Chapter 9
Urban Sprawl and the Quantification of Spatial Dispersion

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ABSTRACT

The uncontrolled spread of cities into their surrounding rural and natural land is an issue of high popular interest and has been the topic of considerable research. Urban sprawl remains controversial, even though among scholars there are still no unambiguous definitions of sprawled zones--their spatial form and their causative factors--nor about the urban processes and dynamics involved. In order to create such a definition, the authors describe the spatio-temporal patterns of urban form in a study area noted for sprawl, focusing on measures that can detect the degree of urban spatial dispersion over time (Batty 2002). The data used is a fusion of archived thematic maps, classified satellite imagery, census data, and forecast maps of future urban scenarios. The area investigated was the northeastern province of Pordenone in Italy, which is particularly relevant and curious because despite being a small city, it was assessed in 2002 as one of the most explicative examples of sprawl in Europe by the European Environment Agency. The authors analyzed urban growth mainly through the evolution of urban patterns over time, hence sprawl is considered as a specific case of growth that drives urban expansion from denser and compact extent to an unorganized and fragmented pattern. How the spatio-temporal dynamics of urban growth are quantified is crucial for urban planners, as knowledge of amounts and rates allows more efficient selection and application of policy and could help researchers to better understand urban sprawl's etiology.

INTRODUCTION

Transitions among land uses and unorganized urban expansion are major causes of many of the human-induced environmental changes affecting our planet. Scholars agree that urban spread and sprawl are predominantly harmful to public services (Carruthers and Ulfarsson, 2003), public health (Ewing et al., 2003) and climate (Ewing et al., 2007). Yet exactly what constitutes urban sprawl is highly multidimensional and remains difficult to quantify (Ewing et al., 2002; Frenkel and Ashkenazi, 2008; Torrens, 2008), especially when all of the causes and impacts are incorporated into the measures (Burchfield et al., 2006; Ewing, 1994). Hasse noted that "…The literature on sprawl, with a tinge of irony, is broadly dispersed and multi faceted. A variety of definitions for sprawl have been put forth that describe sprawl." (Hasse 2003, p. 160). The monitoring of land cover transitions related to urban development over time is usually to find out the amount and location of land use change for reporting or planning purposes. Nevertheless, the ability to *anticipate* a trend in urban sprawl behaviour for a specific region would give planners a useful tool to understand sprawl's long term impact on a region, or even to take steps to prevent or retard it.

Although various studies have been dedicated to the measurement and monitoring of urban growth, they have limitations in providing generalizations of the characteristics of urban sprawl that may be of use in planning. In this study, we choose to define urban sprawl purely cartometrically, that is by quantifying the shape, distribution and spatial extent of built up areas within a region. Our approach follows Batty's concept of form as a result of function (Batty and Kim, 1992), but instead of focusing on theories of density and settlement size (Batty, 2008; Batty, 2002; Batty and Longley 1994) or on human demographic structure (Brueckner 2002, Lowry 1990), we focus on urban spatial form alone. One advantage of this approach is that it avoids the complexity of multivariate sprawl definitions, in addition it also works across spatial and temporal scales and is approachable with data from maps and geographic information systems. The disadvantages are that it does not include specifically both social and economic factors. We believe these factors can be better explored once some basic measures are widely accepted, and cross regional comparison has been conducted.

According to the general principles set forth in Dietzel et al. (2005a; 2005b), we assume urban sprawl to be a phenomenon highly correlated with time, furthermore that urban growth dynamics are characterized by two components, scattered development (diffusion or dispersal) and organic expansion (spread or allometric expansion). Dietzel et al. showed that these patterns could be measured, and that urban growth oscillates between coalescence and diffusion processes over time, with sprawl growth behavior concentrated in the former. Thus, a priori, we expect both sprawl and regular urban expansion to be simultaneously present in space and over time and that there is some sort of inverse proportionality between these two vectors of urban growth. We aim to depict the evolution of sprawl's spatial patterns over time in order to identify a "sprawl evolution signature" for the region of interest, similar to Silva's concept of urban DNA (Silva and Clarke, 2005).

URBAN SPRAWL AS SPATIAL DISPERSION

As previously noted, urban sprawl remains a controversial issue, in fact many definitions are available and different means of investigation have been developed (Jaeger et al., 2010a), in spite of the fact that they are quite different they all tend to mention that "sprawl is related to the uncontrolled and unorganized growth of cities over the surrounding natural environment over time" (Ewing 1994). Hence we seek to focus on the spatial evolution of the phenomenon spe-

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