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Spatial approach to analyzing dynamics of racial diversity in large U.S. cities: 1990–2000–2010

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ABSTRACT

Over the last several decades large U.S. cities became increasingly racially diverse. Understanding spatio-temporal dynamics of this significant social change and identifying its broad trends are important for numerous stakeholders. High resolution population grids, which recently become available for the entire conterminous U.S. and for three time points from 1990 to 2010, are an ideal dataset for analyzing dynamics of racial diversity. Their value to diversity analysis has been already demonstrated at the level of the entire U.S. as well as at the level of an individual city. In this paper, we demonstrate their value for performing a survey aimed at synthesizing diversity dynamics from different cities in order to identify prevalent nationwide trends. Our survey consists of 41 large cities. 1990-2000-2010 snapshots of racial condition at each city are provided by respective grids in which each cell is assigned one of nine possible diversity/dominant race categories. All cells with the same diversity label constitute a zone which we refer to as community and measure using a percentage of a landscape (PLAND) and an aggregation index (AI) metrics. An inclusion of the AI metric makes possible to determine not only whether a given community grows or shrinks but also whether it's merging or fragmenting. We analyze the spatio-temporal evolution of communities by tracking changes in the pairs of the values of these metrics. To simplify we categorize these changes into eight categories resulting in 64 possible change trajectories for each community. Trajectories are histogrammed to reveal variety or scarcity of possible modes of change. Frequent trajectories are identified with broad trends. Eight such trends are identified, they represent most prevalent racial dynamics in the U.S. during the decades of 1990–2010. Two trends correspond to decay of whites-dominated and blacks-dominated communities. The remaining six trends correspond to the expansion of Hispanics, Asian, and racially diverse communities. Trends do not show regional dependence, they truly reflect profound social change occurring across the entire U.S.

1. Introduction

The Unites States is overall a multiethnic society, but on smaller spatial scales of a single city or an individual neighborhood, it has been and still is quite segregated. However, in the last decades, a segregated character of American cities and neighborhoods is eroding (Iceland, Weinberg, & Steinmetz, 2002; Iceland, 2004; Farrell & Lee, 2011; Wright, Ellis, Holloway, & Wong, 2014; Zhang & Logan, 2016) due to increased immigration from non-European countries and shifting social attitudes. Understanding long-term directions of the racial/ethnic character of U.S. cities and neighborhoods is of great interest to numerous stakeholders including academics, policymakers, and the business community. Because of this interest there exist numerous studies devoted to assessing changes in racial diversity at the spatial level of individual cities.

Iceland et al. (2002) and Iceland (2004) measured change over the 1980–2000 period in segregation and diversity of 325 American cities with a population larger than 50,000. They used entropy index (Massey & Denton, 1988) to track changes in an overall diversity of a city and the information theory index to track changes in how evenly different racial groups are distributed across city neighborhoods. Farrell (2008) and Farrell and Lee (2011) calculated the same two indices for 100 largest U.S. cities in 1990 and 2000 to test three different hypotheses for a prevailing trend in changing the racial structure. Fischer, Stockmayer, Stiles, and Hout (2004) also used the information theory index in a comprehensive study of diversity change in 175–331 largest metropolitan areas during the 1960–2000 period. Logan, Stults, Farley, and Stults (2004) measured change over the 1980–2000 period in segregation between two groups (combinations of whites, blacks, Hispanics, and Asians) in up to 255 cities using the index of dissimilarity

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(White, 1986; Massey & Denton, 1988).

The aforementioned studies relied on indices calculated from mutually permeating subpopulations of different racial groups to assess change in segregation/diversity, but another research thread used an approach which relies on the classification of neighborhoods on the basis of the distribution of residents by race. Logan and Zhang (2010) classified local areas (census tracts) and tracked differences in their classification category between 1980 and 2000. In the follow-up study Zhang and Logan (2016) performed a similar analysis of diversity change using a larger sample of 342 cities and a longer time period (1980–2010). Another tract-based classification method was used by Fasenfest, Booza, and Metzger (2004) to quantify 1990–2000 change in racial character in 10 largest U.S. cities, and yet another by Johnston, Poulsen, and Forrest (2003) to quantify 1980–2000 changes in the racial character of four large cities (Chicago, New York, Los Angeles, and Miami). Farrell and Lee (2011) classified tracts into 100 major metropolitan areas into diversity/dominant race categories and analyzed change using matrices showing transitions between tracts category assignments during 1990–2000 period. Wright et al. (2014) used similar classification technique applied to 53 major metropolitan areas using data from 1990, 2000, and 2010. The same methodology, but applied to high resolution grid rather than census tracts, was used in Dmowska and Stepinski (2016) to calculate a transition diagram tracing how the entire U.S. population redistributes among different diversity/dominant race categories during the 1990–2000 period.

Although approaches to assessing change in the racial character of U.S. cities vary (see above), their broad conclusions are qualitatively the same: the white-dominated urban neighborhoods are rapidly decaying, predominantly Hispanic and Asian neighborhoods are on the rise, and black-dominated neighborhoods remain stable. However, although a broad direction of change in the racial character of American cities is now established, important details on spatio-temporal dynamics of these changes were not addressed by the previous studies. For such details to emerge an explicitly spatial analytic approach needs to be applied to high resolution population data.

Since 2013 we have been working (Dmowska & Stepinski, 2014, 2016, 2017; Dmowska, Stepinski, & Netzel, 2017) on making such approach possible. The result of this work is an interactive GeoWeb application SocScape and an associated database (both available at http://sil.uc.edu) which display/provide 30 m/cell grids of U.S. population, its subpopulations, as well as its classification into diversity/dominant race categories. The grids are the results of dasymetric modeling of 1990, 2000, and 2010 census block-level data. Details of racial dynamics can best be observed using change maps constructed from the grids for 363 major metropolitan areas (Dmowska et al., 2017). Examples of such maps for Chicago, Houston, and San Francisco can be seen in Dmowska and Stepinski (2016). They can also be observed for any place in the conterminous U.S. using SocScape for a side-by-side comparison of diversity/dominant race maps at 1990, 2000, and 2010, an example of such comparison for the north-eastern part of Atlanta, GA is shown in Fig. 1.

In this paper, we provide a synthesis of racial dynamics in selected large U.S. cities based on high resolution diversity/dominant race grids (hereafter referred to as diversity grids for short). Because we use gridded data instead of areal units (like tracts) our approach to the synthesis is significantly different from those used in previous studies. We track time evolution (hereafter referred to as a trajectory) of different “communities” in each city in our survey. In this paper, a community means a zone comprising all locations (cells in a grid) assigned to the same diversity category. It also means a specific mix of a different racial group as indicated by a category label; a presumption is that such mix correlates with a broader social character since the name community.

For a given community we gather their change trajectories from all cities in our survey and categorize them to reduce the complexity of the data. A histogram of categorized trajectories shows a range of dynamics this particular community experienced in different U.S. cities. A prominent peak in the histogram indicates an existence of a trend – a specific dynamics that occurred in a significant fraction of the cities in the survey. We search for such trends among all communities. The end result of our synthesis is a list of all identified trends. These trends highlight most widespread patterns of racial change in large U.S. cities during the 1990–2010 period. We also look for possible regional differences in trends as well as less frequent change trajectories.

2. Data and methods

SocScape 30 m/cell resolution racial diversity grids for years 1990, 2000, and 2010 (Dmowska et al., 2017) constitute an input data for our investigation. From this dataset, we extracted grids for a selection of 41 MSA (thereafter referred to simply as cities) defined by the extent of urban areas within them. Our criteria for the selection were as follows: (1) the population of the entire MSA was over 1 million in 2010, and (2) all nine diversity/dominant race communities (listed below) were present in 1990, 2000, and 2010. These grids are a product of three-dimensional classification of cells into 40 categories (including one indicating uninhabited area) based on criteria of racial diversity, dominant race, and population density (Dmowska & Stepinski, 2014; Dmowska et al., 2017). For the present study, we have collapsed the original classification to just 13 classes by eliminating dependence on population density. These classes describe specific racial mixes or communities (see the Introduction section) by commenting on the level of diversity and on the dominant race (if any).

Note that 30 m/cell is a nominal resolution of the grid and corresponds to a resolution of an ancillary data (land cover) used in a dasymetric model (Dmowska & Stepinski, 2017). A grid cell is not an areal unit in the same sense as, for example, a census block is, inasmuch as it carries a value of population density rather than a value of population count. However, a community is an area unit as it is formed from an agglomeration of all cells having the same diversity label.

We focus on nine predominant communities: white low diversity (WL), white medium diversity (WM), black low diversity (BL), black medium diversity (BM), Hispanics low diversity (HL), Hispanics medium diversity (HM), Asians low diversity (AL), Asians medium diversity (AM), and high diversity (Hdiv). For example, the white low diversity community (WL) is a zone consisting of cells where density of white population is over 80% of the total population density, and the white medium diversity community (WM) is a zone consisting of cells where density of whites dominates the total population density but don’t exceed 80% of the total density. The Hdiv is a zone consisting of cells where total population density is not dominated by any single race.

To illustrate how diversity grids depict the change in the racial character of a city Fig. 1 shows grid-based maps restricted to a north-eastern part of Atlanta, GA. The progression of maps from 1990 to 2010 clearly shows the WL community being replaced by the WM community over time. Fig. 1 also shows the growth of HM and Hdiv communities from what used to be WM-dominated part of the city in 1990, and an expansion of BM and BL communities in the north-eastern direction.

2.1. Measuring community zones

A side-by-side visual assessment of a progression of diversity maps for a single city (like in Fig. 1) reveals changes in city’s racial character in details, however, the results of such assessment performed for multiple cities would be difficult to synthesize. To perform synthesis of racial dynamics over multiple cities we introduce two spatial metrics that summarize magnitude and spatial distribution of each community zone. These metrics could be compared from year to year to give a quantitative measure of the change.

In Dmowska et al. (2017) we noted that diversity maps, like the ones in Fig. 1, have the same data format as landscapes in the field of