How to Capture Neighborhood Change in Small Cities

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Abstract

Small cities across North America are experiencing rapid changes, but methodological obstacles hamper researchers' ability to analyze them. This research note explores some of the methodological challenges faced by researchers and offers solutions. Using Charlottetown, Prince Edward Island, as a case study, we show that a major challenge lies in choosing meaningful geographic units for small city neighborhoods, and we evaluate the benefits and drawbacks of several geographical options. Another major challenge is that the boundaries of existing units change between census years, demanding an approach to reconstructing them to allow for temporal analysis. We propose two feasible solutions for re-creating neighborhood geographic units over time: 'moving forward' and 'going backward.' Both involve selecting units from a particular census year to serve as a fixed point of reference for the re-creation of boundaries across multiple census years. We conclude by cautioning that studying changes in small cities over longer time periods in Canada is not feasible because of the extensive and

complex boundary changes that have occurred between census years. We offer an approach for looking at shorter time periods.

1 Introduction

The majority of research analyzing cities has focused on major metropolitan centers (AUTHOR A et al. 2019; AUTHOR B et al. 2014), contributing to our understanding of how large cities transform over time. However, most of the world's cities are small cities, and we know little about them. For example, in 2016, 40% of the Canadian population lived in a place with fewer than 100,000 people (Statistics Canada 2018). At the same time, small cities in North America are experiencing rapid change, warranting further investigation (Everitt and Gill 1993; Ley 1986; MacKinnon and Nelson 2005). But researchers' ability to analyze those changes is hampered by a number of methodological obstacles: in particular, they encounter problems selecting an appropriate geo-spatial scale to analyze neighborhoods in small cities, and inconsistent boundaries in geographic units limit comparability over time. Using Charlottetown, Prince Edward Island, as a case study, we explore issues that affect the analysis of changes in small cities.

2 Socio-spatial Units

Research on urban socio-spatial patterns of change typically focuses on larger cities. There is an abundance of scholarship on Canada's three largest Census Metropolitan Areas (CMAs), Montreal, Toronto and Vancouver, and most of it uses Census Tracts (CTs) as proxies for neighborhoods (e.g., Hulchanski 2010; Ley 1986; Skaburskis 2012). CTs are intended to represent relatively homogenous geographic areas within cities and are typically limited to populations between 2,500 and 8,000. While CTs are well-suited to approximate neighborhoods in major urban centers, they pose challenges for researchers studying neighborhood change in mid- and small-sized cities.

In mid-sized CMAs, as well as in tracted Census Agglomerations (CAs), CTs are assigned but often too large to accurately reflect neighborhoods in these cities. CTs can mask diversity within geographic areas by aggregating heterogenous populations. This is known as the Modifiable Areal Unit Problem (MAUP) (Amrhein 1995; AUTHOR B et al. 2014; Gehlke and Biehl 1934). Within mid- and small-sized cities, CTs often have much internal heterogeneity across income and socio-demographic characteristics. When geographic units are too large, important differences go unobserved. Simply put, smaller cities have smaller neighborhoods, and ideally, this should be reflected in the scale of geographic units used to study them.

Compounding the problem, Statistics Canada does not assign CTs in Canada's smallest cities, CAs with core populations below 50,000. This is a significant challenge for the study of small cities. Other geographic units do exist, which capture data at a finer grain than the CA level. For example, Census Subdivisions (CSDs), Enumeration/Dissemination Areas (EAs/DAs), Forward Sortation Areas (FSAs), and Aggregate Dissemination Areas (ADAs) can all be used to look at smaller areas within small cities. However, each of these units poses problems for researchers interested in learning about city neighborhoods.

In addition to the problem of choosing a meaningful geo-spatial unit for neighborhoods in small cities, another problem emerges with changing geographic boundaries. Although Statistics Canada tries to preserve the boundaries of geographic units across census years, boundary revisions are inevitable. Such revisions are made due to new road construction, neighborhood growth, overall population growth, and community development. In most cases, CTs are split into multiple CTs as they grow over time, requiring researchers to recreate the original CT boundaries by aggregating the data if they want to study changes between censuses. To address some of the challenges around changing boundaries, the Canadian Longitudinal Census Tract Database has been developed using the 1971-2016 Canadian Censuses. Allen and Taylor (2018) offer details on these issues for CTs. The same problems occur for other geographic units as well, but there is less information available on reconstruction or concordance over time. This means problems are exacerbated for those hoping to capture neighborhood changes over time in small cities. In this research note, we discuss various options available for addressing these problems and offer insights on how to study neighborhoods in small cities while capturing changes over time.

3 Untracted Cities and Problems with Alternatives to Census Tracts

Charlottetown is classified by Statistics Canada as a CA and it is untracted; that is, it has not been assigned CTs. While its population is small compared to those of major cities, Charlottetown has experienced rapid population growth in recent years, rising from 58,625 in 2006 to 69,325 in 2016, an 18% increase (Statistics Canada 2007, 2017). Research on the city has shown an increase in immigration is changing the city's economic, socio-demographic and cultural make-up (Baldacchino 2006; Barrieau and Savoie 2006). However, capturing these changes within Charlottetown is difficult because it is unclear what geo-spatial units can be used to represent its neighborhoods. Figure 1 presents some of the options available to researchers and shows how they plot on the city.

[Fig. 1 about here]

CSDs are the classification used by Statistics Canada for municipalities or their equivalent and are one possible option for studying different areas within CAs at a finer grain. Like CTs, CSDs respect the boundaries of larger geographic units like CMAs and CAs. Therefore, in some cases, CSDs can be used as an alternative to CTs for studying neighborhoods or communities in untracted CAs like Charlottetown. However, like CTs, CSDs are also subject to boundary changes and dissolutions between census years. This means effectively tracking changes over time can be quite complicated. If CSD boundaries have changed more than once in the study period, lower geographic units like EAs/DAs are needed to recreate CSDs. The reliability of the measure deteriorates as boundaries change and eventually become impossible to recreate.

In the case of the Charlottetown CA, using CSDs as a proxy for neighborhoods presents another challenge. Among the 22 CSDs that make up the Charlottetown CA, one CSD represents the entire municipality of Charlottetown, with approximately 36,000 residents. Nearby CSDs have populations ranging from 51 to 9,706, and most of their residents would not consider their areas as part of the city (AUTHOR A et al. 2019). Instead, they would see them as outlying towns, villages, and small communities. Moreover, because the majority of Charlottetown residents are living within its principal CSD, neighborhood-level differences within this large and relatively diverse area cannot be ascertained using CSD data. While CSDs can provide meaningful aggregation for smaller communities included within a CA, they are much too large to home in on urban neighborhoods.

Another possibility for constructing neighborhood data for a small city like Charlottetown is to use EAs and DAs. Until 2001, EAs represented small geographic areas composed of one or more neighborhood blocks (Statistics Canada 2001). The number of dwellings within each EA typically varied from a minimum of 125 for small geographic areas like Charlottetown and other rural areas to a maximum of 650 for larger CMAs and tracted CAs. One advantage of using EAs is that they can be aggregated to create any of the geographic areas above them in the geographic hierarchy, such as CSDs or CTs. However, like CTs and CSDs, their boundaries can change over time. EAs were phased out beginning in 2001, fully discontinued in the 2006 Census, and replaced by DAs.

Much like EAs, DAs represent small, stable units composed of one or more neighborhood blocks. However, unlike EAs, DAs have a population target of around 400 to 700. Thus, when DAs replaced EAs, the resulting changes caused significant disruption for researchers looking at changes over time at this level of geography. While a correspondence file was created by Statistics Canada to note these changes, it does not provide sufficient information to effectively re-create the former EA boundaries. Thus, attempting to use this geographic unit can be complicated when the temporal period of analysis includes the transition period from EAs to DAs. Moreover, both units present challenges for those looking at changes over a longer period of study. This is because, like EA boundaries, DA boundaries can also change across census years and may even change multiple times over a longer period (e.g., 1991 to 2016). While this is a drawback to achieving compatibility over time, this option is viable in some cases and will be discussed in detail later.

Forward Sortation Areas (FSAs) are yet another option for studying smaller areas within untracted cities. FSAs represent the area sharing the first three characters of a postal code. However, small cities often have a limited number of FSAs, which can mask variation within them. This can vary substantially by city. Charlottetown, for example, has only four FSAs in its urban area and one FSA for the rural area outside the city. But another untracted CA in Atlantic

Canada, the Cape Breton Regional Municipality—which includes the city of Sydney and its surrounding communities, with a total population of 98,722 in 2016—contains 18 FSAs. Thus, the appropriateness of FSAs may depend on which small cities are being studied. In Charlottetown, FSAs are much too large to capture neighborhoods. But even in cities with more, smaller FSAs, researchers should be aware that this geographic unit does not respect larger units like CSDs or CAs and can have highly irregular boundaries (Maaranen 2015). Moreover, like other geographic units, FSAs change over time, meaning longitudinal comparisons need to account for those changes as well.

The final option we consider is the Aggregate Dissemination Area (ADA), introduced by Statistics Canada in the 2016 Census. ADAs are aggregated geographic units created from existing DAs. They are not limited by physical size and can subsume existing DAs, CTs, or CSDs, respecting the boundaries of each of these units. ADAs are, however, limited by population, with the population of each ADA ranging from 5,000 to 15,000 (Statistics Canada 2016). To meet these population requirements, ADAs outside dense urban areas must usually cover large geographic areas, including multiple towns or communities (CSDs). But, within the urban cores of untracted CAs, ADAs may present a possible level of aggregation that is larger and less finicky than EAs/DAs but which divides highly populated CSDs into meaningful, distinct areas or large neighborhoods. This possibility does not, however, solve the problem of longitudinal analysis that includes census years before 2016. We offer our suggested approach using ADAs 'going backward' below.

We argue that among these options, using EAs/DAs or a combination of ADAs, EAs/DAs, and CSDs are likely the best options for re-constructing neighborhood- or community-level data that is comparable over time. But the organization of small cities and the distribution of geographic units can vary substantially. Thus, it is important to be attentive to the unique population and geographic characteristics of the cities being studied. We recommend using EAs and DAs for the study of urban neighborhoods in small cities whenever possible, since these units are small enough to capture the diversity of neighborhoods in small cities. These can be reconstructed across census years through statistical coding. This process can be labor-intensive, however, as it demands the re-creation of particular geographic boundaries over time. Below, we outline two possible approaches for doing this, as well as the problems we encountered while pursuing these approaches and our lessons learned.

4 Moving Forward or Going Backward to Reconstruct Boundaries and Track Changes over Time

While we believe EAs/DAs are the best scale for capturing urban neighborhoods in small cities without masking internal heterogeneity, we find that reconstructing boundaries over an extended period of time (e.g., from 1996 to 2016) is not feasible in Charlottetown. This is because substantial boundary changes occurred between the 2001 and 2006 Censuses, where 2001 DAs were split into many DAs in 2006. For example, a 2001 Charlottetown DA, 11003005, was split into four new DAs in 2006, leading to a series of 'many-to-many' splits. That is, as shown in Figure 2, parts from two of these four new DAs (11020033 and 11020038) also originate from three other 2001 DAs: 11003009, 11003018 and 11003019.

[Fig. 2 about here]

This is only one example among many, illustrating the complexity of the changes and the impossibility of reconstructing comparable boundaries over extended time periods. Beginning in

2006, however, we find it is possible to reconcile the boundary changes that occurred in Charlottetown from that point forward.

Based on our experience studying Charlottetown, we propose two possible approaches for conducting longitudinal analysis in small cities: 'moving forward' and 'going backward.' Both approaches require the use of 'time blocks.' This means that, once a set of boundaries is chosen as the point of reference (e.g., 2006 DAs), they can be reconstructed in five-year 'time blocks,' using Statistics Canada's correspondence files (e.g., 2006 DAs and 2011 DAs). Because these correspondence files only provide the correspondence between units in adjacent census years, it is not possible to directly determine correspondence over a longer time period (e.g., 2006 to 2016). Instead, researchers studying changes over a longer period must create their own extended correspondence files spanning multiple census years.

The 'moving forward' approach requires fixing time from the past (e.g., 2006) to the present (e.g., 2016). Along with correspondence files, researchers can also use shapefiles representing geo-spatial vector data to determine the physical/geographical change in units across census years. This requires working with geographic information programs like ArcGIS. Once boundary changes have been identified, any changes to unit classification codes between census years should be noted in researchers' extended correspondence files. These steps must be repeated across census years for the entire study period. When this is done, longer periods of time can be analyzed. Appendix 1 shows how this strategy applies to the Charlottetown CSD from 1996 to 2016.

Moving forward through time, tracking changes became extremely complicated due to the elimination of EAs and the introduction of DAs in the 2001 Census. Because the number of EAs and DAs within a larger geographic unit (e.g., CSDs) can be 100 or more, repeating this process to achieve concordance between EAs and DAs for an entire city can be prohibitively labor-intensive, even between two adjacent census years. If the timeframe of analysis is longer, these procedures need to be repeated multiple times. Indeed, given the magnitude and extent of the boundary changes that occurred when DAs replaced EAs, our study determined including Charlottetown data prior to 2006 was an impossible task using this approach. However, from 2006 to 2016, we found this strategy feasible. Appendix 1 provides details for this strategy, where we successfully tracked 66 DAs from 1996 to 2016.

Another option is ‘going backward’ in time, reconstructing current geographies in previous census years. Using this approach, boundaries are fixed to the present (e.g., 2016) and re-created for earlier periods (e.g., 2011, 2006, 2001, 1996). As with ‘moving forward,’ tracking changes ‘backward’ over a longer period of time (e.g., from 2016 back to 1996) was not possible in Charlottetown due to extensive boundary changes. Nevertheless, this approach was particularly valuable due to the addition of ADAs to the 2016 Census. These units are unavailable in previous census years but can be reconstructed ‘going backward’ using DA correspondence files. As with ‘moving forward,’ time blocks are needed to track the correspondence between current ADAs and the DAs from previous censuses and to re-create ADA boundaries. Using this strategy, we were able to track 66 DAs in Charlottetown from 2016 to 1996, as shown in Appendix 1. This approach required writing statistical code for the reconstruction of ADAs by aggregating the DAs that constitute them. For details, see Appendix 2.

We used the ‘going backward’ approach to examine changes in the four ADAs that lie within the city’s principal CSD, approximating large neighborhoods within the urban core of Charlottetown. This approach may be especially valuable to researchers when the DA level is too narrow. For instance, if untracted CAs are being studied alongside tracted CAs and CMAs, researchers may find ADAs in core areas more comparable to CTs in population and physical size than DAs. But outside urban cores, ADAs can be very large geographically to meet population levels of 5,000 to 15,000, often including multiple CSDs. Therefore, as shown below, we find mixing geographic units (e.g., EAs/DAs and CSDs) is necessary to reflect the actual population distribution of small CAs like Charlottetown, which are composed of a principal municipality and its outlying towns, villages, and small communities. For the rest of Charlottetown CA, we used CSDs to track changes from 2006 to 2016. Boundary changes in CSDs did not occur in that period.

5 Conclusion

Determining how best to analyze neighborhood changes in small cities when options for geographic units are limited poses substantial challenges for researchers. Using the CA of Charlottetown, we have demonstrated how complex the task can be using Canadian census data. The problems are twofold. First, CTs, the geographic unit often used to study neighborhoods in large cities, are unavailable in small cities like Charlottetown. Second, when smaller geographic units like EAs/DAs or ADAs are considered, the boundary changes that occur between censuses can be too complicated and difficult to navigate, especially over longer time periods and during the period of transition from EAs to DAs. While Statistics Canada has made many of these changes to help improve comparability over future years, studies looking at changes in small cities since the early 2000s or earlier are severely limited by the inability to re-create comparable boundaries across multiple census years. Moreover, growth and change will continue to necessitate boundary revisions, which researchers must be able to account for whenever possible.

To address these challenges, we have proposed two possible approaches for studying neighborhood changes in small cities over time. First, we suggested the 'moving forward' approach, which involves examining changes by constructing neighborhoods using EA/DA-level data. This approach accounts for changes and inconsistencies in boundaries in chronological order, with the goal of re-creating the boundaries of geographic units as they appeared at the beginning of the study period. Second, we proposed the option of 'going backward' as an alternative means of addressing those changes, which involves using ADAs, a new geographic unit created by Statistics Canada in 2016. ADAs can be used as a proxy for large neighborhoods within highly populated municipalities where CTs do not exist. This is done by re-creating these aggregated units from the EAs and DAs in previous census years. While data and unit problems in census data can often impede the advancement of small city research, the options we outlined will hopefully assist other researchers in their future studies on small cities in Canada.

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Figures

Fig. 1 Map of Charlottetown geographies

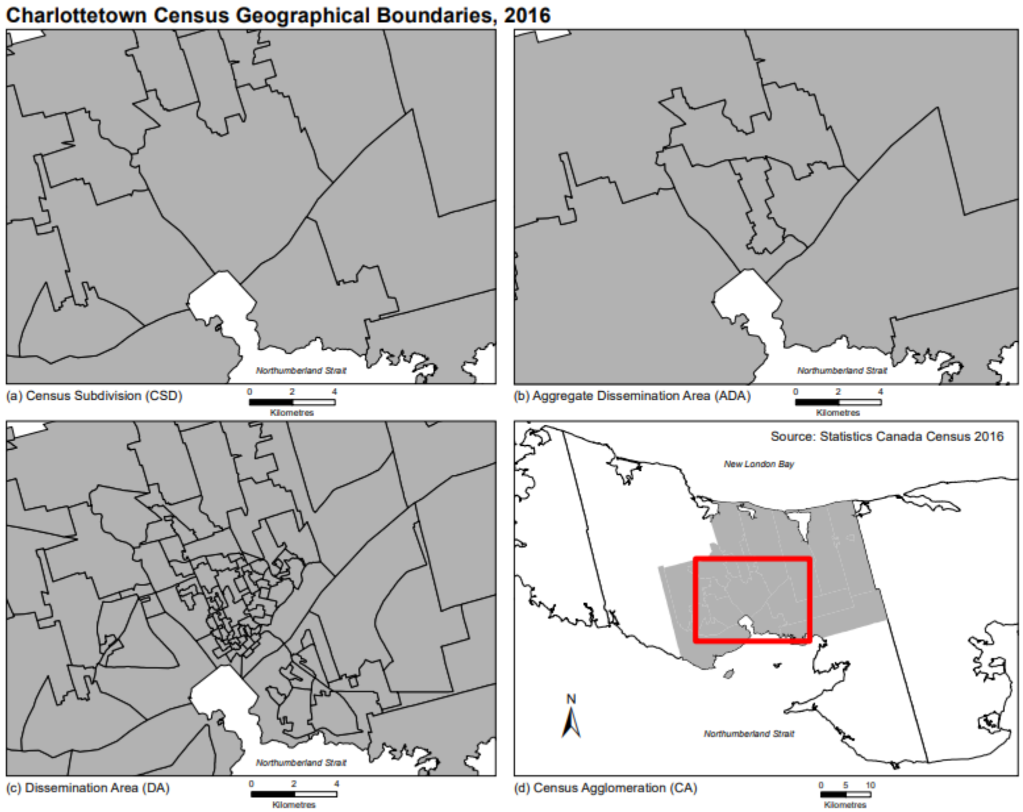

Fig. 2 Many-to-many DA boundary splits (2001-2006 Censuses)

Appendices

Appendix 1 Moving forward and going backward approaches, Charlottetown

(Excel spreadsheets are uploaded to Springer's website as a supplementary file https://static-content.springer.com/esm/art%3A10.1007%2Fs42650-020-00026-8/MediaObjects/42650_2020_26_MOESM1_ESM.xlsx).

Appendix 2 STATA codes for the going backward approach (2006 to 2016), Charlottetown. (A Word document is uploaded to Springer's website as a supplementary file https://static-content.springer.com/esm/art%3A10.1007%2Fs42650-020-00026-8/MediaObjects/42650_2020_26_MOESM2_ESM.docx).