The use of spatial metrics for the characterisation and analysis of urban form

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The recent growing concerns about sustainable development have fostered a renewed interest of the international literature on the physical dimension of cities and, consequently, on the issues of urban morphology (Huang et al., 2007). A large part of the publications o this topics regards urban growth patterns, namely focusing on the phenomenon of urban sprawl and its negative environmental and economical consequences in opposition to the compact city concept, normally seen as the most desirable model for urban development (Ewing, 1997; Frenkel and Ashkenazi, 2008; Huang et al., 2007; Schneider and Woodcock, 2008; Tsai, 2005).

Along with this growing importance of urban morphology and aiming at allowing for a more objective and systematic analysis of these issues (Huang et al., 2007), on the one hand, and to present empirical data for the support of the existing theories (Schneider et al., 2005), on the other, an increasing interest on the development of quantitative methods of urban analysis has been recently observed. In this context, the use of spatial metrics as a tool for the analysis of urban form – namely to study urban growth – has become more and more common on the international literature (Aguilera et al., 2011; Herold et al., 2005).

Spatial metrics are quantitative indexes that represent the patterns and structures of an urban landscape (Herold et al., 2002; Huang et al., 2007). Although they have been used for several decades in the field of landscape ecology – where they are known as *landscape metrics* – these indices have only recently been used in the study of urban form (Aguilera et al., 2011; Herold et al., 2005; Schneider et al., 2005; Seto and Fragkias, 2005). Spatial metrics are particularly relevant for empirical studies since they quantify several aspects of urban form – such as fragmentation, shape complexity or land use diversity, among others – providing a more accurate characterization of urban processes and their consequences (Aguilera et al., 2011; Herold et al., 2005; Huang et al., 2007; Schwarz, 2010).

This work has the purpose of developing a first state of the art regarding the use of spatial metrics in urban studies. We carried out a literature review on the use of spatial metrics for the study of urban form and the process of urban growth, with a focus on empirical studies.

We found several recent empirical studies using spatial metrics for the characterization of urban form, comparison between cities and for the analysis of spatial-temporal urban growth patterns. Spatial metrics are also commonly used in combination with other methods of urban growth analysis – such as cellular automata models – being useful tools for the calibration and validation of these models and for the interpretation of their results. Although there is a quite large number of different metrics, several studies concluded that many metrics are highly correlated and thus most of the urban processes and characteristics can be represented by a smaller set of metrics (Aguilera et al., 2011; Huang et al., 2007; Schneider et al., 2005; Schwarz, 2010). However, the choice of the most appropriate set of metrics to use in each case will depend on the specific characteristics of the study area and on the objectives of the study (Herold et al., 2005).

Most of the metrics found in this literature review have their origin on landscape ecology, and that is the reason why several authors (Aguilera et al., 2011; Herold et al., 2005; Herold et al., 2002; Huang et al., 2007) suggest the development of new metrics tailored to the needs of urban analysis at different scales and studying specific urban processes. The need to extend the application of spatial metrics to a higher number of cities as well as the importance of combining metrics with other data, such as demographic and socio-economic indicators, governance structures or accessibility measures, are also common suggestions for future research (Aguilera et al., 2011; Huang et al., 2007; Schneider and Woodcock, 2008; Schwarz, 2010; Seto and Fragkias, 2005).

Keywords: spatial metrics, urban growth, urban morphology

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