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Towards sustainable transitions of peri-urban neighborhoods of detached houses

J Drouilles[1], **E Rey**[1]

[1]Ecole Polytechnique Fédérale de Lausanne (EPFL), Laboratory of architecture and sustainable technologies (LAST), BP 2225, Station 16, 1015, Lausanne, Switzerland

judith.drouilles@epfl.ch

Abstract. Peri-urban neighborhoods of detached houses are facing countless challenges related to the building stock's low energy efficiency, to the current demographic transition reducing household size and increasing the proportion of elderlies, to their distant location combined with exclusive residential use and few public transportation services. Those challenges represent growing issues for the upcoming years, with regard to the role those neighborhoods have to play in contributing to the collective challenge of the energy transition and to the fact they would have to cope with eventual future crisis. Hence the research investigates the transition potential of existing peri-urban neighborhoods of detaches houses by 2050, in Switzerland. Through a more focused approach, the paper, complemented with a poster, aims at highlighting how future evolutions might affect the overall sustainability of those residential areas. To do so, it focuses on the multicriteria assessment of five scenarios envisioned for peri-urban neighborhoods of detached houses and applied in six Swiss case-studies by 2050. The scenarios *Caducity* and *Exclusivity* follow business as usual trends. The scenario *Opportunity* investigates the effects of soft-densification processes, and *Urbanity* and *Mutuality* offer new perspectives towards densification or landscape integration. A multicriteria comparison relies on results of the systematic assessment of the neighborhoods' environmental quality, energy efficiency, economic viability and social diversity in 2050 and of the scenario's feasibility. It innovates by relying on a spatiotemporal assessment methodology developed at neighborhood scale. Altogether it provides a qualitative decision-making support by identifying strengths and weaknesses of each scenarios. The overall average results show that *Urbanity*, which concentrates its actions on a few plots, presents the best-balanced performances among all criteria. All the other scenarios are favorable to one or two criteria only. Besides providing decision-making support, this assessment also sets a framework to reorient public policies towards more resilient peri-urban residential neighborhoods.

1. Introduction

Rapid urbanization of the last decades is a global challenge for the dispersion of settlements it has induced. An ongoing debate about the evolution of urban forms is stretched between a tendency to favor compactness and centrality [1], and another recognizing the potential of a reticular dispersion [2, 3]. Authors differ about theoretical definition of settlements and whether they are considered as urban. Nevertheless, they tend to agree upon the necessity to develop proactive research to bring those territories towards more sustainable futures [4].

As a direct product of urban sprawl processes, mono-functional settlements of detached houses raise growing issues, that recent works have studied in line with two major topics: 1. the possibility to sustain the development of new settlements of detached houses given their recognized success within current society [5]; 2. the necessity of their adaptation in response to the demographic transition towards an elderly society and to the requirements of residential densification [6]. However, a gap remains: by focusing on new settlements or on the individual house scale, a lack of contextualization is witnessed. It goes against the proposition of holistic neighborhood scale regeneration projects. Our research relies on the identification of transition challenges faced by existing peri-urban neighborhoods of detached houses in the European context and more especially in the Swiss metropolis.

Within this context, the paper (completed with a poster) aims at raising awareness on impacts of future decisions for peri-urban neighborhoods of detached houses; whether nonexistent (inertia) or, on the contrary, highly proactive (transition). The novelty of this research lies on two major aspects: 1. it considers peri-urban areas as worthy case-studies and goes beyond current stigmatization of such settlements of owner-occupied houses; 2. it applies a proactive approach at neighborhood scale and works with the complex land fragmentation. Therefore, the paper lies within the topic of urban transition, as it investigates future scenarios applied to specific territory and policy contexts.

To do so, the research follows a four step methodology. It first identifies the specific research framework based on an explicit understanding of the research object. Second, a series of interviews with experts helped highlighting three transition trends upon which rely the definition of five theoretical prospective scenarios envisioning future evolutions of peri-urban neighborhoods of detached houses. Third, those scenarios are tested, through a research by design approach, by applying them in six existing neighborhoods selected within the urban region of Lausanne. Fourth, the impacts of each scenarios are assessed according to five criteria in order to highlight the strengths and weaknesses of each approach.

This paper will briefly provide points of references about the first three steps of the research in order to mainly focus on the overall results of the comparative multicriteria assessment which gives clues about benefits and warning aspects of each five scenarios.

2. Conception of future evolutions

Within the current debate regarding the understanding of urban sprawl in parallel with metropolization [7] or with planetary urbanization [8] processes, as a starting challenge we identified peri-urban residential spaces in relation to our research goal. Since the research aims at providing decision-making support to local authorities, we chose to work according to the policy framework recently updated in Switzerland [9]. Those planning principles promote a hierarchical polycentric organization of urban spaces, which underlines the lower attractiveness of peri-urban areas with regard to more strategic areas such as urban centers. Those principles justified the elaboration of a typology of peri-urban neighborhoods of detached houses, according to the methodology presented in [10].

Based on this deep understanding of the Swiss policy and territorial frameworks, a series of interviews were conducted with field experts. They helped us highlight current challenges as well as trends and transitions to envision possible futures for peri-urban residential areas. Consequently, two sets of scenarios emerged to qualify potential peri-urban alternatives. One group, composed of scenarios *Caducity* and *Exclusivity,* considers a situation of demographic stagnation resulting from the implementation of current planning policies in favor of densification of strategic urban areas. Scenarios *Urbanity* and *Mutuality*, attached to the second group, recognize potential transition paths, at odds with common practice, towards different built forms and governance systems. Where both sets converge, lies an intermediary scenario called *Opportunity*, which refers to emerging soft-densification processes that qualify densification mainly done at dwelling or plot scales.

One of the innovative aspect of the research lies in the transcription of those five theoretical prospective scenarios into six real peri-urban neighborhoods of detached houses, selected among the previously elaborated typology. The high amount of information available about housing, buildings and plots, underlined the inherent complexity owing to such neighborhoods of owner-occupied houses. A building information modelling (BIM) methodology, conceived at neighborhood scale, resulted being a

strong tool to go beyond the initial land fragmentation complexity [11]. It allowed a clear understanding of the levels of feasibility and operational capacity of each scenarios applied in specific contexts by 2050, and it supported the development of a multicriteria assessment of applied alternative futures.

3. Multicriteria assessment

The constitution of a holistic assessment matrix was meant to highlight the cumulated effects of induced transformations. Five criteria were selected to directly address major challenges related to environmental quality, energy efficiency, economic viability, social diversity and feasibility. To each criteria, several indicators were assessed in a systematic approach in order to allow a transversal comparison of results.

The environmental quality was evaluated according to the proportion of sealed soils and to the level of fragmentation of the green infrastructure. The latter represents a pre-existing feature that constitutes part of the neighborhood's identity. Therefore its preservation is crucial for a better acceptation of future projects. The energy efficiency was assessed at neighborhood scale by considering the environmental impacts owing to the construction/retrofit and to the operation of the dwellings and to the induced daily mobility of their occupants (see [12] for the detailed methodology). Thanks to using BIM, results could be assessed in a dynamic way, showing yearly results across the entire period of study (2015-2050). As reference targets, the study used current Swiss normative documents established in perspective of the 2,000-watt society concept [13]. Economic viability evaluates the capital gain generated by the scenarios implementation on each real-estate property; i.e. it compares the total investments with the final value of all the dwellings at neighborhood scale. Social diversity is assessed according to the repartition of housing types (number of rooms), and to the economic value of dwellings per square meter, for its effects on the households' purchasing capacity. Finally, the feasibility criterion appeared highly relevant considering the owner-occupied status of the residences in those neighborhoods. It is twofold: 1. it assesses the potential of acceptation of the projects among the community, 2. it considers how complex the implementation is in terms of planning and policy adaptation.

4. Results

Although theoretical, the implemented approach, provides rich and diverse results, thanks to its operational scope. Indeed, the integration of essential components of neighborhoods – such as the alternation of occupation cycles and the conditions of individual ownership – plays a major role in ensuring reliability in the application of future scenarios. The implementation of scenarios in six case studies highlights the existence of a morphological adaptation potential, which however maintains the global aspect of the neighborhoods as well as their identity features. As a consequence, the implementation of the scenarios is highly feasible. Scenarios *Caducity* and *Exclusivity* preserve or strengthen the attributes of isolated housing within homogeneous residential areas. *Opportunity* enhances neighborhood's fragmentation by favoring a dispersed and individual densification process. *Urbanity* focuses the transformations on a limited number of plots, which in parallel, maintains the current profile of the rest of the neighborhood. *Mutuality* strengthens the landscape integration by restoring a continuity of the internal green infrastructure. Both *Urbanity* and *Mutuality* increase the proportion of small dwellings in order to ease the internal residential mobility of elderly households.

It was not the aim of this qualitative multicriteria assessment to bring forward "the best scenario". Its goal was rather to identify strengths and weaknesses of each scenarios in order to perceive potential consequences of chosen actions and to be able to anticipate them according to a specific context. As a result, a strategy could be chosen above another in relation to local policy objectives. For instance, a more densely built neighborhood could favor scenarios with higher environmental quality, such as *Caducity* or *Mutuality*, and should take notice of the environmental deterioration caused by *Opportunity*. Regarding energy efficiency, results remain above the targets even for *Urbanity* and *Mutuality* which implement many actions towards energy transition. The assessment highlights the slow pace of improvements related to the individual ownership of detached houses and the population ageing trend that delay building retrofits and population renewal. Hence, cumulated greenhouse gas emissions per person between 2015 and 2050 are on average 3 times higher than 2,000-watt society target. Regarding

economic viability, only *Opportunity* and *Urbanity* show a positive balance. The improvement of social diversity, in *Urbanity* and *Mutuality*, relies on restoring a balance in the repartition of dwellings to make the neighborhood accessible for a wider range of households. Apart from *Mutuality*, which shows a lower feasibility, all scenarios are easily implemented although the ownership fragmentation supposes a degree of uncertainty regarding the implementation process.

5. Conclusion

This research, among other works [1-3], calls for overcoming the urban/rural divide and for considering existing interactions and synergies between residents and users, built spaces, infrastructure, activities and landscape, towards a qualitative territorial planning. Besides providing differential paths and tools on how to shape the future of peri-urban neighborhoods of detached houses, the research highlights potentialities and limits of the evolutions towards a sustainability transition of the built environment. Considered as a decision-making support, the research can orient local actors through the identification of 3 major topics: 1. The energy transition slowness and the high impacts of dwellings under-occupation; 2. the important construction potential remaining within the current neighborhood's perimeter, which supports the containment of sprawl; 3. the effectiveness of neighborhood scale planning to improve the coordination of short term individual interests with mid- or long term collective goals.

Peri-urban neighborhoods of detached houses have proven themselves to be ideal experimentation sites, where the limited growth potential supports diffuse mutations compatible with the specific context of each neighborhood. The research proposes to consider including future peri-urban developments into strategic territorial planning to anticipate renovation delays, to optimize land occupation and to support interdisciplinary design approaches towards neighborhood-scale synergies and resilient communities.

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