

Agent-based modeling for  
sustainable development :  
state of the art &  
research perspectives

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# General context

## Overarching societal issues

- Climate change → toward carbon neutrality
- Human health → increasing concern for exposure to local pollution, noise...

## Transformations in the transport and mobility sector...

- Multiplication of mobility services (SAV, MAAS, UAM...)
- Increasingly diverse activity and mobility patterns (though still structural role of commuting)

## ... that give rise to several questions :

- Can new mobility services contribute to sustainability ?
  - multimodality = sustainability ?
  - controversy over the impact of new mobility services on congestion
  - direct impacts VS lifecycle effects
- How to model these changes in supply and demand?

# Scientific context

**Numerous studies evaluate the impact of introducing new mobility services at a city/metropolis scale**

- Keynote: Nagel (2019)
- Shared autonomous vehicles (ITF 2018, Wang et al. 2019)...

**But fewer studies consider which bundle of mobility services should be supplied at a neighborhood level**

- Local characteristics play an important role in mobility practices and modal choice (Ewing et Cervero 2010)

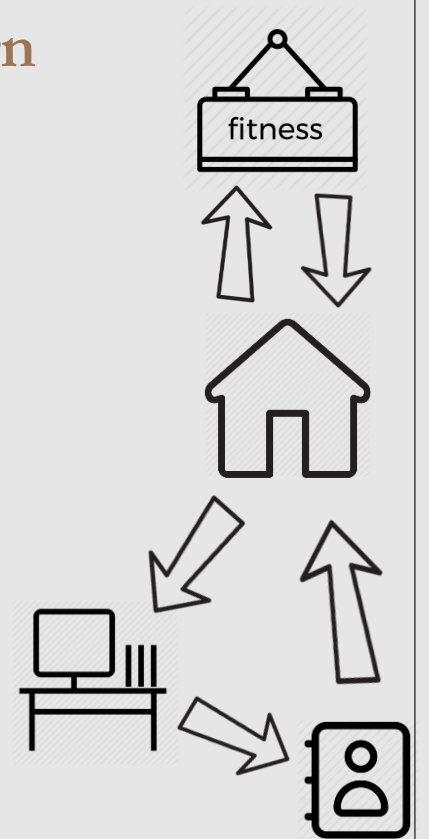
# Research project

## Better understanding mobility at a local scale for better urban design

- How to leverage new mobility services (and practices) for sustainability ?
  - One size fits all ? → influence of urban design, local accessibility...
  - influence of transport supply (including parking space)
  - role of scale : neighbourhood VS metropolis

## Focus

- GHG & air quality
  - main environmental externalities in socio-economic assessments
  - noise : cf next presentation
- from direct impacts to lifecycle analysis (LCA)
- from static to dynamic exposition



# Methodology

## Mobility model: MATSim

- Paris scenario (Hörl, 2019)
- Focus on
  - neighborhood level
  - socio-economic aspects
- Allows to consider:
  - interaction between activities (Home, Work, Leisure, Shopping...)
  - various sources of adjustments (Departure time, destination choice, Transport mode)
  - diversity of modes: standard modes (car, PT), on-demand mobility, micromobility...

## Emissions + air quality model

- emissions : preliminary works with COPCETE
- air quality: research project with CEREAA

# Related studies

## Neighborhood-related sustainable mobility

- Node & place (Bertolini et Split, 1998)
- Micro-analysis of land use and travel in neighborhoods in San Francisco Bay Area (Kitamura et al. 1997)
- Station area development in Tokyo (Chrous, 2012)
- 5 TOD neighbourhoods in Hong Kong (Loo et Verle, 2016)
- Manuel on pedestrian and bicycle connections to transit (Portland State University, 2017)
- Joint development of municipality-transport (IAU, 2017)
- « Move Urban » \* Living lab « Waterkant Berlin » : Pre/Post-survey among inhabitants; impact analysis with ABM (Heldt et Cyganski, 2019)





# « Les Lumières - Pleyel » in the project of Pleyel de Saint-Denis



Urban morphology



Presence dynamics



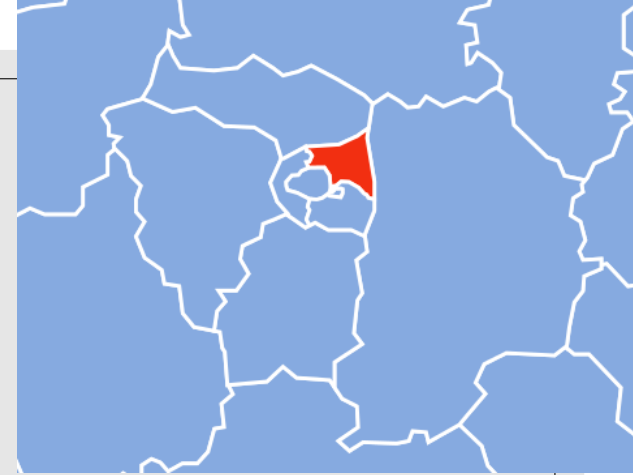
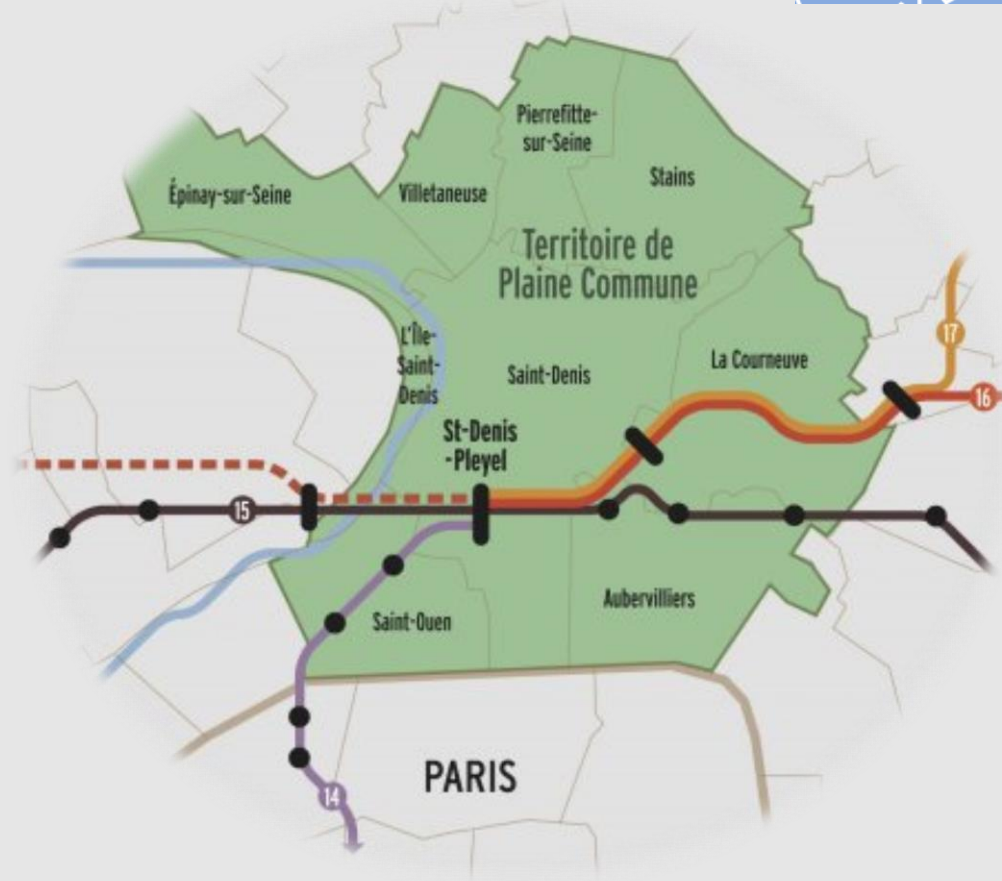
Movement dynamics

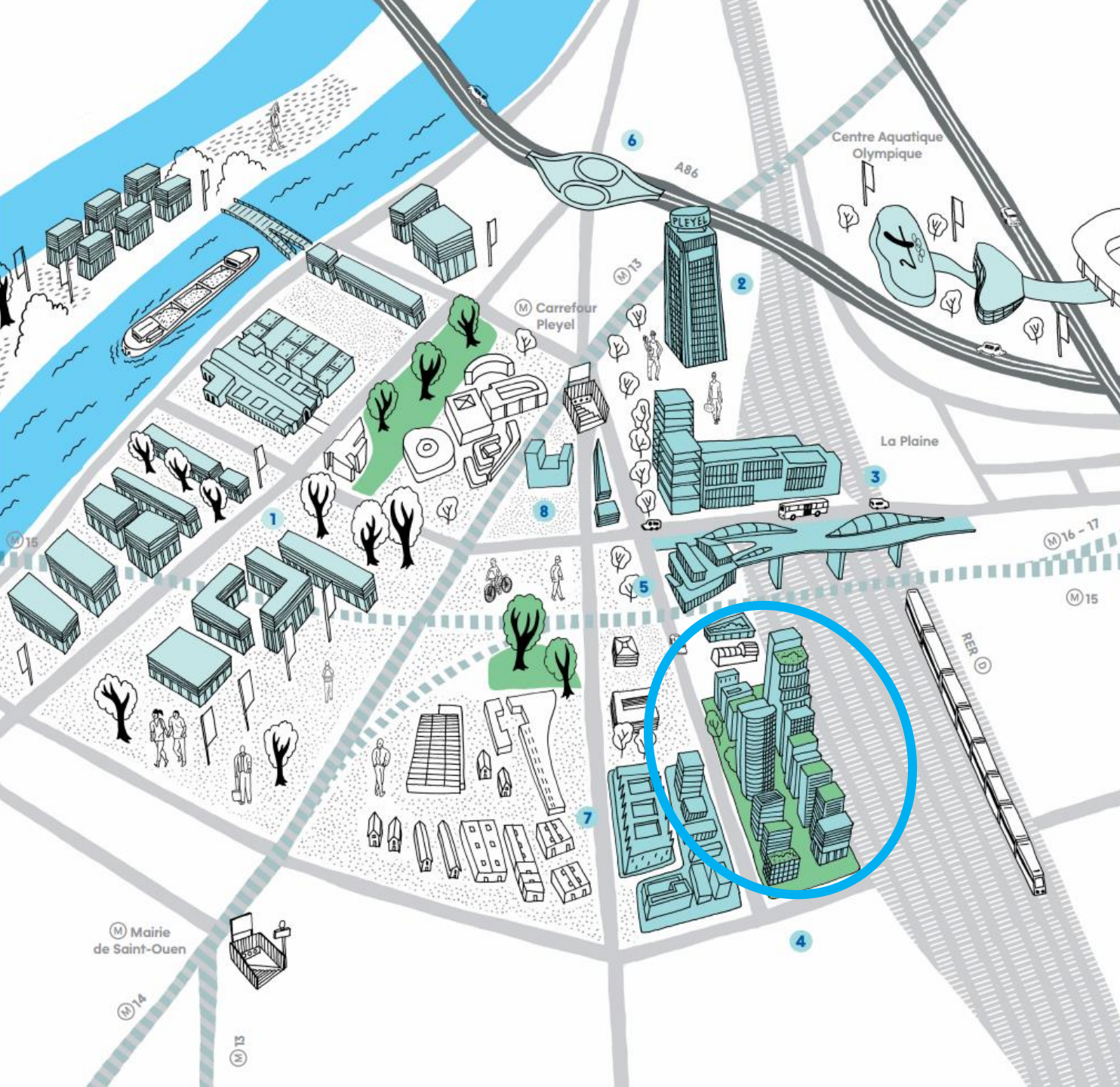


Lifestyle and mobility style

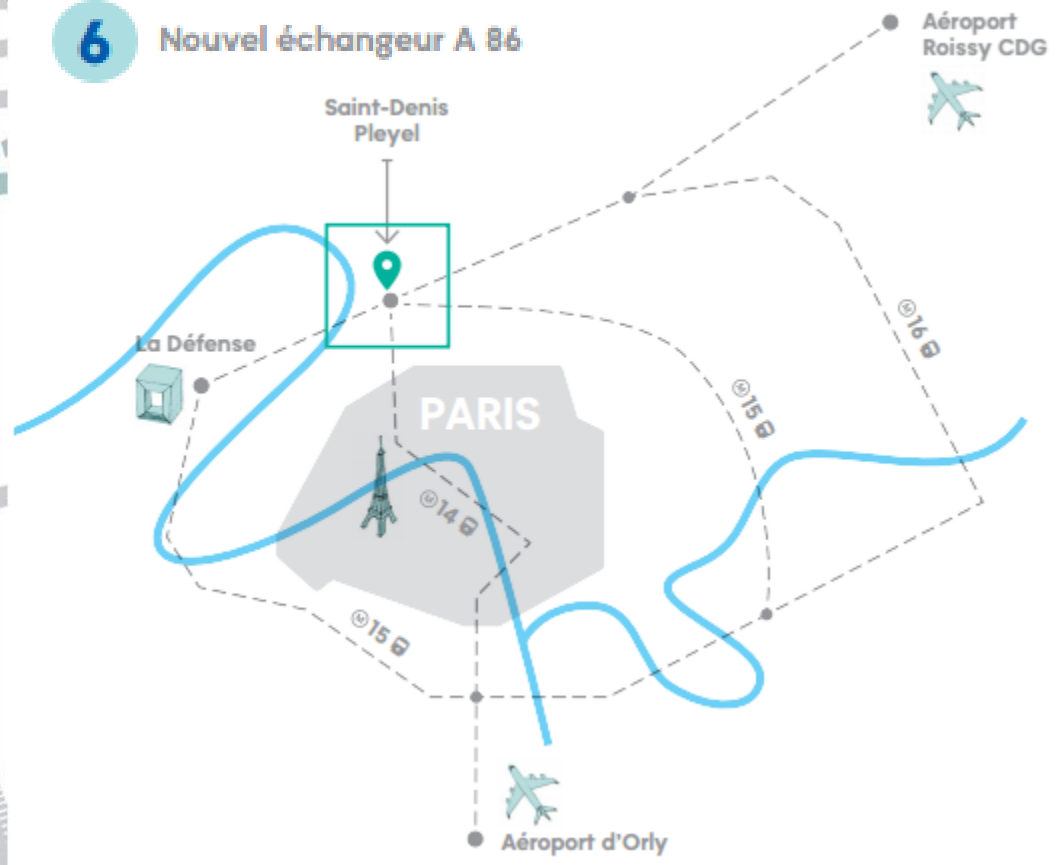


With MATSim : representing a typical day in the « Quartier des Lumières »





- 1 Village Olympique et Paralympique
- 2 Tour Pleyel
- 3 Franchissement urbain
- 4 Les Lumières Pleyel
- 5 Gare Saint-Denis Pleyel
- 6 Nouvel échangeur A 86
- 7 Futur groupe scolaire Lili Boulanger
- 8 Enseigne alimentaire
- Transports en commun structurants
- Autoroutes
- Réseau ferré





# Methodology for case study

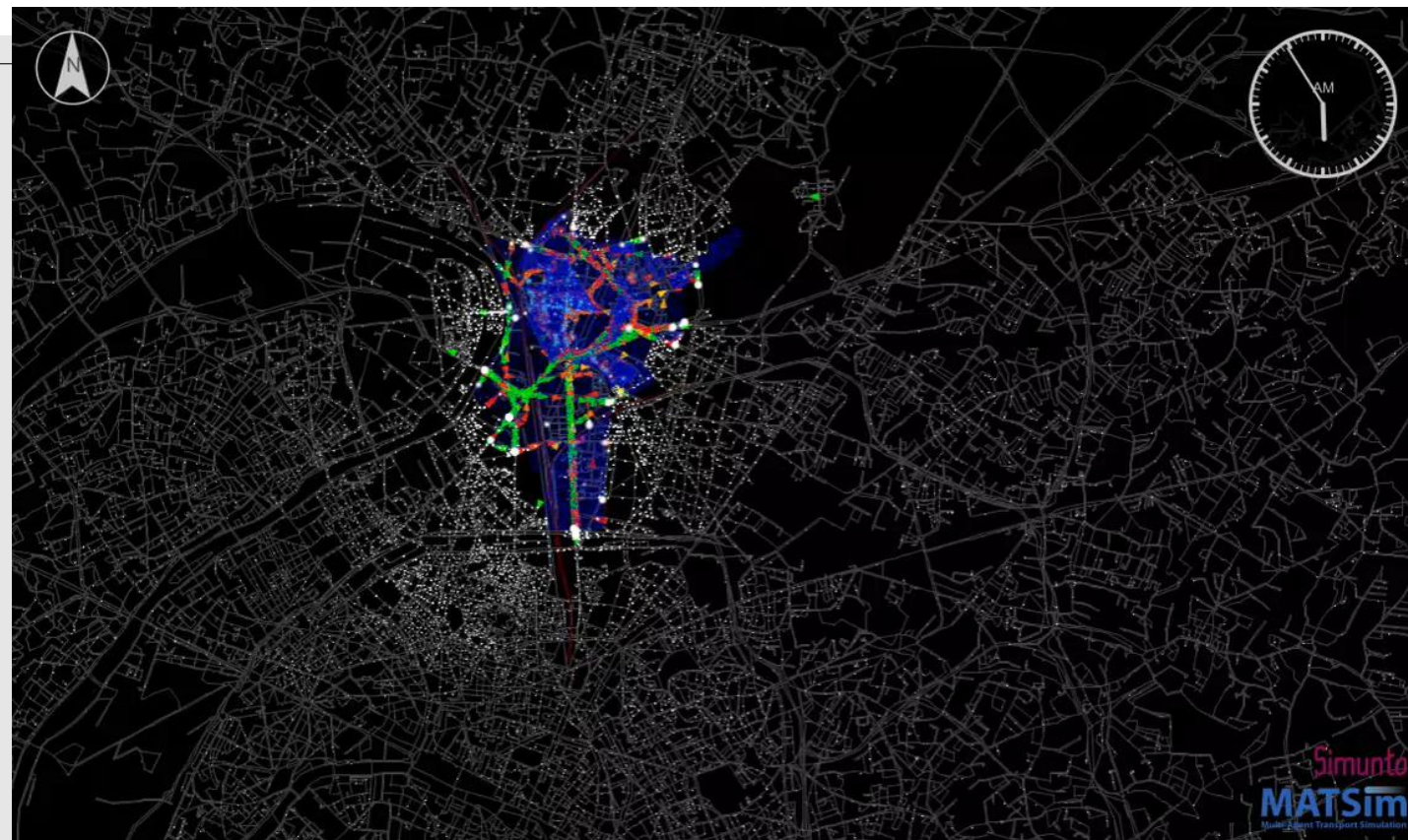
## Cutting the neighbourhood

## Improve calibration at local scale

- Special road segments
- PT itinerary, access/egress time, waiting time and congestion

## Big data serving new behaviour hypothesis

- Subscribers' data (Shared cars, bikes, shared e-scooters...)
- Smart card data : P+R often located at public transport stations
- Mobile-device data: Co-working, teleworking
- Eventually, e-shopping and delivering



# Scenarios

## Demand

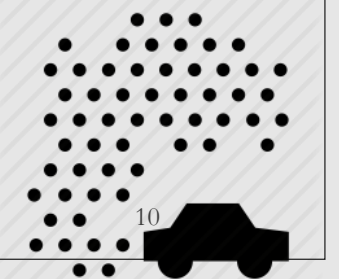
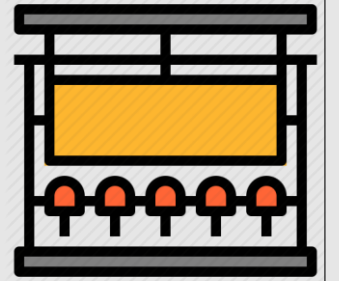
- Baseline scenario
- Olympic games (we plan to...)

## Mobility services

- Shared vehicles (cars, bikes, e-scooters)
- Autonomous shuttles
- Fewer private parking spaces

## Behaviour

- Co-working / teleworking
- Eventually, e-shopping and delivering



# Conclusion

## Our research project

- investigating mobility scenarios at a local scale for better urban & transport design
  - focus on socioeconomic and environmental (GHG, local pollution) aspects
  - focus on contribution of new mobility services
- agent-based modeling as a tool to handle the diversity of modal options
  - especially relevant for options that are not always available (vehicle sharing systems, ridesharing...)

## Challenges

- quality of calibration at a local scale
- multimodal data
- behaviors toward new mobility services

## Longer-term research venues

- leveraging artificial intelligence for better model calibration
- integrating emission-related behaviours into the model chain

