

# **The Geography of Poverty and Segregation in Metropolitan Lima, Peru**

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## **Introduction**

Latin American mega-cities have developed within a specific set of cultural, social, and economic conditions (Gilbert 1996). Indeed, social and economic inequality and highly segregated development patterns have contributed to a socially and culturally fragmented urban environment (Sabatini 2003a). The combination of formal and informal urban development patterns, weak land-use planning, inequitable economic opportunities, and unequal social divisions have created divergent, and highly localized patterns of spatial segregation in varying Latin American urban contexts (Peters and Ward n.d.). Other physical geographic influences (like abrupt mountain features and coastal boundaries) also shape urban form in Latin America. As a result, multiple urban structures and development patterns have emerged in Latin American mega-cities.

All of these characteristics influence the geography of poverty and segregation in Latin American mega-cities. Yet little empirical evidence has been produced to capture the extent and magnitude of socio-spatial segregation in Latin American mega-cities, thus our understanding of this phenomenon is rather limited (for important exceptions see Joseph 2003; Katzman and Wormald 2002; Roberts 2002; Sabatini, Wormald, and Contreras 2003). While detailed ethnographies and community studies document the ways in which the poor are funneled to certain neighborhoods while the rich separate themselves in gated communities, few broad-scale urban spatial analyses exist to confirm the scope of this segregation in the Latin American context. Importantly, the recent emergence of detailed, geo-coded census datasets, along with the development of segregation measures that address the inherent spatial nature of segregation (see Reardon and O'Sullivan 2004; Wong 2002b: for an extensive overview) allow researchers a potentially fruitful opportunity for articulating the principal influences of urban structure and physical geography in processes of socio-spatial segregation at the metropolitan level.

The purpose of this paper, then, is to examine the nature of socio-spatial segregation in Latin American mega-cities, using Lima, Peru as an example. This paper focuses on Lima, Peru as the metropolitan region is noteworthy for its combination of formal and informal development patterns, as well as the way in which the physical environment shapes the urban landscape. Using detailed, geo-coded local-level data released from the 1993 Peruvian Census, this paper bridges both theoretical and empirical gaps in the literature and provides a metropolitan-wide examination of poverty patterns.

We begin by outlining the general patterns of urban development in Latin America. In particular, the discussion focuses on how these patterns have influenced segregation and how the fragmentation of the rich versus the poor continues to expand within the urban environment. Second, we articulate recent trends in segregation studies, and include some recently proposed spatial segregation measures for outlining the specific dimensions of segregation in the Latin American context. Third, we describe the available data for Metropolitan Lima as well as the specific methods and key segregation indicators used for this investigation. We then present an analysis of segregation in the Lima metropolitan region, using descriptive statistics, maps, and both conventional and newer segregation measures to understand the geography of poverty and segregation in the metropolis. Finally, we conclude by discussing how the selected measures can illustrate the particular urban development patterns present in Latin American mega-cities.

### **Urban Development in Latin America**

Since the middle of the last century, Latin America has experienced impressive urban growth, fuelled at first by rapid rural to urban migration and followed by a natural population growth within the urban cores. Since 1950, major cities in Latin America have increased dramatically in absolute size, with Sao Paulo and Mexico City among the largest in the world (Gilbert 1998). During that same time period, the percentage of the population living in urban areas increased relatively from 42 percent to 75 percent in 2000 (United Nations 2003). This

rapid urbanization is no more readily apparent than in Metropolitan Lima, which transformed from a small urban center of less than 400,000 inhabitants in the 1950s, to a massive, sprawling mega-city which currently houses more than 10 million residents (United Nations 2001). Nearly 75 percent of the Peruvian population lives in cities, and two out of five of these residents lived in Metropolitan Lima (Riofrío 1996: 156).

It is widely recognized that Latin American mega-cities act as vital economic engines within global, regional, and national economies (Gilbert 1996; United Nations 2001). While it is true that some of Latin America's largest cities are steady or decreasing in relative size, the absolute population size of Latin America's largest cities continues to increase. And the primacy of these mega-cities not only as centers of population, but also as the key seats of economic and political power, persists.

Despite the importance of Latin American mega-cities to national economies, they are often characterized by marked inequalities between different population groups. Indeed, Latin America as a region has the most inequitable income distribution in the world. A quarter of all national income is earned by 5% of the population and the top 10% of the population control 40% of the wealth, with the majority of Latin American countries experiencing a continued concentration of income within their populations (Filgueira and Peri 2004; United Nations 2000). These growing differences have been compounded by a history of political instability, weak local planning and governance, ineffective land markets, unlegislated development schemes, and the impacts of widespread poverty.

The economic and social realities of Latin America have had a profound influence on the shape and structure of cities (Gilbert 1996; Sabatini 2003a). Rapid urbanization and population growth of mega-cities in Latin America has placed intense pressure on the ability of governments to provide basic infrastructure and services and to ensure adequate employment for much of the working-age population. In concert with this dramatic growth, decentralized and weakened local

governments have created political and economic uncertainty. This long-term instability throughout the region has contributed not only to economic difficulties in providing jobs or housing for residents, but also to a fragmented and generally weak bureaucratic and administrative system. In describing local government systems, Alan Gilbert notes that “to most people the phrase ‘urban management in Latin America’ sounds like a contradiction in terms” (Gilbert 1998: 103).

As a result of this lack of local government power and resources, Latin American mega-cities have often grown on an informal, piecemeal basis, with large proportions of the population without formal title for their property (Aguilar and Ward 2003). Indeed, in the last quarter-century, especially, Latin American mega-cities have changed from being concentrated and structured to being intensely fragmented along multiple social and physical dimensions. As Michael Janoschka observes, the “influences of globalization and economic transformation concentrated the polarization tendencies between the *ciudad rica* and the *ciudad pobre*, and segregation rose on a micro scale” (Janoschka 2002: 1). In short, the processes and results of economic and urban change are becoming more visible and apparent at all scales, and have contributed to the increasing fragmentation and privatization of urban space. This post-modern model of the Latin American mega-city highlights the increasing presence of gated communities, shopping malls, country clubs, and industrial parks with an increasingly dynamic and mobile population (Borsdorf 2003; Dear and Flusty 1998).

The large-scale production of gated communities and residential towers further reveal increasing segregation across the Latin American mega-city. These developments are often located along major transportation arteries and are often closed off from surrounding neighborhoods by physical barriers and other conspicuous security features (including guards, warning signs, and high-tech alarm systems). At the same time, many of these gated communities and private residential developments emerge in the periphery of the Latin American

mega-city (Janoschka 2002), as the middle-class – including the lower-middle class – also seek to isolate themselves from the poorest city dwellers. These social processes further contribute to a physically fragmented and strongly delineated urban space (Arriagada Luco and Rodríguez Vignoli 2003; Coy and Pohler 2002; Sabatini 2003a; Salcedo and Torres 2004).

While wealthier residents establish citadels as a means of protecting and enhancing their positions of power, wealth, and status, those in poverty are often residing in degraded informal settlements, squatter housing, and urban tenements in both the historic center and the outer periphery (Janoschka 2002; Marcuse 1997: 246). The settlement of the poor is complicated by an unpredictable and inequitable land market (Sabatini 2003b; Ward, Jiménez, and Jones 1994). Though many of the squatter settlements established in the last half-century have gradually consolidated to become improved second-generation housing, the majority of settlements are comprised of quasi-legal or illegal housing. In general, the poor have been left to fill in the “gaps” in the urban environment, or to fend for themselves in self-help or irregular settlement, often in the most precarious and squalid of physical environments. Despite the efforts of numerous development projects, few of these settlements have undergone complete regularization by local authorities (de Soto 1989). These areas comprise the majority of the urban fabric in Latin American mega-cities and create an unbroken pattern of poverty across vast portions of the urban landscape.

### **Measurement of Segregation**

Segregation is commonly defined as “the degree to which two or more groups live separately from one another, in different parts of the urban environment” (Massey and Denton 1988: 282). Given this definition, segregation could be between different racial/ethnic groups, different social classes, or by some other unique characteristic of the population such as education or employment status. Furthering this definition, Massey and Denton outline five key characteristics of segregation: dissimilarity, exposure, isolation, clustering, and centralization

(Massey and Denton 1988). The intent of this distinction is to recognize that segregation is not uni-dimensional and operates across a variety of dimensions and through multiple processes.

In this paper, we build upon the more recent definition of segregation by Reardon and O'Sullivan (2004) which states that segregation is "the extent to which two or more individuals of different groups occupy or experience different social environments" (Reardon and O'Sullivan 2004: 122). While this definition stresses social distance and interaction between social groups, we also recognize the inherent spatiality of residential segregation, and thus, incorporate space into our understanding of residential segregation. In other words, we argue that segregation is a socio-spatial phenomenon with complex connections between unequal social groups. Thus, we accept the explicit role of social processes *and* the recursive and influential nature of physical space. As such, places are shaped by social processes, which, in turn, are influenced by the nature of physical space. This definition, which stresses not only the social distance between social groups, but the ways in which social environments are visibly demarcated across the urban landscape, best reflects the realities in Latin America mega-cities.

As such, measuring segregation requires the definition of both the social and spatial environment for each social group and the extent to which these social and spatial environments differ across populations. The choice and use of appropriate indicators becomes a complicated one, especially given the fact that segregation has received a great deal of attention in social sciences literature with many key articles providing a broad review of segregation indicators, their possible dimensions, and their functional inputs (Cortese, Falk, and Cohen 1976; James and Taeuber 1985; Massey and Denton 1988; Reardon and O'Sullivan 2004; Wong 2003c). While little firm consensus has been achieved on what specific indicators are best able to capture desired aspects of segregation, several effective approaches to the measurement of socio-spatial segregation have been identified (Massey and Denton 1988; Reardon and Firebaugh 2002).

Many segregation indices were developed in the context of the US for the purpose of measuring the degree of separation between two racial/ethnic groups (especially between native-born, non-Hispanic whites and blacks). Unfortunately, two-group measures of segregation only capture one dimension of the process at a time which can be addressed to some extent by using multiple trials of two-group populations (Fischer, Stockmayer, Stiles, and Hout 2004). However, the use of a multi-group indicator can measure segregation between multiple groups simultaneously, allowing the most segregated areas within the metropolitan area to be identified more easily. Given that segregation typically occurs between multiple groups, traditional measures have often been adapted for multi-group environments. Thus, for example, groups with a primary education can be compared with any number of other groups that vary by education levels (like those with a high school education vs. those with some college vs. those with a post-graduate degree).

Accompanying the increased use of multi-group methods has been the employment of multi-level approaches that measure segregation at various levels of the urban structure. In these approaches, social groups are recognized to cluster not only in specific subdivisions and neighborhoods, but also in different communities, areas, or regions (Fischer et al. 2004; Reardon and Firebaugh 2002; Wong 2002a). The assumption of these approaches is that individuals make choices on where to live not only based on neighborhood, but also on districts and regions that may not necessarily be defined by political boundaries. This implies that not only individual action reinforces the processes that lead to segregation, but these processes are also reinforced by social groups and actors at higher geographic levels. Thus, using a multi-level approach will address the influences of local-level group interactions at higher levels of geographic aggregation.

Perhaps most importantly, there has been a revitalized emphasis in the literature to recognize segregation as an inherently spatial phenomenon, manifested simultaneously across physical and social space (Gieryn 2000; Grannis 2002; Wong 2003a). Given that segregation is recognized as



a spatial phenomenon occurring across physical space as well as social space, the analysis of segregation and selection of analytic measures has begun to take into account the spatial nature of the urban environment in which social interaction occurs. Thus, both place (the physical points of interaction) and space (the relationships between and within places) are key input and output variables of segregation analyses. Conventional aspatial measures of segregation may mask these characteristics since only within a local context does the extent of fragmentation between different groups become apparent (Wong 2002a).

### **Research Goals, Data, and Methods**

While most of the poor tend to be concentrated in certain areas of the Latin American mega-city, we argue that continued fragmentation of urban space complicates neat generalizations and sweeping conclusions. In other words, we suggest that local realities confound conventional explanations of the dynamics of socio-spatial segregation. Over time it has become apparent that urban development and the socio-spatial fragmentation of social classes is not occurring in the same manner between and across different urban settings. Unfortunately, the empirical story regarding the geography of urban poverty in the Latin American mega-city is incomplete. Given this, in analyzing Latin American mega-cities, our goal is to use a combination of segregation indicators to provide a broader insight into urban development patterns at multiple levels and across multiple social dimensions.

Census data used for this paper are at the household level from the 1993 Peruvian Census of Population and Housing (*IX Censo de Población y IV de Vivienda 1993*), which is the most recent complete census for Peru conducted at the micro level (INEI 1993). Despite the length of time since its completion, the 1993 census is the most reliable and complete census data available for Peru. Additionally, given that the complete dataset is available aggregated to the block level means that it is possible to calculate measures of spatial segregation at the micro

level rather than generalizing segregation patterns at macro levels. Census micro-data and spatial data were obtained on CD provided by the INEI in 2003.

The lowest geographic level of analysis for measuring segregation is the census zone level using census micro-data aggregated by city block. Census zones are subsets of administratively defined municipal districts, set forth by the national government. In general, census zone boundaries do not change greatly from census to census; however, given the rapid urbanization patterns of Lima this has not always been the case. In an effort to remain consistent with the 1993 census data, the 2000 spatial data has been converted to reflect the census zone boundaries and block identifiers defined in the 1993 census.

There are a multitude of spatial methods and measures available, either spatial extensions of traditional measures, explicit spatial formulas not based on common segregation indices, or spatial techniques employed to analyze spatial segregation and differentiation (Reardon and O'Sullivan 2004; Wong 2002a). However, despite the development of many spatial measures of segregation, few are utilized in specific segregation studies, thus, there is little evidence to confirm their importance (Wong 2003a). As a result, this analysis combines several aspatial and spatial multi-group and multi-level measures of segregation across several social dimensions (Table 1, see Appendix 1 for the relevant formulas).

<<<Insert Table 1 here>>>

The dissimilarity index  $D$  was first introduced to measure the proportional level of segregation between minority and majority population groups within US Census Metropolitan Areas (Duncan and Duncan 1955). The continued prominence of the  $D$  index in the sociological literature reflects the continued recognition of dissimilarity as one of the most important dimensions of segregation (Massey and Denton 1988). However, this index has long been criticized for, among other things, ignoring the spatial aspects of segregation as it does not account for changes in segregation levels when groups from different area units are swapped

(Wong 2002a). One of the primary advantages of this index is that it is simple to calculate and interpret, thus remaining one of the central measures of segregation utilized today (Wong 2003b). The output for the  $D$  index ranges from 0 to 1, indicating no segregation, heterogeneity, and perfect segregation, homogeneity, respectively. However, as long as each area unit within the study area is dominated by one group or the other exclusively, the  $D$  index will return a “1”, indicating perfect segregation, even if some adjacent area units are occupied by different groups. Population groups in different area units cannot interact across unit boundaries, even if they are adjacent to each other. Thus, this measure ignores any spatial realities that are inherent in measures of segregation.

Alternative spatial segregation measures have been introduced that further the argument that segregation involves the spatial separation of population groups and that spatial separation reduces interaction among groups over space (Newby 1982). Given this, different population groups locating next to each other, even from different area units, should have relatively low levels of segregation (Morrill 1991). The  $D(adj)$  index introduced by Morrill (1991) is the original  $D$  dissimilarity index, less the amount of potential interaction between different groups across area unit boundaries. The level of potential interaction between any pair of neighboring units is then determined by the differences in the between-group mixes of neighboring units.

A spatial multi-group measure  $SD(m)$  of segregation based on the  $D$  index was developed by David Wong (1998), furthered from the  $D(adj)$  spatial two-group measure and the  $D(m)$  aspatial multi-group measure. With this measure, the population of a group within a given areal unit has access to the total population of other groups in all surrounding units. Given both the multi-group and spatial nature of this indicator, it is capable of differentiating the spatial patterns between different population groups. As with the  $D$  index, output values range between 0 and 1, where 0 indicates no segregation and 1 indicates perfect segregation.

An additional spatial segregation measure is the  $S$  index developed by Wong (1999) which, unlike the previously measures, is based explicitly on spatial dissimilarity. A standard deviational ellipse is used to fit the locations of individuals within a group, capturing the overall spatial distribution characteristics of each population group. After multiple ellipses are derived for each group, they are then compared and combined to derive an index of segregation based upon the ratio of the intersection and union of all ellipses (Wong 1999). A smaller ellipse will result from a clustered distribution and a larger ellipse will result from a more dispersed population. For homogeneously segregated population groups this index will generally result in high values, while for scattered heterogeneous populations, the index will generally result in low values.

The last measure employed in this analysis is a spatial formulation of Theil index ( $H$ ), which measure the evenness of a population, and the entropy score ( $E$ ), which measures the diversity of a population. The calculation of the Theil index begins with the entropy score, which is the proportion of a given group within a defined areal unit. For this analysis, the population proportion is measured for a given areal unit by the total population of a given group within all surrounding units. Commonly, this diversity score is then used to calculate the Theil index; however, for purposes of this analysis this step is not presented.

<<<Insert Table 2 here>>>

In order to understand the geography of poverty in Metropolitan Lima, in this paper we calculate segregation using a series of poverty indicators. These indicators include: (1) education levels of the population over 5yrs of age, (2) employment types for individuals over 15yrs of age, (3) the tenancy status for occupied dwellings, and (4) the socio-economic status (SES) of the household as measured by a standard composite poverty index (Table 2).

We select education as it is a central input to the social system, where an individual's education level influences the potential employment available to them, what potential income

they may earn, and indirectly, what the possible education level their children may obtain (Hall and Peters 2003). This variable is measured as those individuals over 5 years of age without any primary school education, with a primary school certificate, with a secondary school certificate, with some college or technical education, or with some formal university experience. Given that census data are only available in an aggregated format, we were unable to recalculate this indicator to coincide with more commonly used age cut-offs.

Current employment status is measured as those individuals over 15yrs of age who are either an employee of a company or a laborer, who work for the family for no pay, are an independent worker with no employees, are an employer, or are currently looking for work. This variable can be conceptualized as a proxy for the economic potential of individuals within the metropolitan area.

Tenancy of dwellings is specified as those units that are either rented, are owned outright or currently paying a mortgage, are occupied without paying, are being used illegally through land invasion, or other forms of occupation. Given the traditionally high level of informal settlement in Metropolitan Lima and other Latin American mega-cities, we argue that this aspect of urban development is especially informative in understanding patterns of segregation (Peters and Ward n.d.; Sims 2003).

The final variable employed in this study is a five-class measure of socioeconomic status (SES). This indicator of poverty is defined by the national statistics institute and includes education, social status, and economic wealth (INEI 1993). Unfortunately, the exact variables used to construct this composite score are unavailable, largely due to the inherently political nature of defining poverty. For instance, a significant feature of worldwide poverty estimates is the great variation between estimates based on absolute and relative poverty levels as well as the difference between a nutrition-based and an income/expenditure-based absolute poverty line (Chen 2005). These measurement problems also characterize Peru's official poverty estimates.

The official poverty line as a whole has been harshly criticized because it is believed to underestimate actual poverty given its austere threshold, the neglect of regional differences in prices, and costs of living and inflation rates (Schady 2002). It is for this reason that we decided to rely not only on SES, but include the above-mentioned variables for comparative purposes.

## **Results**

### *Mapping the Geography of Poverty and Segregation in Metropolitan Lima*

Given that Lima is the capital city of Peru, and is by far the largest city in the country, it is not surprising that over 30 percent of the country's poverty is concentrated in the Lima Metropolitan Area. There is no doubt that this creates intense social and economic inequality within this mega-city. The pronounced disparities between rich and poor become readily apparent in Table 3 which provides summary statistics for the entire metropolitan region, using the five indicators of poverty selected for this analysis. The most striking feature of this table is the dramatic numbers of impoverished individuals living in the city. In 1993, the proportion of individuals with either low or medium-low SES made up nearly 70 percent of the Metropolitan Lima population. In absolute terms, the individuals living in poverty numbered above 4 million.

More than six percent of households lived in an unauthorized, invasion-type dwelling. Given the lack of cheap, public housing built by the Peruvian government, it is not surprising to find a number of poor individuals building their own accommodations (Riofrío 1996: 160). This relatively low percentage of unauthorized, invasion-type dwellings might be surprising to some who presupposed that the policy that allowed the poor to invade land and build their own shelters was more commonplace. Indeed, before the 1990s, housing for the poor was simply a matter of providing a plot of land, often in the peripheral desert for occupation. Unfortunately, by the 1990s, Lima's government faced major problems with this housing model as unoccupied, accessible, and serviceable land became scarce, and more and more potential developers

competed for smaller and less suitable parcels of land (Riofrío 1996: 161). Thus, by the time of the 1993 Census, this form of tenancy had become less and less frequent, resulting in a relatively small percentage of unauthorized, invasion-type dwellings. In addition, many respondents may be unwilling to reveal the actual nature of their tenancy status to government officials.

Interestingly, the changing age structure of the metropolitan area becomes readily apparent from the education statistics. Because this constructed variable includes the entire population aged five years and older, the percentage of individuals with a primary school education or less accounts for over thirty-four percent of Metropolitan Lima's population. But this number is inflated since it includes a significant number of young children who are currently enrolled in school and who have yet to complete their education. The fact is that the majority of the adult population in Metropolitan Lima has at least some formal education and a large proportion of the population has a secondary school certificate or more (Hall and Peters 2002).

Despite the millions of economically active and literate individuals living in Metropolitan Lima, many are faced with unsatisfied desires and a weak economic situation. As a result, nearly twelve percent of individuals aged fifteen years old and higher are employed in the informal sector. This informal sector provides jobs and increases incomes of the most vulnerable groups in the city – and typically includes the very lowest-SES groups, though there are some medium-SES workers as well. Indeed, many workers employed in the informal sectors maintain that employment in the informal sector is a survival strategy since metropolitan Lima lacks sufficient jobs – whether skilled or unskilled (Aliaga-Linares 2002). As a result, the percentage of individuals employed as informal workers has steadily increased over time, reaching an all-time high in the 1993 census.

<<<Insert Table 3 here>>>

Like in other Latin American mega-cities, poverty is geographically pronounced and the poor tend to be heavily concentrated in a few areas, though there are significant numbers of the poor

residing throughout Metropolitan Lima. Table 4 displays the percentage of households from each SES category within each of the five regions of Metropolitan Lima (see Figure 1 for the locations of regions). Even at an aggregate level, the degree of segregation amongst socio-economic groups between regions is apparent. The percentage of households with the lowest levels of SES varies from a high of nearly sixty percent in the Eastern Cone to a low of twenty-five percent in the City Center. In contrast, the vast majority of households (nearly ten percent) with the highest levels of SES are located in the City Center; another smaller proportion of wealthy households reside in Callao and the Eastern Cone. This distribution reflects the historic development patterns of Metropolitan Lima, where new rural migrants typically settled in the urban periphery (the Northern, Eastern, and Southern Cones) while the middle-class and elites moved to the City Center, and eventually settled in an outward, linear pattern towards the Eastern Cone (Peters and Ward n.d.). At the same time, the distribution suggests that Metropolitan Lima's wealthier urban regions tend to be relatively heterogeneous, incorporating a diversity of socio-economic groups.

<<<Insert Table 4 here>>>

Though not shown here, levels of education also vary greatly between different areas of the metropolitan area. At the district level, the greatest variance occurs in the proportion of the population with some university education, with some districts reporting as few as five percent of the population with some university experience while other districts count more than thirty percent of the population with some university experience. This distribution reiterates the fact that there is a tendency for wealthy, more-educated residents to isolate themselves at the district level, particularly from the illiterate, urban poor. Significantly, middle-class settlers are likely to interact with other social classes at the district level, since they don't form the majority in any one district.

This pattern is reflected in Table 5 which divides the forty-nine municipal districts that comprise Metropolitan Lima into five distinct socioeconomic clusters: those with high



socioeconomic levels, those with medium-high socioeconomic levels, those falling roughly in the middle, those with medium-low socioeconomic levels, and those with low socioeconomic levels. This table is similar to an approach taken by Dietz (1985) using 1983 census data. In this analysis, however, the municipal districts of Callao are also included as part of greater Metropolitan Lima – as this region has seen considerable growth since Dietz’s original analysis.

What is most striking about these results is that the poorest populations are concentrated in twenty-two of the forty-nine municipal districts, and these twenty-two districts tend to be located in the Northern and Eastern regions of the metropolitan area. Significantly, those five districts characterized by a high SES are traditional Central City locations for the elite, along with a newer community that has emerged in Callao. Medium and medium-high-status groups also tend to cluster in Central City districts. Interestingly, the medium-low status group also appears in four Central City districts, once again demonstrating the general observation that, despite high levels of concentration, poorer pockets appear throughout Metropolitan Lima. Simultaneously, this poorer group also resides in newer suburbs which have expanded in all directions at the periphery of the city.

<<<Insert Table 5 here>>>

The relatively concentrated pattern of poverty is readily apparent in Figure 1, which displays the proportion of households with the lowest levels of SES by census tract (regions are highlighted with bold boundaries). Levels of poverty vary greatly between different areas of the metropolitan area. Those census tracts with greater proportions of households with high SES are located near the historic city center and in a linear pattern to the south and east of the metropolitan region along major transportation routes. Some of these districts, such as Miraflores and Barranco, are historically important locations for elites and the middle-class and have recently grown as commercial centers. Conversely, high proportions of households with the lowest levels of SES are concentrated in the Northern Cone, the northern portion of the Eastern

Cone, and in the Southern periphery of the city. These areas were prime areas for informal settlement by rural migrants from the 1950's onward. As the city has grown, these areas have continued to be significant areas for settlement of poorer residents.

<<<Insert Figure 1 here>>>

### *Measuring the Geography of Poverty and Segregation in Metropolitan Lima*

While the above results suggest that there is significant segregation among population subgroups in Metropolitan Lima, they give little indication as to the amount of and/or nature of mixing taking place. Table 6 presents the metropolitan-level results across several poverty indicators. Though not displayed here in tabular form due to space constraints, regional-level results are also discussed (see Appendix 2 for these results). The segregation indices vary considerably by which measure is utilized and by which poverty indicator is employed. Importantly, the broad-scale analysis reveals the overall scope of segregation in Metropolitan Lima, while the regional results demonstrate how the geography of poverty unfolds at a finer scale.

The  $D$  and  $D(adj)$  indices reflect how evenly distributed two groups are among a set of geographic units. In this case, the selected comparison groups are 1) education = primary completed or less vs. all other categories; 2) employment = self-employed vs. all other categories; 3) tenancy = invasion vs. all other categories; 4) poverty = low/med-low. The idea is to measure the amount of similarity or dissimilarity of the population compositions ( $D$ ) across neighboring units ( $D(adj)$ ). The index values range from zero (most even distribution) to one hundred (most uneven distribution). Because  $D(adj)$  is derived from  $D$ , the resulting scores are always lower (Wong 2003c). Yet this indicator is especially useful because it is a spatial measure that adjusts for neighbor characteristics.

What is immediately apparent from the results at both the metropolitan- and regional-levels is that the two-group comparisons of education and employment create markedly low indices.

Yet when we compare the proportion of the population with the lowest socioeconomic status with those medium or higher socioeconomic status groups, the levels of these indicators are relatively high. Indeed, they are what would be considered moderate levels of segregation in the U.S. context (when comparing blacks to whites); in this case, the  $D$ , and  $D(adj)$  indicators are generally in the range of 0.41 to 0.52. In other words, forty-one to fifty-two percent of the poorest residents would have to move in order to have the same geographic distribution as wealthier inhabitants. This pattern is repeated at all scales, indicating that the poor are unevenly distributed in Metropolitan Lima.

Tenancy segregation indices are also moderate; thus invasion-type dwellings are also unevenly distributed across the urban landscape – whether at the metropolitan- or regional-level. In the City Center, especially, invasion-type dwellings are disproportionately clustered. This observation implies that 1) fewer residents in the City Center live in invasion-type dwellings (this makes sense given that this is the historic center of Lima and the oldest area of urban development); and 2) the levels of unevenness between the two observation groups in this area is so high that seventy-five percent of residents in invasion-type dwellings would have to move to have the same geographic distribution as residents in other types of dwellings. In other words, this group is highly segregated from other residents in this area. The high level of invasion-type tenancy segregation is apparent in other regions of metropolitan Lima, with  $D$  indices ranging from 0.57 in the Southern Cone to 0.65 in the Eastern Cone. More than any other indicator, tenancy status reveals the geography of poverty and segregation in Metropolitan Lima.

<<<Insert Table 6 here>>>

The other indicator based on the dissimilarity index,  $SD(m)$  is a multi-group dissimilarity index that also accounts for the potential spatial affects of adjacency and distance between neighboring census tracts. Given that this indicator is based on multiple groups rather than two, the levels of between-group segregation are lower than the standard two-group  $D$  index. Yet, the

interpretation of  $SD(m)$  is the same as  $D$ . So, the higher the score, the more dissimilarity between population groups, even after adjacency and distance are considered. At the metropolitan-level, this indicator is similar to the previous measures in that the education and employment dimensions continue to be lower than the tenancy and SES dimensions. The higher scores for tenancy and SES suggest that fewer residents of different types (whether considering type of dwelling or degree of poverty) have the potential to interact, because they are not living in the same areas of Metropolitan Lima. The  $SD(m)$  index at the regional level highlights the differences between and within the Northern Cone, Callao, the Eastern Cone, the City Center, and the Southern Cone. While each region contains a diversity of population groups, segregation fluctuates for each poverty indicator, suggesting that there is dissimilarity in the geographic distribution of, and interactions between, the various socioeconomic groups.

Why is there such marked variation between the different poverty indicators, with the tenancy and SES having the highest values and education and employment having lower results? The outcomes suggest that while education and employment types are relatively evenly dispersed across the Metropolitan Lima, the tenancy of dwellings and SES are relatively more clustered in the urban landscape. Another possibility related to this is that the vast majority of residents are similar in their education and employment characteristics (most have at least a primary education and the majority are classified as employees or laborers) and thus, these are not particularly useful indicators for understanding the dynamics of socio-spatial segregation. Instead, tenancy and SES are the best variables for capturing the geography of poverty in Metropolitan Lima since these indicators have less homogenous distributions (both statistically and geographically). Of course, SES is a constructed variable that is highly correlated to the other poverty indicators, and yet, it also includes other factors in creating a composite score. Unfortunately, INEI does not provide the equation used to calculate SES in the 1993 Peruvian Census, thus it is impossible to disaggregate the influence of other factors. We can only hypothesize that it is because of these

other factors (especially markedly divergent incomes and housing stock quality amongst otherwise similarly educated and employed individuals) that socio-spatial disparities and segregation emerge.

<<<Insert Figure 2 here>>>

The *S* index supports this suggestion, and reflects the probability of randomly selecting two persons who belong to two different groups. The measure is effective for showing the degree of diversity (or put differently, how different population subgroups coexist in the same area) at both the metropolitan- and regional- levels. The measure is standardized such that the value ranges from 0 (perfect potential interaction, no segregation) to 1 (no potential interaction, perfect segregation) (Wong 2002a: 89). In other words, the higher the score, the less potential interaction between subgroups.

This index produces strong evidence in support of widespread socio-spatial segregation in Metropolitan Lima. Once again, the highest levels of segregation appear between different tenant arrangements and household SES groups. In this case, the poorest residents and those living in invasion-type dwellings are sixty-nine percent *less likely* to be residing in the same areas as wealthier residents who own or rent their dwellings. At the same time, residents with a primary education and working in the informal sector are sixty percent *more likely* to live in the same areas with residents with greater than a primary education and employed outside of the informal sector.

If different groups do not have similar distribution patterns, they are also likely to be separated from one another spatially. In order to capture the spatial distribution patterns of multiple population groups, a standard deviational ellipse can be derived for each group. The ellipses can then be compared both statistically (using the *S* index) and visually to determine the magnitude of spatial overlaps of different groups (Wong 2003a: 251). Figure 2 displays the ellipses constructed for the SES variable by region, with each ellipse representing one of the five

levels of socioeconomic status. A pattern of spatial incongruence becomes readily apparent, with the poorest SES households clustered in distinctly different areas than those with higher levels of SES within each region. This is especially visible in the City Center and Callao, where those households with the highest levels of SES experience little overlap with poorer households living in the same region. In the Eastern Cone, the wealthier households follow the expected direction along traditional lines of urban expansion, while the poorest households tend to concentrate on the margins of the region – where the most untenable housing developments emerge.

The implications of the above results at the metropolitan and regional levels are further supported by evidence at the local-level. Figure 3 displays the differing patterns of segregation between the SES and tenancy indicators, as well as the pronounced local variation within each indicator. Using a section of the Northern Cone, centered on the district of Los Olivos, these two indicators are compared using a standardized spatial entropy score. The patterns of segregation visible in this map illustrate a linear pattern, highlighted by the *Panamericana Norte* and the major thoroughfare *Tupac Amaru*, which extend northwards along the boundaries between Low Olivos, Independencia, and Comas. These patterns are not surprising and reflect the nature of urban development in Lima, which, like other cities in the region, has often followed primary transportation routes. What is most telling from this map is the local-level variation in the entropy score that is evident from each indicator.

The background layer in Figure 3 represents the census zone boundaries, shaded by the calculated values for the spatial entropy score. For the tenancy indicator there is little variation in these values, with most measured values ranging between 0.1 and 0.5, suggesting that there is not a pronounced diversity of tenancy status in this area. However, for the SES indicator, entropy scores are much higher, reflecting a greater diversity of socio-economic groups within this area. In particular, the greatest levels of diversity are in the older, more consolidated areas, whereas there are lower levels of diversity near the edges of the districts. These more recently-settled

areas were originally largely comprised of rural migrants who invaded land at the urban periphery. However, as the city has grown in the last decades, these areas themselves began to consolidate and the housing stock and service infrastructure has slowly improved.

<<<Insert Figure 3 here>>>

Figure 3 also includes city block layers, shaded by the spatial entropy score values. In contrast to the values measured at the census zone level, there is greater variation present between city blocks. In particular, for the tenancy indicator, on a block-by-block level, values range from 0.1 to above 0.8, even within census zones where the measured entropy score is much lower. While part of this is due to the effect of varying population sizes between city blocks, it is clear that the pattern of segregation is much more fragmented than visible at the metropolitan or regional levels. The same variation is visible in the indicator for SES. While for much of the center of the selected area the block-level results mirror those at the census zone level, towards the periphery of the districts there is a greater visible difference between the block and zone-level results. In general, the pattern of segregation values suggests that the more consolidated areas are more diverse between different socio-economic groups, while the peripheral areas are less diverse, with several visible pockets shared by like groups. Clearly, the fragmentation evident from these local-level results supports the general proposition put forth in the paper that the level of segregation in Metropolitan Lima is increasingly fragmented, with widespread variation between metropolitan regions, municipal districts, and city blocks.

## **Discussion**

In this analysis, the separation of social classes by socio-economic status proved to be remarkably widespread, and inequality presented itself not only socially, but geographically as well. The socio-spatial segregation between rich and poor was noteworthy at both the metropolitan-, regional-, and local- levels. We discover that fragmentation is indeed an obvious trend in this Latin American mega-city, where pockets of the rich are highly segregated and

isolated from the vast expanses of the middle-class and poor. Even so, segregation in Metropolitan Lima is highly localized and different social groups end up living in close proximity to each other.

The trends presented above are evidence of the interacting social and spatial processes that undermine the social fabric of Metropolitan Lima. As elites and middle-income residents seek to separate themselves from the poor, they contribute to a physically fragmented and strongly delineated urban space. As a few neighborhoods begin to consolidate and individual households improve their well-being, the diversity within certain areas will increase, while at the same time, the segregation of those in poverty will continue. And if these economic and geographic trends continue, the consequences, especially for the poorest residents may be especially severe. The decrease in rural to urban migration, decreases in urban fertility rates, periods of economic recession, the return of democracy, and the rise of neo-liberalism significantly modified urban structure and the nature of the urban development process in the later half of the twentieth century. The reforms of the 1990s, specifically, led to the dismantling of social services, the decentralization of government, the privatization of public services, and the increase of foreign activity in commercial enterprise. All of these processes manifested themselves in the marked increase of residential segregation. And there appears to be no end to the transformations that are occurring in this rapidly developing Latin American mega-city. It is likely that the changes that will occur in the early twenty-first century will only further contribute to the increased fragmentation and privatization of urban space.



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Table 1.—Selected Segregation Indices

<b>Index</b>	<b>Multi-Group</b>	<b>Dimension</b>
<i>D</i> – Dissimilarity index	No	Dissimilarity
<i>D(w)</i> , <i>D(adj)</i> – Spatial dissimilarity	No	Spatial Dissimilarity
<i>SD(m)</i> – Spatial dissimilarity	Yes	Spatial Dissimilarity
<i>S</i> – Location, dispersion, orientation	Yes	Spatial Congruence
<i>E</i> – Entropy score of diversity	Yes	Population Diversity
<i>H</i> – Theil index	Yes	Spatial Evenness

Table 2.—Selected Poverty Indicators

<b>Indicator</b>	<b>Groups</b>	<b>Level of Analysis</b>
Education	No formal education Primary education Secondary education Some college / technical Some university	Individual > 5yrs
Employment	Employee or labourer Work for family with no pay Independent worker Employer Looking for work (Unemployed)	Individual > 15yrs
Tenancy	Renting Owned, either paid or paying Authorised use without paying Unauthorised invasion Other	Dwelling
Socio-Economic Status (SES)	Low Medium-low Medium Medium-high High	Household

Table 3.—Summary Poverty Indicators in Metropolitan Lima, 1993

<b>Indicator</b>	<b>Total Population</b>	<b>Percent of Group Total</b>
Primary education or less (> 5yrs)	1,906,119	34.34%
Informal (> 15yrs)	518,490	11.97%
Residential tenancy - invasion (household)	84,409	6.51%
Socio-economic status - low and/or med-low (individual)	4,194,061	68.20%
Total Population		6,149,583
Total Households		1,334,550
Total Homes		1,296,166



Table 4.—Household Socio-Economic Status in Metropolitan Lima by Region, 1993.

<b>Region</b>	<b>Low (percent)</b>	<b>Med.-Low (percent)</b>	<b>Medium (percent)</b>	<b>Med.-High (percent)</b>	<b>High (percent)</b>
Northern Cone	53.85	24.32	13.73	7.04	0.70
Callao	44.76	23.84	16.73	11.93	1.77
Eastern Cone	59.44	21.04	10.42	6.24	1.98
City Centre	25.53	18.50	18.70	25.50	9.92
Southern Cone	60.38	22.42	10.40	5.39	0.63

Table 5.—Socio-Economic Clusters in Metropolitan Lima by Municipal Districts, 1993

<b>Low</b>	<b>Medium - Low</b>	<b>Medium</b>	<b>Medium - High</b>	<b>High</b>
Ancón (NC)	Ate (EC)	Barranco (CC)	Jesús María (CC)	La Punta (C)
Carabayllo (NC)	Breña (CC)	Bellavista (C)	La Molina (EC)	Miraflores (CC)
Carmen de la Legua (C)	Callao (C)	La Perla (C)	Lince (CC)	Pueblo Libre (CC)
Cieneguilla (EC)	Chaclacayo (EC)	San Luis (CC)	Magdalena del Mar (CC)	San Borja (CC)
Comas (NC)	Chorrillos (SC)	Surquillo (CC)	San Miguel (CC)	San Isidro (CC)
El Agustino (EC)	La Victoria (CC)		Santiago de Surco (CC)	
Independencia (NC)	Lima (CC)			
Lurigancho (EC)	Los Olivos (NC)			
Lurín (SC)	Rímac (CC)			
Pachacamac (SC)	San Juan de Miraflores (SC)			
Pucusana (SC)	San Martín de Porres (NC)			
Puente Piedra (NC)				
Punta Hermosa (SC)				
Punta Negra (SC)				
San Bartolo (SC)				
San Juan de Lurigancho (EC)				
Santa Anita (EC)				NC = Northern Cone
Santa María del Mar (SC)				C = Callao
Santa Rosa (NC)				EC = Eastern Cone
Ventanilla (C)				CC = City Centre
Villa El Salvador (SC)				SC = Southern Cone
Villa María del Triunfo (SC)				

Table 6.—Segregation Indices for Metropolitan Lima, 1993.

<b>Indicator</b>	<b>Education</b>	<b>Employment</b>	<b>Tenancy</b>	<b>Poverty</b>
D	0.172	0.173	0.672	0.516
D(w)	0.119	0.128	0.572	0.420
D(adj)	0.117	0.127	0.571	0.405
SD(m)	0.230	0.208	0.414	0.417
S	0.408	0.350	0.693	0.790
H(spatial)	0.049	0.051	0.293	0.213

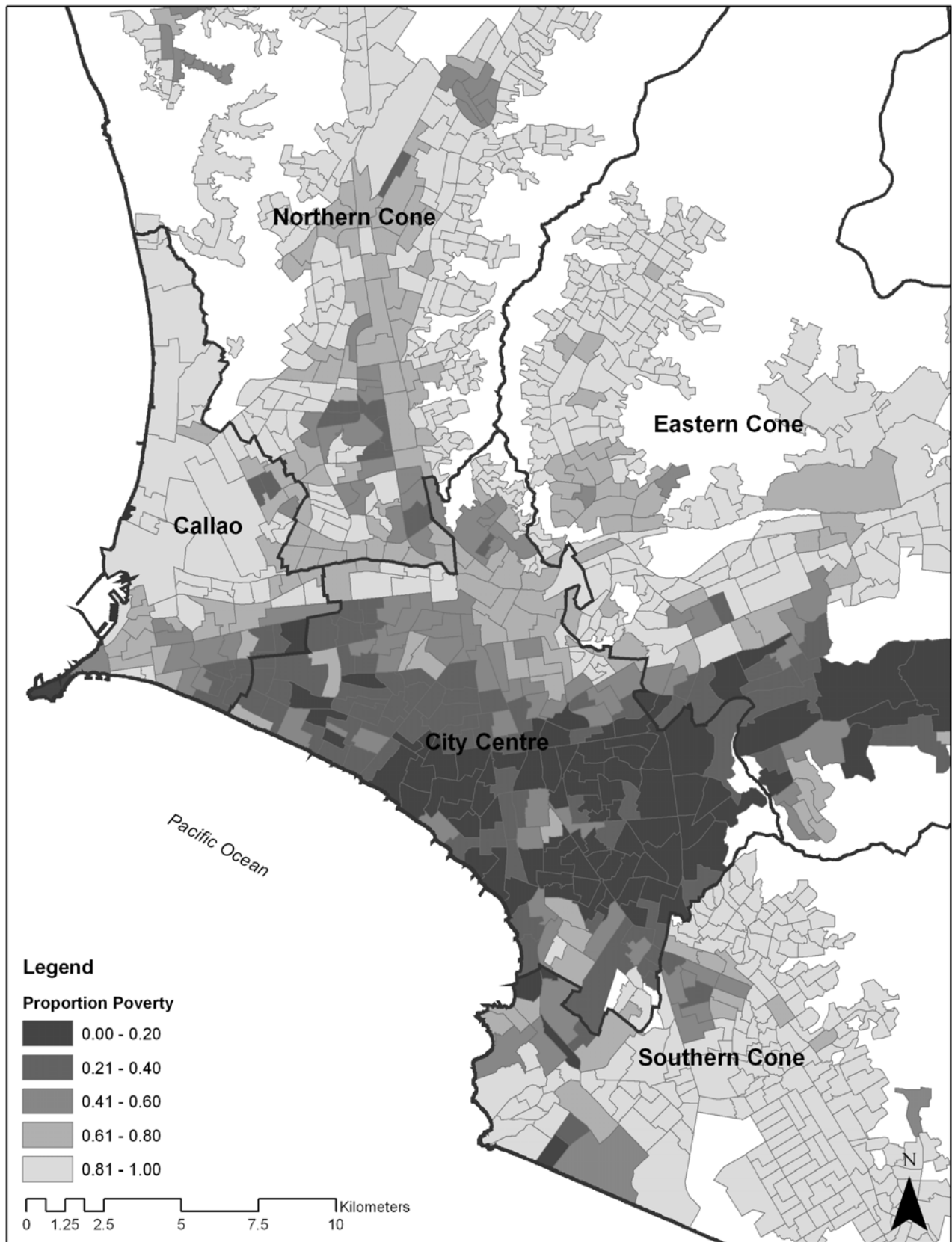


Figure 1.—Percentage of Households by Socioeconomic Status in Metropolitan Lima, 1993.

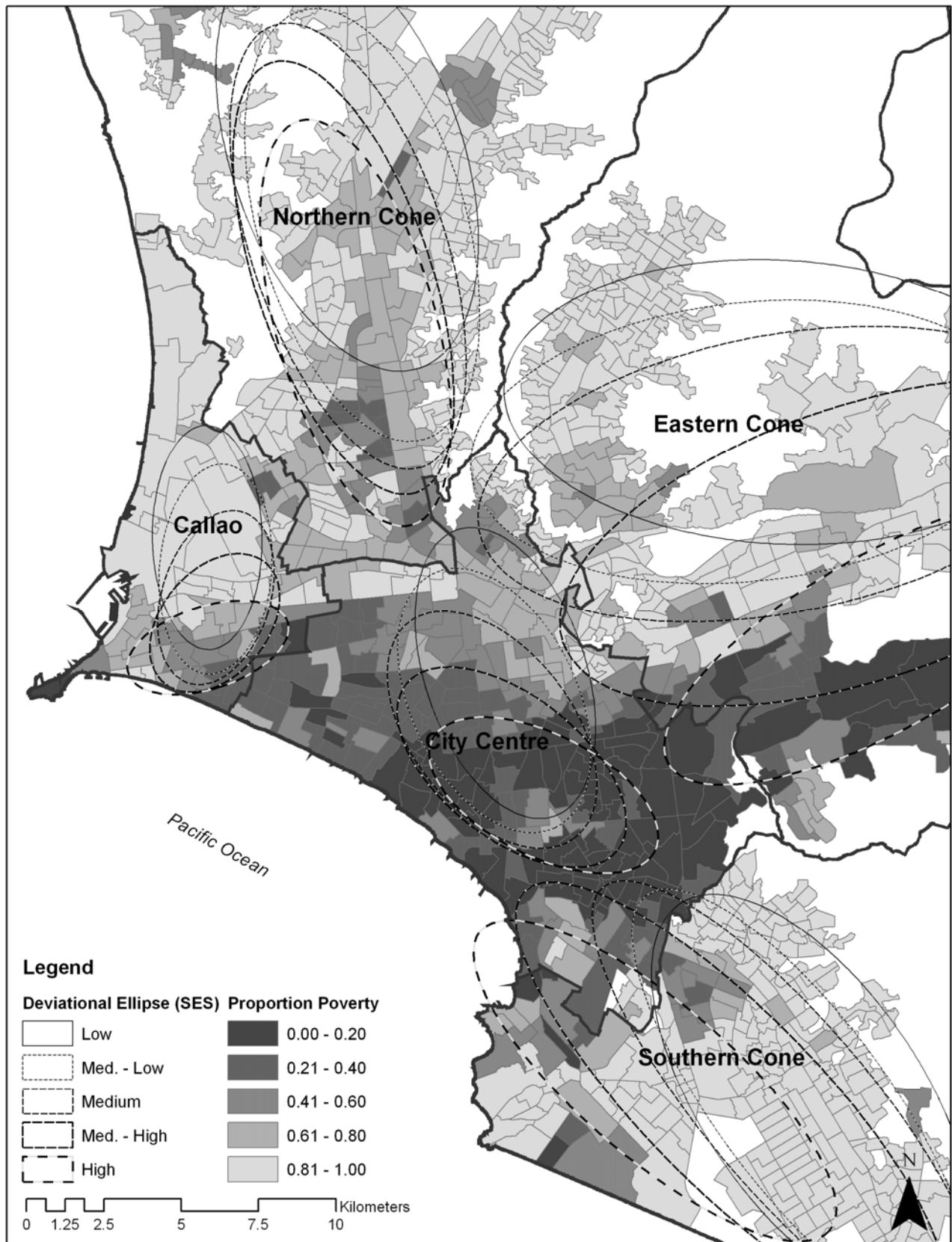


Figure 2.--Distribution Patterns of Socioeconomic Status in Metropolitan Lima, 1993

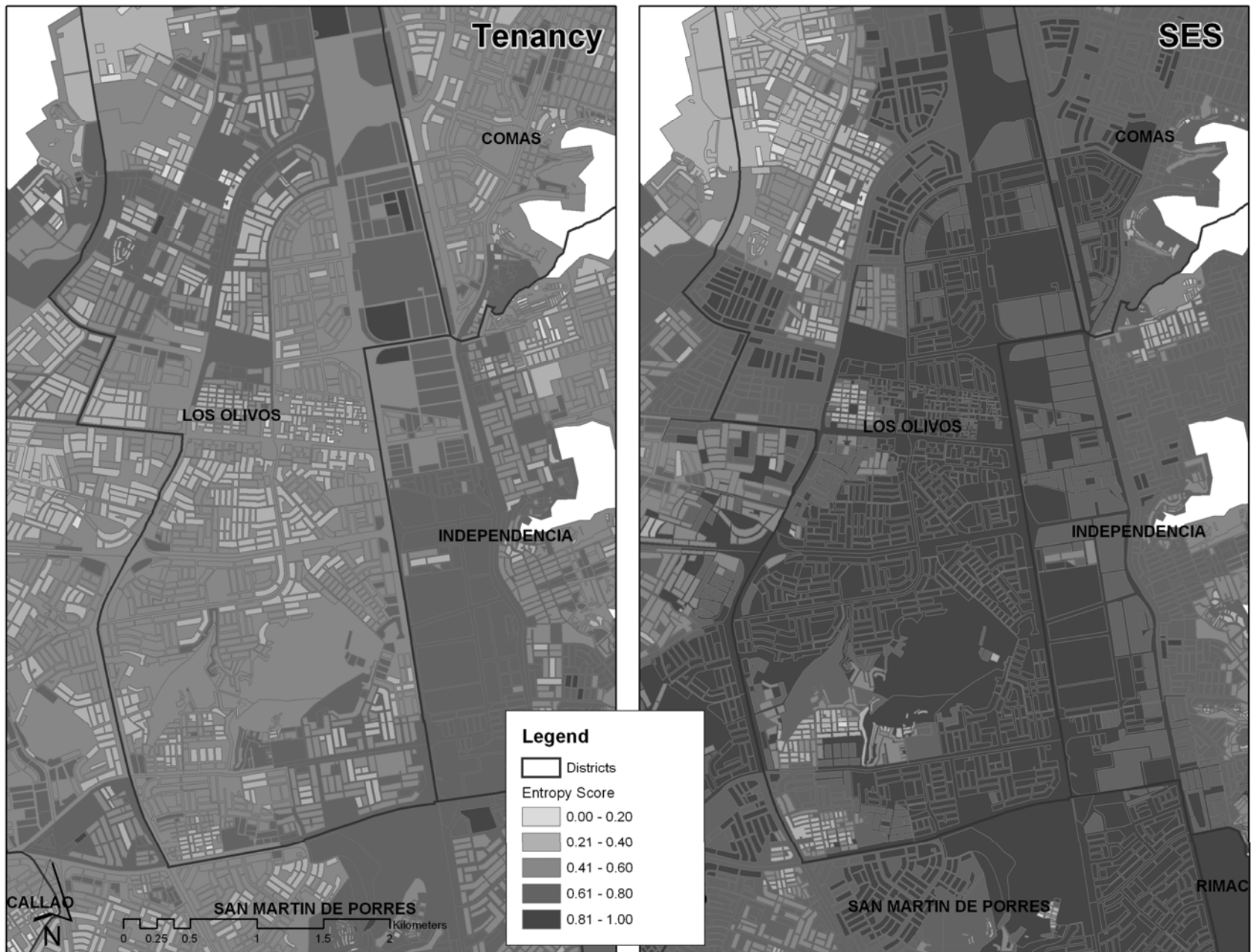


Figure 3: Diversity of tenancy and socio-economic status in the Northern Cone of Lima, 1993.