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Environment Assessment of people's daily mobility in an urban area: coupling a Land-Use and Transport Interaction model with Life Cycle Assessment

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1. Introduction

Regarding the complexity of the urban system, the environmental assessment of its associated people's daily mobility needs to consider social, spatial and technological dimensions. Mobility is indeed greatly affected by both urban forms (e.g. density, accessibility, functional diversity, design ...) and socio-economic characteristics of people (e.g. income, age, education, car ownership ...) [1,2]. And associated environmental impacts are correlated with transport technologies performances including vehicles, fuels and infrastructures [3].

Specific issues also arise from the territorial level, especially from the urban stakeholders who need more spatial results and information to make decisions, identify hotspots or optimize systems [4]. Then mobility needs to be contextualized for both technology and behaviors and environmental impacts should be disaggregated and spatialized.

To integrate these different parameters, the proposed method couples two tools developed in two distinct scientific fields - land-use planning and environmental sciences: with on the one hand, Land-Use and Transport Interaction models (LUTI) and, on the other hand, Life Cycle Assessment (LCA) methods.

2. Materials and methods

To account for both technological processes involved in daily mobility, as well as interactions among stakeholders and territories, the method uses the SIMBAD model developed on the Lyon urban area. This dynamic urban model represents daily mobility through feedback loops between land occupancy (residential, employment, commerce, leisure ...) and transport performance (travel time and cost) and it provides travel flows on road and public transport networks. These flows are then considered as inputs for the LCA which includes all terrestrial and motorized transport modes of Lyon urban area (car, bus, train, subway and tramway) and their dedicated infrastructures. Most inventories are based on the EcolInvent database combined, for the use phase of road vehicles, to the Copert emission model. Spatial specifications were introduced on routes, vehicles fleets, technologies and usages [5].

Then assessed impacts are analysed at three different levels (urban area, spatial units or households) providing allowing multiple interpretations. However, by crossing emissions of vehicles use located at the link level with population dispersion an exposure indicator to local pollutants was developed to emphasize human health damage.

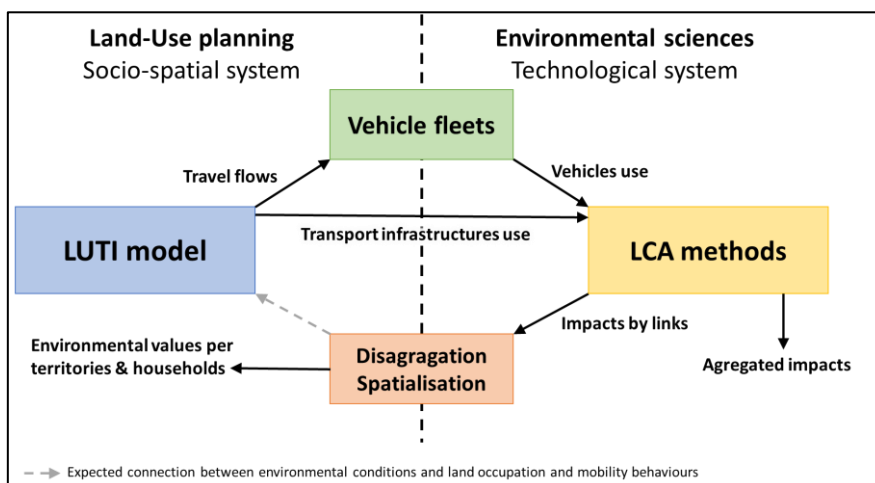


Figure 1: Synthetic scheme of the coupling method SIMBAD-LCA.

3. Results and discussion

3.1. Disaggregated analysis

The average GHG emissions for the Lyon urban area was estimated to 3.2 kg CO₂-eq per inhabitant per day, dominated by exhaust emissions and fuel production (respectively 55% and 15%). Nevertheless, disaggregation by residential locations or by households shows a high heterogeneity on the territory for all environmental impacts, that strongly increase in periurban area. Figure 2 describes this territorial variance for GHG emissions.

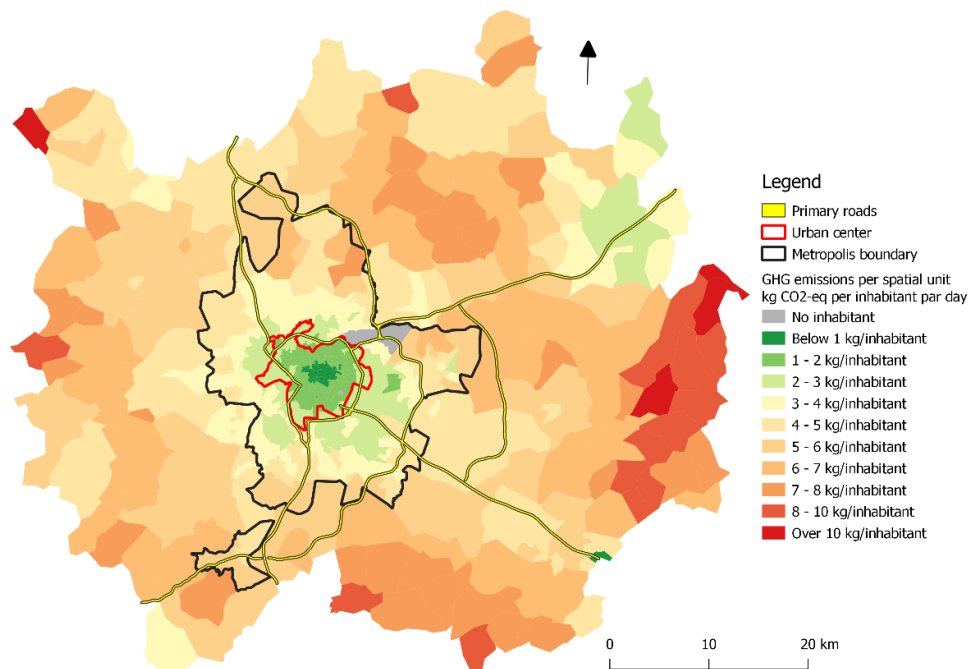


Figure 2: Distribution of GHG emissions levels depending on residential locations.

In depth analyses on various factors show the significant influence of social and spatial aspects on results through family size, employment rate, density or accessibility. For example, a member of a dual-career couple in low density location emits approximately 18 times more GHG than a single person unemployed in a dense location. However, technological factors contribute to environmental impacts by modifying indicators balances through depollution technologies, vehicles weight or motorization technologies

3.2. Local pollutants exposure indicator

The developed local NO_x exposure indicator highlights the externality of compact urban form with higher health damage in city centre and it offsets the conclusions made on the emitters point of view.

4. Conclusions

To assess an object deeply anchored in a territory such as mobility, LCA methods need to be revisited with more spatial approaches. The proposed method on urban mobility presents some advantages to use urban model but also raises new questions such as territorial boundary, allocation system and comparability.

5. References

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