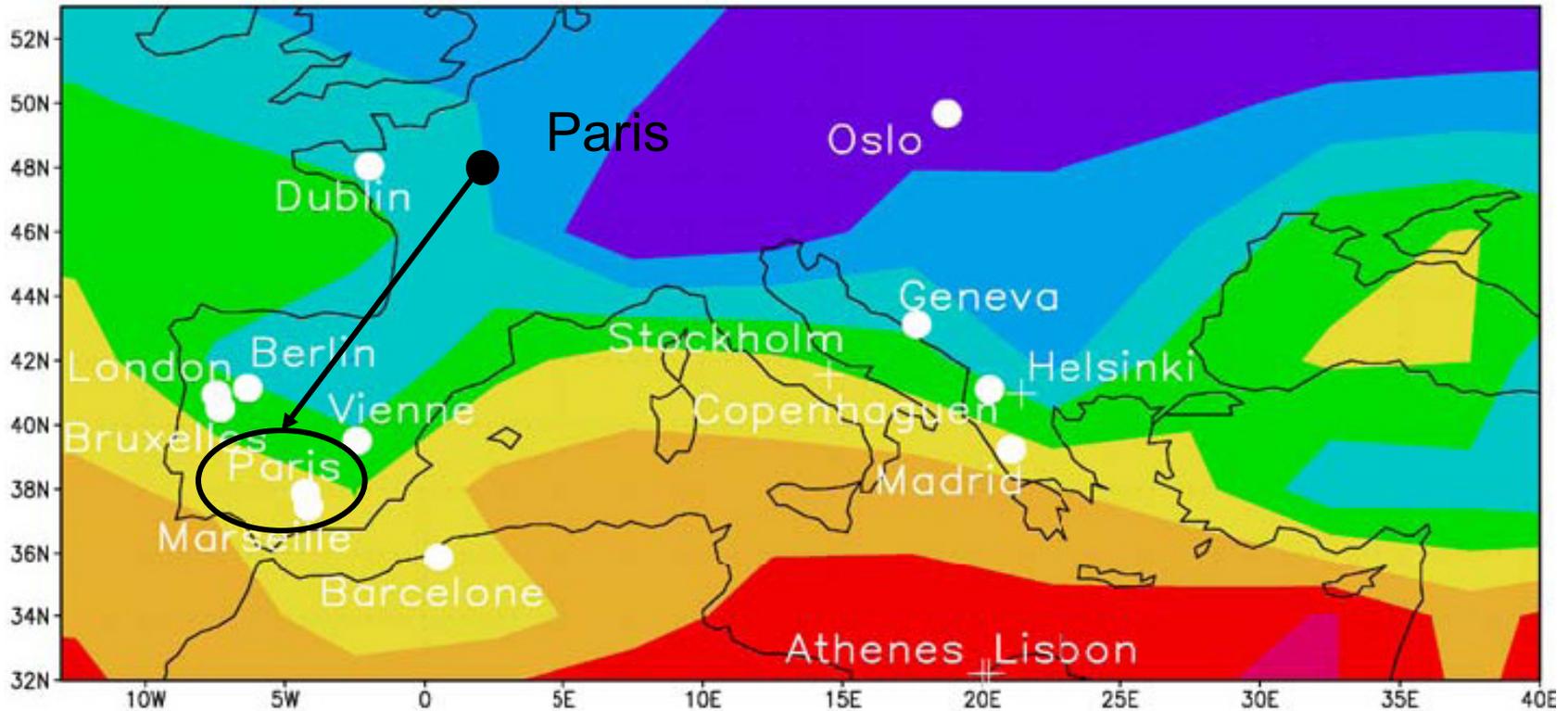
Input for mitigation policy analysis: Example: impact of a €100/tC carbon tax

Monthly rent variation (€/m²/month)



Input for adaptation policy analysis: Adapting to high temperature and air conditioning

HadRM3 climate model, SRES A2 emission scenario



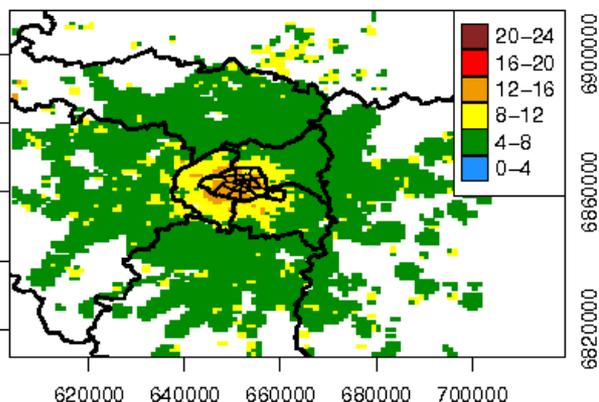
Hallegatte, Ambrosi, Hourcade, 2008.



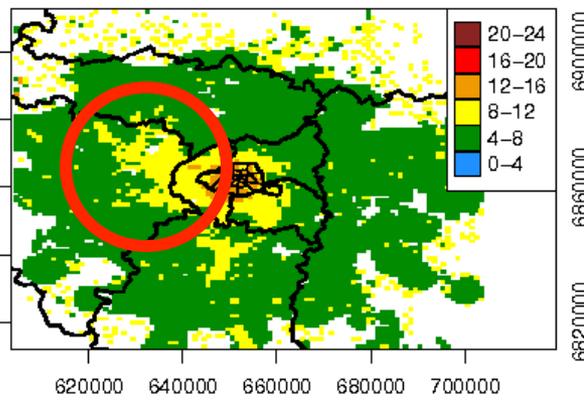
Input for adaptation policy analysis: Adapting to high temperature and air conditioning

Vulnerability to the 2003 heat wave, depending on urban forms and the use of AC.
Heat stress (outdoor, shadow) in number of hours.

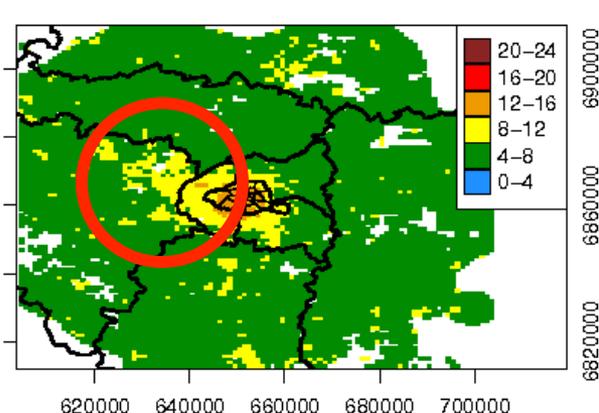
Current Paris



AC high-density scenario

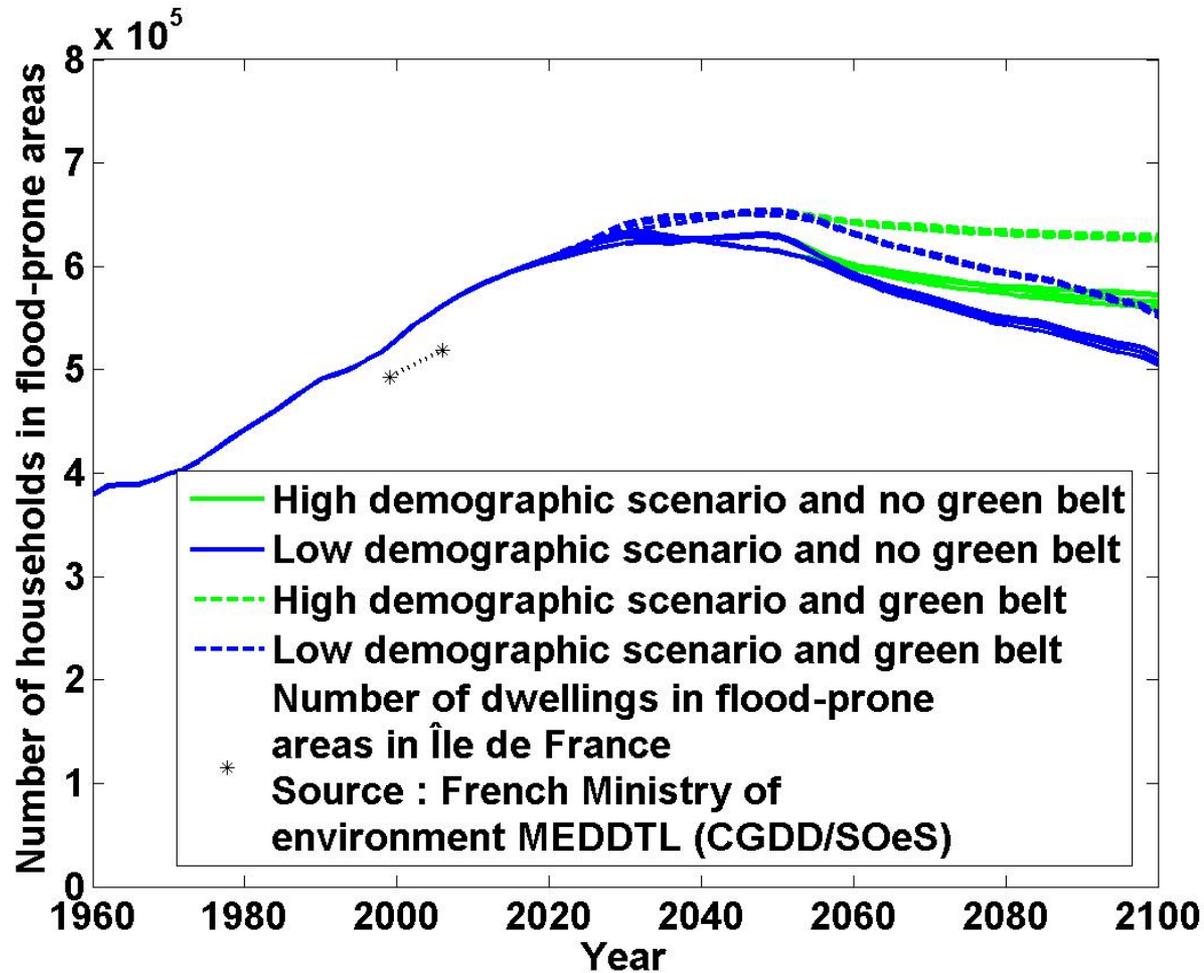


AC low-density scenario



1. Using AC has a negative impact on outdoor heat stress.
2. A high-density city appears more vulnerable to heat wave than a low-density city.

Input for adaptation policy analysis: Example: population exposed to floods and green belt



A green belt to control urban sprawl has a negative impact on flood risks

A few insights...

- Urban sprawl will continue and accelerate, even in a strong peak oil scenario. Only local policies can control urban sprawl.
- A carbon-tax decreases GHG emissions and favor model shift, but it has a significant negative impact on rents in the suburbs, making implementation difficult.
- Mitigation, adaptation, and other environmental objectives interact. For instance, a Green Belt to reduce transport and urban sprawl may increase flood risks and high-temperature vulnerability.
- **Urban economic models and urban-scale long term scenarios provide useful insights into mitigation and adaptation policies.**

Input for mitigation policy analysis: Example: transport-related emissions in Paris

