A normative approach for planning. Simulation of residential growth scenarios in Luxembourg

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Abstract

The main objective of this communication is to present the results obtained within a PhD thesis (COSMELUX project, funded by FNR, Luxembourg, 2010-2014). The aim of the project is to define and assess different scenarios of residential growth in Luxembourg toward 2030. The simulations of residential development have been made by using MUP-City software (Tannier *et al.*, 2012). First, the simulated scenarios have been assessed by the mean of accessibility measures (minimal distance to closest facility, number of facility within a certain range, diversity indicators…) computed with MUP-City. Then, the scenarios have been evaluated according to daily mobility indicators (number of kilometers by inhabitants, modal split, number of trips…). These indicators have been obtained via the simulation of individual daily mobility with the LUTI platform MobiSim (Antoni *et al.*, 2011; Tannier *et al.*, forthcoming).

Keywords

Spatial simulation, Residential growth, Normative planning, scenarios, Urban models.

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Research question

According to the detrimental effects of urban sprawl (land consumption, car dependence, social segregation…), several research works are conducted to define a sustainable city model (Camagni *et al.*, 2002). Compact city, dispersed city, and polycentric city; New Urbanism, Smart Growth, and Transit Oriented Development: different city models are proposed to answer sustainable criteria. In this context, the fractal city model seems to be interesting (Frankhauser, 2015). We propose here a partial application of the conceptual models quoted above for simulating the residential growth in Luxembourg until 2030. The simulation model of residential growth fulfills three objectives: locate population growth, reduce car dependence and limit land consumption. This simulation model traduces a normative approach for planning (Naess, 1977; Klosterman, 1978; Watson, 2002).

Eight scenarios of residential development have been simulated at a fine spatial resolution (cells of 20 meters width). The first scenario is the standard and can be considered as a business as usual policy in Luxembourg. The second scenario is called Fractal Oriented Development (FOD). Inspired by Peter Calthorpe (1993), it aims at facilitating the modal share in direction of public transport infrastructures. Moreover, the local urban form is fractal in order to ease the accessibility to amenities (Frankhauser, 2000; Cavailhès, 2004). Another scenario (densification scenario) tends to double the built density currently observed in Luxembourg, in order to reduce some spatial consequences of low density constructions. A fourth scenario (land availability scenario) limits the residential development to lots declared as developable in planning documents of the Great-Duchy. A fifth scenario (116 municipalities scenario) allows the residential development to occur in all 116 municipalities of Luxembourg, which leads to increase the process of urban sprawl. At the opposite side, the sixth scenario allows the residential growth only in 23 of the 116 municipalities in order to reinforce the existing centralities. Finally, the last two scenarios are based on different demographic forecasts (high and low) and represent two variants of the standard scenario. These scenarios tend to be realistic, in the way that they can be seen as plausible or at least possible futures, of residential growth in Luxembourg. Indeed, the locally fractal form of urban growth simulate extensions of urban fabric which look like current urban design. The different scenarios are compared in term of both spatial accessibility indexes and daily mobility indexes.

Main results

Concerning the spatial accessibility measures, the results are quite different between the eight scenarios. According to the indicators, some variations can be observed in the ranking of the scenarios. In a global manner, the results reveal a better accessibility for the scenarios compared to initial situation, with any indicator. The minimal distance to access to daily retails and services is lower in the case of the dense scenario. The minimal distance to access to daily green or leisure facilities from dwellings is lower in the case of land availability scenarios. In contrast, the minimal distance to access weekly green or leisure facilities are scenarios which are less spatially constrained, like standard scenario (business as usual) and 116 municipalities scenario. The minimal distance to monthly or rarest green or leisure facilities is greater for all scenarios compared to initial situation. This result can be explained by the location of both new residential areas and forest areas, which differs. The minimal distance to access to the closest train station is largely minimized in Fractal Oriented Development scenario. This

scenario was built with this objective but it is also the case for the 23 municipalities scenario.
The accessibility to a certain number of daily retails and services within a neighborhood of 1000 meters is better within FOD and dense scenarios. With the same indicator applied to weekly green and leisure facilities, the dense and 23 municipalities scenarios provide better results. It is also the dense scenario which is able to give a larger number of bus stop locate at 1000 meters of each dwelling. Last example of result obtained, the minimal distance to reach each type of monthly retails and services is lower within dense and 23 municipalities scenarios.
The exploitation of the results for daily mobility are still in progress. In order to limit the computation times, just three scenarios have been compared: standard, FOD and 23 municipalities. The modal split (for all trips) of initial situation is 70% for car, 15.2% for public transport and 14.8% for soft modes. With the FOD scenario this modal split becomes 58.5% for car, 21% for public transport and 20.5% for soft modes. The results are quite similar for the two others scenarios. The number of kilometers travelled by inhabitants and by car is decreasing between 2010 and the three scenarios, going from 28.5 km to less than 26 km in FOD scenario. At the opposite, the distance travelled by train or by soft modes is increasing. The time budget for public transport and soft modes is also increasing (due to changes in modal split), meanwhile time budget for car travels is staying the same. This result shows that congestion is limited in the case of our scenarios. These results will be developed in terms of trip purposes and socio-economic characteristics of individuals.

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