Zoning and Land Cover Metrics for Municipalities in Argentina (1990–2001)

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Abstract

This paper explores a new set of metrics conducive to a better understanding of regulation, in particular zoning regulation, its determinants and characteristics, and the analysis of spatial fragmentation of the urban built-up area over time and across municipalities in Argentina. Our aim has been to answer simple questions such as: How much the zoning of land use differs across municipalities? What is the composition of the built-up area in a given municipality? How do municipalities compare in terms of spatial fragmentation of the urban area? How did spatial fragmentation evolve in the period 1990–2001? We acknowledge that this paper is a preliminary analysis of the metrics calculated from zoning maps and satellite images. Nevertheless, it provides some suggestive insights that motivate future research. For example, the analysis of zoning indicates that residential use accounts for nearly 60 percent of the non-rural zoned area of municipalities, with a high standard deviation of nearly 20 percent. To understand this variability is an important task for future research. Future research may also use the new metrics to weight land use regulation and building parameters according to each land use zoning category and empirically test hypothesis related to the causes and consequences of land use regulation.

Keywords: Zoning, Urban and Regional Planning, Land Cover Metrics, Satellite Images, Cities in Argentina, Urban Land Use Regulation.

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1. Introduction

In this paper we present descriptive statistics on land use zoning based on geographical data and land cover metrics for a large sample of municipalities (local governments) in Argentina. This descriptive work is part of a larger research agenda that compiles and produces new data in order to make possible the empirical study of significant questions associated with urban economics, such as the causes and effects of land use regulation, the effect of regulation on the tenure condition of households, and the relationship between regulation and urban form as for example special fragmentation. We supplement with new data the information on urban regulation provided by the 2011 Land Use Regulation Survey (see Goytia, Hagedorn, and Pasquini, 2012).

The first part of the paper examines regulation on the basis of geographic zoning maps obtained from municipalities in collaboration with the *Secretaría de Asuntos Municipales* (Municipal Affairs Secretariat—SAM) at the *Ministerio del Interior de la Nación Argentina.* This information was provided by municipal planning directors or similar officials and covers 111 municipalities. Because land use terminology used for zoning purposes in not standardized in Argentina, we had to apply common criteria to the municipal zoning maps and measure, with the help of GIS instruments, the area covered by each zone, so as to permit comparative analysis across municipalities.

This zoning information is used to improve knowledge on the relative stringency of regulation as applied to land use and building norms across jurisdictions. Building norms usually take different values according to the respective zoning category and might even be different within the same zone. Thus, for a comprehensive analysis of stringency of building norms in any given municipality, we had to take into account both the values of the parameters in each zone and the extension of the area covered by each zoning category. In this paper we only present descriptive statistics on the extension area of each zoning categories. Further research will examine the linkages between building norms and zoning. Albeit preliminary, the analysis presented in this paper is interesting in itself since it allows measuring similarities and differences in zoning regulations across jurisdictions.

Preliminary findings show a general pattern of zoning regulation for urban land use in Argentinean municipalities, where the zoning for residential use accounts for an average of about 60 percent of the non-rural zoned area. We also found a great degree of dispersion in land use zoning across municipalities. Our preliminary analysis shows larger residential zoning areas in jurisdictions undergoing extensive urbanization, i.e. where the urbanization process covers larger portion of the municipal territory. Interestingly, land zoned for gated communities represents, on average, only 3 percent of the territory but the share is larger in jurisdictions undergoing more extensive urbanization. For other characteristics of the municipalities, such as population, incidence of vacant urban land for example, we found no clear correlation in the descriptive analysis.

The second part of the paper presents the analysis of land cover metrics developed from satellite images. There are many reasons why this information is relevant. Just to mention some of them, there is need for a better measure urban density—a central variable in any urban economic analysis. In a country such as Argentina, the density measures available are not fully adequate because the physical limits of the jurisdiction—needed to calculate area in the density denominator—are not always available. Later in this paper we discuss these constraints in more detail. The is also need of a better measure of vacant urban land in order to better understand the impact of regulation and other aspects of the urban development process. In this paper we define vacant land as pixels measuring 30 by 30 meters containing mostly open space or vegetation. Although this definition of vacant land is not as precise as we would like (because it does not discriminate ownership or regulatory restrictions such as ecological reserves), the resulting measure is useful for analytical purposes. A third reason why land cover metrics are important is to measure spatial fragmentation of the urban area, which is a central issue in planning for infrastructure provision and its cost. Spatial fragmentation is also significant as it relates to formal and informal land ownership.

Our analysis of land cover relies on satellite images classified according to land cover metrics following the methodology developed by Angel, Civco and Parent (2010). The satellite images used in our study cover practically all urban areas of Argentina, comprising 30 urban agglomerates (with 140 municipal jurisdictions) in two points in time—circa 1990 and 2001. This database permits the analysis of developments that occurred during the last decade of the twentieth century in every city. Among the metrics produced are the extent of built-up land surface and its composition, distinguishing among urban, suburban and rural built-up areas; the extent of new developments and its composition, distinguishing among infill, extension and leapfrog developments; and an indicator of fragmentation defined as built-up areas that are spatially fragmented, which permits the analysis of open space in different spatial scales. Together these measures permit rigorous quantitative assessment of the urban spatial structure and its changes over time.

One preliminary findings of our analysis of land cover metric is based on the quantitative measure of the relationship between spatial fragmentation and population, across different scales. We found such relationship to be negative, as expected. We also found more spatial fragmentation in jurisdictions undergoing extensive urbanization. Notably, we documented a steady decline in spatial fragmentation in almost all jurisdictions and all the scales of analysis during 1990–2001.

This paper is organized as follows: Section 2 presents the motivation and brief literature review covering the use of GIS and satellite imagery in empirical studies. Section 3 introduces the methodology used in the analysis of zoning and land cover metrics. Section 4 presents the descriptive statistics; and the final section concludes.

2. Empirical Studies of Land Use Zoning Regulation and Land Cover

It is important to note, at the outset, the advantages provided by the use of satellite imagery and geo-referenced spatial data to enhance the analysis of spatial phenomena. The vast amount of new sources and types of data, such as land cover metrics, are helping understand better several spatial issues. For example, in our study these data help advance our knowledge and test new hypothesis regarding determinants and effects of land policies in general, and land use regulation in particular. Basically, we are now becoming even more familiar with GIS to integrate data from different sources and these highly original data sources are increasingly been adopted as standard in every economic analysis of phenomena that takes place in space.[1]

One of the most promising developments is the rapid increase in the availability of, and ability to process remote sensing data on land use; together with the parallel ability to integrate such physical data with socio-economic or other data. Until recently, these tools were seldom used outside a relatively small, technically-proficient group of scholars. The increasing accessibility of GIS software and growing interest in spatial analysis has changed this. The 30 x 30 meters land use raster images categorized into land cover classes[2] has allowed researchers to ask new questions, for example, examine how much land is developed in each jurisdiction and the characteristics of such land development, an information that can be matched with population and other types of data.

The first study that examines multiple regulatory measures of land use, observed simultaneously and over an extensive area, is by Evenson and Wheaton (2003). Their paper describes land use patterns and zoning rules from a single state in the United States. While a few other studies have amassed geographical data on a specific type of land use regulation, Evenson and Wheaton (2003) provide very detailed data on most land uses, the rules governing them, and the norms regulating future developments in Massachusetts. The authors show how to integrate very detailed physical data on use of land with jurisdictional and socio-economic characteristics. They match a rich set of data on land use controls for Massachusetts with information on geo-referenced zoning ordinances across a large number of towns and counties, and combine that with data generated from satellite imagery measuring all open land. The latter is done by relying on digitized maps of open space matched with their respective regulation. Finally, they match town-level data on land use and regulation with information on the maximum potential development that can take place under given regulatory laws. The exercise enables the authors to assess the "potential development," computing for specific areas the build-up allowed under existing land use regulations.[3]

Sprawl studies (Burchfield et al., 2006) and land-cover studies (Angel et al., 2005, 2010, 2011) have significantly benefited from the availability of these new types of data. These studies estimate urban land cover metrics for large samples of towns or cities.[4] They use econometric models to explain several facts, such as the sources of variation in urban land cover across jurisdictions, and make projections for future development, as the projections from 2000 to 2050 by Angel et al. (2010).[5]

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[1] One of the most powerful aspects of GIS technology is arguably its ability to quickly analyze spatial data matched with information from different sources (Gibbons and Overman, 2009).

[2] This group of studies uses satellite imagery classified by land cover to identify land use in each 30-by-30-meter pixel in the study area. Every pixel is classified as either built-up, open (that is, not built-up), or water. Angel et al. (2010) for example, produce indicators for the built-up area, the urbanized area, and the city footprint for each city for two time periods.

[3] Their effort has been celebrated (Quigley, 2003; Guyrko, 2003). The ability to merge and intersect these data spatially means that they are much more precise relative to all previously available measures.

[4] Measured with ArcGIS software.

[5] The metrics of urban spatial structure based on these data sets, measure a city's built-up area (containing buildings and impervious surfaces) and the city footprint (the built-up area plus open spaces surrounded by or within 100 meters of built-up area). Population densities for these areas are calculated by based on demographic data. The study uses measure of population and area to produce comparable average urban built-up area densities for the year 2000.

Angel, et al.(2010) analyze urban-sprawl, defined as the fragmentation of the built-up area of cities observed when open spaces interpenetrate build-up areas (distinct from sprawl understood as lower-density development). They do that using satellite images and census data for 1990 and 2000 for a global sample of 120 cities. They explain variations in fragmentation (defined at various spatial scales as the relative share of open space in the urban footprint) among cities and regional groups of cities using econometric models. The authors found that larger cities are less fragmented; and those cities that do not permit development in large surrounding areas are slightly, yet significantly, less fragmented.

Angel et al. (2011) estimate future urban expansion by assembling four complementary datasets: Landsat satellite images for the universe of over 3,600 metropolitan areas and cities over 100,000 inhabitants in the year 2000; geo-coded census tract data; and data drawn from digitized historic maps for a sample of 120 cities for 1990 and 2000. They found that on average, built-up area densities in developing countries are twice as high as those in Europe and Japan and that such average built-up area densities declined by 2 percent per annum between 1990 and 2000. Further, the fragmented open spaces in and around cities are equivalent in size to the city built-up areas, but the share of fragmented open space within the city footprints has declined slowly yet significantly in the 1990s. Finally, considering the average annual growth rate of urban land cover between 1990 and 2000, the growth of the city footprint was twice that of the urban population. The authors conclude by pointing out the importance of these different rates of growth, as population is expected to double in 43 years while urban land cover will double in only 19 years. The authors stress the need for policies to prepare cities for sustainable growth and expansion in rapidly urbanizing regions, replacing containment planning policies which are seen to be non-effective and harmful-.
The study by Burchfield et al. (2006) uses remote-sensing data to track the evolution of land use on a U.S. grid of (8.7 billion) 30-by-30 meter cells. With this dataset, the authors provide basic facts about the extent of urban residential land development, in particular, whether residential development is sprawling or compact. The paper describes variation in compactness and investigates how various theories of urban economics may explain the patterns observed.

Another example of the use of land cover metrics is the calculation of the amount of developable land, which has been introduced as a key explanatory variable in recent urban economics literature. For example, developable land has been used to construct instrumental variables that help in the identification of causal effects. (See Burchfield, 2006, and Hilber and Nicoud, 2010, who use topography and other set of metrics for their estimations.)

Hilber and Nicoud (2010) matched data from various sources and geographical levels of aggregation to the metropolitan statistical area (MSA) level using GIS (referred to the National Land Cover Data 1992 derived from satellite images) to create a measure of developed land (SDL) and use two US regulatory indices—these are the WRLURI and Saks (2008) regulation index—as the counterpart for the equivalent of a regulation tax. Emphasizing political economy mechanisms, this information is used to understand how the fraction of land actually developed influences regulation.

Another study, Saiz (2010), builds a measure of developable land based on metrics obtained from satellite images for each large U.S. metropolitan area (MSA), and uses it with the Wharton Residential Land Use Regulatory Index (WRLURI) to characterize land supply elasticity as function of both physical and regulatory constraints.

To conclude, the literature reviewed here provides a strong motivation for our study since, given the scarcity of empirical studies that combine spatial and regulatory data, our efforts to assemble such database are certainly warranted.

3. Methodology

Zoning Metrics

In order to understand land use regulation and, in particular, its degree of stringency/ flexibility, our empirical analysis considers parameters that determine the intensity of land use. Some of these parameters are: the minimum area and minimum front length of a lot, as well as building norms, such as the floor to area ratio (FAR or *Factor de Ocupación Total* (FOT) in Spanish), or the maximum building height. Goytia, Hagedorn and Pasquini (2012) survey many of these variables for the municipalities in Argentina. To gain a better understanding of the degree of stringency or flexibility of the regulation, we add the spatial dimension to the analysis by incorporating the spatial extent to which the regulatory variables constrain the total buildable area. To do that we develop zoning maps metrics and use those to provide a spatial dimension to the regulation variables.

The collection of geographic zoning maps is the result of request made to local planning authorities (i.e., the Municipal Planning Director or a similar official) through the Ministry of Government of the Buenos Aires Province. The maps were then geo-referenced and each land use zone delimited by creating shape files in GIS software (ArcGIS 9.3). Since the zoning categories and characteristics differ across jurisdictions, we proceed to categorize the zoning maps according to common criteria using 10 simplified zoning categories reflecting major uses in order to carryout our comparative analysis. Table 1 shows the land uses that were taken into consideration. We grouped zoning categories as: i. residential (including different categories for High, Medium and Low Density); ii. commercial (or mixed when the category incorporates residential uses); iii. industrial; iv. gated urbanizations or communities; and v. other uses. This latter category includes “equipment/specific uses” and “green space,” and “rural” (including reserved areas and to be developed).

On the basis of this categorization and the geo-referenced maps, GIS thematic layers were created for the adjusted zoning districts, and the respective areas were computed.

Table 1: Categories Used for GIS Analysis of Zoning

Proposed Category	Zoning category according to SIOUT
Rural	Extensive agriculture/animal husbandry
	Intensive agriculture/animal husbandry
	Rural service corridor
Private urbanization	Gated community
	Country club
Residential high density	First level centrality
	Second level centrality

	Third level centrality
Residential medium/mixed	Main commercial corridor
	Secondary commercial corridor
Equipment	Equipment (community facilities)
	Specific use
Green area	Leisure/green area
Industrial	Exclusive industrial
	Mixed industrial
Residential medium density	Residential medium density
Residential low density	Residential low density
Residential mixed	Residential mixed
Others	Protected zone
	Recovery zone
	Special regulation/urban expansion zone
	Reserve zone
S/D (no data)	S/D (no data
Others	Route service

Sources: Interactive System for Urban Planning and Land—SIOUT, Ministry of Government, Province of Buenos Aires; Official websites of the municipalities: Malvinas Argentinas, Moreno, Moron, San Fernando and San Miguel. Results obtained based on image geo-referenced (zoning masp of each municipality) in ArcMap 9.3. Gauss-Kruger projection, coordinates POSGAR 1998 Strip 5.

When computing land use zones as percentage of total zoned area, it is important to note that in Argentina, territorial jurisdictions for local governments (municipalities) are allocated differently by each province. In other words, the country does not use a unique territorial definition for municipal jurisdictions. For example, in a few provinces, such as Buenos Aires, Mendoza, La Rioja, and San Juan, the entire provincial territory is subdivided according to the second level administrative boundary, or *departamento*, but those boundaries match the limits of the municipal jurisdictions and each municipal jurisdiction comprises urban areas and also a significant amount of rural land. In other provinces (such as Catamarca, Córdoba, Chaco, or Santa Cruz, among others) a municipality only has administrative jurisdiction over its main urban area (or "ejido" in Spanish); in these provinces, a multiplicity of municipal jurisdictions might exist within first level administrative boundaries. In other provinces the limits of municipalities can be even more complex, as for instance when they comprise a non-contiguous territory, or simply are not clearly defined.

As a result of the non-standardized jurisdiction boundary definitions, our zoning land use metrics, calculated as percentage of total zoned area, will be biased in relation to the specific jurisdiction limits, particularly with respect to the size of rural territory compassed by a given jurisdiction. To correct for this bias, we recalculate those percentages on the basis of the non-rural total zoned area. Also, for our purpose of understanding the zoning allocation for residential uses as compared to other land uses (particularly in relation to the land use in areas provided with some infrastructure), this measure results more appropiate.

Land-Cover Metrics

We follow Angel, Parent, and Civco (2010) in their use of satellite images to measure the extent of the urban footprint, built-up area, fragmentation indicators, and the extent of developable land (using topographic imagery) in each municipal jurisdiction.

By using satellite images we detect and distinguish surfaces that characterize built-up areas from non-built open spaces in and around them. We coded the images into maps of pixels, where each pixel is classified as built-up, open space, or water. We used Landsat 5-satellite images with a 30-meter pixel resolution. We classified images covering a sample of the 30 largest urban agglomerates in Argentina for two time periods, one circa 1990 and the second circa 2000.[6]

Once the images were classified, we obtained the metrics by closely following the methodology of Angel, Parent, and Civco (2010).[7] To ease the reading of this paper, we replicate the definition of the main indicators that were analyzed. For more details, the reader should consult the referenced paper.

For all measurements, the main input is the grid of classified pixels covering all the area of analysis. Then we calculate all indicators based on their relative location.

A brief description of the indicators used:

<u>Built-Up Area Components</u>

We calculate the area occupied by all built up pixels. In addition, the methodology allows the definition of a finer classification of built-up areas into urban, suburban and rural areas: An *urban* pixel is defined as a built-up pixel that had a majority of built-up pixels in its immediate neighborhood, that neighborhood defined as a circle 1 km^2 ratio from the center of the pixel. A s*uburban* built-up pixel is defined as a built-up pixel had more than 10 and less than 50 percent of its immediate neighborhood occupied by built-up pixels; and a rural built-up pixel is defined as a built-up pixel had less than 10 percent of its immediate neighborhood occupied by built-up pixels. All open space pixels that were more than 100 meters away from urban or suburban built-up pixels were considered to be *rural open space*.

<u>Fragmentation Indicators</u>

Fragmentation indicators, refer both to the way in which open spaces fragment the built-up areas of cities and the manner in which the built-up areas of cities fragment the open spaces in and around them. More specifically, by using fragmentation indicators we seek to understand the extent to which open spaces break up built-up areas of cities and make them non-contiguous. The fragmentation indicators were defined at different scales, which go from micro-scale (a 30-by-30 pixel scale unit of analysis) to the largest city scale.

[6] The appendix provides a description of the methodology used for the classification and selection of images, which was carried out by Anna Chabaeva.

[7] We used the Python's scripts coded for the Angel, Parent, and Civco (2010) research.

1. The Edge Index: The edge index measures the frequency that built-up area pixels are immediately adjacent to open space or water pixels. This index varies between 0 and 1, and the higher the value for this index, the larger the frequency that built-up pixels are found adjacent to open space pixels. Since pixels in the satellite images we used measure 30-by-30 meters, the edge index is thus a good measure of the fragmentation of built-up areas at the scale of individual buildings, namely of the fragmentation of the open space in an around cities at the *micro* level. (Angel, Parent and Civco, 2010)

2. The Openness Index: The openness index measures the share of open space in a circle of 1 km^2 around each built-up pixel. The radius of this circle, 586 meters, corresponds to a distance covered on leisurely 10-minute walk. The openness index is thus an indicator of the amount of open space within walking distance of every urban location, or the amount of open space "in the neighborhood." In fact, it measures the average share of the area of that 1 km^2 circle that is open and not built-up.

3. Core Open Space Ratio: The core open space ratio is a ratio of open space at the core to the built-up area , i.e. at the urban core. It focuses attention on the urban core as a whole, while leaving aside for the time being the fragmentation of open space in suburban areas.

4. City Footprint Ratio: The city footprint ratio measures the relative amount of open space in and around the entire built-up area of the city that is fragmented or disturbed by it.

   A *fringe open space pixel* is defined as an open space pixel that is less than 100 meters away from an urban or suburban built-up pixel. The *city footprint* is defined as the area that includes the city's built-up area, its fringe open space pixels and the open spaces that are entirely surrounded and thus captured by both types of pixels.

<u>New Developments (2001–1990)</u>

Total new developments (which are obtained by comparison of built-up pixels between periods) are decomposed into three measures: infill, extension, and leapfrog developments:

Infill is defined as consisting of all new development that occurred within *interior open space*, defined earlier as the set of all fringe open space pixels that were more than 100 meters away from rural open space in 1990.

Extension is defined as consisting of all new development that occurred in contiguous clusters that occupied *exterior open space* in full or in part, and were not infill. Exterior open space is defined earlier as the set of all fringe open space pixels that were less than 100 meters away from rural open space in 1990.

Leapfrog is defined as consisting of all new development that occurred entirely within *rural open space*, defined earlier as the set of all open space pixels that were more than 100 meters away from urban or suburban built-up pixels in 1990.

4. Results

Zoning Metrics

On the basis of the zoning maps collection, a total of 111 jurisdictions were analyzed. 47 (42 percent) belong to Big Urban Agglomerates (B.U.A.)[8] and the remaining 64 are located outside B.U.A. (18 of those have more than 20,000 inhabitants). Most of the jurisdictions that were analyzed 77 come from the Pampa Region (representing 69 percent of the universe of jurisdictions), 8 jurisdictions were analyzed belonging to the region of Cuyo, 16 to the North East Region (NEA in spanish), 2 to north-west (NOA), and about 8 to Patagonia Region.

The first issue to note about the zoning data is the high percentage of total zoned area allocated to rural use. Table 2 of the appendix shows that a jurisdiction has on average 66 percent of land allocated to rural use. The median is slightly higher (73 percent,) indicating the center of the distribution is slightly higher and the existence of some left-skewed values. We therefore conclude that our sample has a majority of jurisdictions with significant amount of rural area. Second, this measurement presents a significant standard deviation of about 33 percent, which accounts for the fact that our sample comprises jurisdictions that are nearly completely urbanized (the minimum in in this variable is zero percent), and also jurisdictions that are completely rural (the maximum 99.85 percent). Those that are nearly completely urbanized, might even be surrounded by others in similar conditions, such as for example, jurisdictions in the agglomerate of Buenos Aires which is the largest in the country.

It follows from the high share of rural land use zoning, that the rest of the zoning categories seem quite low in percentage terms. On average, only 17 percent of the land is allocated to residential use (with 1.2 percent high, 12 percent medium and mixed, and 8.24 percent low density, respectively). When considering the median values for the share residential use, these measurements become even lower: 0.4 percent for high, 3.2 percent for medium and mixed and 4.43 for low density residential zoning. Also, on average, industrial land use zoning occupies 4.7 percent and the land allocated to green spaces and to equipment is around 2 percent in each case.

What can we learn from these percentages? Given the fact that jurisdictions limits in Argentina are not uniformly defined—some comprise rural areas and others don't depending to a large extent on provincial-level legislation,[9] the answer seems to be: not too much. Jurisdiction limits change significantly across provinces and total zoned areas change accordingly. It therefore becomes important to exclude the rural component and analyze the new resulting distribution. In particular, for our purpose of understanding the zoning allocation of land for residential uses vis a vis other land uses—particularly in relation to the

[8] The definition of Big Urban Agglomerates (B.U.A.) is given by the National Institute of Statistics and Census (INDEC) of Argentina. These are geographic entities for use by all statistical agencies in collecting, tabulating, and publishing federal statistics. A B.U.A. consists of all the area in the metropolitan footprint. Thus, each agglomerate comprises one or more municipalities and includes the jurisdictions containing the core urban area, as well as any adjacent ones that have a high degree of social and economic integration with the urban core jurisdiction. This definition is dynamic over time, as urban areas expand. The Great Buenos Aires agglomerate is the bigtest urban area in the country, with 30 jurisdictions of which 14 are included totally and 16 partially. (INDEC, 1998).

[9] See the Methodology Section for a discussion of this point.

use of land provided with some infrastructure—it seems more appropiated to focus our analysis on the zoning allocation of the non-rural territory of the jurisdiction.

Table 3 of the appendix displays zoning percentages were each land use zoning category is calculated on the basis of total zoning area except the rural area. Now, on average, residential uses accounts for approximately 62 percent of the total zoned area. Nearly half of it corresponds to low density residential zoning (30 percent), a similar share is taken by medium and mixed (29 percent), and only 3 percent is allocated, on average, for high density residential use. The industrial use follows in terms of share, with 15 percent of the total zoned area. Eight percent is allocated to green spaces, 6.8 percent to urban equipment and 2.6 percent to gated communities.

Here is also worth noting the high level of deviation between jurisdictions in most zoning categories. Low and medium, and mixed densities residential land use zoning display standard deviations of more than 20 percent, and both categories vary from 0 up to nearly 100 percent in some jurisdictions. There are jurisdictions, such as Lanús and Granadero Baigorria, that are examples of how extreme these measurements can be: Lanús is a municipality in the Buenos Aires region that has 93 percent of the total non-rural zoned area allocated to mixed use. These municipalities do not allocate zoning area for low density residential or for industrial uses. Granadero Baigorria allocates 100 percent of the total non-rural zoning area to medium and mixed residetial use.

When we examine land use zoning shares across population-based jurisdiction quintiles (figure 1, also table 4 of the appendix), we notice that the zoning categories remain quite stable across them (coeficcients of variation are below 30 percent with the exception of gated communities and other categories). The observed variations do not suggest any clear correlation between land use zoning and jurisdiction population as measures in quintiles.

When jurisdictions are grouped according to their surface coverage (figure 2, also table 4 of the appendix) we note that residential zoning (all densities considered) is nearly 10 percent higher in jurisdictions in process of urbanization compared to those that are mostly rural. The total residential area remains close to 70 percent in jurisdictions that are mostly completely urbanized. The increase in residential area in jurisdictions undergoing urbanization process is driven by a significant increase in the medium and mixed zoning category. In fact, in juristictions with the largest share of territory still rural, the average share of medium and mixed residential zoning category nearly doubles from 27 to 48 percent of the total zoned area (table 4 of the appendix). In this jurisdictions we also see a decrease of 10 percent in the area allocated for low density residential zoning. The share of gated communities is also significantly higher in the case of jurisdictions in process of urbanizaton. When we add gated communities to other residential land use categories to obtrain an overall measure of residential zoning, we find that jurisdictions in process of urbanization display a significantly higher percentage of zoning for residential use.

Figure 1: By Population-Based Jurisdictions' Quintiles

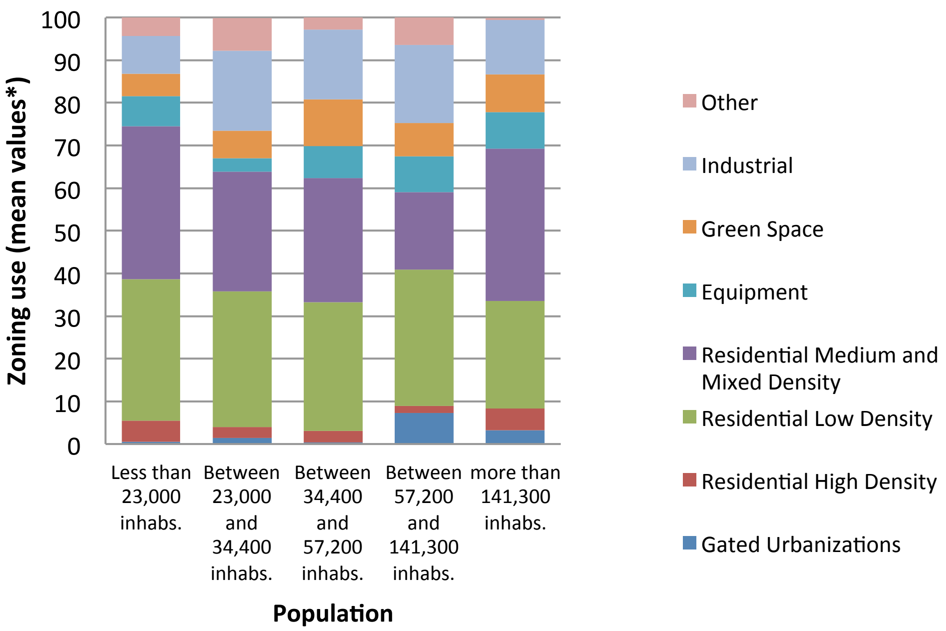
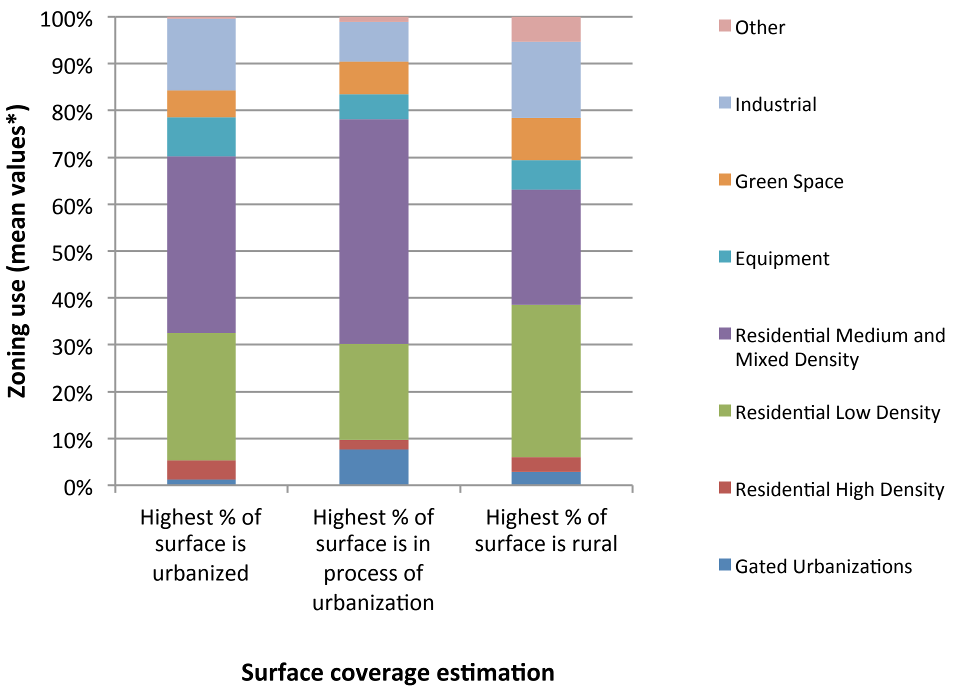


Figure 2: Zoning Uses by Surface Coverage



Land-Cover Descriptive Statistics

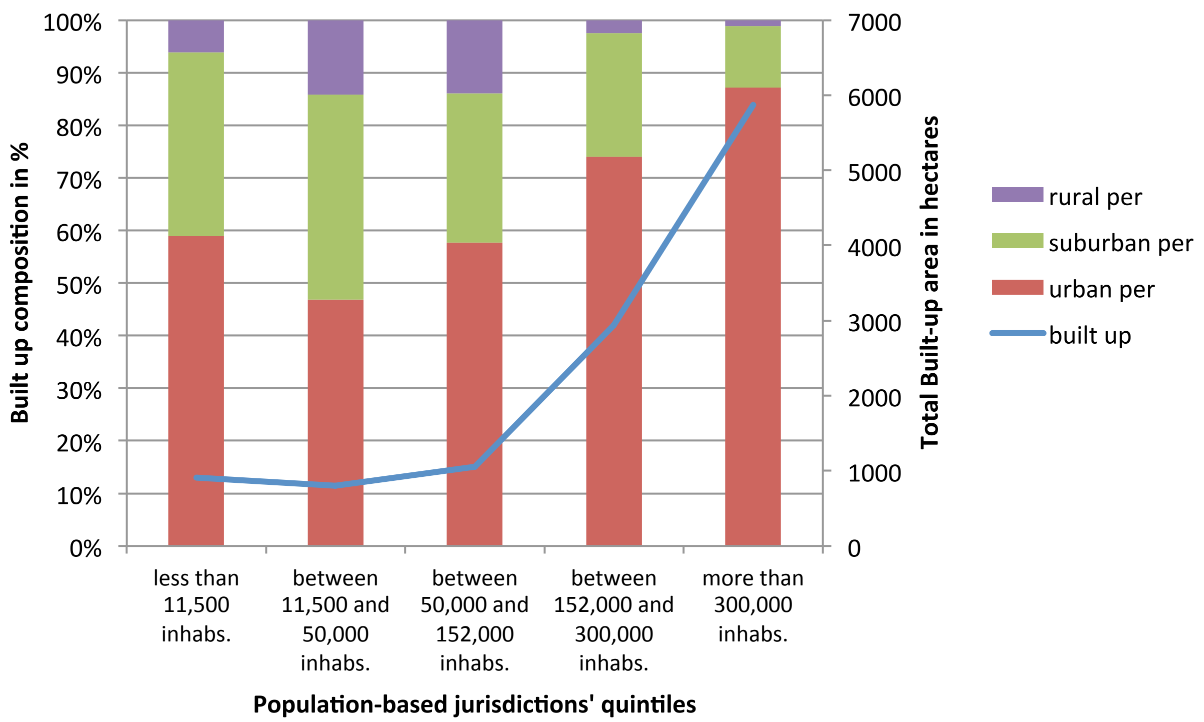
Satellite images used in this research make it possible to calculate several metrics that are useful for subsequent research to test specific hypothesis. The images were obtained for 30 urban agglomerates circa 1990 and 2001. The images cover more than 140 local jurisdictions (municipalities), which are all those belonging to the big urban agglomerates plus other medium sized agglomerations (20,000 to 50,000 inhabitants and over 50,000 inhabitants) located outside the largest metropolitan areas. Land cover images were processed and several metrics and indicators computed. Using these data we analyze the characteristics of the municipal areas and some of the dynamics occurring during the period 1990–2001.

Total Built-Up Area Components

The metrics for total built-up area metrics and its main components include: the urban, suburban and rural built-up areas, which were computed for a total of 139 jurisdictions. Table 5 of the appendix shows the descriptive results. The average jurisdiction in the sample has a total built-up area of about 1,948 hectares, and the median jurisdiction approximately 656 hectares. Observed distributions in this variable are strongly right-skewed due to a relatively small number of jurisdictions with high total built-up areas. In terms of the composition, the average jurisdiction has more than half of its built-up area (59 percent) in the urban core, 38.5 percent in the suburban area and 10.5 percent in the rural area.[10] The median components of a jurisdiction are 68.2 percent urban, 31.9 percent suburban, and 3.7 percent rural.

As expected, we find that jurisdictions with more population display higher total built-up areas, and have a higher percentage of built-up area in the urban core. For instance, jurisdictions in the highest population size quintile show an average build-up area in urban core percentage (87.3 percent) (figure 3). High percentages of built-up area in the urban core occurs in jurisdictions with less reported available vacant land (67.2 percent), high percentage of urbanized land (78.7 percent), and in jurisdiction that are part of large urban agglomerates (66.5 percent) (table 5 of the appendix).

Figure 3: Built-Up Area and Its Components



[10] Notice that these are average values of a distribution of percentages; the numbers might not necessarily sum up to 100 percent. This is because the average jurisdiction is analyzed in terms of the three component variables. A scaling of these values, computed for illustrative purposes, results in 55 percent urban, 35 percent suburban and 10 percent rural.

Buildable Areas

Table 6 of the appendix reports a measure of the total buildable land. These measures were computed from topographic images, taking into account two alternative maximum land slopes of 15° and 30°. The measures are calculated as percentages of the total urban footprint area.

Results show little variability in the measurements, ranging from 95.3 to 100 percent of total footprint area. The mean values are 99.4 and 99.6 (for 15 degrees and 30 degrees respectively) with a standard deviation of 1 percentage point. These results somehow reflect the fact that the jurisdictions under study are located in topographically plain areas. Both variables share a median of 100 percent buildable area.

Fragmentation Indicators circa 2001

We follow Angel, Parent, and Civco (2010) in measuring fragmentation of the built-up areas (and the open space in and around them) in the jurisdictions studied. according to different metrics, each measuring fragmentation at a different spatial scale.

The edge index is used to measure fragmentation at the scale of individual buildings; the openness index is used to measure fragmentation at the neighborhood scale; the core open space ratio measures fragmentation at the urban core; and the city footprint ratio measures fragmentation in the entire surface of the jurisdiction, including suburban areas.

The edge and openness indices display similar results; both with means of nearly 0.5 (recall that these indicators are defined to be ranged between 0 and 1) and medians of 0.45 and 0.46 respectively (table 7 of the appendix).[11] There is a significant degree of dispersion with a standard deviation of 0.23 in both cases. Both measures are strongly correlated (0.97) and maintain a positive high correlation with the core open space ratio and the city footprint ratio (ranging from 0.61 to 0.69). We return to this finding below. The openness index suggests that close to one half of the one-square-kilometer area in the immediate vicinity of a randomly selected built-up area in a given city is likely to consist of open space. In other words, a typical urban neighborhood has approximately equal areas of built-up and open space. This gives us a sense of the fragmentation of the typical city at the neighborhood level.

The fragmentation indicators at the smallest scale level show maximum values (highest probability of adjacency with open space) in the jurisdictions at second population quintile (between 11,500 and 50,000 inhabitants) and then (as expected) decrease in more populated jurisdictions (figure 4). Interestingly and quite surprising the fact that the least populated jurisdictions are not the ones with more open space (or more fragmentation at the micro or

[11] This values are quite similar to those mean values of the Edge Index obtained by Angel et al, 2010 for their whole sample of 120 cities, which was 0.494±0.027 (sig. 2-tailed 0.000) in 1990 and 0.445±0.025 (sig. 2-tailed 0.000) in 2000 . However, for their sample, the standard deviation from the mean was 0.15 in 1990 and 0.14 in 2000. In the case of the case of Openness Index, in their sample, the mean value for a typical city was 0.47±0.02 in 1990 and 0.42±0.02 in 2000 (sig. 2-tailed 0.000) and those findings for cities in the global sample in 1990 and 2000 were quite similar in value to the earlier findings of Burchfield *et al* (2005) for the United States in 1976 and 1992. In this case as well, standard deviations from the mean are higher than those obtained in the cited studies (0.14 in 1990 and 0.13 in 2000)

lowest scale levels).[12] Jurisdictions with largest share of territory in process of urbanization or with rural use show more open space (figure 5), as expected.

Figure 4: Edge and Openness Index

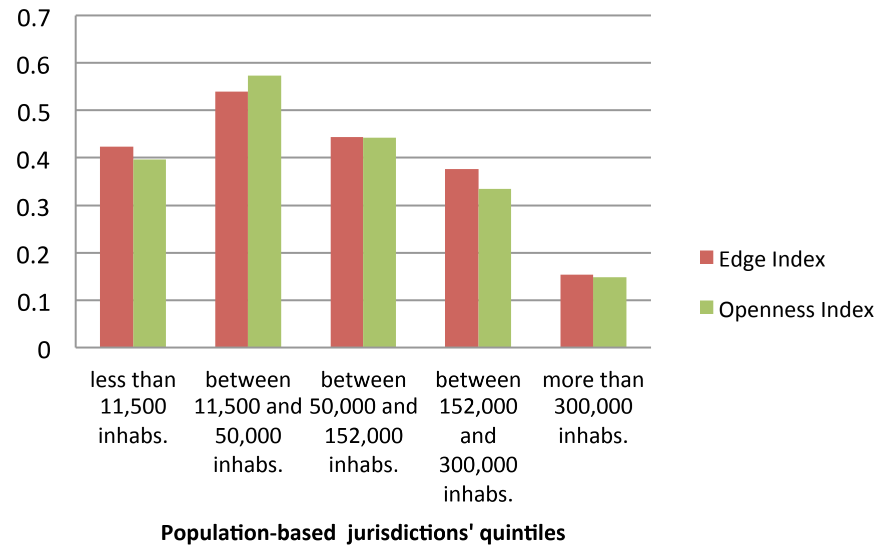
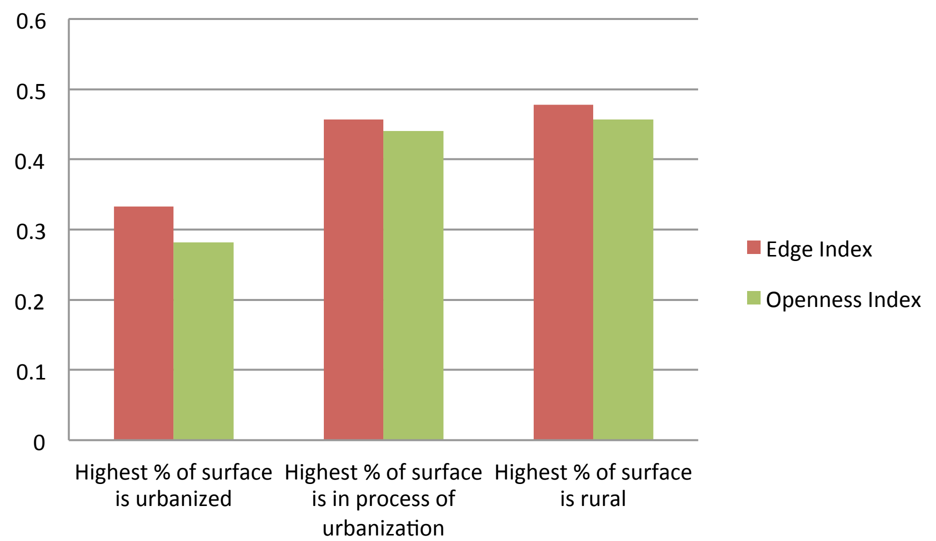


Figure 5: Openness and Edge Index



We then examine fragmentation at the urban core and at the city level using the core open space and urban footprint ratios. We find for the average jurisdiction a 1.4 core open space ratio, with a standard deviation 0.3 (the median ratio is 1.3) (table 8 of the appendix). For the city footprint ratio the mean is 4.8 (the median is 2.5), and the degree of dispersion is relatively higher, with standard deviation of 6.7. Both distributions are similarly skewed to

[12] Recall that in these case, least populated jurisdictions are not necessarily isolated cities, but might be jurisdictions that are part of a larger urban agglomerate with low density. This result might also be due to the jurisdiction limits problem we have mentioned in the Methodology Section: In the resulting sample, the lowest populated jurisdictions are located in those provinces allowing the existence of smaller—urban area restricted (i.e., Ejidos)—jurisdictions.

the right, although in the case of the urban footprint ratio this appears to be more evident due to the larger standard deviation. Both ratios are highly correlated, displaying a correlation coefficient of 0.85 (significant at 1 percent level).

Similarly to what is we find in the case of the edge and openness indicators, the highest level of fragmentation appears in the second population quintile, and then tends to decrease as total population increases. The same is clearly the case for the urban footprint ratio but less so for the core open space ratio (figure 5).

In jurisdictions in process of urbanization show marked differences between the smallest and the largest scale of fragmentation (1.43 and 3.23 respectively). Higher indices of fragmentation are also found in jurisdictions with relatively more vacant land (1.39 and 2.87) (table 11 of the appendix). Jurisdictions that are mostly rural present lower fragmentation indices.

Figure 6: Core Open Space Ratio and Footprint Ratios by Population-Based Jurisdictions' Quintiles

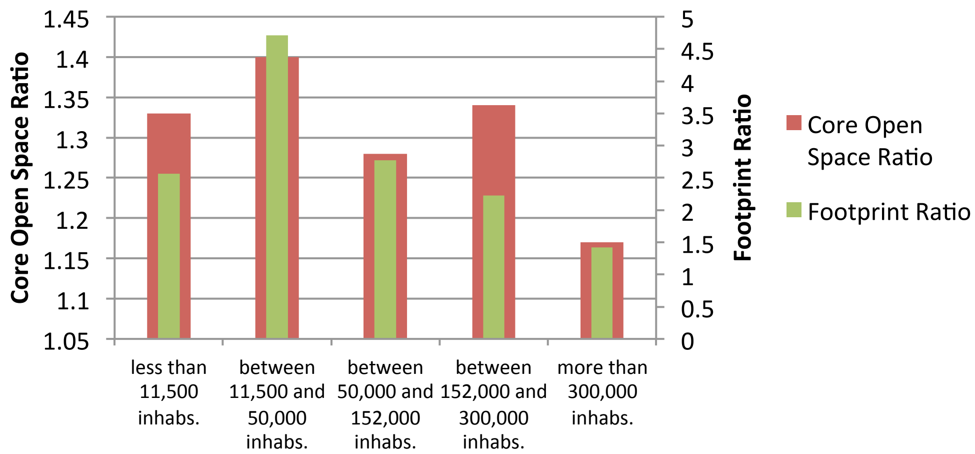
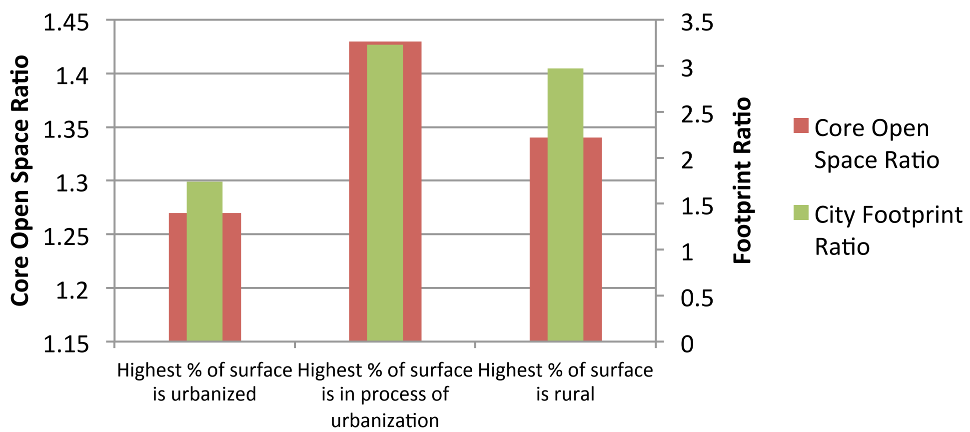


Figure 7: Core Open Space Ratio and Footprint Ratios by Population-Based Jurisdictions' Quintiles



New Developments (1990–2001)

Table 9 of the appendix presents the metrics related to new developments in the jurisdictions during the period 1990–2001. Following Angel et al. (2010), we draw the measure of total new developments from the comparison of built-up pixels between the two time periods, and decomposed it in three measures: infill, extension, and leapfrog developments (see discussion in the Methodology section above). We present these measures as percentage of total new developments.

The mean of the total development is 415.90 hectares with a lower median value of 158.60 (i.e. a right skewed distribution with a number of significant high observations).

Decomposing the metrics for new developments we find that most development takes place as *extension* of the urban area, rather than infill or leapfrog development. On average, *extension* accounts for 61 percent of total new developments. Another 29 percent is computed as *infill* and the average share of leapfrog development is 10 percent. Median percentages show slightly higher share of *extension* (65 percent), and lower infill and leapfrog development (25 and 8 percent respectively).

As expected, the percentage of new developments identified as *extension* and *infill* is strongly negatively correlated across jurisdictions, with a negative and significant correlation coefficient of -0.9 (significant at 1 percent confidence level, table 9b of the appendix). Interestingly, the percentage of *leapfrog* development is not correlated with *extension*, but is negatively correlated with the percentage of *infill* development. The correlation coefficient is -0.54 (significant at 1 percent).

The largest jurisdictions (in terms of population) display the lowest percentage of new developments that take place as *extension* (49.4 percent for jurisdictions with more than 300,000 inhabitants). Similarly, these jurisdictions show the lowest percentages of *leapfrog* development (4.7 percent). In other words, these jurisdictions show the higher percentage of *infill* new developments (47.6 percent). However, the table does not suggest a homogeneous tendency between population and the spatial composition of new development across all categories. We also find the lowest *extension* for the jurisdictions that report the highest percentages of their surface as completely urbanized (50.7 percent) and as having less vacant land (58.7 percent). Jurisdictions with more vacant land also display more extension and more leapfrog development.

Less Fragmentation Across All Jurisdictions: Fragmentation Evolution (1990–2001)

We examine the evolution of fragmentation in the period 1990–2001 in relation to the variation in the indicators of edge and openness indices, and core open space and footprint ratios described above.

We find a homogeneous tendency towards less fragmentation across all the indicators and across all jurisdictions considered. In other words, fragmentation indicators for the year 2001 compared to 1990 declined across all scales of analysis considered and in most jurisdictions.

For example, edge and openness indices, which measure fragmentation at the individual buildings and neighborhood level respectively, declined on average by -0.1 and -0.07 (table 10 of the appendix). Recall that circa 1990 these indicators take average values of nearly 0.5, suggesting an average decline of 20 and 14 percent respectively. Figure 8 illustrates this declining trend, with each point representing a jurisdiction. The strong correlation in the differences, observable in this figure, suggests that jurisdictions with less fragmentation at the individual building scale also tend to be less fragmented at the neighborhood scale.

The evolution of fragmentation indicators also varies according to population size. The more populated jurisdictions have experienced less reduction in fragmentation (figure 4). This is an expected result considering that more infill development occurs in more populated jurisdictions, which are generally also more urbanized, compared with the less populated jurisdictions which in general tend to be in process of urbanization.

Figure 8: Edge and Openness Index. 2001–1990 Differences Cross Plot of Jurisdictions

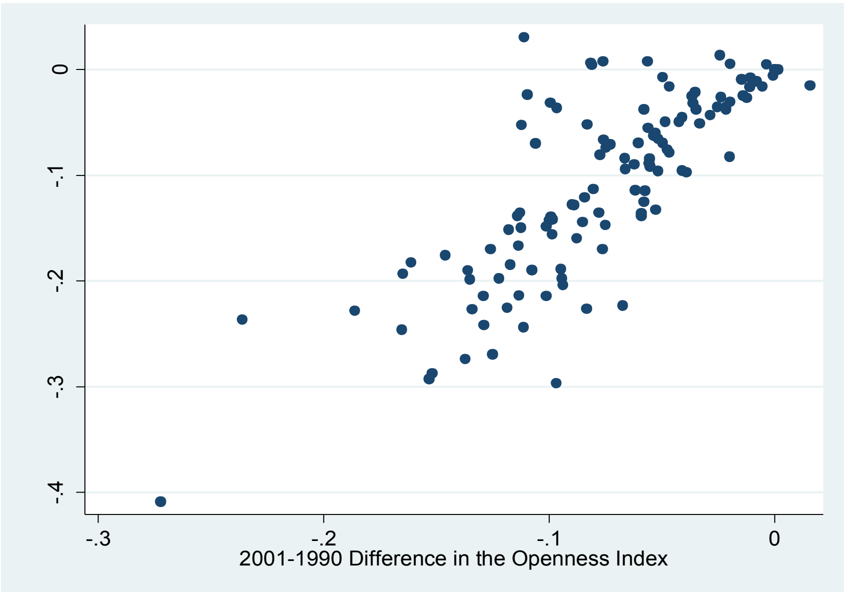


Figure 9: Edge and Openness Index. 2001–1990 Differences

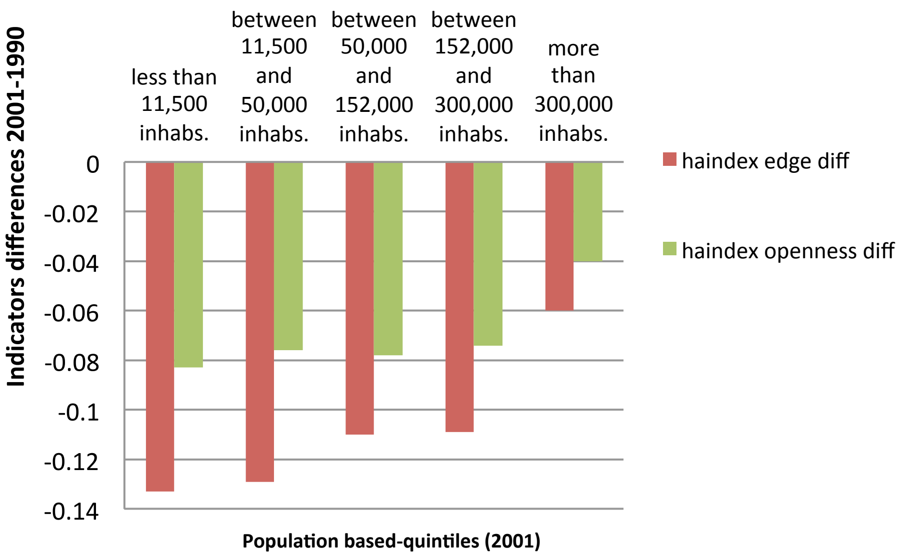
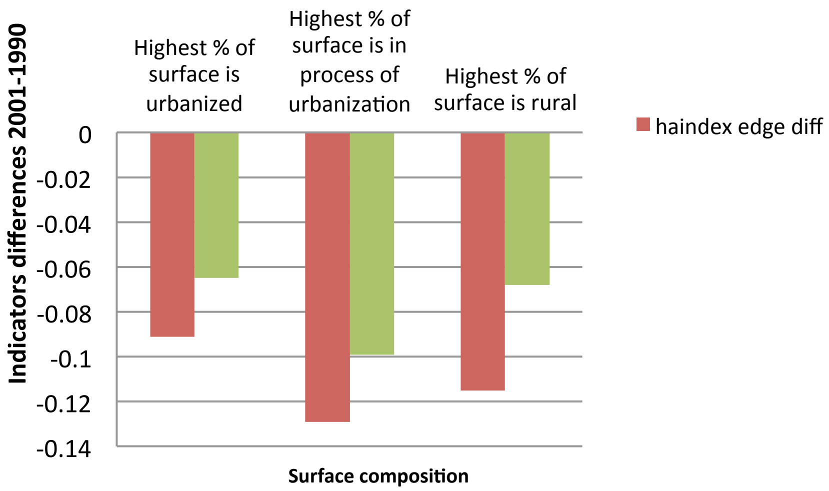


Figure 10 shows that jurisdictions with the highest percentage of the territory completely urbanized (by 2001) experienced a lower reduction in fragmentation than jurisdictions in process of urbanization, and the same is true for jurisdictions whose territory is mostly rural. Unfortunately in this analysis it is not clear whether this reflects lower population growth rate in these jurisdictions, because our surface composition variable is a 2001 variable.

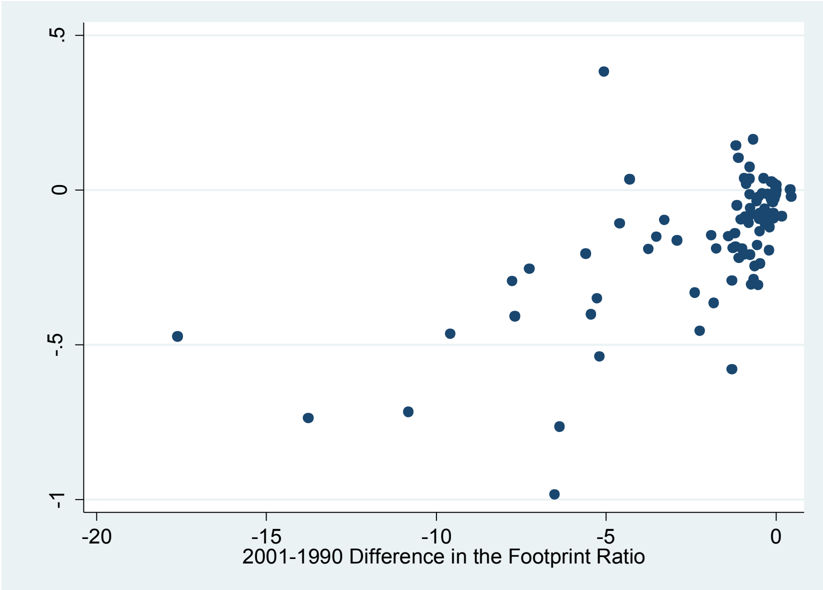
Figure 10: Edge and Openness Index. 2001–1990 Differences



Reductions in fragmentation are also found when we analyze the ratios of core open space and city footprint, which measure fragmentation at the urban core; and at the entire territory of the jurisdiction, including suburban areas. The average reductions in these ratios is -0.13, -1.85 (table 11 of the appendix), implying average reductions of 9 percent and 36 percent respectively.

Figure 11 illustrates these reductions in core open space and city footprint ratios, showing all jurisdictions with negative values for differences in the footprint ratio and also a majority with negative values for the core open space ratio. In addition, we find that those jurisdictions which have decreased more their fragmentation at the urban core also tend to have experienced a decline in fragmentation at the scale of the entire jurisdiction. However, here the correlation is less clear than in figure 4, in part because many jurisdictions exhibit the lowest values of both indicators. Similarly, we do not find clear correlations between reductions in these ratios and other variables considered in the analysis (see table 11 of the appendix) such as population quintile—here the relationship is less clear than in the case of the other fragmentation indicators.

Figure 11: Core Open Space and Footprint Ratios 2001–1990 Differences



5. Conclusions

This paper explores a new set of metrics conducive to a better understanding of regulation, in particular zoning regulation, its determinants and characteristics, and the analysis of spatial fragmentation of the urban built-up area over time and across municipalities in Argentina. Our aim has been to answer simple questions: How much does land use zoning differ across municipalities? What is the composition of the built-up area in a given municipality? How do municipalities compare in terms of spatial fragmentation of their urban area? How did fragmentation evolve in the period 1990–2001?

We acknowledge that this paper only presents a preliminary analysis of the metrics derived from zoning maps and satellite images. Nevertheless, it provides some suggestive insights that motivate future research. For example, the analysis of zoning indicates that residential use accounts for nearly 60 percent of the non-rural zoned area of municipalities, with a high standard deviation of nearly 20 percent. To understand this variability is an important task for future research. Future research may also use the new metrics to weight land use regulation and building parameters according to each land use zoning category and empirically test hypothesis related to the causes and consequences of land use regulation.

In the case of land cover metrics, we have described several indicators including characteristics of fragmentation and its interactions with patterns of fragmentation, population, and surface coverage. We have presented preliminary evidence on how much fragmentation declines with population and also find that largest degree of fragmentation occurs in jurisdictions in the process of urbanization. Notably, we document a homogeneous trend towards less fragmentation over the period 1990–2001, a finding that is consistent with the available evidence in the cited literature, but in our case we think that still deserves further analysis.

In the analysis of zoning, it is important to point out that the collection of zoning images faced the problem of many jurisdictions, namely those that do not have or do not have recently updated zoning maps. Of course, this is a problem which is more prevalent in smaller jurisdictions and we might need to consider this issue in future analysis—for example, by correcting a possible bias in the related estimations. A second problem encountered in the zoning analysis is the heterogeneity of zoning categories that, even though exhibiting some degree of similarity, do not follow a standard typology conducive to comparative analysis and aggregate understanding. Regarding the relative stringency-flexibility of land use and building regulation within each land use zone, although we do not address this paper, we recognize its importance and are aware that these might differ across municipalities. It is possible, for example, for the same zoning category to have different building parameter in different jurisdictions. Therefore, the construction of flexibility/stringency regulation indicators will have to take these issues into account.

In carrying out this study we reach the conclusion that, in order to facilitate the general understanding of land use regulation, a priority is to maintain a national database with carefully collected and updated information by a national agency.

Regarding land cover metrics, we acknowledge that the availability of (low cost) satellite images and the technology for the classification of pixels is powerful in terms of the analytical possibilities of urban phenomena that they open. Still we are at the point where it is worth to discuss the construction of indicators, and will be good to check their elasticity to some changes over time. We find some metrics to be simple and appealing, such as for example the appropriate measurement of the total built-up surface, and the composition of new developments into infill, extension and leapfrog.

In terms of the analysis undertaken in this descriptive paper, we recognize that there are many issues which are not addressed, such as the geographic representation of jurisdictions across urban agglomerates which is necessary to control for the relative position of jurisdiction in the urban agglomerate. This is an exercise that would provide for a better understanding the spatial dimension of the urbanization process, the existence of regulation and related externalities. Future research should also devise an appropriate econometric test for many relationships that are only superficially explored here. These improvements to the analysis will be incorporated in the subsequent phases of our research.

References

Angel, Shlomo, Sheppard, S., Daniel Civco, Buckley, R., Anna Chabaeva, Gitlin, L., Kraley, A., Jason Parent, and Perlin., M. 2005. The Dynamics of Global Urban Expansion. *Transport and Urban Development Department*. The World Bank. Washington D.C.

Angel, Shlomo, Jason Parent, Daniel Civco, and Alejandro M. Blei. 2011. Making Room for a Planet of Cities. SBN 978-1-55844-212-2. *Policy Focus Report*, Cambridge, MA: Lincoln Institute of Land Policy.

Angel, S., Jason Parent, and Daniel Civco. 2010. The Fragmentation of Urban Footprints: Global Evidence of Sprawl, 1990–2000. *Working Paper*, Lincoln Institute of Land Policy, Cambridge, Massachusetts.

Cheshire, P. and Sheppard, S. 2004. Land markets and land market regulation: progress towards understanding. *Regional Science and Urban Economics* 34 (2004) 619– 637

Burchfield, M., H.G. Overman, D. Puga, and M.A. Turner. 2006. Causes Of Sprawl: A Portrait From Space. *Quarterly Journal of Economics* 12(1): 587–633.

Evenson, B., and W.C. Wheaton. 2003. Local Variations in Land Use Regulations. *Brookings Wharton Papers on Urban Affairs*: 221–260. Washington, D.C.

Gibbons, Steve, and Henry G. Overman. 2010. Mostly Pointless Spatial Econometrics? *SERC Discussion Papers* 0061, Spatial Economics Research Centre, London School of Economics and Political Science, London, UK.

Glaeser, E.L., And B.A. Ward 2009. “The Causes And Consequences Of Land Use Regulation: Evidence From Greater Boston.” *Journal of Urban Economics*, 65(3): 265–278.

Goytia, Cynthia. and Ricardo A. Pasquini. 2010. Land Regulation in the Urban Agglomerates of Argentina and its Relationship with Households’ Residential Tenure Condition. *Working Paper*, Lincoln Institute of Land, Cambridge, Massachusetts.

Goytia, Cynthia. and Ricardo A. Pasquini, and T. Hagedorn. 2012. Land Use Regulation and Practices in Argentina: 2011 Survey Results (forthcoming).

Gyourko, J. and Summers, A. A. 2006. The Wharton Survey on Land Use Regulation: Documentation and Analysis of Survey Responses. Zell/Lurie Real Estate Center at Wharton School, September (mimeograph), University of Pennsylvania, Philadelphia, PA.

Gyourko, J., A. Saiz, and A. Summers. 2008. A new measure of the local regulatory environment for housing markets: The Wharton Residential Land Use Regulatory Index. *Urban Studies*, 45(3): 693–729.

Hilber, C. and F. Robert-Nicaud. 2010. The Origins of Land Use Regulations: Theory and Evidence from US Metro Areas. *Working Paper*, London School of Economics and Political Science, London, UK.

Saiz, A. 2010. The Geographic Determinants Of Housing Supply. *Quarterly Journal of Economics*.125 (3), 1253–1296

Saks, R. E. 2008. Job Creation and Housing Construction: Constraints on Metropolitan Area Employment Growth. *Journal of Urban Economics*, 64(1): 178–195

Appendix

Methodology for Classifying and Selecting Satellite Images

The Landsat Thematic Mapper (TM) and Enhanced Thematic Mapper-Plus (ETM) data were used as the base maps for image analysis and land cover classification. Cloud-free scenes for both T1 and T2 periods covering applicable metropolitan area were selected and downloaded from the Global Land Cover facility (GLCF) archives (http://glcf.umiacs.umd.edu/index.shtml).

Each image was geo-referenced to the Universal Transverse Mercator (UTM) projection and the WGS-84 datum. Image pixels were re-sampled to 28.5 meters. Some of the images were orthographically corrected to remove geometric distortions and displacements.

Each selected Landsat image was subset to cover only the extent of the metropolitan area to facilitate further analysis and increase the quality of the land cover maps produced. Each subset map was then subjected to the Iterative Self-Organizing Data Analysis (ISODATA) algorithm available as part of the Leica Geosystems ERDAS Imagine 9.3 image processing and pattern recognition software suite.

The ISODATA clustering algorithm was used to partition the T1 subset scenes into 50 spectrally separable classes. Using the Landsat data themselves, along with independent reference data when available, each of the 50 clusters was classified into one of three pre-defined cover classes: water, urban, and non-urban. Because per-pixel, spectral data-alone classification methods often encounter difficulty in discriminating between urban vs. barren and urban vs. water cover types the classification maps were carefully scrutinized to detect obvious misclassifications by comparing results with the source image, through a careful, section-by-section examination of the Landsat imagery. On-screen editing of regions of pixels obviously misclassified was performed through heads-up digitizing. The intervention of the analyst and the application of her expert knowledge increased both the thematic and spatial accuracies of the classifications.

The resulting land cover classifications were recoded into three classes: water, non-urban, and urban. This dataset was then used to mask out pixels classified as urban from the T2 Landsat image subset to simplify the process of further image analysis and increase the quality of resulting base maps. The same ISODATA clustering algorithm was then applied to the T2 Landsat subset to produce three-class land cover map for the T2 time period. As this map would be missing urban pixels from the T1 period, it was then combined with the resulting map from T1 to fill in the omitted data.

Table 1: Geographic Coordinates and Dates of Satellite Images

	Big Urban Agglomerates	LAT	LONG	Path	Row	Date T1	Date T2
1	Gran Buenos Aires (p2)	-34.6084	-58.3732	225	84	28-May-89	23-Dec-01
	Gran Buenos Aires (p1)			225	85	28-May-89	23-Dec-01
2	Gran Rosario	-32.9507	-60.6665	227	83	27-Jul-91	13-Nov-01
3	Gran Santa Fe	-31.6324	-60.6995	227	82	02-Dec-91	03-Nov-01
4	Gran Córdoba	-31.3989	-64.1821	229	82	16-Dec-91	17-Nov-01
5	Gran Resistencia	-27.4517	-58.9863	226	79	22-Nov-87	11-Oct-01
6	Gran Tucumán – Tafí Viejo (p1)	-26.7325	-65.267	230	79	25-Sep-91	01-Dec-01
	Gran Tucumán – Tafí Viejo (p2)			231	79	18-Jul-89	11-Jan-02
7	Gran Mendoza (p1)	-32.8902	-68.8441	232	83	28-Jun-91	08-Dec-01
	Gran Mendoza (p2)			232	82	28-Jun-91	08-Dec-01
8	Gran La Plata	-34.9173	-57.9501	224	84	29-Dec-91	11-Sep-01
9	Gran Paraná (p1)	-31.7413	-60.5115	227	82	02-Dec-91	03-Nov-01
	Gran Paraná (p2)			226	82	06-Jul-89	12-Nov-01
10	Mar del Plata – Batán	-37.9799	-57.5898	224	86	01-Aug-89	14-Nov-01
11	Salta	-24.7829	-65.4122	231	77	25-Jul-92	01-Dec-01
12	Gran San Juan	-31.5273	-68.5214	232	82	28-Jun-91	08-Dec-01
13	Stgo. del Estero – la Banda	-27.7844	-64.2673	230	79	18-Jul-89	11-Jan-02
14	San Luis -El Chorrillo (p1)	-33.2996	-66.3492	230	83	20-Mar-89	24-Nov-01
	San Luis -El Chorrillo (p2)			230	84	20-Mar-89	24-Nov-01
15	Corrientes (p1)	-27.4712	-58.8396	226	79	22-Nov-87	11-Oct-01
16	Jujuy – Palpalá	-24.2648	-65.2118	231	77	25-Jul-92	01-Dec-01
17	Bahia Blanca-Cerri	-38.7117	-62.2681	226	87	27-Dec-91	15-Feb-02
18	Posadas	-27.3621	-55.9009	224	79	29-Dec-91	17-Jan-02
19	Neuquén – Plottier	-38.9493	-68.0658	230	87	23-Dec-91	24-Nov-01
20	Formosa	-26.1852	-58.1754	226	78	06-Jul-89	08-Aug-01
21	Gran Catamarca	-28.469	-65.779	231	80	25-Sep-91	01-Dec-01
22	Entre Rios	-32.5176	-59.1042	226	82	06-Jul-89	12-Nov-01
23	Río Cuarto	-33.132	-64.3497	229	83	17-Jan-92	17-Nov-01
24	Comodoro Rivadavia – Rada Tilly	-45.8679	-67.5	228	92	20-Jul-86	07-Sep-01
25	La Rioja	-29.4128	-66.856	231	80	25-Sep-91	01-Dec-01
26	Rawson - Trelew	-43.2999	-65.0995	227	90	19-Jan-92	21-Dec-01
27	Santa Rosa – Toay	-36.6693	-64.3787	228	85	10-Jan-92	10-Nov-01
28	Viedma - Carmen de Patagones	-40.8119	-62.9962	227	88	03-Jan-92	16-Sep-01

Zoning Uses and Land Cover Metrics Tables

The population of each jurisdiction is obtained from the 2001 Argentine Census. Jurisdictions were then sorted and grouped according to five population quintiles reflecting the resulting distribution of jurisdictions.

The variables *surface, vacant land,* and *survey samples* were obtained from the survey Land Use Regulation and Practices in Argentina, 2011 edition (see details in Goytia, C., Pasquini, R. A., and T. Hagedorn, (2012). The categorical variable *surface* was constructed using the composition of the surface coverage (in percentage terms) as estimated by the planning director of each jurisdiction (see section 3 under "Zoning Metrics"). The jurisdictions were grouped according to whether the highest percentage of its surface was completely urbanized, in process of urbanization, or rural.

The categorical variable *vacant land* was constructed using the estimation of vacant land as percentage of the total urbanized area and as a total of the area in process of urbanization (see section 3 under "Zoning Metrics"). The percentiles 50 and 75 were used to group the jurisdictions as follows. The first group of jurisdictions comprises those with approximately less than 4.3 percent of estimated vacant land in a completely urbanized jurisdiction, and less than 13 percent in a jurisdiction in process of urbanization. The third group comprises jurisdictions with more than 37 percent of estimated vacant land and completely urbanized, and jurisdiction with less than 83 percent in vacant land that are in the process of urbanization. The rest of the jurisdictions formed the second group.

The *survey samples* comprise the three groups of jurisdictions as sampled for the cited survey. The first sample consists of all the jurisdictions that are located within the larger urban agglomerates (B.U.A.) of Argentina.[13] The second comprises those jurisdictions with a population above 50,000 inhabitants. The third comprised smaller jurisdictions with 20,000–49,999 inhabitants. According to the 2001 Census, our targeted sample accounts for nearly 80 percent of the total population in Argentina (approximately 60 percent in the B.U.A. and additional 20 percent in the other two samples).

As explained in the methodology (section 3) above, a total of 140 jurisdictions were analysed separately for the land cover study. The resulting data was matched with 2001 Census information—at the time the latest Census information available—and with survey data. Due to mismatch between present governmental jurisdictions and jurisdictions at the time of the 2001 population census, some jurisdictions could not be matched. In the case of the survey, the matching rate was even lower due to non-response to the survey, which explains the lower number of available observations in most of the group-based statistics.

[13] The definition of big urban agglomerates is given by the National Institute of Statistics and Census (INDEC) of Argentina. See footnote 8.

Table 2: Zoning as Percent of Total Jurisdiction Zoned Area

Variable	N	Mean	Median	Sd	Min	Max
Rural	111	66.13	73.22	32.49	0	99.85
Gated Urbanizations	111	1.13	0	4.34	0	34.81
Residential: High Density	111	1.43	0.13	2.83	0	15.32
Residential: Low Density	111	8.24	4.43	11.37	0	58.06
Residential: Medium and Mixed Density	111	11.89	3.28	18.34	0	95.26
Urban equipment	111	2.49	0.16	6.08	0	43.67
Green spaces	111	2.63	0.22	5.6	0	31.19
Industrial	111	4.73	1.37	7.65	0	40.21
Other	111	1.29	0	6.52	0	53.61

Table 3: Zoning Uses as Percentage of Total Zoned Area, Excluding Rural Land Use

Variable	N	Mean	Median	Sd	Min	Max
Gated Urbanizations	111	2.64	0	10.53	0	81.79
Residential: High Density	111	3.32	1.78	5.12	0	28.59
Residential: Low Density	111	30.2	27	19.29	0	85.96
Residential: Medium and Mixed Density	111	29.28	25.73	23.32	0	100
Urban equipment	111	6.89	2.69	10.13	0	54.14
Green spaces	111	7.95	3.91	11.86	0	81.13
Industrial	111	15.35	11.61	16.53	0	89.16
Other	111	4.33	0	13.81	0	99.8

Table 4: Zoning Uses as Percentage of Total Zoned Area, Excluding Rural Land Use

		Mean			
	N	Gated Urbanizations	Residential High Density	Residential Low Density	Residential Medium and Mixed Density
Population					
Less than 23,000 inhabs.	17	0.6	4.9	33.2	35.8
Between 23,000 and 34,400 inhabs.	25	1.5	2.5	31.8	28
Between 34,400 and 57,200 inhabs.	23	0.4	2.7	30.1	29.1
Between 57,200 and 141,300 inhabs.	21	7.3	1.7	31.9	18.1
more than 141,300 inhabs.	25	3.3	5	25.3	35.6
Total	111	2.6	3.3	30.2	29.3
Surface					
Highest % of surface is urbanized	21	1	4.2	26.7	38.6
Highest % of surface is in process of urbanization	6	7.6	2.1	20.5	48.1
Highest % of surface is rural	81	2.8	3.1	32.5	24.6
Total	108	2.7	3.3	30.7	28.6
Vacant Land					
Vacant Land up to percentile 50	52	0.7	2.5	32.3	29.5
Vacant Land between percentile 50 and 75	51	4.3	4	28.4	29.7
Vacant Land above percentile 75	7	5.5	3.4	31.2	23.3
Total	110	2.7	3.3	30.5	29.2
Survey Samples					
Belongs to a big urban agglomerate	47	3.3	4.9	23.7	34.4
Not in a B. U. A. and more than 50k inhabs.	18	5.5	1.6	34.6	16.7
Not in a B. U. A. and between 20k-50k inhabs.	46	0.8	2.4	35.1	28.9
Total	111	2.6	3.3	30.2	29.3
Region					
Cuyo	8	0.1	3.6	21.3	45.7
NEA	16	2.3	6.5	27.9	28.9
NOA	2	4.2	1.2	24	61.9
Pampeana	77	3.2	2.4	32.9	26.3
Patagonia	8	0	5.9	19.6	34.4
Total	111	2.6	3.3	30.2	29.3

Table 4 (continued): Zoning Uses as Percentage of Total Zoned Area, and Having Excluded the Rural Use

	Mean			
	Equipment	Green Space	Industrial	Other
Population				
Less than 23,000 inhabs.	7	5.3	8.9	4.3
Between 23,000 and 34,400 inhabs.	3.2	6.4	18.8	7.7
Between 34,400 and 57,200 inhabs.	7.6	10.9	16.4	2.8
Between 57,200 and 141,300 inhabs.	8.4	7.8	18.3	6.5
more than 141,300 inhabs.	8.6	8.8	12.8	0.5
Total	6.9	8	15.3	4.3
Surface				
Highest % of surface is urbanized	8.1	5.9	15	0.5
Highest % of surface is in process of urbanization	5.3	7	8.5	1.1
Highest % of surface is rural	6.4	8.9	16.3	5.4
Total	6.7	8.2	15.6	4.2
Vacant Land				
Vacant Land up to percentile 50	7.1	7.1	17.4	3.3
Vacant Land between percentile 50 and 75	6.4	8.5	13.3	5.2
Vacant Land above percentile 75	7.9	7.3	15.6	5.8
Total	6.8	7.8	15.4	4.3
Survey Samples				
Belongs to a big urban agglomerate	9.1	7.1	14.9	2.4
Not in a big U. A. and more than 50k inhabs.	6.7	9.8	17.5	7.6
Not in a big U. A. and between 20k-50k inhabs.	4.7	8.1	15	5
Total	6.9	8	15.3	4.3
Region				
Cuyo	4.8	5	18.6	0.9
NEA	7.8	16.2	7.6	2.7
NOA	0	4.5	4.1	0
Pampeana	7	6.2	17.3	4.8
Patagonia	8.2	12.5	11.7	7.7
Total	6.9	8	15.3	4.3

Table 5: Built-up Area Components

Variable	N	Mean	Median	Sd	Min	Max
Total built-up area (hectares)	139	1948.10	656.60	3040.40	3.20	18906.10
Urban (Percentage)	121	58.90	68.20	29.80	0.00	100.00
Sub-Urban (Percentage)	139	38.50	31.90	27.60	0.00	100.00
Rural (Percentage)	135	10.50	3.70	17.80	0.00	100.00

By categories	N	Category Average Value			
		Total built-up area (hectares)	Urban (%)	Sub-Urban (%)	Rural (%)
Population					
Less than 11,477 inhabs.	16	909.5	61.10	36.30	6.40
Between 11,477 and 49,621 inhabs.	16	802	48.30	40.10	14.60
Between 49,621 and 152,226 inhabs.	16	1057.2	62.80	30.80	15.20
Between 152,226 and 300,400 inhabs.	16	2936.6	74.10	23.50	2.50
More than 300,400 inhabs.	16	5875.5	87.30	11.60	1.20
Total	**80**	**2316.2**	**67.20**	**28.50**	**8.00**
Surface					
Highest % of surface is urbanized	19	2991.2	78.70	23.00	2.60
Highest % of surface is in process of urbanization	4	2431.8	58.90	36.10	5.00
Highest % of surface is rural	33	1812.2	54.20	36.40	12.60
Total	**56**	**2256.5**	**62.90**	**31.90**	**8.80**
Vacant Land					
Vacant Land up to percentile 50	21	2979.7	67.20	26.20	6.50
Vacant Land between percentile 50 and 75	33	1913	62.90	31.80	9.50
Vacant Land above percentile 75	6	1784.7	55.60	46.10	7.60
Total	**60**	**2273.5**	**63.80**	**31.30**	**8.20**
Survey Samples					
Belongs to a big urban agglomerate	58	2399.9	66.50	31.00	6.10
Not in a big U. A. and more than 50k inhabs.	1	62.7	0.00	62.40	37.60
Not in a big U. A. and between 20k-50k inhabs.	2	107.4	30.50	18.30	51.20
Total	**61**	**2286.4**	**64.10**	**31.10**	**8.10**
Region					
Cuyo	12	1550.5	64.10	34.10	7.80
NEA	10	1353.3	45.60	48.20	15.20
NOA	20	1014.2	61.50	39.20	17.70
Pampeana	75	2552.9	61.20	36.30	10.10
Patagonia	6	1158.3	63.80	33.50	2.70
Total	**123**	**2039.3**	**60.50**	**37.40**	**11.20**

Table 6: Buildable Area Metrics. As percent of Total Footprint Area

Variable	N	Mean	Median	Sd	Min	Max
Buildable Area with 15°	120	99.4	100	1	95.3	100
Buildable Area with 30°	120	99.6	100	0.9	95.3	100

By categories	N	Median	
		Buildable Area with 15°	Buildable Area with 30°
Population			
Less than 11,477 inhabs.	16	99.774	99.781
Between 11,477 and 49,600 inhabs.	13	99.979	99.994
Between 49,600 and 152,200 inhabs.	14	99.996	99.996
Between 152,200 and 300,400 inhabs.	16	99.942	99.974
More than 300,400 inhabs.	15	99.979	99.979
Total	**74**	**99.951**	**99.972**
Surface			
Highest % of surface is urbanized	19	99.91	99.91
Highest % of surface is in process of urbanization	4	99.886	99.955
Highest % of surface is rural	29	99.969	99.979
Total	**52**	**99.918**	**99.946**
Vacant Land			
Vacant Land up to percentile 50	19	99.996	99.996
Vacant Land between percentile 50 and 75	31	99.914	99.914
Vacant Land above percentile 75	6	99.963	99.996
Total	**56**	**99.942**	**99.962**
Survey Samples			
Belongs to a big urban agglomerate	56	99.942	99.966
Not in a big U. A. and more than 50k inhabs.	0		
Not in a big U. A. and between 20k-50k inhabs.	1	98.175	99.12
Total	**57**	**99.934**	**99.966**
Region			
Cuyo	11	99.999	99.999
NEA	10	99.796	99.796
NOA	16	99.944	99.944
Pampeana	66	99.943	99.966
Patagonia	6	99.372	99.46
Total	**109**	**99.952**	**99.978**

Table 7: Openness and Edge Index

Variable	N	Mean	Median	Sd	Min	Max
Edge Index	126	0.5	0.4	0.2	0	1
Openness Index	128	0.5	0.5	0.2	0	1

By categories	N	Median	
		Edge Index	Openness Index
Population			
Less than 11,477 inhabs.	14	0.423	0.397
Between 11,477 and 49,600 inhabs.	16	0.539	0.574
Between 49,600 and 152,200 inhabs.	15	0.444	0.442
Between 152,200 and 300,400 inhabs.	16	0.377	0.334
More than 300,400 inhabs.	14	0.154	0.148
Total	**75**	**0.38**	**0.363**
Surface			
Highest % of surface is urbanized	19	0.333	0.282
Highest % of surface is in process of urbanization	4	0.457	0.441
Highest % of surface is rural	30	0.478	0.457
Total	**53**	**0.424**	**0.38**
Vacant Land			
Vacant Land up to percentile 50	21	0.375	0.328
Vacant Land between percentile 50 and 75	30	0.417	0.383
Vacant Land above percentile 75	6	0.532	0.493
Total	**57**	**0.422**	**0.376**
Survey Samples			
Belongs to a big urban agglomerate	55	0.392	0.366
Not in a big U. A. and more than 50k inhabs.	1	0.79	0.866
Not in a big U. A. and between 20k-50k inhabs.	2	0.721	0.714
Total	**58**	**0.416**	**0.376**
Region			
Cuyo	11	0.5	0.457
NEA	7	0.64	0.626
NOA	19	0.498	0.506
Pampeana	72	0.434	0.432
Patagonia	6	0.395	0.358
Total	**115**	**0.444**	**0.457**

Table 8: Core Open Space and Footprint Ratios

Variable	N	Mean	Median	Sd	Min	Max
Ratio_urbanized_built_up	111	1.4	1.33	0.29	1.04	2.99
Ratio_footprint_built_up	111	4.76	2.45	6.74	1.04	44.78

	N	Median	
		ratio urbanized built up	ratio footprint built up
Population			
less than 11,477 inhabs.	15	1.33	2.56
between 11,477 and 49,600 inhabs.	14	1.4	4.71
between 49,600 and 152,200 inhabs.	13	1.28	2.77
between 152,200 and 300,400 inhabs.	16	1.34	2.23
more than 300,400 inhabs.	16	1.17	1.42
Total	74	1.3	2.29
Surface			
Highest % of surface is urbanized	18	1.27	1.74
Highest % of surface is in process of urbanization	4	1.43	3.23
Highest % of surface is rural	29	1.34	2.97
Total	51	1.32	2.45
Vacant Land			
Vacant Land up to percentile 50	20	1.33	2.14
Vacant Land between percentile 50 and 75	30	1.3	2.58
Vacant Land above percentile 75	5	1.39	2.87
Total	55	1.32	2.43
Survey Samples			
Belongs to a big urban agglomerate	55	1.32	2.39
Not in a big U. A. and more than 50k inhabs.	0		
Not in a big U. A. and between 20k-50k inhabs.	1	1.28	3.2
Total	56	1.32	2.41
Region			
Cuyo	11	1.42	3.04
NEA	7	1.48	2.96
NOA	13	1.32	2.97
Pampeana	62	1.3	2.29
Patagonia	6	1.27	2.27
Total	99	1.32	2.45

Table 8b: Fragmentation Metrics. Correlation Matrix

	Core Open Space to Total Built-up ratio	Footprint to Total Built-up ratio	Openness Index	Edge Index
Core Open Space Ratio	1			
	111			
Footprint to Total Built-up ratio	0.8504*	1		
	0.000			
	111	111		
Openness Index	0.6295*	0.6143*	1	
	0.000	0.000		
	104	104	128	
Edge Index	0.6984*	0.6355*	0.9659*	1
	0.000	0.000	0.000	
	102	102	126	126

Note: First row displays correlation coefficient. (*) Significant at 1%. Second row displays significant level, Third row reports the number of observations.

Table 9: New Developments and Its' Composition Metrics

Variable	N	Mean	Median	Sd	Min	Max
Total development	139.0	415.90	158.60	641.40	0.00	3728.30
Extension (%)	131.0	60.50	65.20	21.30	0.30	100.00
Infill (%)	124.0	29.30	25.40	24.20	0.30	99.70
Leapfrog (%)	120.0	12.80	7.90	15.40	0.10	97.80

By categories	N	Median			
		Total development	Extension (%)	Infill (%)	Leapfrog (%)
Population					
Less than 11,477 inhabs.	16.0	219.00	65.30	27.10	11.60
Between 11,477 and 49,600 inhabs.	16.0	192.00	68.00	23.60	9.10
Between 49,600 and 152,200 inhabs.	16.0	256.00	60.50	20.90	7.60
Between 152,200 and 300,400 inhabs.	16.0	716.00	57.20	38.90	3.90
More than 300,400 inhabs.	16.0	980.00	49.40	47.60	4.70
Total	**80.0**	**268.00**	**61.90**	**32.60**	**5.50**
Surface					
Highest % of surface is urbanized	19.0	271.00	50.70	45.20	5.50
Highest % of surface is in process of urbanization	4.0	982.00	71.60	24.00	5.20
Highest % of surface is rural	33.0	399.00	66.50	20.90	9.00
Total	**56.0**	**405.00**	**63.90**	**28.00**	**8.00**
Vacant Land					
Vacant Land up to percentile 50	21.0	411.00	58.90	37.60	4.50
Vacant Land between percentile 50 and 75	33.0	310.00	63.20	29.30	8.60
Vacant Land above percentile 75	6.0	453.00	70.50	18.90	9.10
Total	**60.0**	**333.00**	**63.20**	**28.40**	**8.00**
Survey Samples					
Belongs to a big urban agglomerate	58.0	405.00	62.60	28.60	7.30
Not in a big U. A. and more than 50k inhabs.	1.0	19.00	90.80	0.40	8.80
Not in a big U. A. and between 20k-50k inhabs.	2.0	23.00	64.20	32.10	19.70
Total	**61.0**	**356.00**	**63.20**	**28.60**	**8.00**
Region					
Cuyo	12.0	370.00	66.50	19.80	9.50
NEA	10.0	177.00	66.50	18.90	13.20
NOA	20.0	72.00	69.20	21.30	5.20
Pampeana	75.0	197.00	61.90	28.40	7.80
Patagonia	6.0	281.00	64.30	30.00	9.90
Total	**123.0**	**197.00**	**64.60**	**26.10**	**8.00**

Table 9b: New Development and It's Composition. Correlation Matrix

	Extension (percentage)	Infill (percentage)	Leapfrog (percentage)
Extension (percentage)	1		
	0.0000		
	131		
Infill (percentage)	-0.9003*	1	
	0.0000		
	124	124	
Leapfrog (percentage)	-0.2073	-0.5425*	1
	0.0231	0.0000	
	120	114	120

Table 10: Edge and Openness Index. 2001–1990 Differences

Variable	N	Mean	Median	Sd	Min	Max
haindex_edge_diff	125	-0.1	-0.1	0.1	-0.4	0
haindex_openness_diff	128	-0.1	-0.1	0	-0.3	0

	N	Mean	
		Edge diff	Openness diff
Population			
less than 11,477 inhabs.	14	-0.133	-0.083
between 11,477 and 49,600 inhabs.	15	-0.129	-0.076
between 49,600 and 152,200 inhabs.	15	-0.11	-0.078
between 152,200 and 300,400 inhabs.	16	-0.109	-0.074
more than 300,400 inhabs.	14	-0.06	-0.04
Total	**74**	**-0.109**	**-0.07**
Surface			
Highest % of surface is urbanized	19	-0.091	-0.065
Highest % of surface is in process of urbanization	4	-0.129	-0.099
Highest % of surface is rural	30	-0.115	-0.068
Total	**53**	**-0.107**	**-0.069**
Vacant Land			
Vacant Land up to percentile 50	21	-0.082	-0.056
Vacant Land between percentile 50 and 75	30	-0.127	-0.075
Vacant Land above percentile 75	6	-0.075	-0.068
Total	**57**	**-0.105**	**-0.068**
Survey Samples			
Belongs to a big urban agglomerate	55	-0.108	-0.069
Not in a big U. A. and more than 50k inhabs.	1	-0.084	-0.056
Not in a big U. A. and between 20k-50k inhabs.	2	-0.038	-0.037
Total	**58**	**-0.106**	**-0.068**
Region			
Cuyo	10	-0.182	-0.107
NEA	7	-0.045	-0.051
NOA	19	-0.07	-0.045
Pampeana	72	-0.091	-0.069
Patagonia	6	-0.176	-0.114
Total	**114**	**-0.097**	**-0.07**

Table 11: Urbanized and Footprint Ratios. 2001–1990 Differences

Variable	N	Mean	Median	Sd	Min	Max
ratio_urbanized_built_up_diff	96	-0.1	-0.1	0.2	-1	0.4
ratio_footprint_built_up_diff	97	-2	-0.7	3.4	-17.6	0.4

	N	Mean	
	ratio urbanized built up diff	ratio urbanized built up diff	ratio footprint built up diff
Population			
less than 11,477 inhabs.	13	-0.106	-0.968
between 11,477 and 49,600 inhabs.	12	-0.18	-3.184
between 49,600 and 152,200 inhabs.	12	-0.133	-1
between 152,200 and 300,400 inhabs.	16	-0.114	-1.32
more than 300,400 inhabs.	16	-0.056	-0.409
Total	**69**	**-0.114**	**-1.311**
Surface			
Highest % of surface is urbanized	17	-0.113	-1.319
Highest % of surface is in process of urbanization	4	-0.089	-2.746
Highest % of surface is rural	26	-0.118	-1.484
Total	**47**	**-0.114**	**-1.531**
Vacant Land			
Vacant Land up to percentile 50	19	-0.098	-1.049
Vacant Land between percentile 50 and 75	27	-0.112	-1.205
Vacant Land above percentile 75	5	-0.231	-5.064
Total	**51**	**-0.119**	**-1.525**
Survey Samples			
Belongs to a big urban agglomerate	51	-0.118	-1.51
Not in a big U. A. and more than 50k inhabs.	0		
Not in a big U. A. and between 20k-50k inhabs.	1	-0.187	-1.272
Total	**52**	**-0.119**	**-1.505**
Region			
Cuyo	10	-0.316	-3.344
NEA	6	0.052	-1.355
NOA	12	-0.066	-1.157
Pampeana	56	-0.115	-1.794
Patagonia	5	-0.267	-1.743
Total	**89**	**-0.129**	**-1.85**