

Using TIMES on non-energetic purposes

Matthieu Denoux*, Nadia Maïzi

MINES ParisTech, PSL Research University, CMA - Centre de Mathématiques Appliquées,
Sophia-Antipolis, France

* matthieu.denoux@mines-paristech.fr

with ANMA (Agence Nicolas Michelin et Associés), Paris, France

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Context

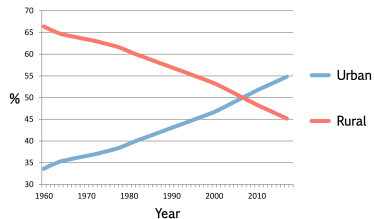


Figure: Urban and rural world population evolution.

source: United Nations, Department of Economic and Social Affairs, Population Division (2018).

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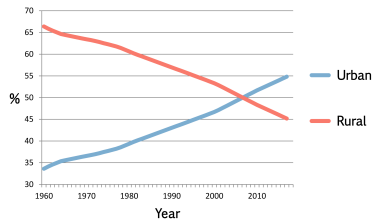


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Figure: Bordeaux Bassins à flots plan.

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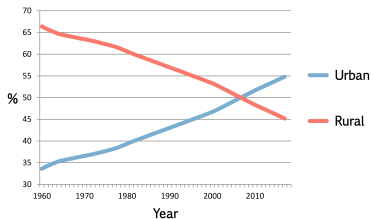


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Figure: RES example.

What can prospective modeling bring to the issue?

Optimization bottom-up models:

- **Long-term** study;
- **Scenario-based** approach (as urban planners);
- **Territory** centered (no general solution);
- **Optimization** flexible tool;
- Integrated assessment with **energy and environmental issues**.

Data gathering

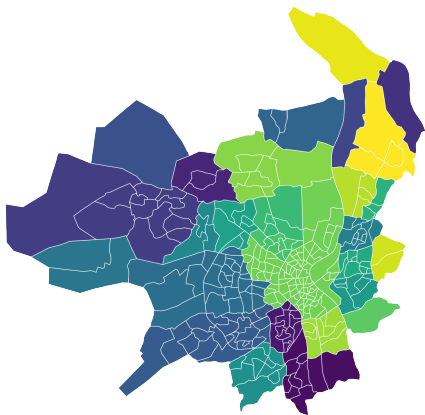


Figure: Bordeaux Metropolitan territory, colored by cities (27 gathered) and separated by IRIS zones.

From Bonhomme, 2013, Adam et al., 2005, Cerezo et al., 2017, Gonçalves et al., 2017 and Delmastro et al., 2016 among others.

Data gathering

bathroom
 inhabitants
 windows
 density
 number
 household
 families
 floor
 height
 length
 heating
 age
 program

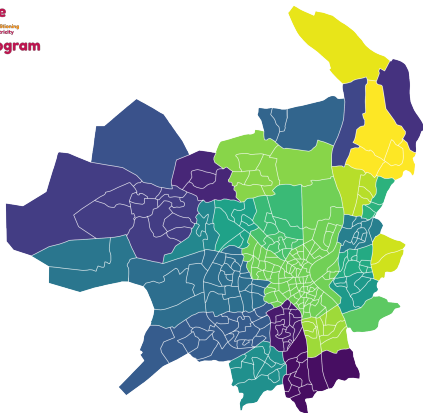
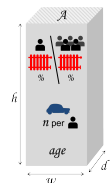


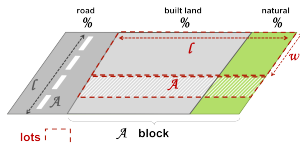
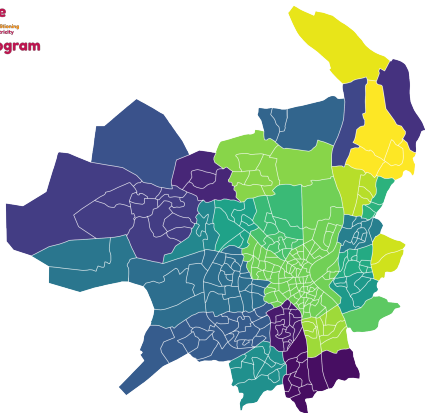
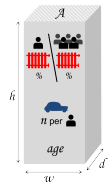
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Data gathering

Word cloud of urban data variables:

- bathroom
- families
- age
- inhabitants
- floor
- height
- number
- length
- heating
- windows
- density
- household
- program
- landfilling
- statistics



Word cloud of urban data variables:

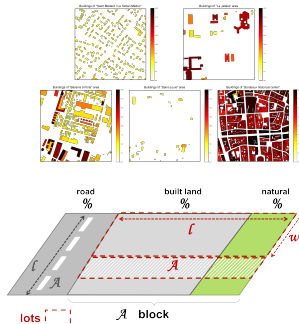
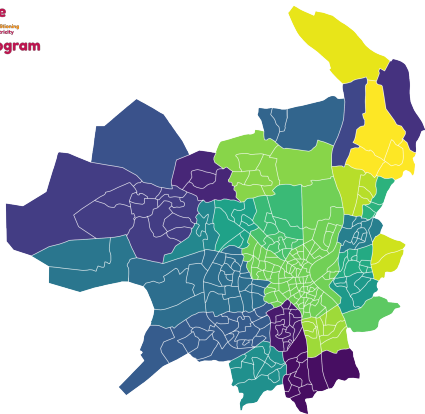
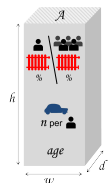
- footprint
- area
- urban
- block
- average
- green
- plots
- occupancy
- coefficient
- equipment
- angle
- ground
- lot
- size
- length
- entropy
- width
- vegetated
- spaces
- empty
- business
- road

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Outputs

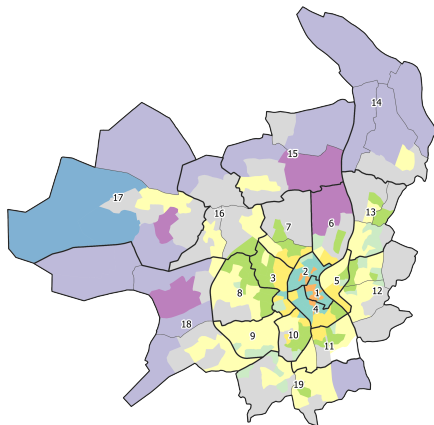


Figure: Map of clusters created on parameters concerning land-use.

Reference land system

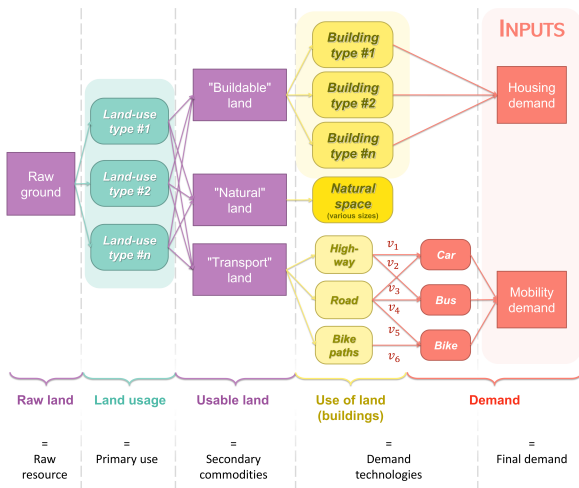


Figure: System used

Zoom on the land-use archetypes

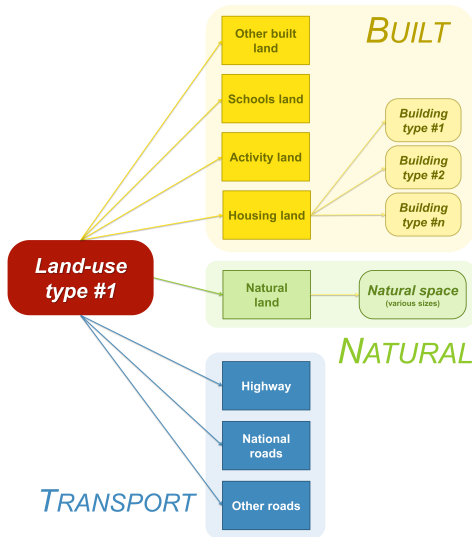


Figure: Around land-use archetypes

Energy related and environmental outputs

Urban constraints:

- *Limited areas* by local plans;
- *Historical center* and other specific areas;
- *Lifespan* of buildings;

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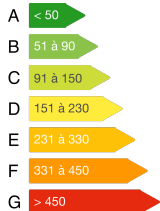
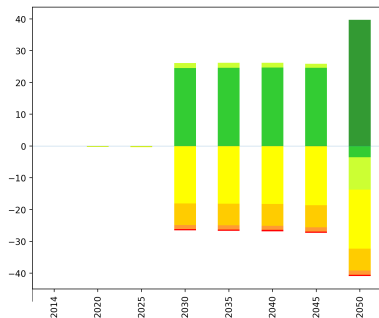
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Environmental constraints:

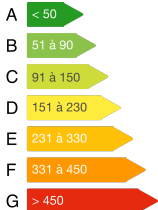
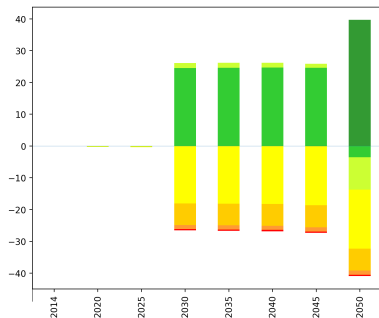
- WHO recommendations on *green areas access* [WHO Regional Office for Europe, 2016];
- *Limited artificialization* of the land;
- *Retrofitting program* to diminish buildings performing weakly;
- ...

Results: DPE constraint

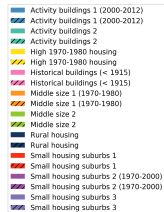
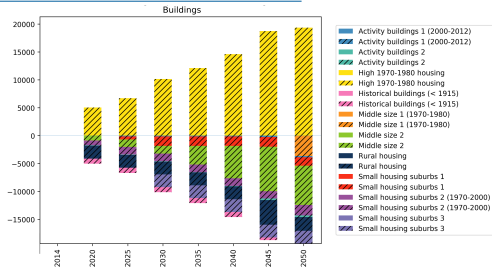


kWhEP/m².an

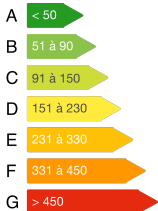
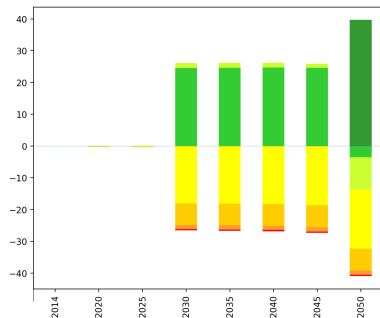
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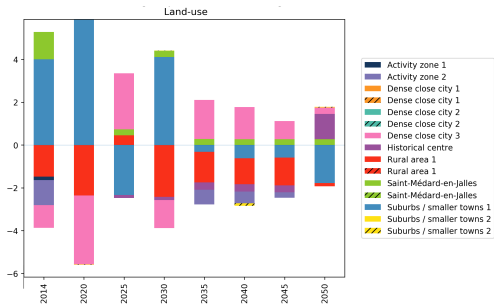
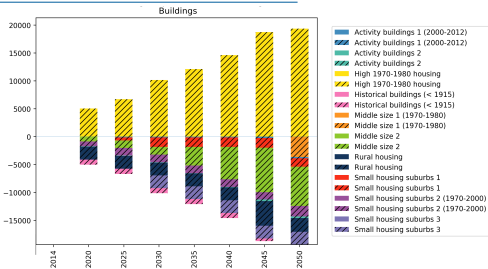
kWhEP/m².an



Results: DPE constraint



kWhEP/m².an



Perspectives

Possible **coupling** with an energy model:

- Changing **final demand** using converting tools based on land-use model outputs [Le Gallic et al., 2016];
- Changing **technologies** themselves proposed to the model;
- **Constraining potential** of each technology (e.g. no collective heating if no collective buildings are built);
- Integrating all technologies in the land-use model.

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Other perspectives on land-use:

- Add urban planners' **future projects**;
- Combine with **jobs and commercial sector** data;
- Link **transportation demand** with urban shapes;

Thank you!

Matthieu Denoux
matthieu.denoux@mines-paristech.fr



A/NMA



References I



Adam, Claire and Muriel Moulinié (June 5, 2005). "Appréhender la densité 2 : Les indicateurs de densité". In: *Note rapide sur l'occupation du sol* 383, p. 4. URL: <https://www.iau-idf.fr/savoir-faire/nos-travaux/edition/apprehender-la-densite-2.html> (visited on 10/12/2018) (cit. on pp. 6–9).



Bonhomme, Marion (Dec. 11, 2013). "Contribution à la génération de bases de données multi-scalaires et évolutives pour une approche pluridisciplinaire de l'énergétique urbaine". Thèse de doctorat. Université de Toulouse. 557 pp. URL: http://lra.toulouse.archi.fr/lra/productions/theses-et-hdr-soutenues/theses-soutenues/Marion_Bonhomme/memoire_v10 (visited on 10/11/2017) (cit. on pp. 6–9).



Cerezo, Carlos, Julia Sokol, Saud AlKhaled, Christoph Reinhart, Adil Al-Mumin, and Ali Hajjah (Nov. 1, 2017). "Comparison of Four Building Archetype Characterization Methods in Urban Building Energy Modeling (UBEM): A Residential Case Study in Kuwait City". In: *Energy and Buildings* 154 (Supplement C), pp. 321–334. ISSN: 0378-7788. DOI: 10.1016/j.enbuild.2017.08.029. URL: <http://www.sciencedirect.com/science/article/pii/S0378778817314743> (visited on 10/12/2017) (cit. on pp. 6–9).



Delmastro, Chiara, Guglielmina Mutani, and Laura Schranz (Sept. 2016). "The Evaluation of Buildings Energy Consumption and the Optimization of District Heating Networks: A GIS-Based Model". In: *International Journal of Energy and Environmental Engineering* 7.3, pp. 343–351. ISSN: 2008-9163, 2251-6832. DOI: 10.1007/s40095-015-0161-5. URL: <http://link.springer.com/10.1007/s40095-015-0161-5> (visited on 06/18/2018) (cit. on pp. 6–9).



Gonçalves, Jorge, Marta Castilho Gomes, Sofia Ezequiel, Francisco Moreira, and Isabel Loupa-Ramos (Apr. 1, 2017). "Differentiating Peri-Urban Areas: A Transdisciplinary Approach towards a Typology". In: *Land Use Policy* 63, pp. 331–341. ISSN: 0264-8377. DOI: 10.1016/j.landusepol.2017.01.041. URL: <http://www.sciencedirect.com/science/article/pii/S0264837717300960> (visited on 01/31/2018) (cit. on pp. 6–9).



Le Gallic, Thomas, Edi Assoumou, and Nadia Maïzi (July 2016). "Investigating Long-Term Lifestyles Changes in France: A Statistical and Modelling Approach". In: *22nd International Sustainable Development Research Society Conference (ISDRS 2016)*. Lisbon, Portugal: The International Sustainable Development Research Society (ISDRS). URL: <https://hal-mines-paristech.archives-ouvertes.fr/hal-01355927> (visited on 03/13/2018) (cit. on pp. 18, 19).



References II



WHO Regional Office for Europe (2016). *Urban Green Spaces and Health : A Review of Evidence*. Copenhagen: WHO. URL: http://www.euro.who.int/__data/assets/pdf_file/0005/321971/Urban-green-spaces-and-health-review-evidence.pdf (visited on 02/20/2019) (cit. on pp. 13, 14).