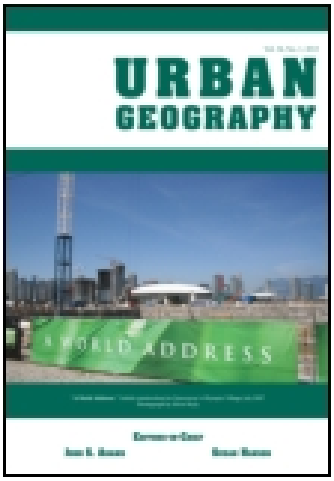

Urban Geography
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/rurb20

Research Note—Measuring Ethnic Residential Segregation: Putting Some More Geography In

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Published online: 16 May 2013.

To cite this article: Ron Johnston , Michael Poulsen & James Forrest (2009) Research Note—Measuring Ethnic Residential Segregation: Putting Some More Geography In, Urban Geography, 30:1, 91-109, DOI: 10.2747/0272-3638.30.1.91

To link to this article: http://dx.doi.org/10.2747/0272-3638.30.1.91

RESEARCH NOTE—MEASURING ETHNIC RESIDENTIAL SEGREGATION: PUTTING SOME MORE GEOGRAPHY IN

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Abstract: Most studies of urban ethnic residential patterns rely on various single-number indices to demonstrate the degree of spatial segregation. These have been criticized on a variety of grounds, and various other approaches have been proposed, including the use of measures of statistical autocorrelation and typologies of areas based on their population composition. These alternatives provide a greater geographical appreciation of segregation than the indices. It is argued here—using Auckland, New Zealand as a case study—that their integration could substantially increase our evaluation of segregation levels. [Key words: ethnic segregation, measurement, local statistics, Auckland.]

There is a massive literature on ethnic residential segregation in urban areas across many countries (see recent reviews in Kaplan and Woodhouse, 2004, 2005; Reardon, 2006). Much of it provides estimates of the degree of segregation of individual groups, almost all using single-index measures—some of ever-increasing complexity and uninterpretability. Our contention is that, useful though they are, such indices conceal as much as they reveal, if not more. A fuller, more informative discussion of segregation levels needs *more geography.* Some have started doing just that in recent years, but we contend that they have not gone far enough.

A classic study by Massey and Denton (1988) identified five separate dimensions to ethnic residential segregation—evenness; exposure; concentration; centralization; and clustering—although whether these are empirically (in the United States) as well as conceptually separate is open to doubt (Johnston et al., 2007a). Of those dimensions, geographers have made most use of measures of evenness, notably the much-deployed indices of dissimilarity and segregation. These, however, are somewhat aspatial as they ignore the relative locations of the areal units deployed in their calculation (e.g., census tracts), leading some to propose indices that combine two or more of the dimensions, usually

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Urban Geography, 2009, **30**, 1, pp. 91–109. DOI: 10.2747/0272-3638.30.1.91

evenness with clustering (on which Wong, 2002, has done much innovative work; see also Reardon and O'Sullivan, 2004).

Although informative, such indices suffer from a number of disadvantages: they discard a huge amount of the information from which they are calculated; they are often difficult to interpret; and they are not clearly linked to a definition of segregation. For those reasons, as well as other technical issues relating to their comparability over time and space, we have developed an alternative approach to segregation measurement linked to an explicit definition of the concept that has proven valuable in a variety of contexts, including international comparisons (Johnston et al., 2007b). However, one of its identified drawbacks (as noted in Johnston, Poulsen, and Forrest, 2008b) is that it largely ignores the clustering dimension identified by Massey and Denton (1988).

This research note indicates one way of addressing that lacuna. It integrates our classification scheme with one of the techniques of spatial autocorrelation and local statistics recently adopted by other analysts. We build on that latter approach, accepting its value for the identification of significant spatial clusters of ethnic groups within an urban matrix, but extending it by arguing that examining the internal patterning within those clusters, using our typology, provides a much more detailed understanding of the degree of segregation. Accordingly, we demonstrate the complementarity of the two approaches as the basis for further exploration of segregation's full dimensionality.

To illustrate our arguments we use data taken from the 2006 New Zealand Census for the 8,579 meshblocks of the Auckland urban area (total population, 1,147,185).[2] These meshblocks are the smallest areas for which New Zealand census data are released (those for Auckland in 2006 had a mean population of 134; standard deviation 74), and at this scale separate data are provided for four main ethnic groups: New Zealand Europeans (625,857; 55% of the total); New Zealand Maori (125,379; 11%); Pacific Islanders (174,696; 15%); and Asians (230,448; 20%).[3]

SETTING THE SCENE

Although the meaning of the concept of segregation is generally appreciated, without precise definitions confusion and misunderstandings can arise (as exemplified in Simpson, 2004, 2007; Johnston et al., 2005). There are two common understandings of the term (see also Kaplan and Woodhouse, 2005; Reardon, 2006): (1) segregation as *pattern description*—the degree to which members of different groups live apart from each other; and (2) segregation as *process description*—the processes by which such spatial separation is generated. They form integral parts of a whole but need to be separated for analytical purposes. Our focus here is on pattern description, and our definition of segregation is *the degree of spatial isolation of identified ethnic groups*.

[2]We are grateful to Statistics New Zealand for making these data available for the past four censuses on a comparable set of meshblocks. Data are also available, for a wider range of ethnic groups, at a larger scale—census area units—for which there were more than 300 in Auckland in the 2006 census, exhibiting a mean population of 3,393.

[3]Because individuals can identify with more than one ethnic group (which less than 10% do), the totals sum to more than the metropolitan population.

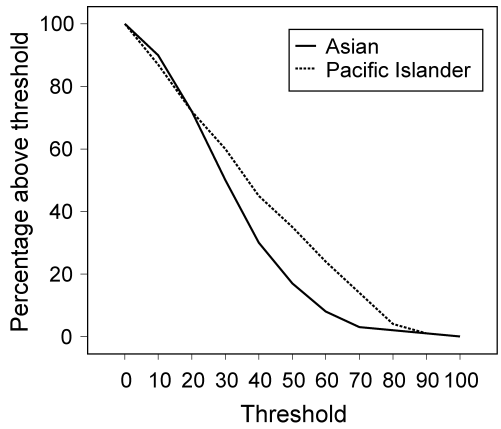

Fig. 1. Concentration profiles for Pacific Islanders and Asians in Auckland, 2006.

Given that definition—more generally, the degree to which groups live apart from each other, and thus in areas where they alone predominate—we need a robust measurement procedure. The widely used indices do not offer this, for two related reasons.

(1) *Interpretive difficulties*. Most indices vary between either 0 and 100 or .0 and 1.0, with the larger value in each case indicating greater segregation. This is readily interpreted if an index is close to either pole of the continuum: an index of segregation greater than 90, for example, indicates that a group's members live in almost completely separate areas from the rest of the population, whereas an index close to zero indicates that they are found in the same proportion in most areas. But what of indices of 40, 50 or 60? These could indicate that some of the group live in areas where their members predominate whereas the remainder live in mixed areas where they form a small minority—or it could indicate that although members of the group are more numerous in some areas than others they predominate in none, so that, given our definition, there is little or no segregation.

(2) *The absence of any indication of variation.* Some indices reflect the situation of an average group member, but with no indication of any variation about that value. For instance, an index of exposure of .6 indicates that the probability of a member of group *x* encountering a member of group *y* at random in her/his residential area is .6. But is it the same for all members of *x*, or do some have a probability close to .0, whereas for others it is close to 1.0—indicating that some live in areas where there are virtually no members of *y*, whereas others live in areas where *y* predominates? Indices cannot answer such questions; they cannot tell us what proportion of a group's members live in highly segregated areas and the like, and so cannot properly address our definition of segregation.

To counter these problems, we developed a two-stage procedure building on work by Philpott (1978) and Peach (1996). The first stage involved the construction of concentration profiles (Poulsen et al., 2002). Figure 1 exemplifies these for Auckland's Pacific Islander and Asian populations—for which the indices of isolation are .38 and .32, respectively; the modified indices of isolation (standardized according to group size as a proportion of the urban total) are .27 and .15, suggesting that neither group is particularly

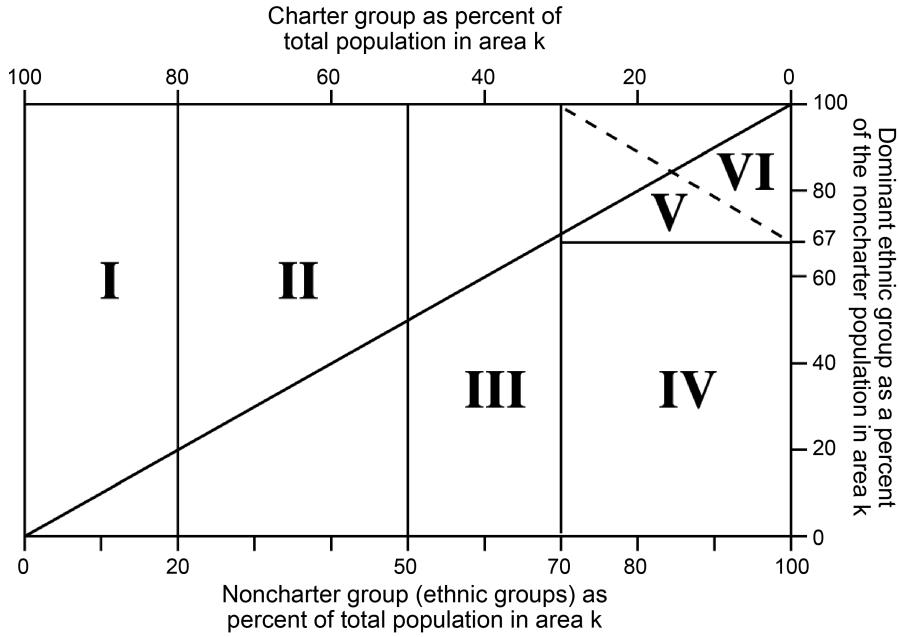

Fig. 2. The typology. Areas in Types V and VI have the same percentages in the two categories indicated on the horizontal and vertical axes; in addition, areas in Type VI have more than 30% of the urban area's total population of the relevant ethnic group.

segregated, although Pacific Islanders were much more so than Asians (on the necessity of standardizing the index of isolation for comparative purposes, see Johnston, Burgess, et al., 2008; Clark, 2007, illustrates the problems when this is not done).

The concentration profiles illustrate clear differences between the two groups in the extent of segregation (i.e., the degree to which their members live apart from the remainder of Auckland's population). Thus, for example, whereas some 34% of the Pacific Islanders lived in meshblocks where their coethnics formed a majority of the population, only 16% of the Asians lived in areas where Asians were in the majority—a twofold difference. If the threshold is increased to 70% of the meshblock total, then 13% of the Pacific Islanders lived in such areas compared to just 2% of the Asians—a sixfold difference. The different degree of segregation for the two groups is shown by the relative size of their modified indices of isolation, but the proportion of each group that lived in relative isolation from the remainder of the society is not.

Such profiles provide excellent illustrative material but need to be summarized to provide a synoptic view of the degree of spatial separation of each group. For this, we introduced a classification procedure (Poulsen et al., 2001) that has been widely used in comparative studies, including in this journal (Johnston et al., 2003). Its rationale has been clearly set out in a number of places (e.g., Johnston et al., 2007b) and will not be repeated here. Figure 2 shows the classification scheme, which identifies six Type-areas according to the percentage of their population in (1) the charter group (the economically

and politically most powerful, which is usually the city's majority and is sometimes termed the "host society"), and (2) the various ethnic (usually minority) groups: (I) areas where members of the charter group—*X*—predominate, forming more than 80% of the total population; (II) areas where members of the charter group—*X*—dominate, forming 50%–80% of the total population, but members of ethnic groups (*y* and *z*, perhaps) form a substantial minority; (III) areas where members of ethnic groups *y* and *z* dominate, forming 50%–70% of the total population, but members of the charter group—*X*—form a substantial minority; (IV) areas where members of ethnic groups *y* and *z* predominate, forming 70% or more of the total, but neither group dominates the other; (V) areas where members of ethnic groups *y* and *z* predominate, forming 70% or more of the total, and one group is at least twice as large as the other; and (VI) areas where members of ethnic groups *y* and *z* predominate, forming 70% or more of the total, one group is at least twice as large as the other, and at least 30% of that group's total population in the city live in those areas.

Type I areas demonstrate extreme segregation, where members of the charter group (*X*) live in relatively exclusive separation from the ethnic minorities (what Marcuse, 1997, termed "white citadels"). Types IV–VI are similarly highly segregated areas where the ethnic minorities (*y* and *z*) live very largely apart from the charter group: within those three, Type V areas are typical ethnic enclaves where one group predominates, whereas Type VI areas are characteristic of ghetto-like situations. Type II and III areas are relatively mixed in their ethnic composition. Most of the boundary lines between the types are based on a simple majority–minority division: those between Types I–II on the one hand, and Types III–IV on the other, are relatively arbitrary, but were based on the inspection of a large number of datasets. Exploration suggests that moving them slightly (e.g., that between Types I and II from 80% to 75%) would change the absolute patterns though not the relative situation.

Table 1 shows the results of applying this scheme to Auckland in 2006:[4] the Type V areas have been subdivided according to which of the three main ethnic minority groups dominates; there were no Type VI areas. The purpose of this research note is not to interpret the patterns in any detail (for that, see Johnston, Poulsen, and Forrest, 2008a) but rather to illustrate the method and the clear differences it exposes. For instance, more than twice as many Asians as Pacific Islanders lived in meshblocks where New Zealand Europeans dominated (i.e., Types I and II), on the one hand, whereas on the other more than twice as many Pacific Islanders as Asians lived in Type V meshblocks where they predominated. Few Maori lived in areas where they predominated in the local population, however; the majority resided in the relatively mixed meshblocks of Types II and III, as—to an even greater extent, though with many more in the Type II areas—was the case with the New Zealand Europeans.

[4]The percentages in this table differ slightly from those in Johnston, Poulsen, and Forrest (2008a), which were based on Statistics New Zealand's initial data releases for 2006; when they later issued a combined dataset for the four censuses 1991–2006, they had ethnically reclassified some 60,000 Aucklanders in 2006, hence the differences—which are nevertheless not major and the overall patterns are very similar.

TABLE 1. THE PERCENTAGE DISTRIBUTION OF AUCKLAND'S FOUR ETHNIC GROUPS, 2006, ACCORDING TO THE CLASSIFICATION SCHEMA OF FIGURE 2

Area type	European	Maori	Pacific Islander	Asian
I	33.9	9.8	2.5	6.8
II	46.1	33.0	19.0	42.0
III	14.6	27.1	22.8	32.2
IV	3.4	19.6	36.1	10.5
V–Maori	0.0	0.8	0.2	0
V–Pacific Islander	1.2	8.9	28.5	1.6
V–Asian	0.8	0.8	0.9	6.8
Total population	627801	125628	174732	230514

MOVING FORWARD

This classification procedure gives a much fuller picture of the degree of segregation (as we define it) than single-number indices, but leaves some issues unaddressed. One of the most important is the degree of clustering of the areas where a group is relatively concentrated (e.g., the Type V areas). It could be, for example, that the 6.8% of Auckland's Asians living in Type V areas were spread across several small clusters of meshblocks whereas all of the Pacific Islander Type V meshblocks formed a single cluster. A cartographic means of addressing that issue has been presented in earlier work using larger spatial units to identify the degree of clustering of Type V meshblocks (Johnston, Poulsen, and Forrest, 2008a). Here we introduce a more rigorous analytical approach to this issue of clustering, extending the pioneering application of local statistics to this concern by Brown and Chung (2006; Chung and Brown, 2007; see also Wong, 2008; Forrest et al., 2009), who explicitly addressed the "checkerboard" issue identified by Watts (2008) as one of the problems with our classification approach.[5]

Local indicators of spatial association (LISA; Anselin, 1995; Anselin et al., 2006) are part of the body of techniques generally known as "local statistics," which have significantly expanded the classic works on measuring spatial autocorrelation introduced by Moran (1950) and others. In this application we use Moran's I statistic to identify the overall degree of clustering for each group plus the G*, or "hotspot," approach for identifying clusters of observations within that general pattern developed by Getis and Ord (1992; Ord and Getis, 1995, 2001), operationalized in the ArcGIS spatial statistics toolbox (for an introduction to these approaches, see Rogerson, 2006).[6] This takes the data for each ethnic group for each meshblock—expressed as percentages of the meshblock total to take account of variations in meshblock size—and identifies the groups of two or more neighboring meshblocks within a 1,000 m distance band where there is greater clustering

[5]For a valuable extension of the approach, see Brimicombe (2007).
[6]See http://webhelp.esri.com/arcgisdesktop/9.3/index.cfm?TopicName=Hot_Spot_Analysis_(Getis-Ord_Gi*)_(Spatial_Statistics)

TABLE 2. MORAN'S I FOR THE DISTRIBUTIONS OF AUCKLAND'S FOUR ETHNIC GROUPS, 2006, WITH THEIR RELATED Z-SCORES

Group	I	Z
Nz European	0.051	184.9*
Maori	0.121	436.8*
Pacific I	0.151	543.6*
Asian	0.058	210.1*

*Statistically significant at the .001 level or better.

of the group than might be expected if its members were randomly distributed across the 8,579 separate meshblocks. Those clusters can be identified according to their degree of significance: the higher the Z-score, the greater the probability that the clustering is non-random. Three thresholds are identified commensurate with the classic significance levels: 2.58 (the .01 level), 1.96 (the .05 level), and 1.65 (the .10 level).[7]

The degree of overall clustering of the four ethnic groups in 2006 is given by the relevant Moran's I statistics, with their associated Z-scores (Table 2). All four are highly significant statistically, indicating very substantial clustering in each case. But there are major differences across the four groups: Maori and, especially, Pacific Islanders were far more segregated (I values of .151 and .121, respectively) than Asians (I = .058) and New Zealand Europeans (I = .051).

Maps of these clusters are displayed in Figures 3–6 for the four main ethnic groups, using the Z-scores of +/–2.58 as the key thresholds. These divide the urban area into three segments for each group: the meshblocks that form clusters containing larger percentages than expected of the group under consideration (i.e., those with a Z-score of +2.58 or greater); those that form clusters where that group is significantly underrepresented (i.e., with a Z-score of –2.58 or greater); and those with no clustering, where the distribution of the group is not significantly different from random (i.e., with Z-scores between +2.58 and –2.58).

The differences among the four distributions are marked. The main clusters of New Zealand Europeans were in the central isthmus and much of Auckland's North Shore (Fig. 3), whereas much of southern Auckland and the southwestern isthmus comprised areas where they were significantly underrepresented; the areas where their proportion of the total populations did not significantly differ from a random distribution were mainly in the city's north, far west, and southeast.

Of the other three groups, both Maori and Pacific Islanders (Figs. 4 and 5) were significantly fewer in number in large blocks of territory on the North Shore, the central isthmus,

[7]The use of different distance bands and different significant levels would alter the details of the geography identified and displayed, and experimentation is needed to examine the extent of this—which may well vary according to the particular circumstances of each individual city. In addition, there are competing implementations of the local statistics concept (e.g., in Anselin's GeoDa package; https://www.geoda.uiuc.edu/), which should be subject to a comparative analysis.

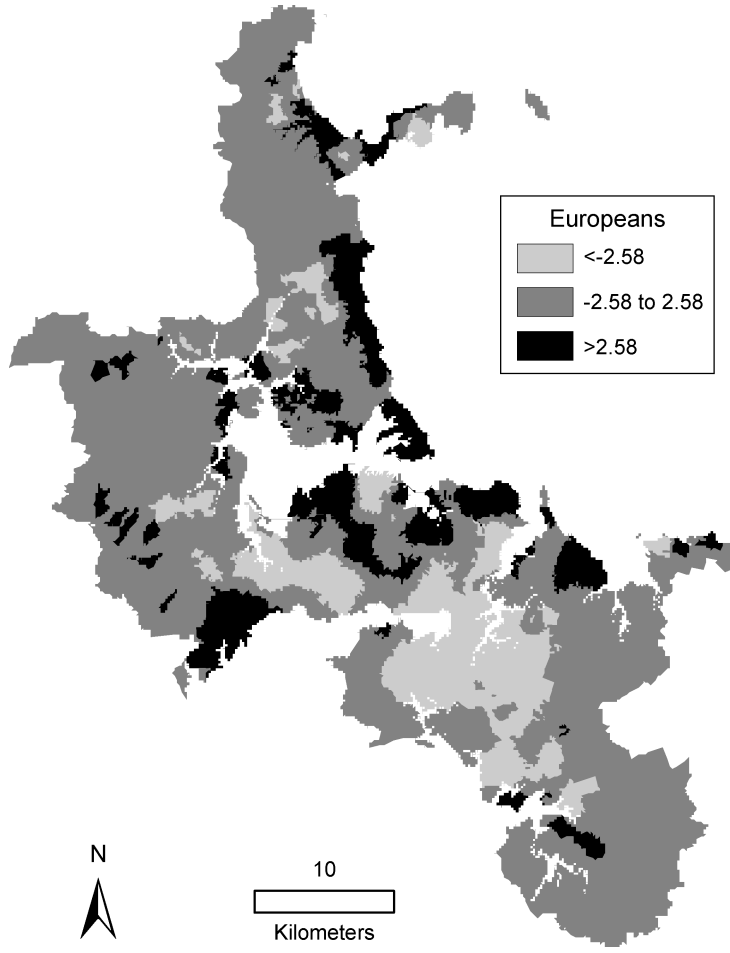

Fig. 3. The significant clusters of New Zealand Europeans in Auckland, 2006. The first category (with a Z-score less than –2.58) indicates the areas where New Zealand Europeans are significantly fewer in their relative number than expected from a random distribution; the third category (with a Z-score greater than +2.58) indicates the areas where New Zealand Europeans are significantly greater in their relative number than expected from a random distribution; and the middle category indicates areas where they are neither greater nor fewer in number than expected.

and the eastern suburbs, and they shared significant clusters in the south, areas dominated by state (social) housing. There were also Maori clusters to the west of the harbor plus two small blocks on the North Shore, and several smaller clusters of Pacific Islanders in the south of the isthmus. This suggests considerable sharing of residential space by these two groups (reflecting the allocation procedures for state housing; Johnston, Poulsen, and Forrest, 2008b), with only a few areas where one predominated in the other's absence. Finally, there were three main clusters of meshblocks where Asians were proportionally much more numerous than a random allocation would generate (Fig. 6): in parts of the

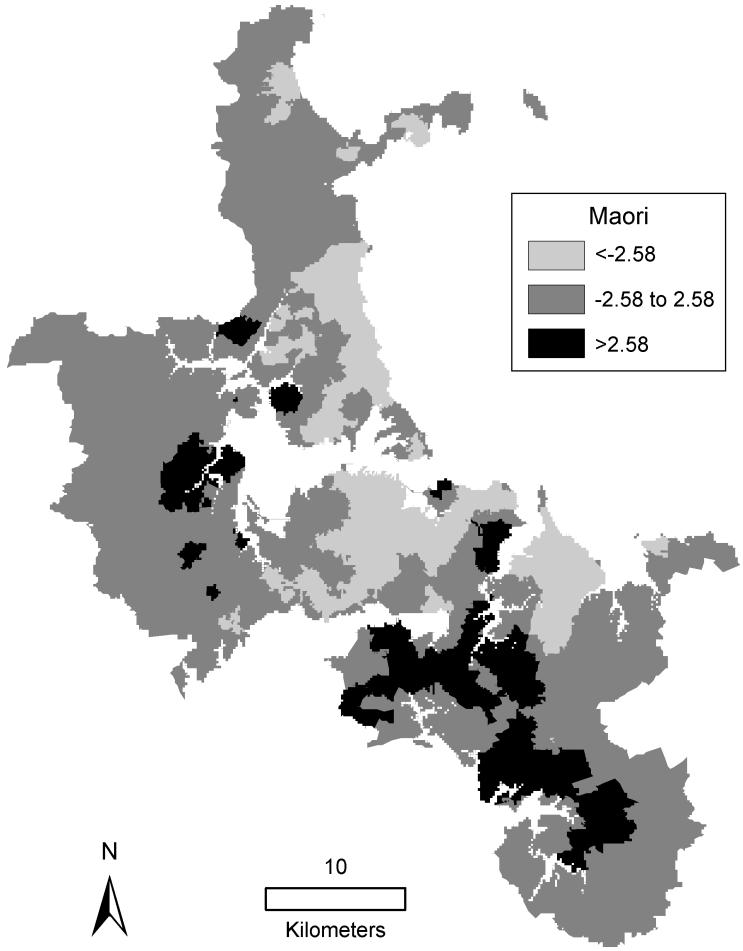

Fig. 4. The significant clusters of New Zealand Maori in Auckland, 2006. The first category (with a Z-score less than –2.58) indicates the areas where Maori are significantly fewer in their relative number than expected from a random distribution; the third category (with a Z-score greater than +2.58) indicates the areas where Maori are significantly greater in their relative number than expected from a random distribution; and the middle category indicates areas where they are neither greater nor fewer in number than expected.

eastern suburbs, in a substantial block on the North Shore (many of the Asians there are of Korean origin), and on the southern shore of the isthmus.

Having identified the clusters, we can calculate the percentage of each group's population that lived in them. For this, seven types are deployed, using the three thresholds. Clusters with a Z-score of 2.58 or greater are highly significant clusters, where there is much greater concentration of the group than expected from a random distribution and those with a score of between 1.96 and 2.58 are also significant. At the other extreme, clusters with a Z-score of less than –2.58 are areas where there are far fewer members of the group than would be expected (and presumably there is clustering of one or more of

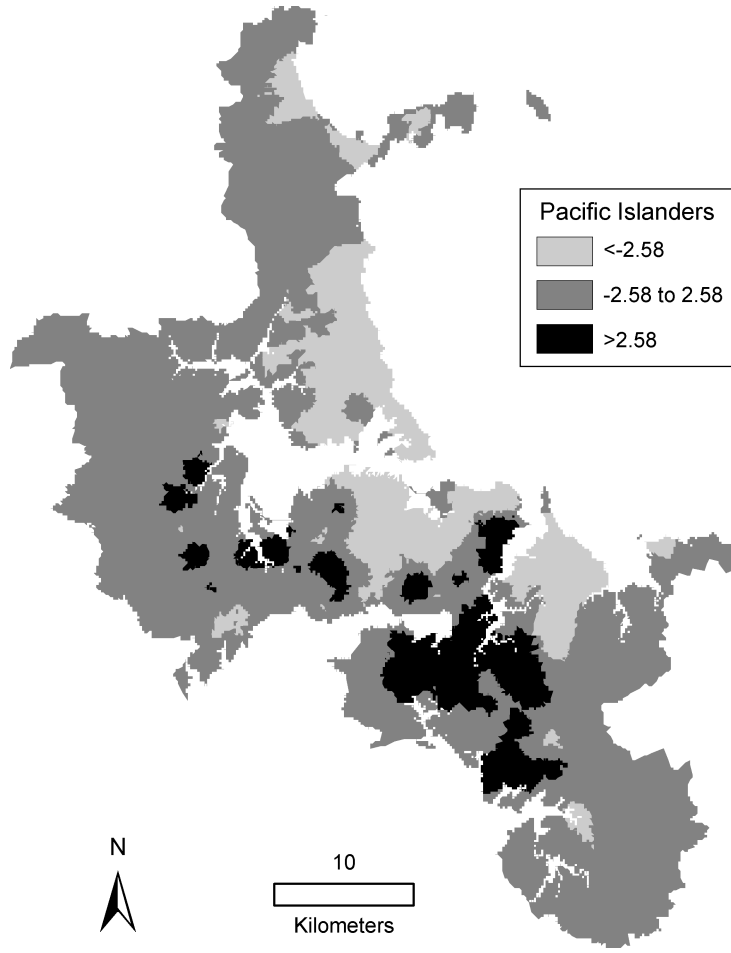

Fig. 5. The significant clusters of Pacific Islanders in Auckland, 2006. The first category (with a Z-score less than –2.58) indicates the areas where Pacific Islanders are significantly fewer in their relative number than expected from a random distribution; the third category (with a Z-score greater than +2.58) indicates the areas where Pacific Islanders are significantly greater in their relative number than expected from a random distribution; and the middle category indicates areas where they are neither greater nor fewer in number than expected.

the other groups). Areas with Z-values between –1.65 and +1.65 are those where there are neither more nor fewer members of the group in those adjacent meshblocks than would be expected if they were randomly distributed across the city.

Table 3 shows the percentages of each of Auckland's four main ethnic groups in the various clusters. The majority of every group's members (over 80% in each case) were in one of three categories only: those with Z-scores greater than +/–2.58 and those with insignificant Z-scores between –1.65 and 1.65 (i.e., they were in either the highly significant—positive or negative—clusters or the areas where there is no significant clustering). There are, however, substantial differences across the four in their distributions

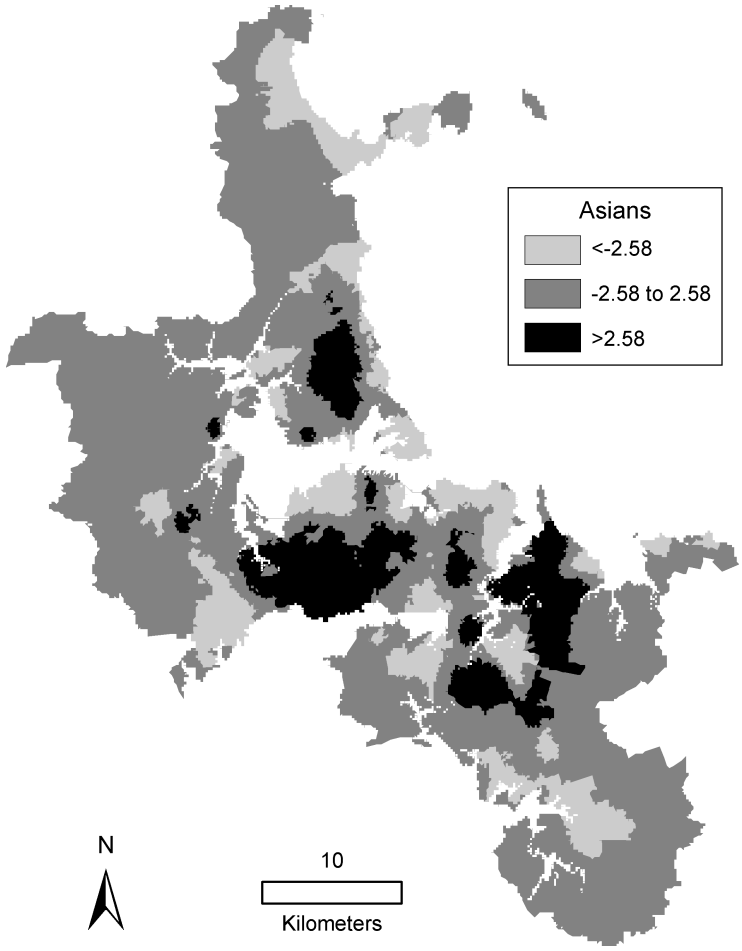

Fig. 6. The significant clusters of Asians in Auckland, 2006. The first category (with a Z-score less than –2.58) indicates the areas where Asians are significantly fewer in their relative number than expected from a random distribution; the third category (with a Z-score greater than +2.58) indicates the areas where Asians are significantly greater in their relative number than expected from a random distribution; and the middle category indicates areas where they are neither greater nor fewer in number than expected.

across those categories: (1) many more Pacific Islanders, Asians, and Maori lived in their respective major clusters (those with a positive Z-score of 2.58 or greater) than was the case with New Zealand Europeans, indicating that the former three groups (especially the Pacific Islanders) were more likely to reside in relatively segregated areas; (2) substantially more New Zealand Europeans than any of the other three groups lived in the areas where clustering is insignificant and the populations are ethnically mixed (i.e., where the group's percentage of the total population is not significantly different from expectations based on a random distribution); and (3) a substantial minority of each group—though

TABLE 3. THE DISTRIBUTION OF AUCKLAND'S FOUR ETHNIC GROUPS, 2006, ACCORDING TO THE ALLOCATION OF MESHBLOCKS TO VARIOUS CLUSTERS, IDENTIFIED BY THEIR Z-SCORES

Z–score range	European	Maori	Pacific Islander	Asian
>2.58	38.4	52.9	65.6	57.6
1.96 to 2.58	7.7	2.9	3.7	4.1
1.65 to 1.96	4.1	1.6	2.3	2.4
–1.65 to 1.65	29.1	22.2	18.2	20.0
–1.96 to –1.65	1.6	2.1	1.4	1.6
–2.58 to –1.96	3.3	4.4	2.5	3.9
<–2.58	15.6	13.7	6.1	10.1

many more Europeans than Pacific Islanders—lived in areas where they were significantly fewer in number (i.e., with a Z-score greater than –2.68).

LINKING THE TWO APPROACHES

Do the two approaches—the typology (Fig. 2; Table 1) and the local clustering (Table 3)—present the same overall picture? Comparison of Tables 2 and 3 suggests they do: the percentage of each group's members in the relatively mixed Type-areas (II and III; Table 2) is clearly correlated with the percentages in the nonclustered areas (between –1.65 and +1.65; Table 3). But they also clearly complement each other. The typology analysis takes no account of the spatial clustering of meshblocks where each group dominates. Furthermore, the clusters generated by the G* analyses only identify areas where members of an ethnic group are to be found in greater numbers than expected from a random distribution; these need not comprise areas where group members predominate (i.e., Type V meshblocks according to the typology approach).

This last point is illustrated by Figures 7 and 8. Figure 7 shows the typology allocation for each meshblock within the Asian cluster on the central Auckland isthmus. It indicates several small cores of Type V areas, surrounded by meshblocks in Types III and IV and a considerable periphery in Type II. Thus whereas Asians are concentrated in this contiguous territory to a much greater extent than would occur if they were randomly distributed across the entire urban area, in much of it they form only a minority of the meshblock populations. There was relative but not absolute segregation—and the latter is our definition of the concept.

Figure 8 shows the classification of meshblocks within some of the South Auckland significant clusters of Pacific Islanders identified in Figure 5, a very different geographic pattern from that for the Asians. Most of the meshblocks are of either Type IV or Type V, with only a relatively narrow peripheral margin of Type II–III areas. This intensity undoubtedly reflects the domination of state housing in those parts of the city.

These two maps suggest that the two approaches—typology and clustering—need to be combined to provide a clear picture of the geographical extent and intensity of

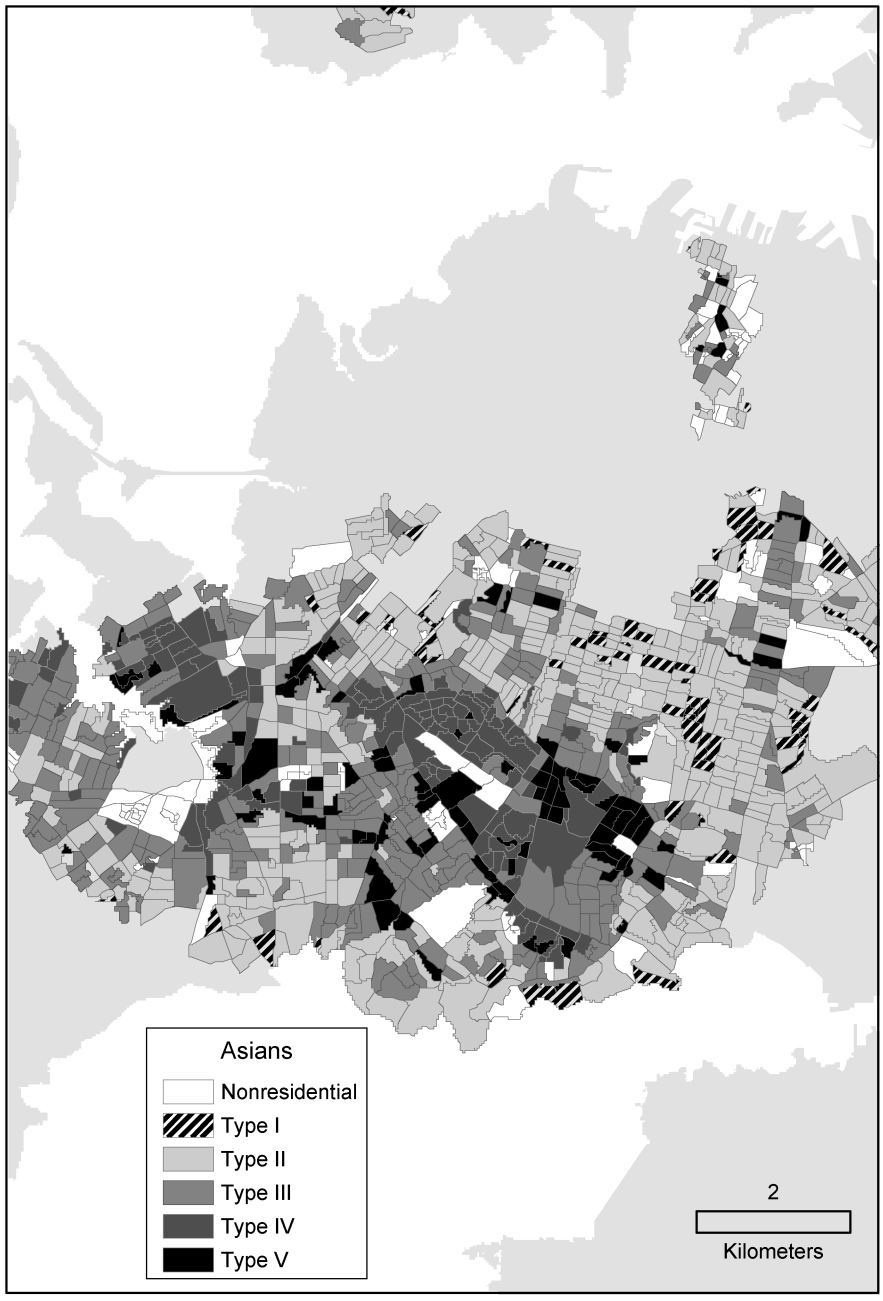

Fig. 7. The typology of meshblocks included in areas of significant clustering of Asians in parts of southern Auckland, 2006.

segregation. For this, Table 4 shows the percentage distributions for each ethnic group according to both the Type-area into which each meshblock was allocated and whether

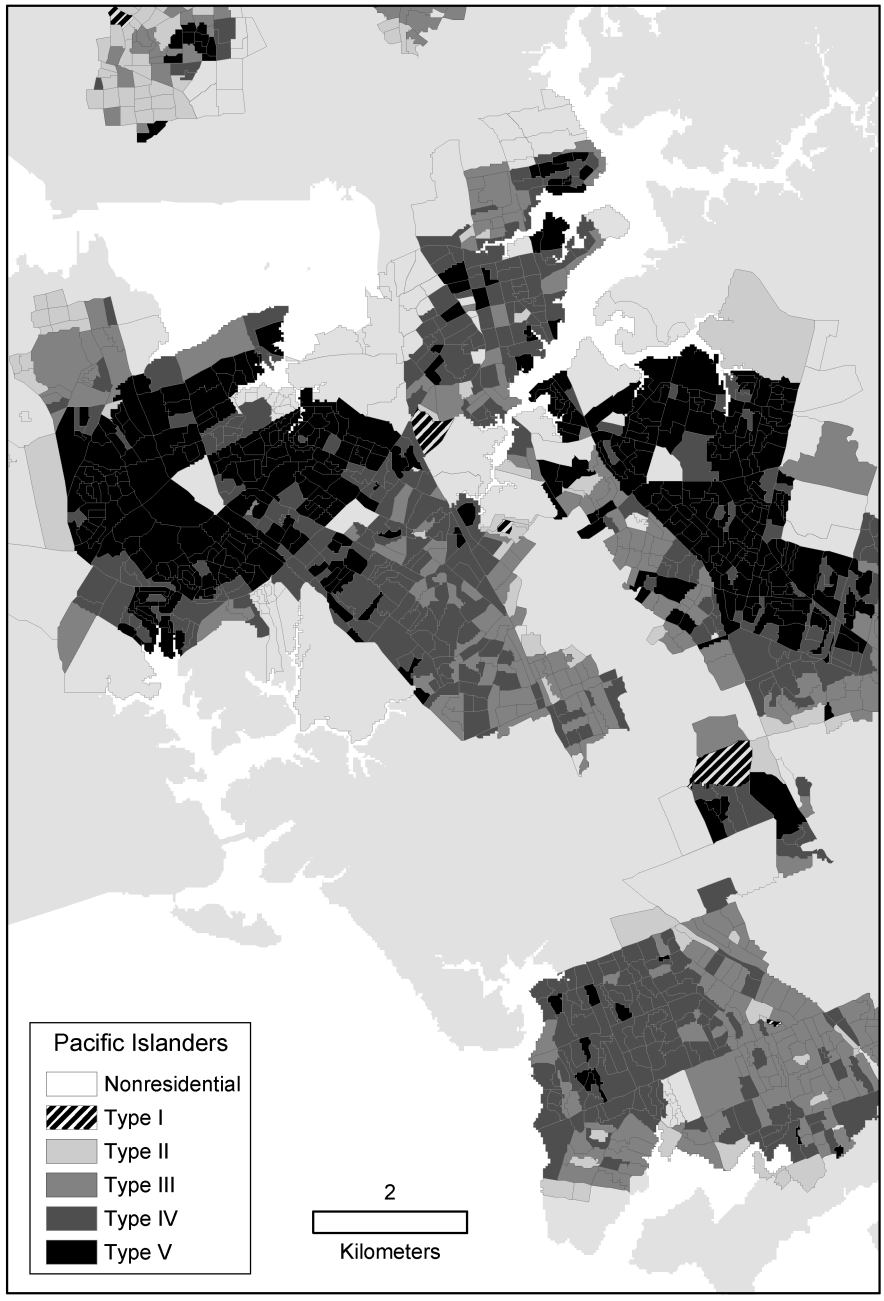

Fig. 8. The typology of meshblocks included in areas of significant clustering of Pacific Islanders in parts of southern Auckland, 2006.

that meshblock was in a statistically significant cluster as defined for that group. There are thus three rows for each ethnic group that show the "positive clusters" (where the

TABLE 4. THE DISTRIBUTION OF AUCKLAND'S FOUR ETHNIC GROUPS, 2006, ACCORDING TO THE ALLOCATION OF MESHBLOCKS TO THE TYPE AREAS IDENTIFIED IN FIGURE 2 AND TABLE 1 INTO THE VARIOUS CLUSTERS, IDENTIFIED BY THEIR Z-SCORES IN THE LOCAL G* ANALYSIS

	I	II	III	IV	V
New Zealand Europeans					
>2.58	65.9	33.7	3.6	0.6	0.9
–2.58 to 2.58	31.7	57.8	53.1	10.9	22.4
<–2.58	2.4	8.5	43.2	88.8	76.6
Maori					
>2.58	4.4	31.5	62.0	84.0	85.1
–2.58 to 2.58	58.2	47.7	28.8	14.7	11.5
<–2.58	38.4	38.5	9.2	1.3	0.3
Pacific Islander					
>2.58	1.6	14.0	51.9	89.1	93.9
–2.58 to 2.58	51.1	66.4	43.2	10.8	5.8
<–2.58	47.2	19.5	5.0	0	0
Asians					
>2.58	9.9	50.8	72.0	59.7	72.1
–2.58 to 2.58	45.2	40.7	24.0	26.3	19.1
<–2.58	44.9	8.5	4.0	13.9	8.7

group was significantly concentrated at the .01 level or better); the "random distribution areas" (where the group was neither under- nor overrepresented); and the "negative clusters" (where the group was significantly underrepresented at the .01 level or better). For example, of the New Zealand Europeans living in Type I areas (where they formed 80% or more of the total population) 65.9% lived in clusters of meshblocks where their coethnics were significantly overrepresented, and an additional 31.7% in parts of Auckland where that group is neither under- nor overrepresented. Not surprisingly, very few New Zealand Europeans (2.4%) residing in Type I areas were found in the clusters where such people are significantly underrepresented.

The data in Table 4 show important differences across the four ethnic groups. The pattern for New Zealand Europeans is straightforward and unsurprising. Most of the group's members who lived in Type I or II meshblocks (some four-fifths of the group total; Table 1) are found in either "positive clusters" of New Zealand Europeans or the "random distribution areas," whereas those who lived in the more multiethnic Type II–III communities were in either the "random distribution areas" or the "negative clusters." The small number (7.8%) in the Type IV and V enclaves were almost all to be found in the "negative clusters" where their group was significantly underrepresented.

Turning to the three minority ethnic groups, there are both similarities and differences in the patterns for Maori, Pacific Islanders, and Asians. Those residing in Type IV and V meshblocks were heavily concentrated in the relevant group's "positive clusters," clearly

indicating that those enclaves are spatially concentrated within Auckland rather than more widely distributed through the metropolitan area. The percentages living there were smaller for the Asians in Type IV and V meshblocks, however, with more than one-quarter of those in Type IV areas living in the "random distribution areas." For Asians, much more so than for Maori and Pacific Islanders, therefore, not all of the meshblocks where they predominate are to be found in tight clusters; some, as indicated in Figure 7, may be relatively isolated from similar small blocks of territory with Asian majorities.

There are also differences at the other end of the typology continuum, especially with regard to those living in Type II meshblocks (only very small percentages reside in Type I areas; Table 1). Among Asians, for instance, half of those living in Type II meshblocks (nearly one-third of all Asians in Auckland) were in Asian "positive clusters," indicating that, again as clearly indicated by Figure 7, the clusters identified in the G* analysis do not just comprise areas where the group dominates the local population. Figure 7 shows most of the Type II meshblocks on the outer edges of the "positive clusters" (perhaps indicative of the first stages of an "invasion–succession" process as the Asian population continues to expand; it grew by over 250% between 1991 and 2006), but others encapsulated within the area dominated by Type III–IV meshblocks. By contrast, many fewer of the Pacific Islanders living in Type II and III meshblocks were in the identified Pacific Islander "positive clusters" than was the case for Asians, and many more were in the "random distribution areas" where the group in question was neither more nor less numerous than expected. The Asian "positive clusters" contained many more relatively mixed meshblocks than was the case with those where Pacific Islanders were the main ethnic group. Pacific Islanders living outside those clusters were more likely to be found in the "random distribution areas," whereas Asians were more likely to be found in areas (e.g., Type II meshblocks) where they not only were in the minority but New Zealand Europeans dominated.

This brief discussion of Table 4 indicates the desirability of combining the two approaches. The significant clusters identified by G* show groups of meshblocks where a group's share of the total population is significantly greater than would be expected were they randomly distributed across the metropolitan area—but they do not indicate the degree to which they dominate the local population.[8] The typology, on the other hand, identifies areas with different population compositions, thereby addressing the core definition of segregation, but says little about their geography, in particular whether the various types of meshblocks are spatially clustered or not. Combining the two capitalizes on the potential of both, enhancing the geographical approach to studying segregation advanced here.

[8]This is not surprising, since the three minority ethnic groups form only 11%, 15%, and 20% of Auckland's population, respectively (Table 1). The G* analyses were conducted on percentages of meshblock populations rather than absolute numbers to take into account variations in meshblock size (although tests suggested no substantial differences in the patterns if absolute numbers were used), and significant differences from those figures might be well short of, say, 50%.

CONCLUSION: MORE GEOGRAPHY PLEASE

Although the very substantial literature on ethnic (and other forms of) residential segregation has produced considerable insights into the urban residential mosaic, its almost total reliance on single-number indices has not fully addressed the nature of segregation. To redress that situation, we argue for an approach more closely aligned to our understanding of the concept of segregation—one that is more *geographical*.

That approach—based on concentration profiles and a typology derived from them—is largely descriptive, although its output has been deployed in formal statistical analyses that have extended our understanding of levels of segregation in comparative perspective. This research note has, therefore, explored and extended an approach recently adopted by other analysts that uses local statistical techniques to emphasize the geography of residential distributions—versus the aspatiality of many of the single-number indices—within a rigorous statistical framework. Our brief illustration of the clustered patterns in Auckland has demonstrated the benefits of that approach and also identified a significant drawback—that clusters may be internally differentiated according to the intensity of segregation there. Hence our proposal to combine the two procedures, integrating the typology with the clustering.

As occurs so often in methodological pieces, a main conclusion is that more research is needed—both technical and substantive. Whatever direction it takes, it should ensure that geography is at the forefront, because for too long studies of residential segregation have relegated it to the sidelines.

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