Chapter 26
Estimate Urban Growth and Expansion by Modeling Urban Spatial Structure Using Hierarchical Cluster Analyses of Interzonal Travel Data

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ABSTRACT

Estimating the spatial organization of cities yields insights into interactions over a spatial structure, and thus creating efficient subcenters with more balanced distribution of travel patterns over urban agglomerations can be exercised via models which support an evidence-based spatial planning. As cities evolve and self-organize as complex spatial structures, problems such as accessibility, environmental sustainability, and social equity or weak economy can be incurred by unrealistic development scenarios. In this regard, it is claimed that the dynamic nature of the urban spatial structure can to be modeled to estimate growth and expansion of it using the patterns of freight and passenger movements throughout metropolitan areas under the assumption that there is a simple and straightforward link between travel flows and urban spatial structure. The main effort of this study is to describe and model urban spatial structure and its evolution due to the spatial distribution of population, and employment centers.

INTRODUCTION

Urban geography can be characterized by analyzing travel patterns of people and goods in and across urbanized areas. Modeling urban structures is essential for supporting an evidence-based spatial planning policy (Cats et al., 2015). Elements of the urban transportation system, namely, types, capacity and

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characteristics of travel modes, infrastructures, and users, and the cost or time of travel, have a unique spatial imprint which shapes the urban form. Each city presents different socioeconomic and geographical characteristics; therefore, the spatial imprint of the transportation system differs correspondingly (Rodrigue et al., 2013). For instance, while some cities have an urban form shaped by mainly highway modes, and others have different spatial forms compared to the former because various public transport modes, including non-motorized modes and infrastructure developments are taken place in a more balanced transportation system. It is already studied that commuting patterns reflect the corresponding urban spatial structure (Sohn, 2005). Urban spatial structure is affected by spatial interactions among different activity locations and land uses over the city's transport system since each city has its unique circulation pattern of passengers and goods. In that sense, it is claimed in this paper per the authors that urban spatial structure can be modeled using interzonal (O/D) travel data. OD data are the outputs of the trip distribution step from the travel demand modeling (TDM) process. Thus, by comparing the spatial structures obtained from the models created by employing Hierarchical Cluster Analysis (HCA) for a base year and future scenarios, urban growth and expansion can be estimated in terms of population and/or employment changes, based on the level of interaction, represented by distance or similarity calculated based on trip interchanges, over the transportation network. For example, a network with substantial highways projects and the other having substantial public transportation investments can be compared with respect to the spatial structure impacted by the dominant elements of the transportation system such as highway, public transit modes, and major transport terminals.

This paper presents a case study of the analyses of urban spatial structures of Sakarya Province of Turkey (Figure 1) for base and future scenarios. Base year and future urban structures were modeled and compared to estimate the urban growth and expansion for years 2012 and 2023. The objective of this study is to examine how the spatial-temporal distribution of transport passenger flows via all modes could be used to model urban structure dynamics. In this paper, we aimed to describe and model urban spatial structure and its evolution due to the spatial distribution of population, and employment centers. A methodology to identify and classify centers and subcenters based on travel data was applied to Metropolitan Sakarya in Turkey using transport passenger flows via all modes. Results of the analyses can be used to confirm the growth and the expansion of urban city core as well as other urban and suburban developments and their emergence with their neighboring clusters. Decision makers will be able to develop their capacities to plan ahead in order to meet future needs better from the spatial restructuring in urban agglomerations, when they know the extent and location of the future growth ahead.

Background

Cities are traditional places of economic activities, which stem from the interactions between people and infrastructures over the transport system. Traditional urban theories study how cities develop and grow through systematic interactions among production systems that benefit from co-location, have been identified as chief forces in the growth of cities. However, over the last decades the traditional understanding that the only outcomes of these forces should be an accelerating concentration of population, infrastructures and jobs has been challenged by the evidence of deconcentration, first in the United States, Canada and Australia, and later in Europe. The immigration of rural populations into the city known as a centuries old factor in rural depopulation and the dominant force in creating urban agglomerations is now giving way to a reverse migration into the countryside, at least in many western cities, as urban