Harmonising Geographies for Analyses of Residential Segregation: An Example Using the 1km^2 cells of the European Grid for the City of Barcelona

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Abstract

To determine the trajectory of residential segregation over time we need a series of consistent population estimates. However, a time-series of estimates is hard to calculate for a variety of reasons, most notably due to alterations to the geographical boundaries for which data are disseminated. Therefore, unless a consistent geographical approach with time series data are taken, it is difficult to know whether changing trends are taking place or whether observed changes are simply an artefact of a boundary change. In Spain, this problem is particularly acute for small geographies such as census tracts, which are constantly affected by electoral changes. In this paper, we provide evidence of the potential of harmonising time-series data on a consistent geographical basis using the 1km^2 cells of the European grid as the target geography for national and international comparisons. Using data from the Municipal Register of Inhabitants (or population register), we present an implementation for analyses of residential segregation for the City of Barcelona. In doing so, we address our main research question –can consistent time-series be used as a way to improve comparability of residential segregation of foreign-born populations over time and space? Our results suggest that making the census tracts consistent over time is crucial for the interpretation of change in segregation, as indices can be altered and misleading when data directly from the population register are used. In this context, the results highlight that an increase in segregation can be purely artefactual, reflecting solely small area boundary changes between 2002 and 2013. After harmonising time-series data on a consistent geographical basis a decrease in residential segregation is observed for most groups, with alterations on the index values that can be greater than the impact of changes over time.

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Background

Small geographies in Spain and elsewhere are frequently used as an ideal base unit for collating and presenting local statistics from census rounds and population registers. Since both statistical operations are required to produce population data for each of the geographical units of the contemporary statutory geography, change in the electoral geography (secciones censales or census tracts) is one of the main processes that cause change in small geographies. As such, it represents a major influence on the geographical units and, consequently, a continuous challenge for analyses of population change in small areas over time. The development of the $1km^2$ cells of the European grid[1] clearly represents a solution to avoid the complexity of dealing with the boundary changes of census tracts in Spain.

A fundamental issue for this paper is to make small geographies comparable across time and space so that analyses of residential segregation are consistent. Any bias due to boundary changes results in a bias in the index values of residential segregation. Therefore, measuring residential patterns using indices of segregation at different points in time can be further reviewed by applying consistent population time series where geographical boundaries are harmonised across time. The sensitivity of segregation indices to this issues can vary significantly as shown by Simpson (2007) and Sabater (2010). Of course, this is seen as important from the standpoint of current debates on residential segregation in Spain, as it will help to understand more appropriately the level and direction of change in residential segregation since the beginning of the millennium after the unprecedented arrival of international migrants. While a few studies on residential segregation in Spain have taken into consideration boundary changes (Sabater et al. 2012; Sabater and Massey, 2015) using Geographical Conversion Tables (GCTs) that contained street addresses from the Electoral Census Street Map (Instituto Nacional de Estadística, 2012), the advantage of using $1km^2$ cells of the European grid constitutes a major step forward for consistent comparisons over time within and between European cities and/or countries. This paper seeks to further that interest by providing an implementation for analyses of residential segregation between 2004 and 2014 for the City of Barcelona. In doing so, we address our main research question –can consistent time-series be used as a way to improve comparability of residential segregation of foreign-born populations over time and space?

Data and Methods

This paper uses small area data from the Municipal Register of Inhabitants (a pivotal statistical source for population counts in small areas during intercensal years) and the $1km^2$ cells of the European grid for the City of Barcelona. The latter contains 104 cells of $1km^2$ where at least one primary or non-primary dwelling is located[2]. For expository purposes, Table 1 shows the

[1] In 2007 the European Parliament passed the INSPIRE directive, aimed to establish an Infrastructure for Spatial Information in the European Community (Directive 2007/2/EC). One of its outcomes was the creation of a geographic-harmonized grid (with a resolution of $1km^2$) for all EU28, EFTA and EU candidate countries, which can be used for disseminating statistical data (INSPIRE, 2014).

[2] The complete European grid can be download from: http://www.efgs.info/data/european-datasets/eurogrid

difference in the number of census tracts for years 2002 (1,491) and 2013 (1,061) as well as the population composition by region of birth for the City of Barcelona.

Table 1: Census tracts and population composition by region of birth – Barcelona, 2002 and 2013

	Year 2002	Year 2013
Number of census tracts	1,491	1,061
Population (born in):		
Spain	1,384,923	1,260,629
Latin-America	74,346	172,615
Western Europe	22,757	56,835
Eastern Europe	6,575	28,047
Africa	17,386	24,283
Asia	19,212	63,555
Other	1,991	5,858
Total Population	1,527,190	1,611,822

Source: Own elaboration with data from the Municipal Register of Inhabitants (Spanish Statistical Office, aka INE)

Methodologically, this paper is divided in two parts. First, we update population data collected from the previous spatial system (i.e. population counts by region of birth in census tracts between 2002 and 2013) to a set of contemporary zones (i.e. the 1km^2 cells of the European grid) applying a generic long-term GIS solution based on data interpolation (Goodchild *et al*., 1993). The following steps provide a summary of its implementation[3]:

1) Source and target geographies are assembled as separate layers to indicate the extent of overlap between the previous spatial system and the contemporary zones (see Figure 1 in the Annex).
2) An intersection shapefile is created, which allows the computation of weights. Each weight shows the proportion of the source geography unit that lies in the target geography unit[4]. The advantage of this approach to adjustment is that the summation of population data of the source geography is preserved in the transformation of the new target geography[5].
3) Populations are proportionally redistributed among the intersection polygons.
4) Each intersection-polygon keeps the ID of the grid cell and the population can be allocated by summing up the population in each cell of the grid (see Figure 2 in the Annex).

Second, we assess the spatial situation of foreign-born populations by region of birth across grid cells in the City of Barcelona by employing the two most common measures of segregation: the dissimilarity index (D) and the isolation index (P_{xx}*). Although a plethora of indices have been used to capture various dimensions of residential segregation (Massey and Denton 1988; Massey et al. 1996), we rely on the most two most common in order to maintain continuity and allow

[3] All steps have been performed using the free and open code software QGIS.
[4] We use the poly.areas function of the GIStools package for R (Brunsdon & Chen, 2006).
[5] When a lack of coverage between the source geography and the target geography exists, this can result in population losses. For example: in 2013 there are 14 census tracts (out of 1,061) with different share of their areas not covered by any cell. This situation results in a loss of 5,642 people (0.35% out of the total population). In order to avoid this, the weight of the uncovered areas is distributed among rest of polygons belonging to the same census tract.

straightforward comparisons both nationally and internationally. These measures reveal the level and change over time with respect to two dimensions of spatial variation: *evenness* and *exposure*. The dissimilarity index measures how unevenly distributed each foreign-group is relative to native Spaniards across grid cells within the municipality of Barcelona. Multiplying by 100 expresses the share as a percentage, such that 0 indicates complete spatial integration and 100 represents total spatial segregation. Residential isolation is computed using the P_{xx}* index, which is used to indicate the degree of potential contact between members of the same group, represented by *x*. This index is also commonly expressed as a percentage, where 0 indicates no likelihood of contact with own-group members within grid cells and 100 means that the unit contains *only* the same foreign-born group.

Preliminary findings and implications

Since in the Spanish context census tracts are frequently changed in order to ensure electoral equality, the use of a consistent time series appears to be fundamental in order not to confound trends in residential segregation with boundary changes. The analysis indicate that after converting population data from 2002 to 2013 using the $1km^2$ cells of the European grid a decrease in residential segregation is observed for all groups, with alterations on the index values that can be greater than the impact of changes over time. Therefore, unless a consistent geographical approach with time series is taken, it is difficult to know whether changing trends are taking place or whether observed changes are simply an artefact of a boundary change. The latter is not only important for comparisons of residential segregation over time within and between European cities and/or countries, but also for academic research which uses annual time series of small area populations, including analysis of population change, small area projections; and when data from the population register are used as the denominators in rates.

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ANNEX

Figure 1: 1km^2 grid for the municipality of Barcelona (1), Barcelona by census tracts in 2002 (2), overlap between 1 and 2 (3); and intersection between 1 and 2 (4)

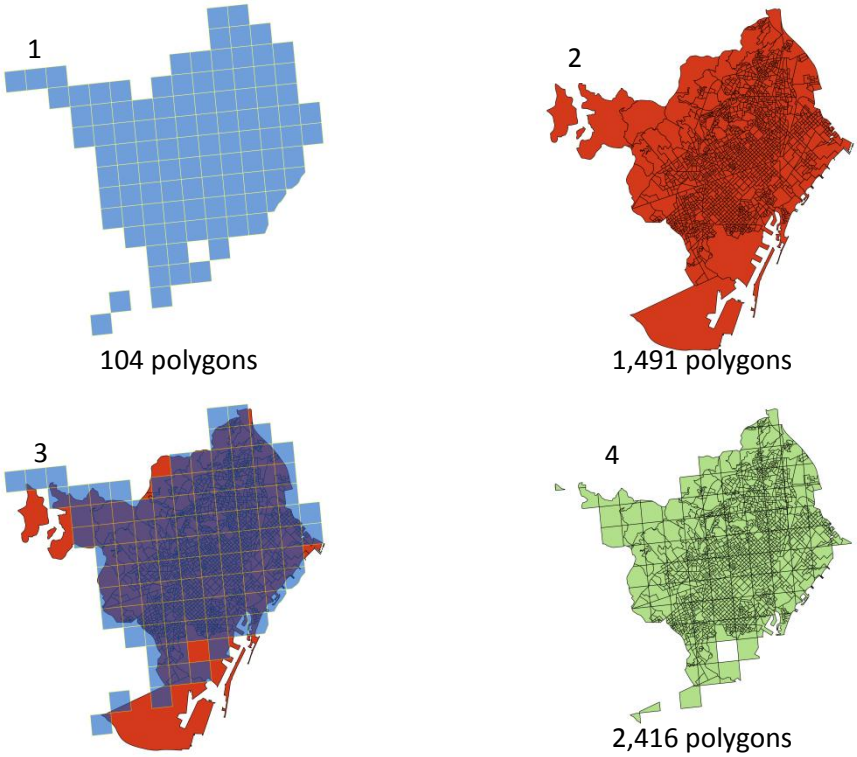
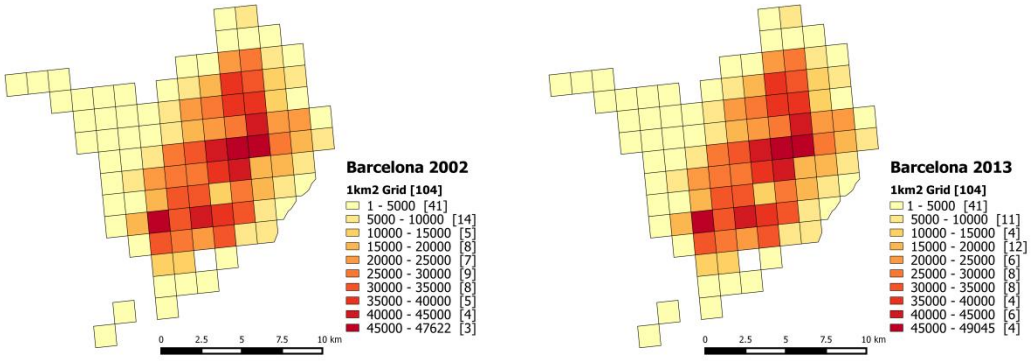


Figure 2: Total population by 1km^2 cells – Barcelona, 2002 and 2013



Source: Own elaboration