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A Multidirectional Optimal Ecotope-Based Algorithm to Delineate a Commuter Shed

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1. Introduction

In commuting research the geographic area under investigation is of crucial importance. When examining commutes occurring in a region of interest, the selection and use of different city, county, or metropolitan region boundaries will have a large impact on analyses of travel times and distances, whether a transit network provides adequate access to jobs, levels of congestion, and so on. This is closely linked to the spatial form of cities (especially in the North American context) where a relatively dense city is surrounded by suburbs with progressively lower densities. Determining what actually constitutes a commuting region (or “commuter shed”) is typically a matter of using administrative boundaries prescribed by the U.S. Census Bureau. In general though, the metropolitan region is often used because it represents a big enough area to capture most of the economic activity occurring inside. The issue with metropolitan boundaries, however, is summarized in Morrill et al. (1999), “... metropolitan areas are widely recognized as far from consistent in meaning or adequate in definition.” The problem is largely attributed to the use of counties as building blocks. Counties that are selected to comprise a metropolitan region are those neighboring the county or counties containing the largest principal city. The neighboring counties are included if they are socially and economically connected to the principal county, as measured by the number of commuters coming into the central county (Office of Management and Budget, 2010). Counties have a large spatial extent, and oftentimes include vast rural spaces with little relationship to the urbanized area of interest to many researchers. A method for providing a more precise measure is warranted.

In many ways a commuter shed is like a cluster of commuting activity, where there are significant links between residents moving between relevant, contiguous zones. Here, we use a cluster detection method to delineate the commuter sheds of the counties that make up the Miami, FL metro region. We take census tracts as the building blocks to provide a more precise representation of the commuter shed, and test the spatial interaction of these tracts using the percentage of commutes into the various zones and an advanced spatial clustering statistic.

2. Relevant Literature

As previously mentioned, commuter sheds are the de facto analysis areas of most commuting research, the results of which are sensitive to the definition of the study area. Researchers are therefore interested in these definitions, as they attempt to accurately describe settlement patterns across the country and provide a reasonable assessment of how people move within an urban region. The current method used by the US Census examines the “percent of commutes” in a county to the nearest county containing a central city. So, an outlying county is included if it has at least 15% of its commuters working in that central county (or counties). But an outlying county can only be assigned to one central county and the determination is made based on commutes from the possible central counties added to commutes to the central county.

Generally, this effort is to determine the location of suburbs of various urban areas and which rural places are not exurban suburbs but places unto themselves.

3. Methods

This research expands on Morrill et al.'s work by using a novel cluster detection method to delineate the commuter shed of Miami, Florida. The method is called A Multidirectional Optimal Ecotope-Based Algorithm or AMOEBA, developed by Aldstadt and Getis (2006). AMOEBA uses the G_i^* statistic to determine spatial interactions (Getis & Ord, 1992). The method calculates G_i^* for all of the zones in a region iteratively determining whether to include a zone in the cluster based on the mean G_i^* score. The variable used here to determine the presence of a cluster is the percentage of the commutes that terminate within an area of interest. To test the sensitivity of defining commuter sheds in a multi-core region using a clustering analysis, as the identification of clusters will be subject to the number of total tracts included, we use study areas that include tracts within 60-, 90-, 150- and 180-mile buffers of Miami-Dade, Broward, and Palm Beach counties, as well as the Miami Urbanized Area. Finally, as the high-resolution commuting data are stratified by a number of interesting categories (described below), we additionally run the AMOEBA method on these different sets of workers to see how commuter sheds vary.

4. Data

The data used here are origin-destination pairs from the Census' LEHD dataset, referred to also as the LEHD Origin-Destination Employment Statistics (LODES). These data are available annually for most of the U.S. between 2002 – 2014. Several commuting studies have made use of the LEHD dataset like Horner et al. (2015), demonstrating the utility of high-resolution commuter data.

The OD data files contain counts of the number of workers making trips between census blocks, however, in order to execute the computation of the clustering statistic in a reasonable amount of time, these counts are aggregated up to the census tract level. These OD files include counts stratified by three income categories, three age categories, and three industry classification categories. The LODES data also distinguishes between primary and secondary employment, so only primary employment is considered in this study. As administrative boundaries often change over time, the LEHD data program has resolved the 2002-2009 data to the corresponding 2010 blocks.

5. Results

As mentioned previously, the U.S. Census Bureau uses commute trips into the county or counties that contain the urban area. Figure 1 shows the census tracts within 90 miles of Miami-Dade County and the percentage of commutes that terminate within Miami-Dade County.

Figure 2 shows the results of the AMOEBA method applied to the city of Miami, Miami-Dade county, the Miami urbanized area, and finally the entire three county metro region, each with a 150-mile buffer. With the clustering results of all counties displayed the overall cluster appears to match well with the Census Bureau's delineation (all three counties). What is interesting here is that, with the exception of a little overlap at the boundary of each county, each cluster is relatively relegated to the county it comes from. Each of these counties is home to a relatively large city and the clustering suggests that the Miami metro region might more accurately be described as three metropolitan regions.

All together these clusters present a novel way to depict an area's commuter shed by improving on the current U.S. Census Bureau definition. Using a cluster detection method with high-resolution data, as we do here, removes many of the issues that arise when defining

unique commuter sheds related to particular city. Table 1 shows the total number of tracts that constitute the high cluster, low cluster, and the outside cluster.

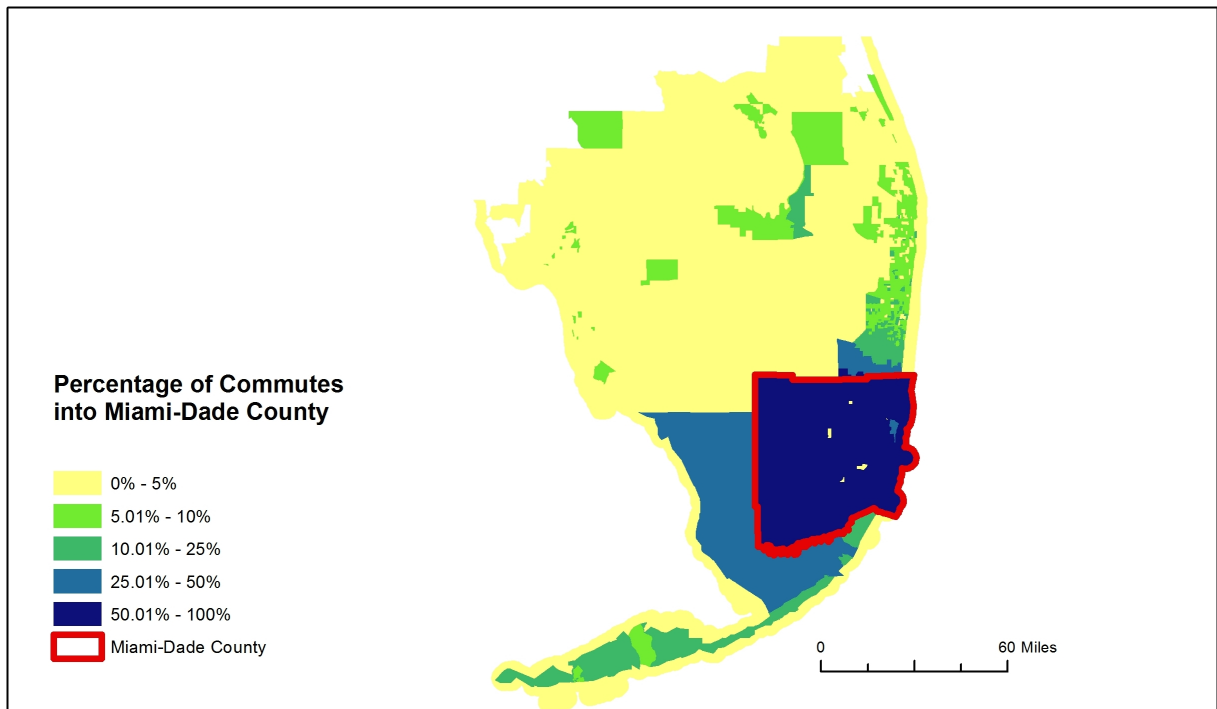


Figure 1. Commutes into Miami-Dade County in 2013.

Table 1. Number of tracts in each AMOEBA cluster.

	60 miles			90 miles			120 miles			150 miles		
	high	low	outside	high	low	outside	high	low	outside	high	low	outside
Cities												
Miami	497	630	26	497	751	27	503	993	21	506	1178	18
Fort Lauderdale	277	954	7	279	1054	6	282	1287	13	290	1295	10
West Palm Beach	190	872	18	193	1198	16	197	1536	12	199	2038	11
Counties												
Miami-Dade	516	736	12	519	1037	10	519	1176	11	519	1384	13
Broward	360	994	4	361	1276	5	361	1429	5	366	1950	8
Palm Beach	331	1127	7	330	1450	8	330	2118	8	330	2914	8
Metro Region	1206	282	5	1207	597	6	1207	1250	10	1207	2035	11
Urbanized Area	1195	168	5	1199	310	7	1202	636	7	1205	1207	12

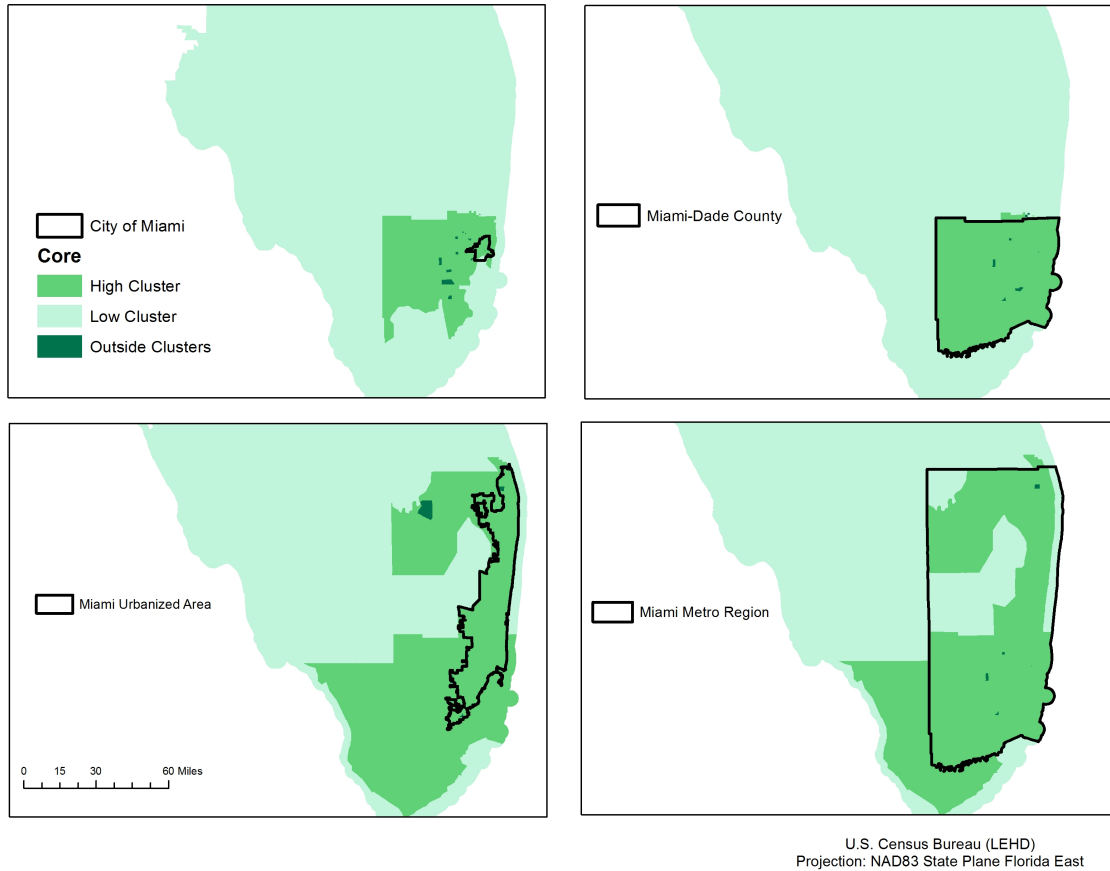


Figure 2. AMOEBA results for Miami, Miami-Dade County, the Miami urbanized area, and the metro region.

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