



Conception and use of an individual-based model of residential choice in a planning decision process. Feedback from an experimental trial in the city of Besançon, France



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ABSTRACT

In this paper, we present an experimental trial involving the use of a complex spatial simulation platform to support a planning decision process in the city of Besançon (eastern France). In medium-sized towns across France, households with children are leaving to settle in periurban areas, and Besançon is no exception. Under those circumstances, the political objective of the Besançon City authority is to keep middle- and high-income households with children within the city. The simulation platform MobiSim was used in this context to explore the possible outcomes of spatial planning policies, set by both the Greater Besançon authority (Besançon and the surrounding periurban communities) and the city of Besançon, on residential migrations over a 20 year period. MobiSim integrates several models representing demographic, social, economic, and spatial processes. Modelled entities are individuals and dwellings. Rules determine how individuals form households. Other rules locate dwellings in buildings.

The experimental trial began in October 2012. It involved two researchers in geography and planning from the University of Franche-Comté (Besançon, France) and two planning practitioners working in Besançon city council's planning service: the Department of Planning, Projects and Forward Planning. The first stage of the trial was the collective definition and simulation of a baseline position simply extending existing trends from 2010 to 2030: the 'Business as usual' scenario. The second stage was a collective reflection on possible modifications to some of the variables and parameters of this scenario in order to simulate a pro-active policy of housing construction in the medium term.

Under the conditions represented in the model, the 'Pro-active housing construction' scenario in Besançon allows an overall reduction of migration flows from Besançon to the surrounding periurban areas. More single parent families choose to reside in Besançon during the whole simulation time. Couples with children, however, choose preferentially to reside in Besançon until 2022 only. At this date, the controlled housing developments become less numerous.

This experimental trial gave the researchers and the planning actors involved in it the occasion to exchange their scientific knowledge and their empirical knowledge. The simulation of the 'Business as usual' scenario was, as it were, a means to thoroughly explore one possible future. This then led the group to discuss possible planning actions designed to reduce migration flows of households with children out of Besançon into periurban areas.

The trial also shows some limitations: it highlights that this kind of PSS makes the planning actors heavily dependent on the expertise of the researchers for every stage of the process.

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1. Introduction

In a global context of urban sprawl and increasing housing costs, policies for residential mobility and residential development are an important aspect of urban and regional planning. There are two major planning concerns: firstly, to ensure that housing supply meets housing demand both quantitatively and qualitatively, and

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secondly to reduce the negative environmental impacts that may result from residential development, especially an increase of the length and the number of trips by car and the fragmentation of natural and agricultural areas.

In medium-sized towns across France, middle-income households with children are leaving to settle in periurban areas. Classical explanations for this are the household preferences for detached houses in a green residential environment where housing costs (land prices and taxes) are lower, although transportation costs in these periurban areas are higher. Considering this, the political objective of the Besançon's city authority, located in eastern France, is to keep middle- and high-income households with children within the city. Setting this objective raises the question of the possible effects of applying existing policies set in the official planning documents for the urban region of Besançon (i.e. the strategic land use plan and the local housing plan) on residential mobility of middle- and high-income households with children in the city, notably centre-to-periphery migration flows, with a view to retaining this population within the city boundaries.

This question has been addressed in the frame of an experimental trial involving two researchers in geography and planning from the University of Franche-Comté (Besançon, France) and two planning practitioners working in Besançon city council's planning service: the Department of Planning, Projects and Forward Planning (*la Direction 'Urbanisme, Projets et Planification'*). To answer this question, this group of researchers and planners has conceived and piloted the use of a very detailed individual-based model of residential choice that represents the current known behaviours of households and that takes into account a range of recommendations set by scholars to ensure the usefulness of simulation models to support planning decision processes.

Many models have been developed since the 50s to explain and/or forecast residential choices and residential dynamics. Most of them are based on micro-economic assumptions. They often use the multinomial logit model (Prashker, Shiftan, & Hershkovitch-Sarusi, 2008; Wegener, 1985; Weisbrod, Lerman, & Ben-Akiva, 1980) or the nested logit model (Ben-Akiva & de Palma, 1986; Ettema, Jong, Timmermans, & Bakema, 2007; Kim, Pagliara, & Preston, 2005; Quigley, 1985; Vega & Reynolds-Feighan, 2009). As an alternative, multi-agent simulation models are also sometimes used (Benenson, 1998; Ettema, Arentze, & Timmermans, 2011; Filatova, Parker, & van der Veen, 2009). All these models allow a better understanding of variables and processes involved in residential choices and residential migration. However, they contribute little to defining planning policies or to supporting planning decisions. The large number of variables involved in residential decisions and the existence of non-linear relationships between them explain the difficulty of forecasting future configurations of both residential locations (who will live where in the future) and residential satisfaction (who will be more or less satisfied and where). Because of this complexity, a simple linear extrapolation of trends offers no real help in making planning choices. Yet identifying possible bifurcation points, as suggested for instance by Wilson (2010), is difficult. Despite this difficulty, the group of researchers and planners in Besançon has chosen to build a model that represents the complexity of residential location dynamics and to pilot its use. The planning practitioners were interested in dealing with this complexity because they are constantly confronted by it in their daily work. They hoped the researchers could help them to manage it. As for the researchers, it was important to build a model that represents complex processes involved in residential location dynamics.

According to Batty et al. (2013), the role of models in the planning and design of city systems has radically changed during the last decades. "Fifty years ago there was a sense in which both

model builders and stakeholders regarded models as providing predictions which could be used with some confidence to help figure out the impact of their plans in rather definite ways with a high degree of certainty. This confidence is now widely regarded as having been misplaced and the role of most models is now to inform, steer, and focus dialogue (Epstein, 2008), notwithstanding the continuing practical plea for some measures of certainty about the future. Interaction between model builders and stakeholders has thus become the name of the game (...)" Following the same idea, Failing, Gregory, and Harstone (2007) argued that the integration of science and local know-how during decision making becomes an unavoidable task, in Europe as well as in North America. Indeed, many publications dedicated to the analysis of the use of planning support systems (PSS) insist on the necessity for planners and system developers to share knowledge and demands, and to adopt a cooperative development process (Te Brömmelstroet & Schrijnen, 2010; Van Delden, 2009; Vonk, Geertman, & Schot, 2007). This requirement holds especially when both the targeted planning task and the PSS used for achieving it are complex. In the process of the pilot test presented in this paper, the group of researchers and planners has tried to follow this recommendation.

Another point raised by Silva and Te Brömmelstroet (2014) is that the effective use of PSS is currently suffering from a 'rigour-relevance dilemma', with developers mainly concerned with rigour while users are mainly concerned with relevance. Ever more complex PSS are developed by researchers as a pursuit of scientific rigour and this seems to increase the gap between supply (scientists) and demand (planning practitioners). In the frame of the pilot described here, one objective was to test the possibility to develop a complex simulation model that is not a black box and that can be used as a discussion medium between planners and researchers.

The paper is organized as follows. We first briefly describe the context of the pilot and how its guidelines have been defined jointly by the researchers and the planning practitioners involved in it. Then we describe the model, whose variables and rules have been set by both the researchers and the planning practitioners. After this, we describe the way this model has been used to determine the possible outcomes of the planning policies contained in the official planning documents (local housing plan and strategic land use plan) on the migration flows of households from the centre city to its surrounding periurban areas. Finally, we expose how the researchers and the planning practitioners have imagined an alternative planning policy that is the application of a pro-active housing construction by the city of Besançon, and how the model has allowed them to explore the possible outcomes of this policy on the residential locations of households.

2. The trial: context, objectives and guiding principles

2.1. The context for the experimental trial

The study area is the urban region of Besançon known as *Le Grand Besançon*, in eastern France: *Le Grand Besançon* is an intercommunal authority responsible for a range of policy areas including planning and transport. We will refer to this area as Greater Besançon. This urban region includes a core city (117,000 inhabitants) managed by one local authority (*la Ville de Besançon*, which we will refer to as Besançon City Council) and periurban residential areas with low population densities spread across 58 smaller local authorities. The experimental trial with the simulation model involves two researchers in geography and planning, and two urban planners from the core city's planning service (*la Direction 'Urbanisme, Projets et Planification'* of Besançon). Note: although not all the authors of this paper

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