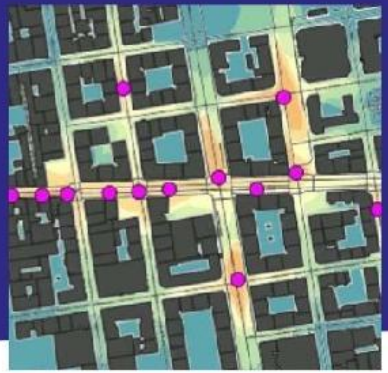
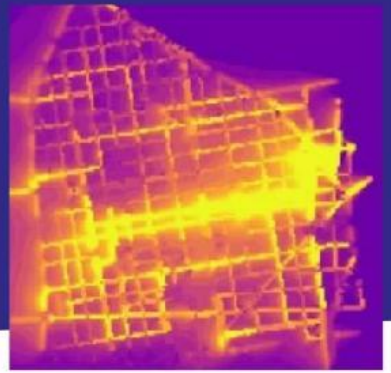
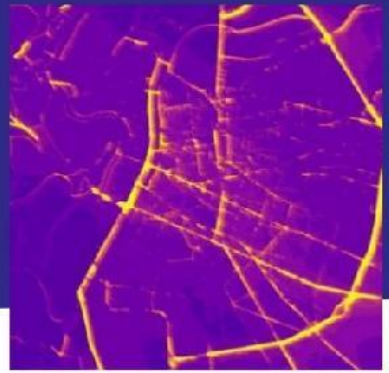





Retour sur le projet SYMEXPO

Pierre Aumond, *Arnaud Can*

pierre.aumond@univ-eiffel.fr;

arnaud.can@univ-eiffel.fr

JTAV, 24/06/2026

FICHE D'IDENTITÉ DU PROJET

Symexpo

Approche systémique pour évaluer l'impact de la mobilité urbaine sur l'exposition aux pollutions environnementales

Équipe : acoucité, Atmo Auvergne-Rhône-Alpes, ENTPE, INSA Lyon, iPLesp, Université Gustave Eiffel

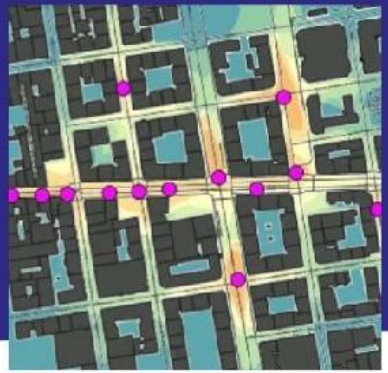
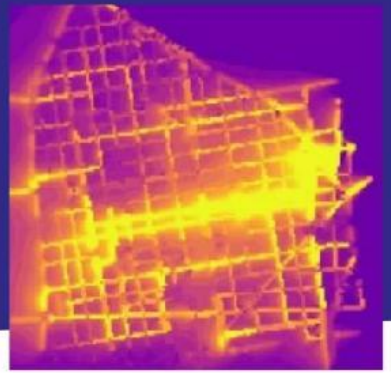
Financement : anr agence nationale de la recherche

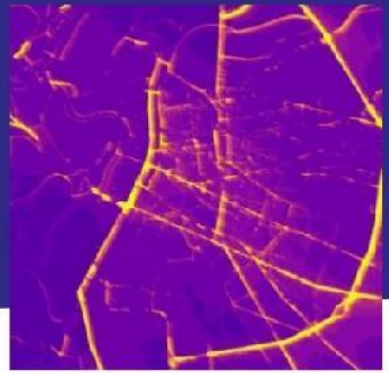
PRC - CE22 - Sociétés urbaines, territoires, constructions et mobilité
Budget total : 1398€ ; aide ANR accordée : 601878€

Coordination : UMRAE (coord. Arnaud Can)

Dates : *01/11/2021 – 28/02/2026*

Pôle de compétitivité : CARA



Simuler les habitants et leurs mobilités pour évaluer l'exposition au bruit

Pierre Aumond, *Arnaud Can*
pierre.aumond@univ-eiffel.fr;
arnaud.can@univ-eiffel.fr

JTAV, 24/06/2026

CONTEXTE SOCIÉTAL

- Mobilité urbaine vs. environnement et santé

- Interactions entre les politiques de mobilité et la répartition des expositions

Luc Schuiten – Les cités végétales

CONTEXTE SOCIÉTAL

- Mobilité urbaine vs. environnement et santé

- Interactions entre les politiques de mobilité et la répartition des expositions

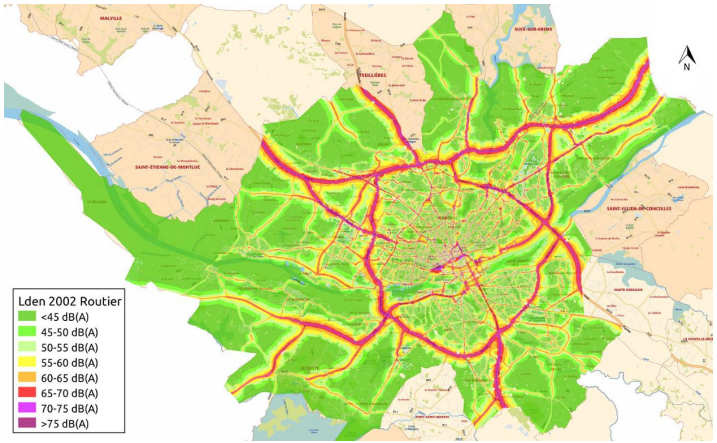
Luc Schuiten – Les cités végétales

Outils d'aide à la décision nécessaires pour :

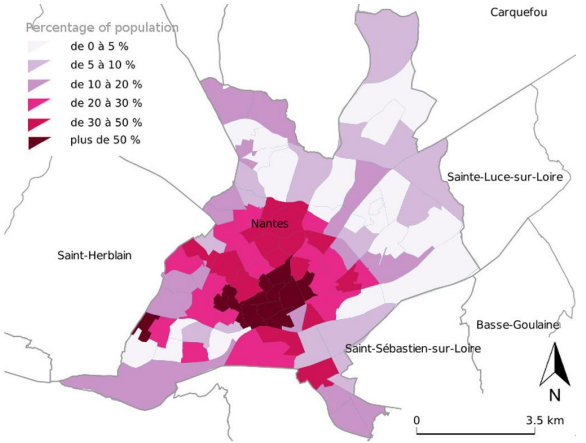
- Évaluer les solutions de mobilité
- Intégrer les nuisances sonores et la pollution atmosphérique
- Prendre en compte la justice environnementale

CONTEXTE SCIENTIFIQUE

- Approches standard pour l'évaluation des impacts



Carte stratégique de bruit
(réalisée avec NoiseModelling)



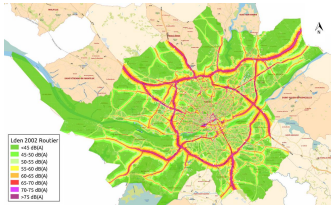
Pourcentage de la population exposée à des niveaux de bruit nocifs

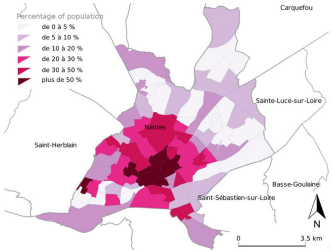
https://noise-planet.org/noisemodelling.html

CONTEXTE SCIENTIFIQUE

- Approches standard pour l’évaluation des impacts

Limites:

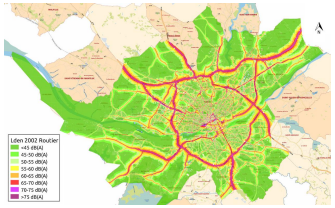


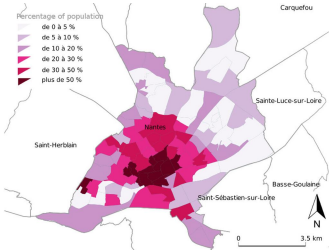


Ma et L. (2020). “Assessing personal noise exposure and its relationship with mental health in Beijing based on individuals’ space-time behavior”

CONTEXTE SCIENTIFIQUE

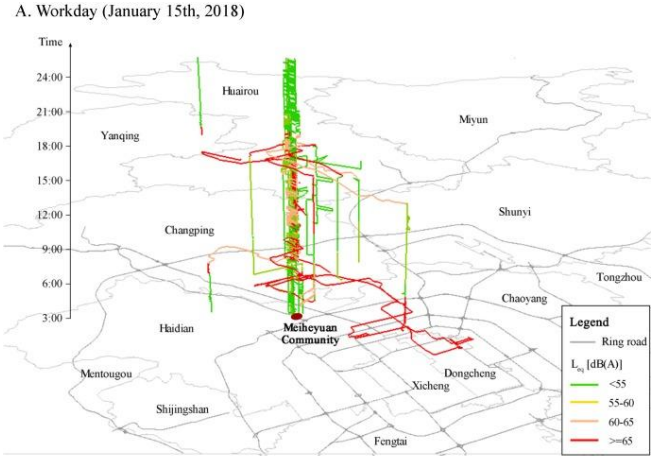
- Approches standard pour l’évaluation des impacts





Limites:

- Négligent la mobilité des agents



Visualisation 3D géolocalisée de l’exposition individuelle au bruit intégrant les trajectoires spatio-temporelles des individus (Ma et al., 2020)

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CONTEXTE SCIENTIFIQUE

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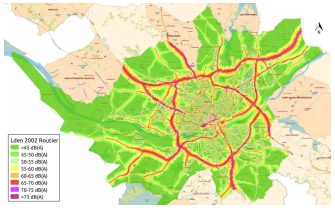
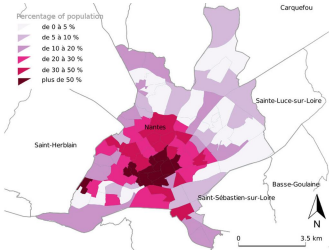
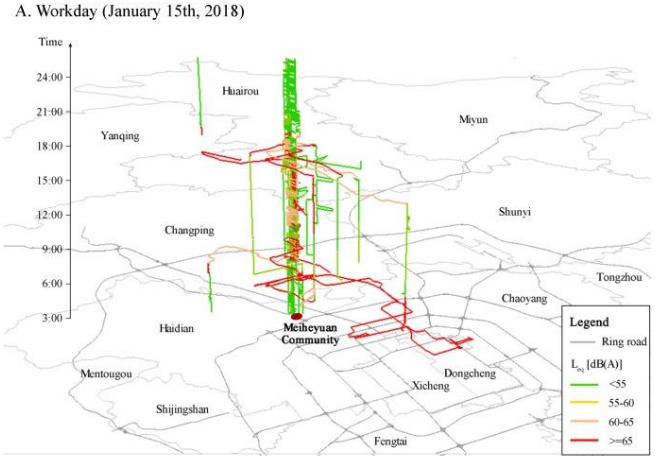




Limites:

- Négligent la mobilité des agents
- Négligent les variations temporelles des polluants



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OBJECTIFS SCIENTIFIQUES & TECHNIQUES

Symexpo

Approche systémique pour évaluer l'impact de la mobilité urbaine sur l'exposition aux pollutions environnementales

Analyse de données : mobilité et expositions

Modèles open-source:

- Bruit & pollution atmosphérique
- Deux échelles spatiales d'intérêt : quartier & aire métropolitaine

Campagnes de mesures

Cadre d'évaluation multicritères

- Mobilité des agents / Indicateurs dédiés / Justice environnementale
- Etudes de cas

acoucité ENTPE Atmo votre parten'air AUVERGNE-RHÔNE-ALPES iPLesp INSA INSTITUT NATIONAL DES SCIENCES APPLIQUÉES LYON Université Gustave Eiffel

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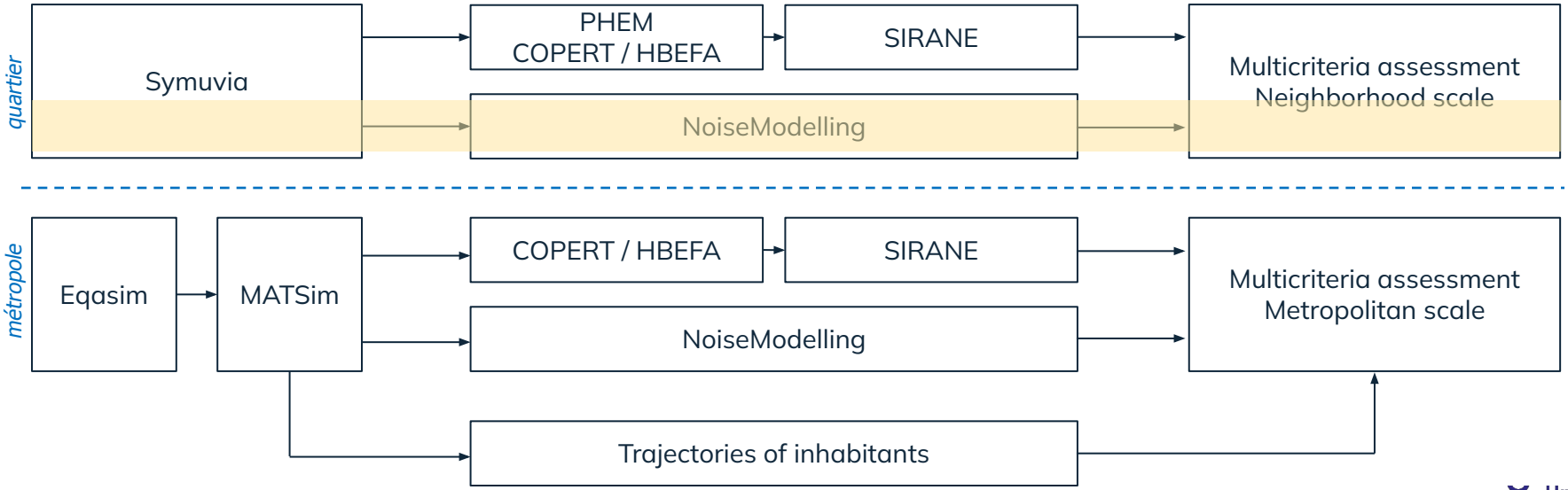
RÉSULTATS

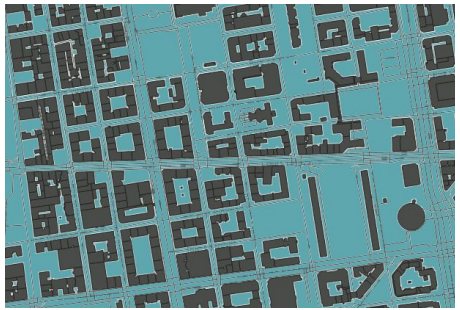
4 chaînes de modélisation open-source :



RÉSULTATS

4 chaines de modélisation open-source :

quartier



métropole

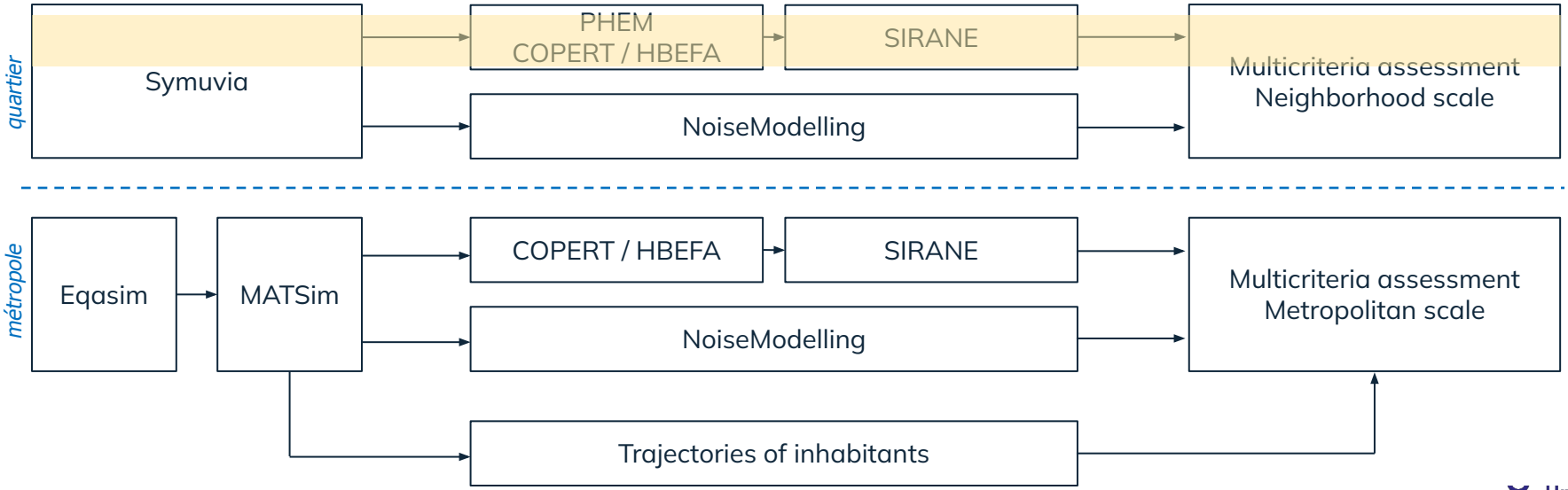
bruit

Polluants atmosphériques

Université Gustave Eiffel

RÉSULTATS

4 chaînes de modélisation open-source :



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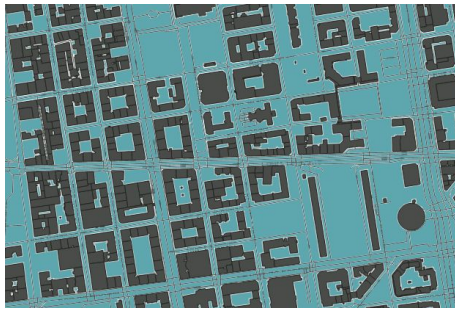

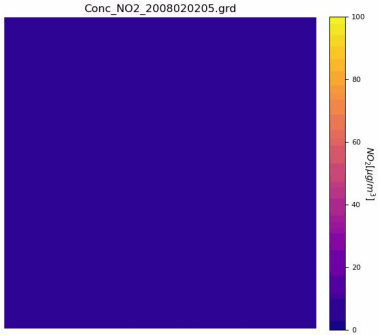

métropole

bruit

Polluants atmosphériques

Université Gustave Eiffel

RÉSULTATS

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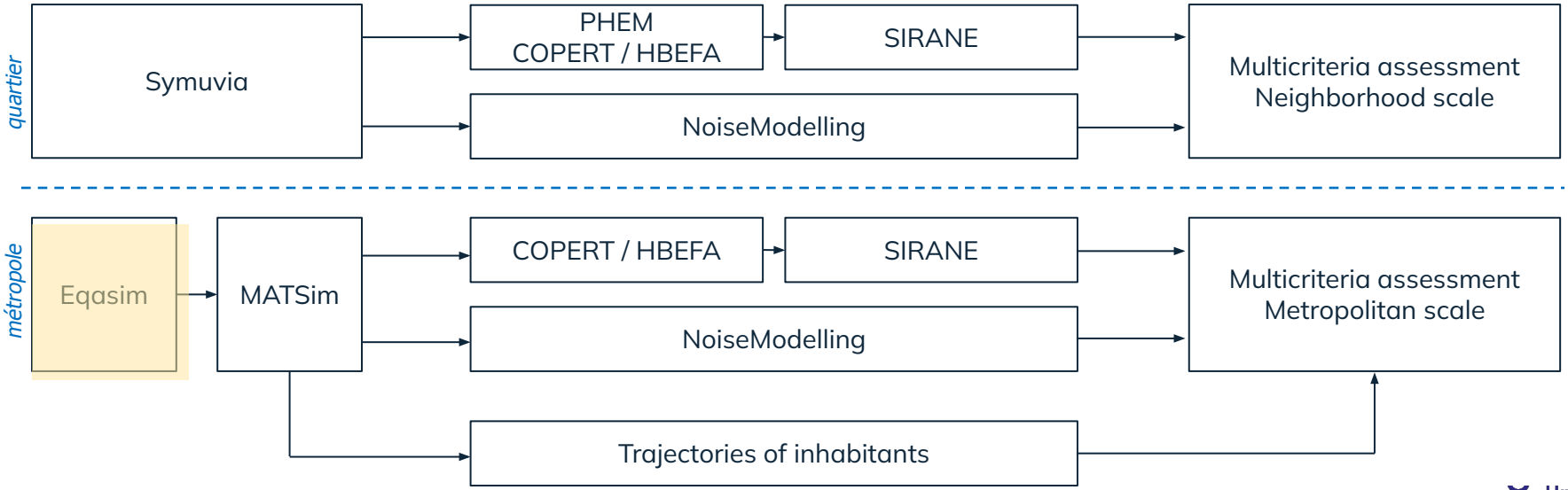
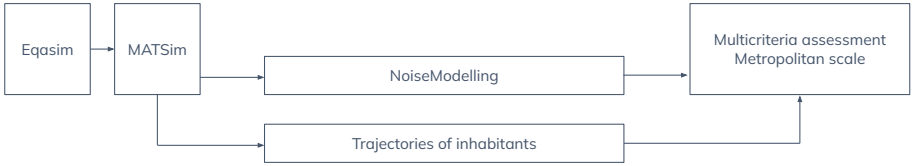


Methods

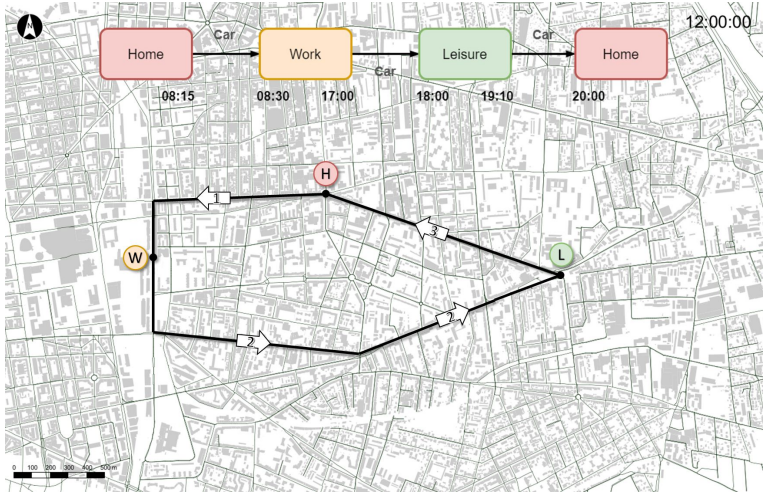


Agent-based transport models:

Individual-traveler who attempts to perform his daily activities

Synthetic population

Activity plan

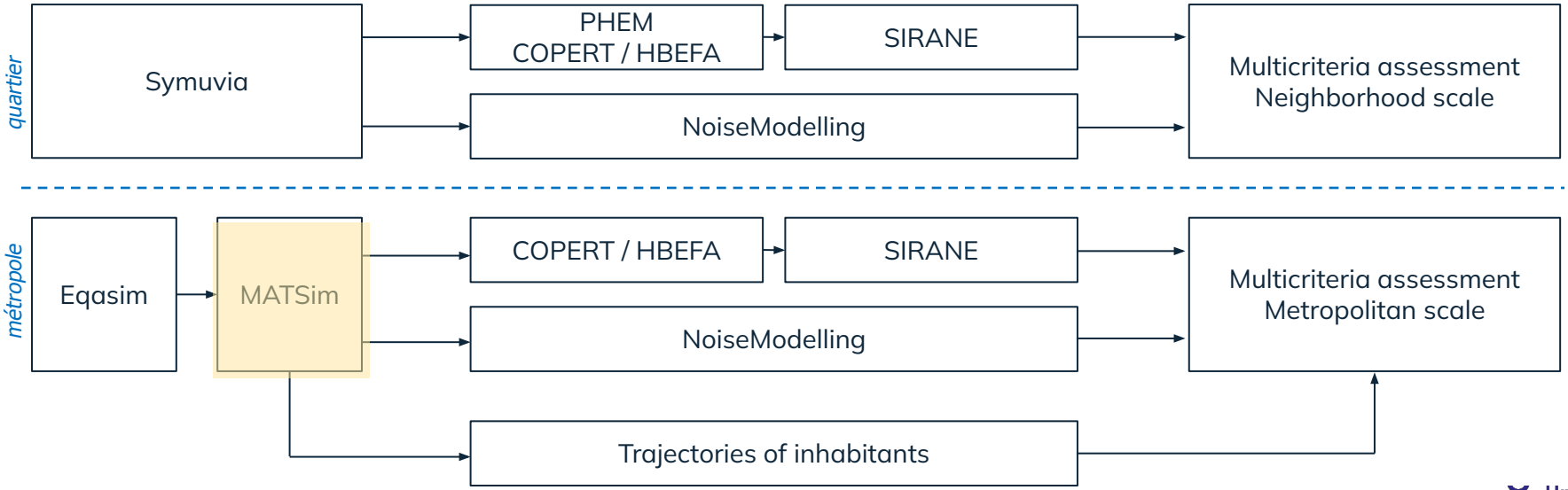


eqasim

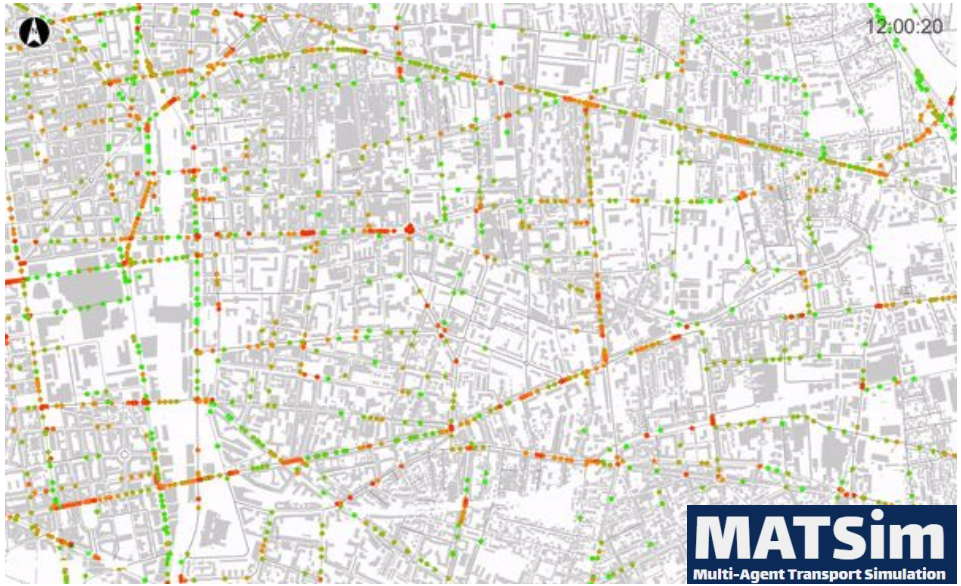
eqasim.org

RÉSULTATS

4 chaînes de modélisation open-source :



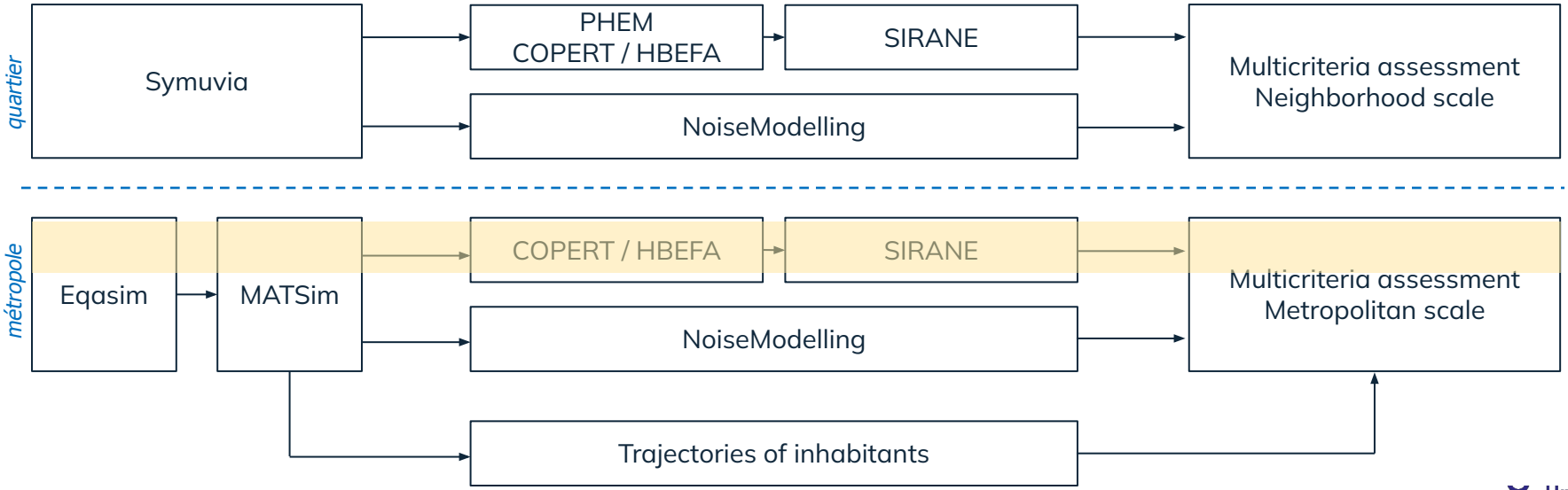
Agent-based transport simulation



Modes: car, public transport, bike, walk
Activities: home, work, education, shop, leisure, others.

RÉSULTATS

4 chaînes de modélisation open-source :



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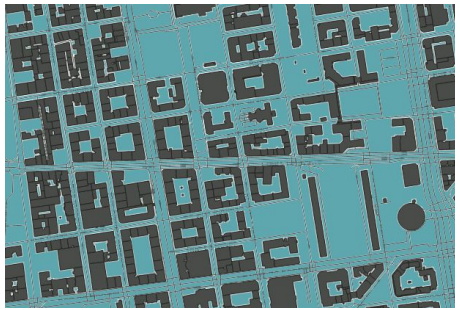
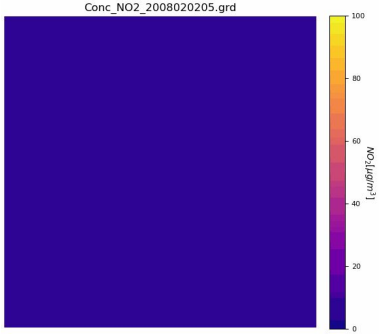
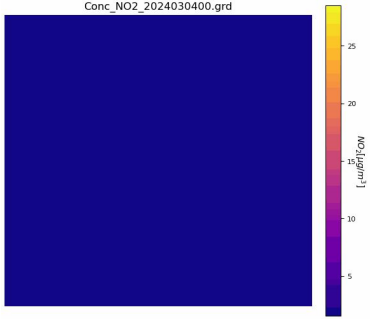




métropole



bruit

Polluants atmosphériques

Université Gustave Eiffel

RÉSULTATS

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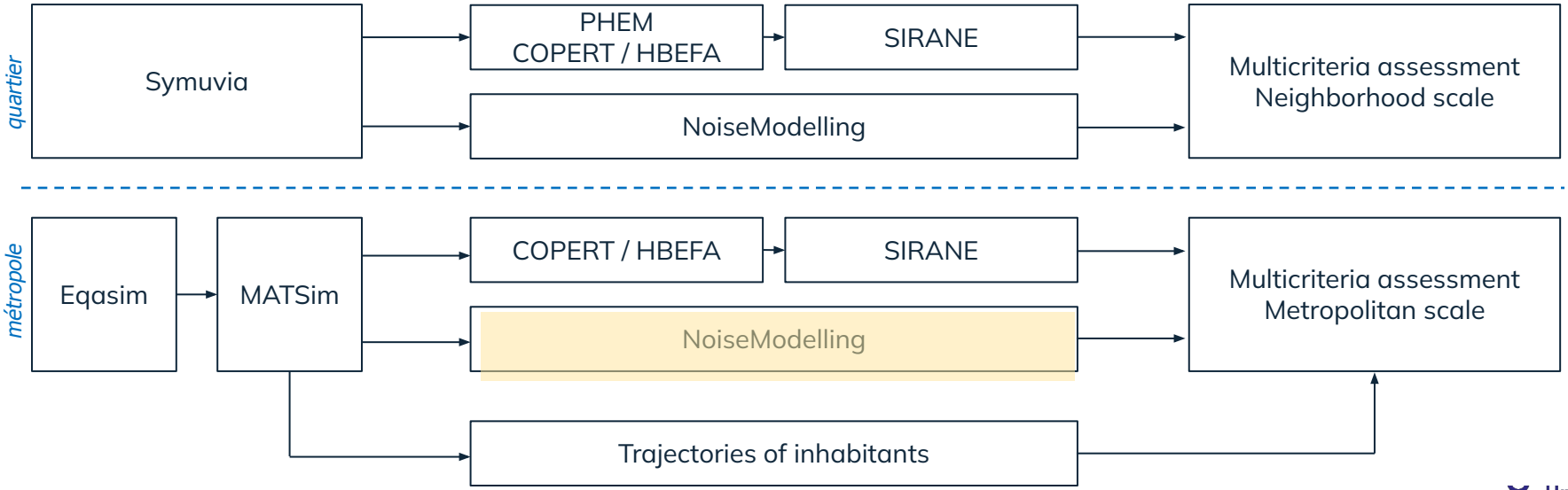
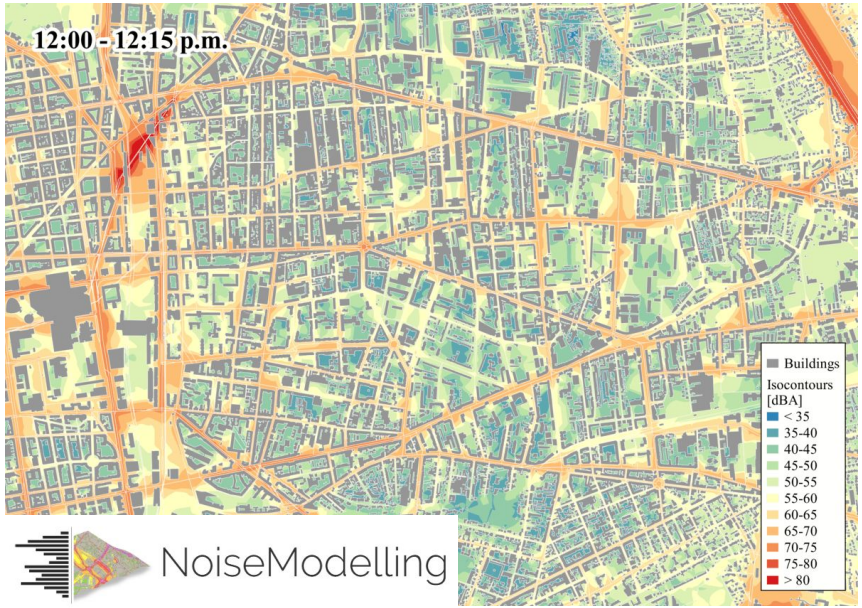


Agent-based transport simulation

Modes: car, public transport, bike, walk
Activities: home, work, education, shop, leisure, others.

Dynamic noise maps

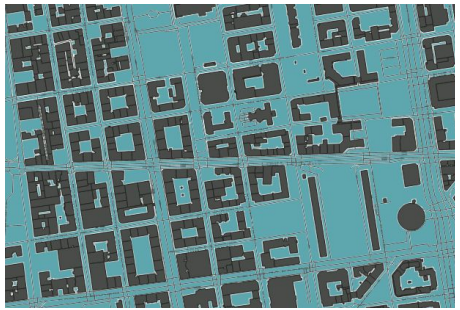


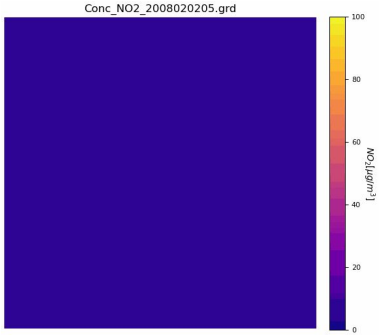
Road traffic noise: LAeq,15-min

RÉSULTATS

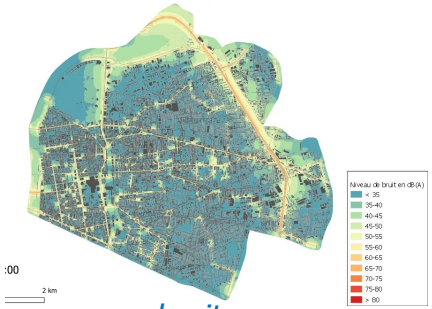
4 chaines de modélisation open-source :

quartier





métropole



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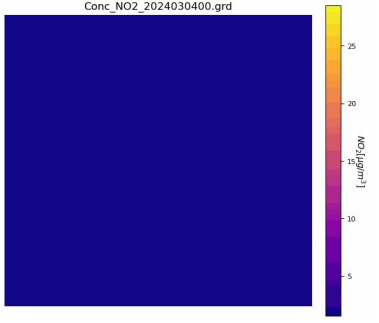


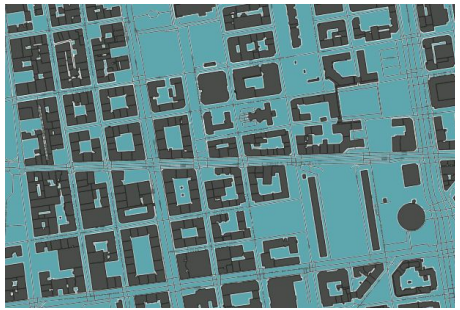
Polluants atmosphériques

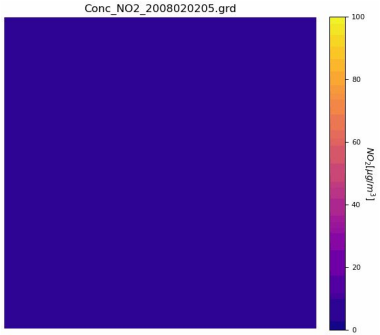
Université Gustave Eiffel

RÉSULTATS

4 chaines de modélisation open-source :

quartier





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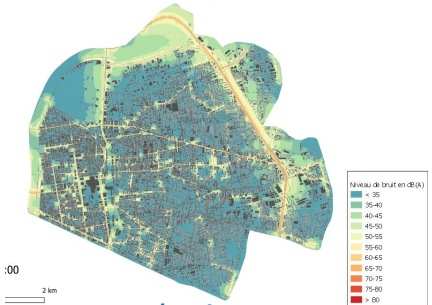

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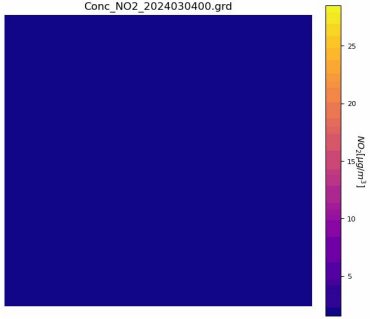
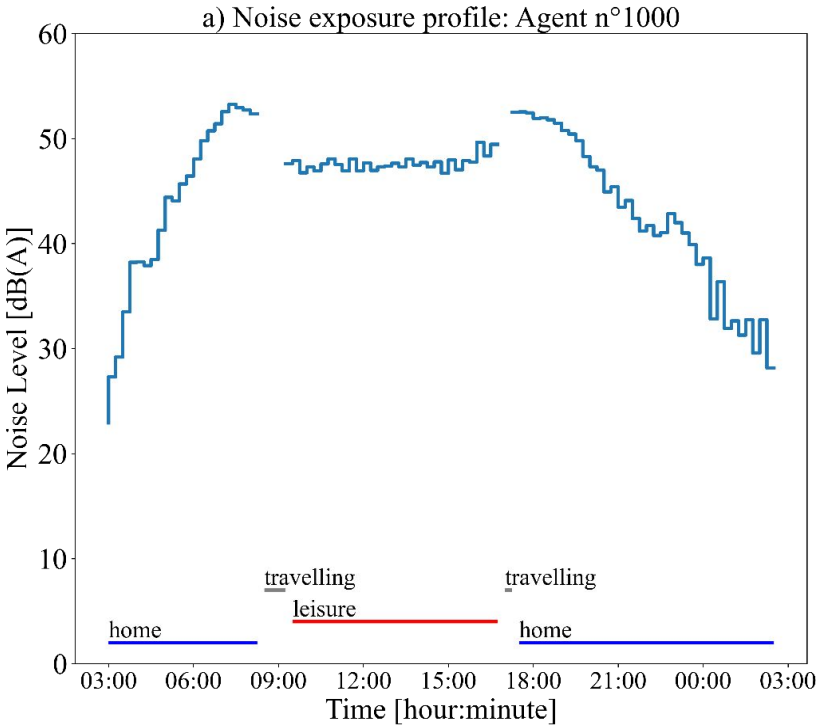


Polluants atmosphériques

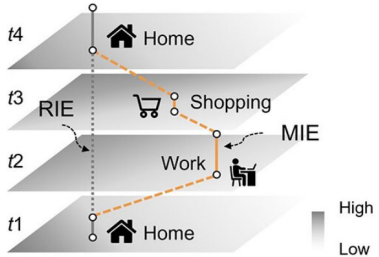
Université Gustave Eiffel

Profil d'exposition au bruit routier d'un agent simulé



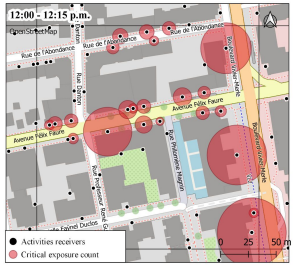
Leonardo
Luquezi

Everyday mobility into exposure assessment



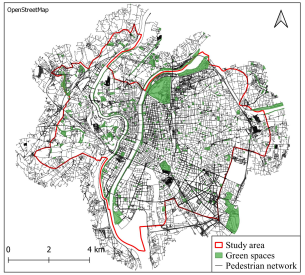
Negative effects on health

Critical noise exposure areas

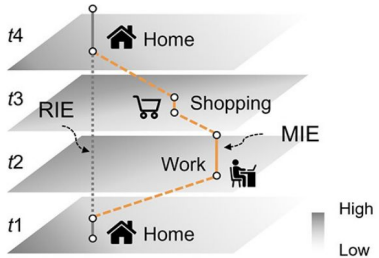


Positive effects on health

Population access to quiet areas



Everyday mobility into exposure assessment



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Positive effects on health

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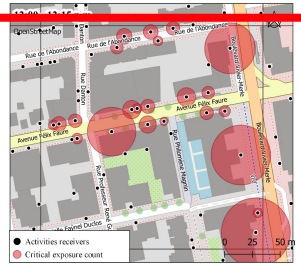

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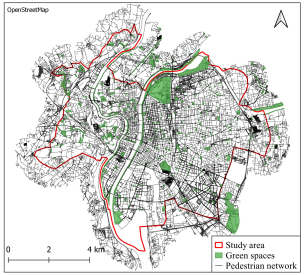


Assessing critical exposure areas

a) Definition of critical exposure:

Selected indicator:

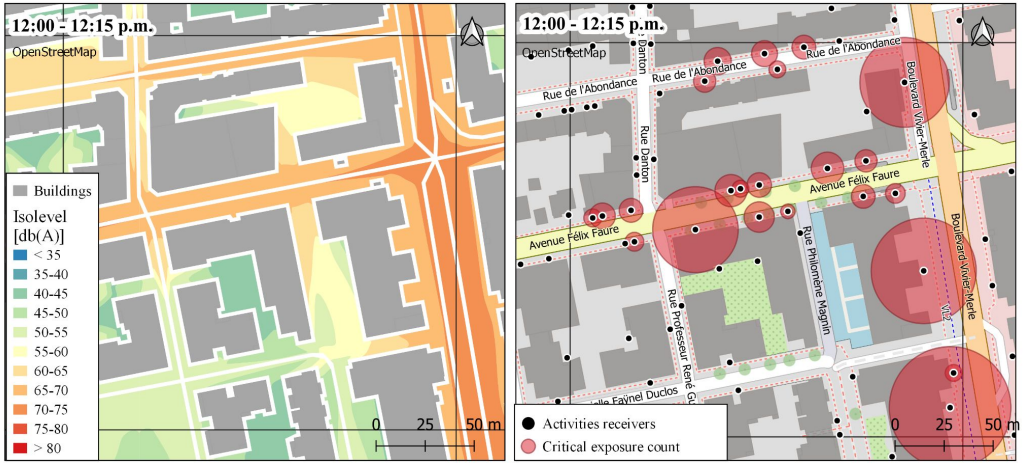
LAeq,15 min >= 65 dB(A)

b) Definition of critical areas:

Selected indicator:

Occurrence of critical exposure in a 15-minute interval.

Noise map and number of agents in facilities exposed to critical noise levels (LAeq,15min >= 65) between 12:00 and 12:15



L.G. Luquezi al. 2025

Kloth et al. 2009, Hankach et al. 2024

Lyon Metropolitan Area application

Model area:

Lyon Metropolitan Area.

Population:

1.4 million inhabitants.

Synthetic population:

100% sampling rate.

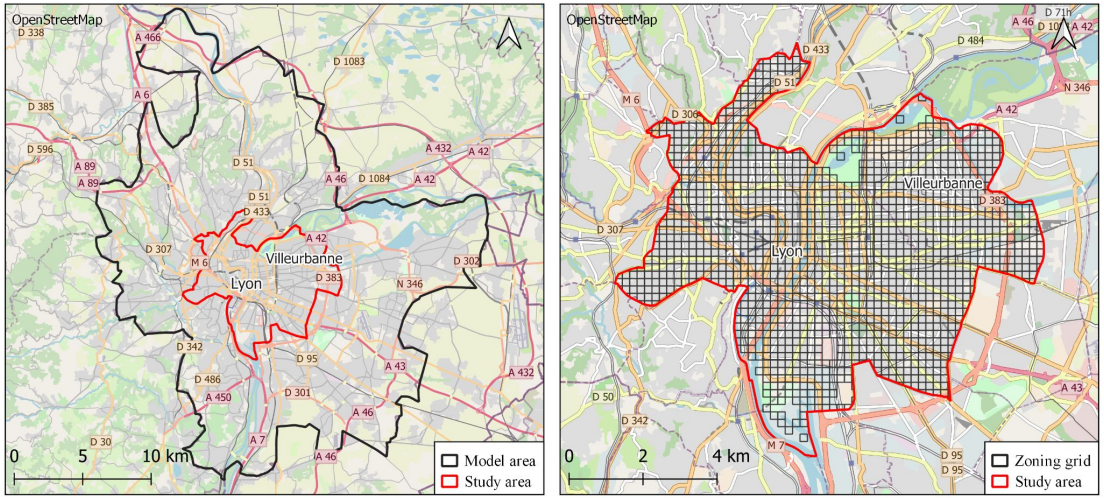
Study area:

Lyon and Villeurbanne.

Period:

06h00 to 22h00

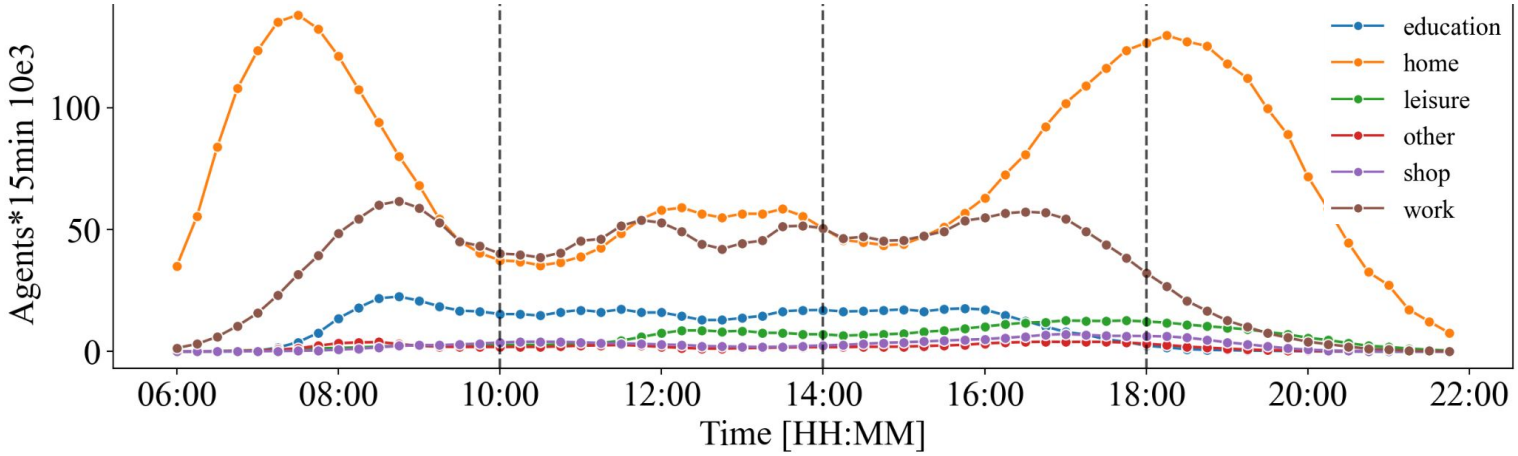
Model area, study area, and zoning grid of the agent-based framework of Lyon Metropolitan Area.



Homogeneous-grid: cell 200x200 meters

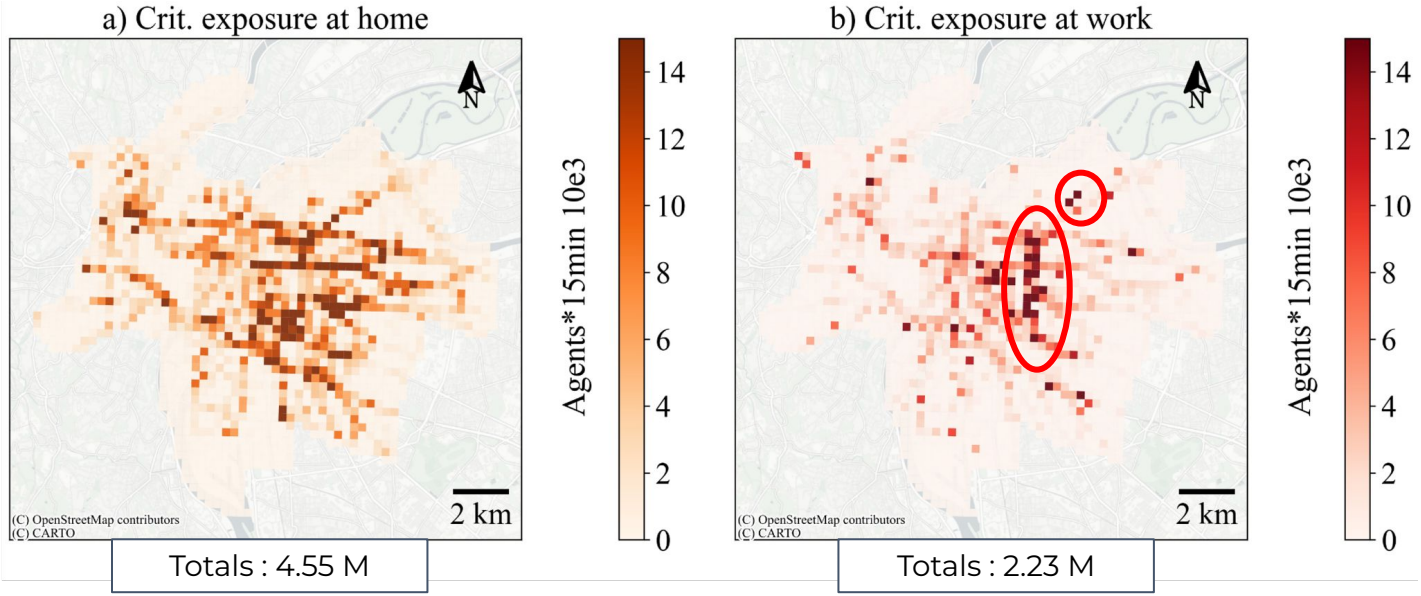
Temporal distribution of critical exposure occurrences by activity

Number of agents critically exposed to road noise (LAeq,15min >= 65dB(A)) by activity in the study area



Spatial distribution of critical exposures

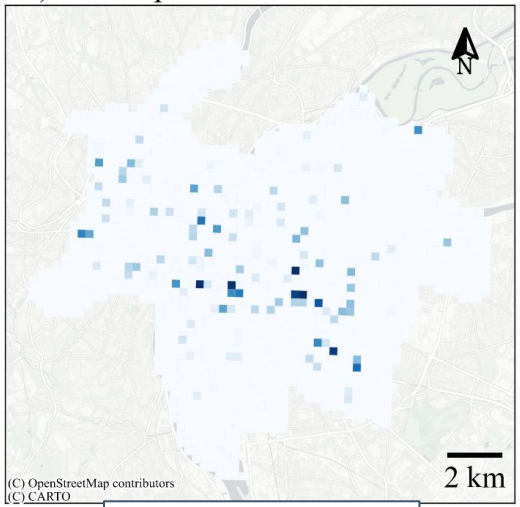
Critical exposure areas between 06:00 and 22:00 segmented by activities

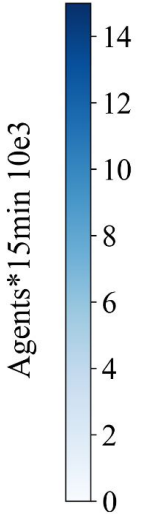


Critical exposures of young agents

Critical exposure areas for agents with an age range of 0–15 years between 06:00 and 22:00 segmented by activity

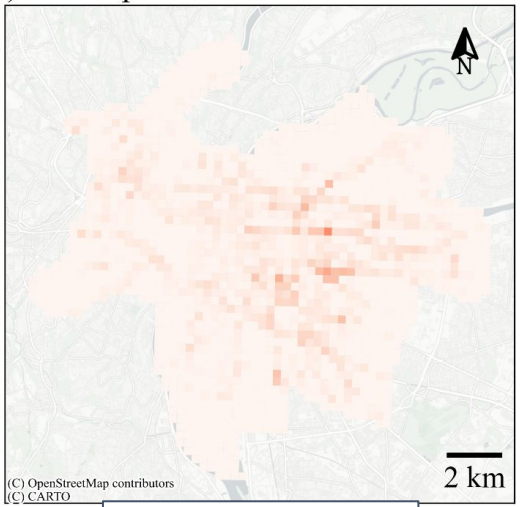
a) Crit. exposure: 00-15 at education

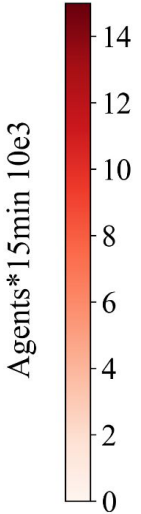




Totals : 0.52 M

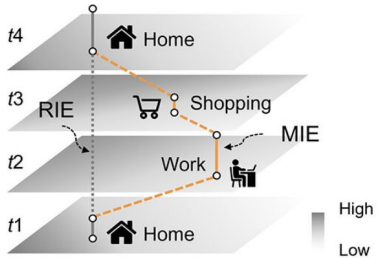
b) Crit. exposure: 00-15 at other activities





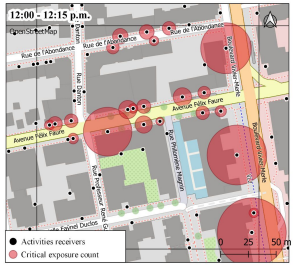
Totals : 0.61 M

Everyday mobility into exposure assessment



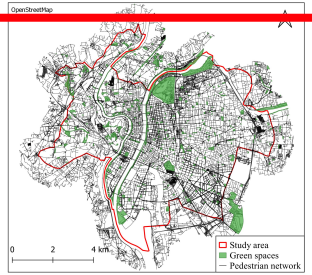
Negative effects on health

Critical noise exposure areas



Positive effects on health

Population access to quiet areas



Metrics for quiet areas accessibility

a) Eligible spaces : green spaces

b) Definition of quiet area:

Selected indicator :

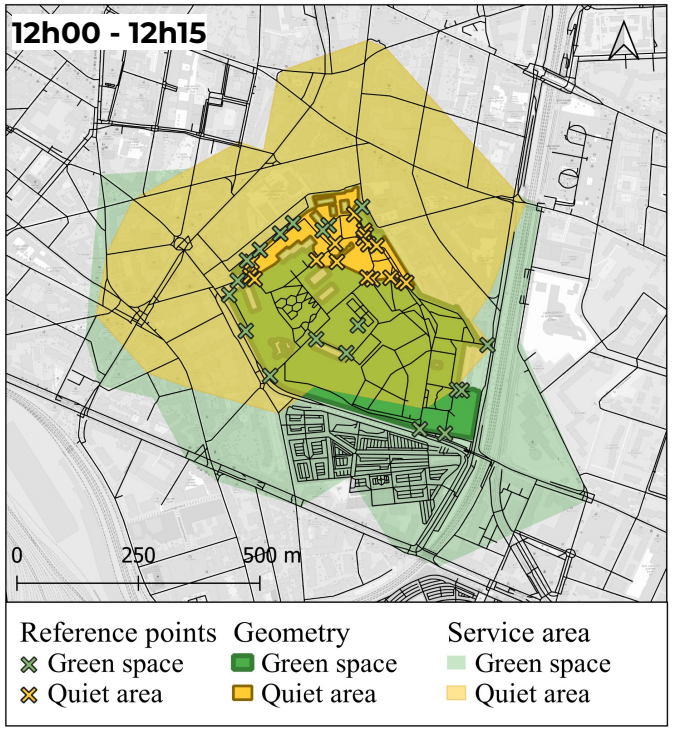
- LAeq,15-min <= 50 dB(A)
- Minimum size of 100 m^2

c) Definition of accessibility:

Selected indicator:

- 'Within 5 minutes walk'

Service areas of green space and its quiet areas for a 5-minute walk at 4.5 km/h



Python OSMnx

Peris 2020, Martinuzzi et al. 2020 L.G. Luquezi al. 2025

Lyon Metropolitan Area application

Open and green spaces and pedestrian network of the study area of Lyon

Model area:

Lyon Metropolitan Area.

Population:

1.4 million inhabitants.

Synthetic population:

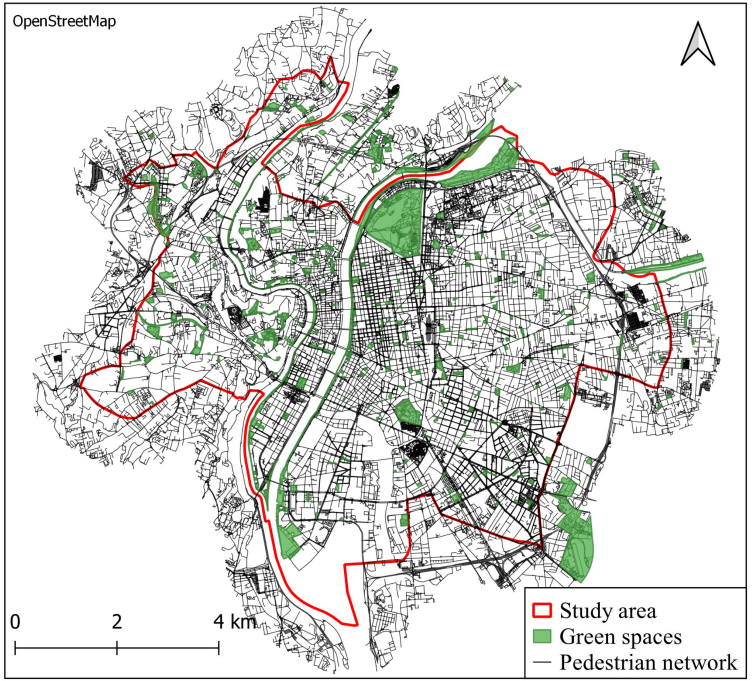
100% sampling rate.

Study area:

Lyon and Villeurbanne.

Period:

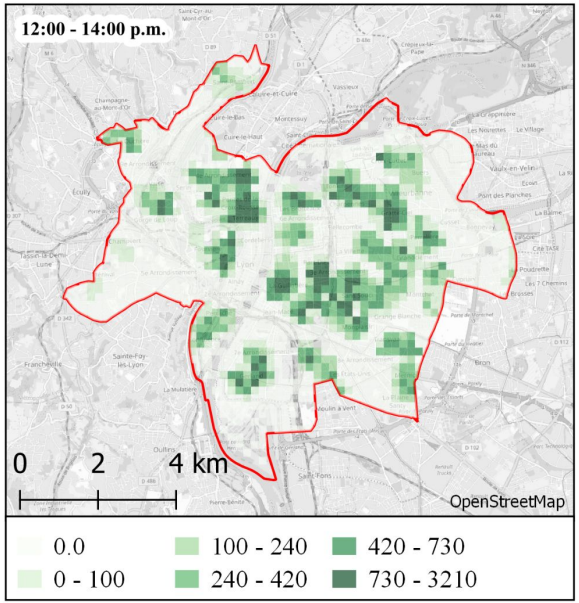
12h00 to 14h00 (lunch break)



Spatialization of accessibility

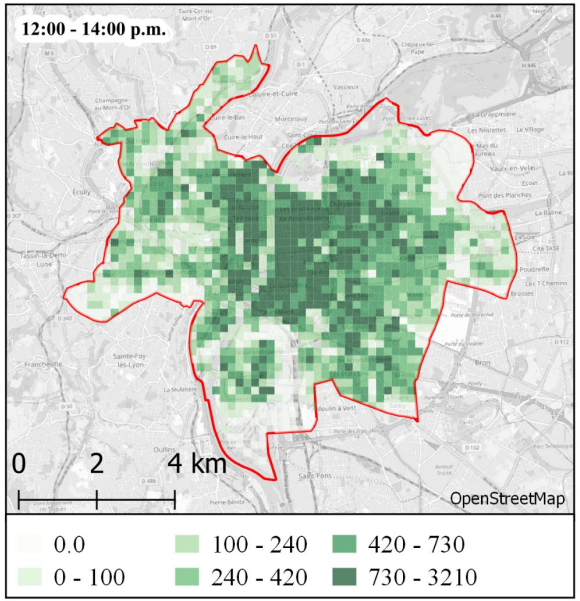
Temporal average of the no. of agents with access to a quiet area or to a green space between 12:00 - 14:00

a) Number of agents with access to a quiet area



30 % of moving agents with access

b) Number of agents with access to a green space



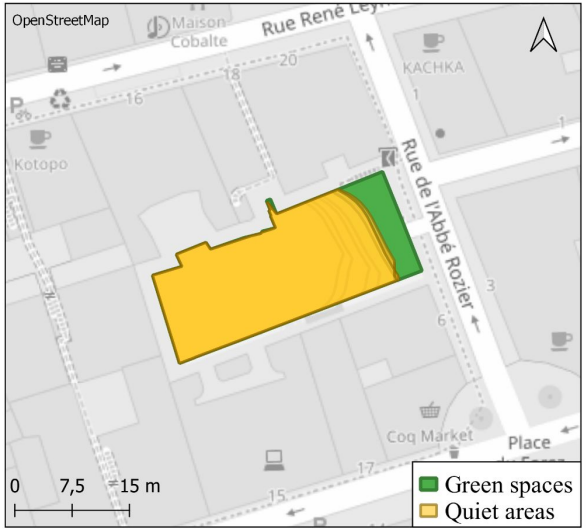
80 % of moving agents with access

Quiet areas with high accessibility

Green spaces ordered by temporal average of the number of agents with access to their current quiet areas between 12:00 and 14:00.

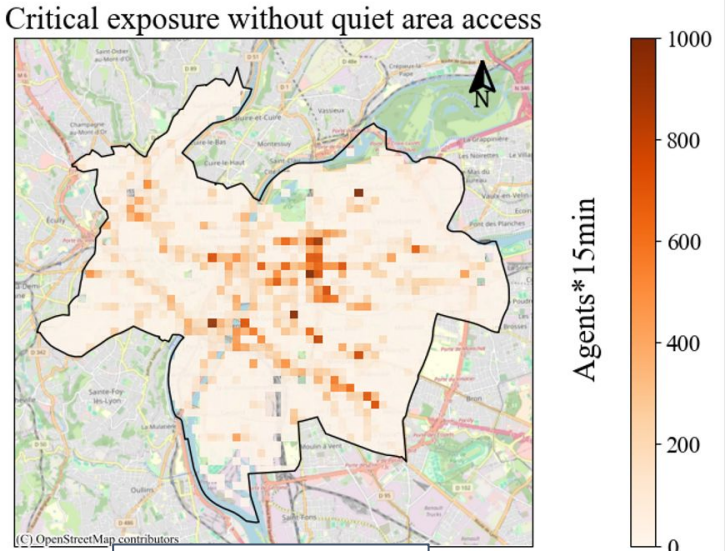
Name	Category	$\overline{n}$ [No.]	$\overline{s}$ [m²]
Jardin Dalle Rozier	Garden	9,177	354
Jardin Saint Michel	Garden	7,941	1,637
Jardin Clos Carret	Garden	7,786	2,920
Jardin de la Grande Côte	Garden	7,145	3,870
Jardin d'Essling	Garden	6,965	320

a) Jardin Dalle Rosier (Garden)



Cross-analysis: environmental impact and opportunities.

Temporal average between 12:00 and 14:00 of the number of agents critically exposed without access to at least one quiet area



Average: 100,000 M

L.G. Luquezi al. 2025

PERSPECTIVES

#1 Améliorer l'estimation des expositions :

- **Prendre en compte les micro-environnements**

PERSPECTIVES

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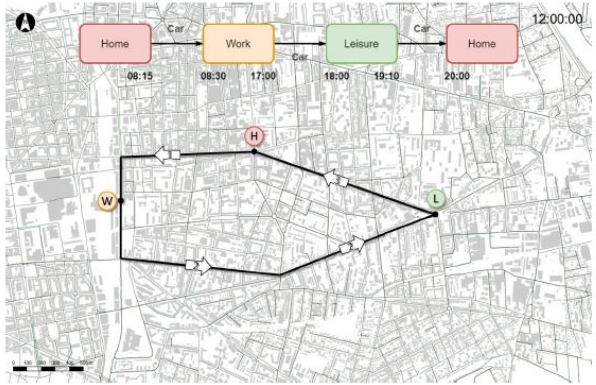
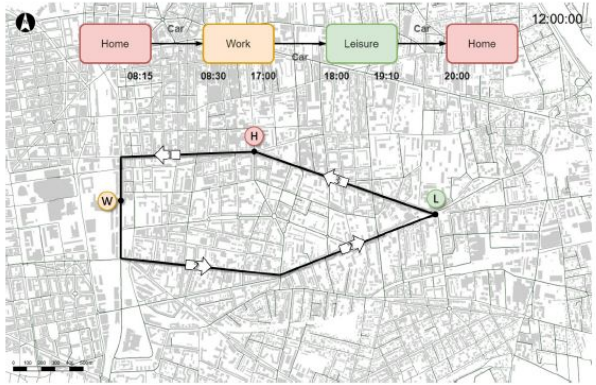
- **Prendre en compte les micro-environnements**



PERSPECTIVES

#1 Améliorer l'estimation des expositions :

- **Prendre en compte les micro-environnements**

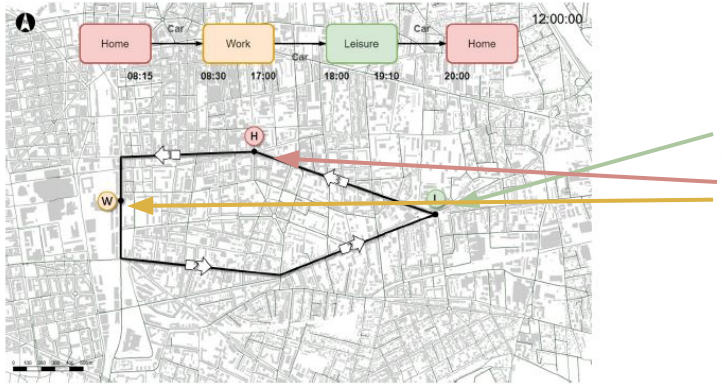


	$L_{Aeq,activity}$ Median (SD)
Food and commerce services	69 (12)
Leisure, cultural, and social activities	70 (13)
Residence	58 (9)
Work	64 (8)
Car and motorcycle	70 (12)
Walking	70 (8)
Outdoor public transport	71 (9)
Underground public transport	74 (8)
Bicycle, scooter, other	72 (11)

PERSPECTIVES

#1 Améliorer l'estimation des expositions :

- **Prendre en compte les micro-environnements**



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PERSPECTIVES

#1 Améliorer l'estimation des expositions :

- Prendre en compte les micro-environnements
- **Mieux inclure l'hétérogénéité du trafic :**

PERSPECTIVES

#1 Améliorer l'estimation des expositions :

- Prendre en compte les micro-environnements
- **Mieux inclure l'hétérogénéité du trafic :**

PERSPECTIVES

#2 Affiner les études d'impact multidimensionnelles :

- **Affiner les indicateurs utilisés**

PERSPECTIVES

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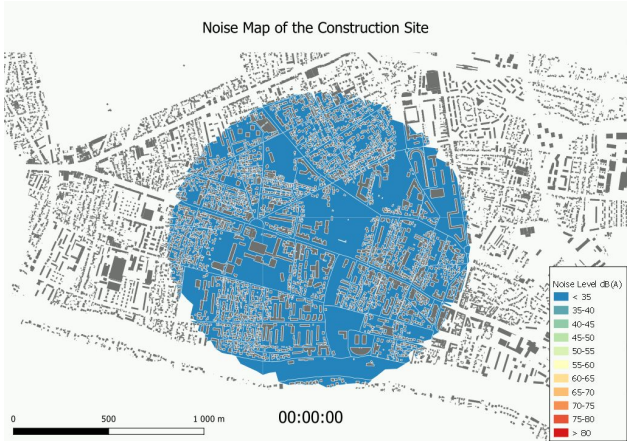
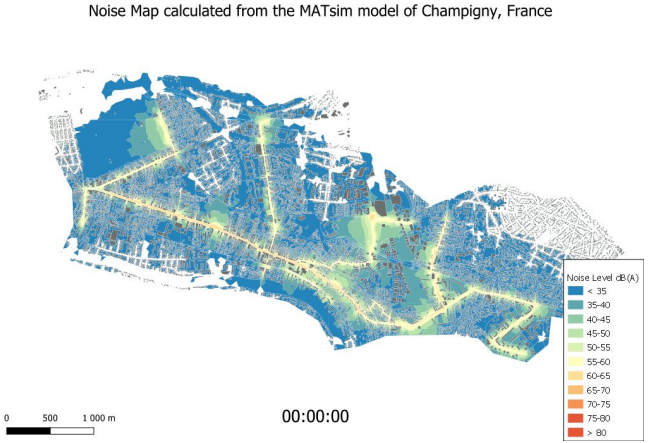
- **Affiner les indicateurs utilisés**





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PERSPECTIVES

#2 Affiner les études d'impact multidimensionnelles :

- **Affiner les indicateurs utilisés**

Nouveaux indicateurs :

- Nombre d'individus exposés, toutes les 15 minutes, à des niveaux de bruit dépassant 65 dB(A) du fait du site de construction, excluant ceux déjà exposés à 65 dB(A) à cause du bruit de trafic

PERSPECTIVES

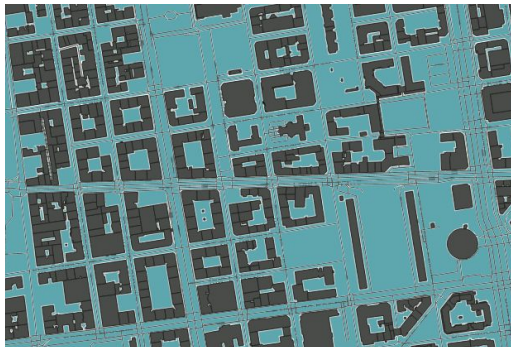
#2 Affiner les études d'impact multidimensionnelles :

- **Affiner les indicateurs utilisés :**
  - Acoustique : indicateurs décrivant plus finement les environnements sonores
  - Pollution de l'air : Taux d'inhalation

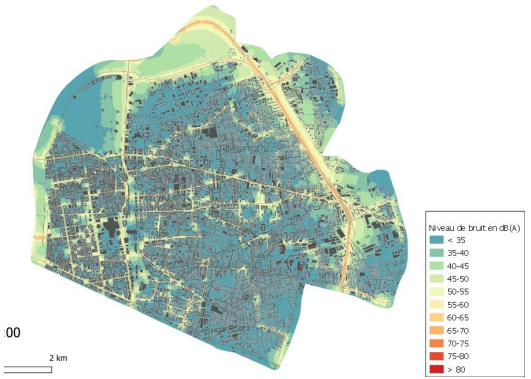
PERSPECTIVES

#2 Affiner les études d'impact multidimensionnelles :

- Affiner les indicateurs utilisés
- **Proposer des représentations hybrides**



vs.



Gao Y., Baclet S., Aumond P., Rumpler R., Can a. Temporal Resolution Dynamic Traffic Noise Modelling via Traffic Flow Stochastic Disaggregation, under review (Transportation Research part D.)

PERSPECTIVES

#2 Affiner les études d'impact multidimensionnelles :

- Affiner les indicateurs utilisés
- Proposer des représentations hybrides
- **Déployer de nouvelles études d'impact :**
  - Questions de justice environnementale
  - Scénarios de logistique urbaine, etc.

Symexpo

Arnaud Can, P. Gastineau, B. Chaix, D. Sengelin, L. Soulhac, P. Muñoz, J. Cozic, P. Aumond, N. Fortin, Galassi-Luquezi, Y. Gao, B. Gauvreau, A. Beziat, M. Koning, V. Le Bescond, P.O. Vandanjon, G. Fancello, C. Bécarie, M. Tirico, P. Charvolin-Volta, S. Carra and B. Vincent*
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GitHub repositories :
https://noise-planet.org/noisemodelling.html;
https://noisemodelling.readthedocs.io/en/latest/Matsim_Tutorial.html

MATSim: https://www.matsim.org/
NoiseModelling: https://noise-planet.org/noisemodelling.html

References :

Fancello G., Can A., Aumond P., Bisat S., Chaix B. (2025). Space-Time Behaviours and Personal Noise Exposure Using Isotemporal Substitution Models in the Grand Paris Area, Journ. Exp. Sc. Environ. Epid.

Galassi Luquezi L., Le Bescond V., Aumond P., Gastineau P., Can A. (2024). Current limitations and opportunities for improvements of agent-based transport models for noise exposure assessment, Journal of Environmental Management, 368, 122129, ISSN 0301-4797.

Galassi Luquezi L., Le Bescond V., Aumond P., Gastineau P., Can A. (2025). Including everyday mobility with agent-based models in the assessment of critical areas of noise exposure, Sustainable Cities and Society, 130, 106551.

Galassi Luquezi L., Le Bescond V., Aumond P., Gastineau P., Can A. (2025b). Assessing accessibility to quiet and green areas at the city scale using an agent-based transport model, Landscape and Urban Planning, 263, 105452.

Gastineau P., Can A., Yameogo F., Galassi-Luquezi L., Hankach P., Vandanjon P.O., Le Bescond V. (2023). Transp. Res. Rec.

Hankach P., Le Bescond V., Gastineau P., Vadanjon P.O., Can A., Aumond P. (2024). Individual-level activity-based modeling and indicators for assessing construction sites noise exposure in urban areas, Sust. Cities Soc 101, 105188.

Nygren J., Le Bescond V., Can A., Aumond P., Gastineau P., Boij S., Rumpler R., O'Reilly C. (2024) Sust. Cities. Soc. 103, 105278.

Tirico M., Le Bescond V., Sengelin D., Gastineau P., Can A. (2025). Multi-scale comparison of modeling chains for traffic-related air pollutant emission assessment, Sustainable Cities and Society, 129, 106354.

Tirico M., Gao Y., Sengelin D., Gastineau P., Aumond P., ... , Can A. Modeling traffic-related air and noise pollution: multi-criteria assessment case study around schools. Accepted to Transportation Research Part D, 2025.


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Michele Tirico
Post-doc researcher


Valentin Le Bescond
Engineer