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Urban containment in action? Long-term dynamics of self-contained urban growth in compact and dispersed regions of southern Europe

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ABSTRACT

The present study illustrates an indicator of self-contained urban growth derived from official statistics with the aim of verifying if a shift from compactness towards settlement diffusion has occurred in cities with different socioeconomic and morphological characteristics. According to this approach, changes in settlement's distribution and density were assessed in four Mediterranean cities (Lisbon, Barcelona, Rome, and Athens) during 80 years between 1919 and 2001. Results indicated that settlement distribution, building density and self-contained urban growth diverged in the four regions since the early 1980s. However, cities with a compact form showed an higher self-contained growth rate than cities with dispersed form. These findings contrast with the similarity in settlement characteristics, population trends, and spatial organization of economic activities observed during the 'compact growth' phase (1950–1980) in all examined regions. Comparative analyses of exurban development through morphological indicators may inform strategies promoting self-contained urban growth.

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Introduction

Compact growth and sprawl are linked to the debate on the sustainability of different urban forms (Jenks and Burgess, 2000; Thinh et al., 2002; Jabareen, 2006; Aguilar, 2008; Zhang et al., 2011; Miller, 2012). Previous studies have suggested how urban diffusion was reflected in a considerably low rate of self-contained growth, determining landscape fragmentation and even limiting land availability to further edification (Couch et al., 2007). By the contrary, promoting self-contained growth represents a possible strategy to control low-density urban diffusion and to mitigate land consumption (Couch and Karecha, 2006). Unfortunately, a restricted number of studies have been devoted to analyse long-term dynamics of self-contained growth in cities with different socioeconomic characteristics and contrasting forms.

European cities developed over the last 50 years with different demographic, socioeconomic and morphological characteristics (Turok and Mykhnenko, 2007). Although in the past European cities, especially those belonging to the Mediterranean region, have been characterized by similar forms, demographic trends, and productive structures, the variety in socioeconomic characters makes impossible, at present time, the identification of an unique archetype for this group of cities (Leontidou, 1996; Dura-Guimera, 2003; Gospodini, 2009; Chorianopoulos et al., 2010). While economic development, compact urban expansion, and rapid population growth were common trends observed during the 1960s and 1970s, in the following years most of southern European societies were gradually abandoning the traditional pro-urban ideology and the preference for dense and continuous settlements (Couch et al., 2007; Longhi and Musolesi, 2007; Turok and Mykhnenko, 2007).

Since the early 1990s, the diffusion of medium- and low-density settlements driven by de-concentration of inner cities and peri-urbanization has represented a dominant trend in Mediterranean urban regions. This process is involving large areas at higher distance from the city centre (Antrop, 2004; Kasanko et al., 2006; Catalàn et al., 2008; Schneider and Woodcock, 2008). While unplanned land development has been one of the most important factors determining fragmented urban expansion till the 1980s (Costa, 1991; Costa et al., 1991; Krumholz, 1992; Kourliouros, 1997), service-oriented ribbon sprawl and infrastructure-driven residential sprawl are now reflecting the change towards a dispersed and horizontal rather than vertical growth, experiencing development modalities that determine a larger consumption of land than in the past (Richardson and Chang-Hee, 2004; Bruegmann, 2005; Gargiulo Morelli and Salvati, 2010). This emerging land-use pattern indicates a mismatch with planning norms and land value theories which, underpin urban planning instruments and principles like equitable provision of basic services and complimentary urban land development (Pendall, 1999; Heim, 2001; Forster, 2006; Sun et al., 2007; Wu and Zhang, 2012).

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The present paper contributes to this fascinating issue with a comparative analysis of the long-term urban expansion in four southern European regions (Lisbon, Barcelona, Rome, and Athens) using self-contained growth as an indicator of sustainable urban form and sprawl dynamics (Couch et al., 2005). Opposite to previous studies (e.g. Catalàn et al., 2008), we investigated a broader area for each city including the whole metropolitan region. The four study areas have been selected as paradigmatic cases of traditionally compact cities undergoing spatial restructuring towards urban diffusion.

Methods

Study area

The four largest urban regions in southern Europe – three of which are capital cities – are considered in this paper: Lisbon in Portugal, Barcelona in Spain, Rome in Italy, and Athens in Greece (Fig. 1). The main morphological and demographic characteristics of these cities have been reported in Table 1. For each city, the investigated area corresponds to the NUTs-3 (Nomenclature of Territorial Units for statistics) province (or prefecture) administered by that city. Each selected area encompasses (or is a little larger than) the boundaries of the related 'Urban Atlas' region. 'Urban Atlas' is the major initiative dealing with sprawl monitoring in Europe and represents an information tool for both assessment and urban policy analysis (European Environmental Agency, 2010). In order to collect comparable data among regions, we considered the enumeration districts of the last population census as the elementary spatial domain. The use of enumeration districts allows for a detailed analysis of building density and human settlement distribution for a relatively long time period (Salvati, 2013).

Data and indicators

Cartographical data

Since the early 1990s, the National Institutes of Statistics of Portugal (INE), Spain (INE), Italy (ISTAT), and Greece (ESYE) have developed Geographic Information Systems (GIS) which comprise digital databases supporting census operations (e.g. Martinuzzi et al., 2007). These databases consist of digital cartographical data which have been produced through aerial photograph processing. The digital data have been converted to the corresponding analogical diagrams at 1:25,000 scale in urban areas and 1:50,000 scale in rural areas. The information available in these databases include a vector map covering the whole investigated area with the geometry of thousands enumeration districts corresponding to 3–5 building blocks in urban areas (Salvati, 2013). The surface area of each enumeration district polygon was calculated by way of the relevant ArcGIS 'Spatial analyst' tool (ESRI Inc., Redwoods, USA).

Settlement distribution and density

Depending on the city, the density of buildings was calculated in 1919 or 1920, 1945 (1940 in Barcelona), 1960 or 1961, 1970 or 1971, 1980 or 1981, 1990 or 1991, and 2000 or 2001 using the data collected in the framework of the Censuses of Population and Buildings, carried out by the representative national statistical authority, mentioned above. The building density was, then, calculated over time at each enumeration district. Six building density classes have been considered here: (i) density < 0.5 buildings *per hectare*, (ii) 0.6–1.0 buildings *per hectare*, (iii) 1.1–2.0 buildings *per hectare*, (iv) 2.1–5.0 buildings *per hectare*, (v) 5.1–10.0 buildings *per hectare*, and (vi) >10.0 buildings *per hectare*. The total surface area corresponding to each density class was calculated by summing the surface area of each enumeration district classified within that class. We calculated an indicator of urban growth as the ratio over time of land surface with more than 0.5 buildings *per hectare* to land surface with less than 0.5 buildings *per hectare*, and an indicator of 'compactness' as the ratio of dense urban land surface (with more than 10 buildings *per hectare*) to land surface with intermediate and low density (0.5–10.0 buildings *per hectare*) (see also Gargiulo Morelli and Salvati, 2010).

The analysis of self-contained urban growth

Self-contained growth was intended here as a process of settlement densification instead of the conversion of non-urban areas into impervious surfaces (hereafter 'urban expansion'). We have thus considered the proportion of new development that is occurring on previously developed land, rather than converting previously undeveloped land (e.g. agricultural land) to urban use, as a *proxy* of self-contained growth (Couch and Karecha, 2006). Following this definition, self-contained growth was quantified at each enumeration district of the four considered regions using three indicators (the number of buildings occurring on previously developed land, the related surface area, and the increase in self-contained building density) observed for 1945, 1960 (or 1961), 1970 (or 1971), 1980 (or 1981), 1990 (or 1991), and 2000 (or 2001). The reverse process (i.e. urban expansion) was assessed at the same years by way of the proportion of buildings developed in newly built-up districts on total buildings and the surface land of newly built-up settlements (Gargiulo Morelli and Salvati, 2010). Urban expansion in the four examined regions is also illustrated in maps (Fig. 2) representing the encroachment of the newly built-up districts through the years analysed.

Statistical analysis

In order to calculate changes in building distribution and density and to relate these variables to self-contained urban growth, the investigated time period was partitioned into six sub-periods (1919–1945, 1945–1961, 1961–1971, 1971–1981, 1981–1991, 1991–2001 for Rome, Lisbon, and Athens and 1920–1940, 1940–1950, 1950–1960, 1960–1970, 1970–1980, 1980–1990, 1990–2000 for Barcelona). The distribution of self-contained settlements (in terms of settlement density) was studied over time according to a mono-centric model incorporating the average distance of each enumeration district from the inner city. This variable was calculated by way of the ArcGIS 'spatial analyst' tool using the enumeration district centroid and a central place for each city (Praça de Rossio in Lisbon, Plaça de Catalunya in Barcelona, Piazza Barberini in Rome, and Platia Syndagmatos in Athens: see the map zoom level in Fig. 1).

Since the investigated urban regions have similar population size, each study area was classified into six concentric belts: (i)

Table 1
Selected morphological and demographic features observed in the four investigated regions.

City	Urban form	Population trends
Lisbon	Fragmented, medium-density, mono-centric	Slight decline after increase
Barcelona	Compact, high-density, polycentric	Slight increase after decline
Rome	Dispersed, low-density, moderately polycentric	Moderate decline after rapid increase
Athens	Hyper-compact, medium-density, mono-centric	Stable after strong increase

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