THE FORMS OF RESIDENTIAL DENSITY IN THE CONTEMPORARY CITY. The case of Santiago, Chile

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Abstract

This work addresses the issue of density and its relationship to urban form. Density is a recurring and very relevant parameter in both the diagnosis and planning of cities. It is expressed by a formula (people per hectare or dwellings per hectare, for example), which results in an abstract regulatory mechanism to manage city growth. However, these densities are not necessarily implemented or explicit a city model city. Indeed, a density may correspond to different urban forms and a particular typology can have different densities, depending on the surface of the dwellings or the land used for public space and facilities.

Density is a complex concept, which characterizes and determines the form and urban life and that is often applied and handled in a reductionist way. While density is not directly related to building types, it has been stated that at certain densities, the number of people in a given area is adequate to generate the necessary interactions and make viable certain activities and urban functions. Therefore, this paper aims to clarify the concept of density, to understand the complexity and relativity of the term and its implications for the various logics of urban growth. It intends to give some answers related to the following question: What urban morphologies, inherent of the city of Santiago, may be associated with different forms of residential density?

An initial complexity of the term “density” is the difficulty to measure it, resulting in different definitions of the concept: bulk, net, residential, adjusted, population, edification, spatial and social density, among others. A second complexity refers to the logic of density and its implications for urban form in different scales of analysis. At the district level, density is the most important variable in determining that status of "urbanity", which implies urban vitality and livability. On the lot scale, density becomes important as a design variable, which also reflects the degree of economic exploitation of a site, and a critical tool related both to the size and layout of buildings. On this scale, the concept of density is extended and associated with complementary concepts, such as floor area ratio, lot occupation and height. Thus, different combinations of these variables may be manifested in a variety of urban forms. In this sense, some authors have defined density as the third dimension of the city.

A third complexity associated with the phenomenon of density is its subjective and qualitative condition, which it is possible to explain not only from the intensity of use and activities, but also through the spatiality of the built environment.
INTRODUCTION

Density is a recurring and very relevant parameter in both the assessment and planning of cities. It is expressed by a formula (people per hectare or dwellings per hectare, for example), which results in an abstract regulatory mechanism to manage urban growth. The topic of this work will focus on the relationship between residential density and morphological patterns, in the context of the city of Santiago, Chile. From the analysis of different urban fragments of the city, it will be possible to reveal morphological variables and how they relate to each other and with density indicators. Also, it will be possible to discuss to what extent spatial proximity and concentration of people are determinant of urban activities and social interactions.

Currently, density augmentation is associated with a decline in the use of agricultural land and transport problems by reducing the urban area and length of trips. Density is also associated with the reduction of infrastructure costs and the creation of the necessary conditions to encourage interaction between people. It has been stated that an efficient public transport system and the proper provision of urban facilities require minimum densities, so to guarantee a minimum demand for those infrastructures.

Density has also been defined as the most determinant variable of "urbanity"1, mainly because in a greater or lesser extent, it allows social interaction, as well as the relation of people with public spaces, public transport and urban facilities. In fact, some authors have identified certain density thresholds that ensure these conditions of urbanity. While Allan Jacobs argues that a density of 37 dwellings/ha is required to ensure a minimum of urban vitality (Jacobs, 1985), Eduardo Lozano noted that this threshold corresponds to 29 dwell/ha2, since under this threshold it is difficult to provide services close to every household in a neighborhood (Lozano, 1990).

It has also been argued that sustainable urban development requires a return to the compact city as a model of growth, with a consequent increase in density.3 But, is there really a coincidence between the compact city model and high density? For example, some neighborhoods in the Providencia district in Santiago have suffered a major densification process, so it could be related to the compact city model. However, this neighborhood presents the same density as the neighborhoods of social housing blocks on the periphery of the city. In other words, densification mechanisms do not necessarily ensure the control of the shape of the city.

Therefore, this work addresses the following question: What urban morphologies, inherent of the city of Santiago, may be associated with different forms of residential density? In the following pages, the relationship between residential density and urban morphology will be approached. In order to demonstrate that density is not necessarily indicative of a particular morphology, we will raise residential densities in fragments of the city of Santiago.

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1 Eduardo Lozano defines “urbanity” as the potential ability of the inhabitants of a town or city to interact with a number of people or institutions concentrated in that territory. (Lozano, 1990, pp. 162, pp.165)

2 12 dwellings per acre in the original text

Quoting Panerai, it is expected that "the knowledge derived from urban analysis increases our capacity to describe and discuss about the city as a social and physical phenomenon" (Philippe Panerai, 1980). Thus, the general objective of this paper is to clarify the concept of density, to understand the complexity and relativity of the term and its implications for the various logics of urban growth. It is also aimed to calculate the gross residential density of several residential urban fragments of Santiago, to analyze these fragments’ morphological patterns and its relationship with indicators of density. Also, it is aimed to discuss the meaning and limits of the density parameter as a planning tool and its ability to define urban form and urban lifestyles.

AN APPROACH TO THE COMPLEX TERM OF DENSITY

We have noted that density is one of the most important city planning tools. We also addressed the importance of exploring the forms of residential density, since it constitutes a contribution to the discussion on contemporary city growth. We will now explore some of the actual meanings of density and if the different authors who have addressed this issue, coincide or differ in relation to it.

Density is an objective and quantitative measure, referred to a spatial fact that is typically calculated from the ratio of persons or housing units per surface unit. On the one hand, it is an indicator that allows analyzing the urban phenomenon; on the other, it is a formula for managing city growth. However, it is possible to suppose that this is a quite reductionist way of approaching the issue of density, since it is a broad and complex concept.

In general terms, density is associated with: (1) a pre-condition for urban life, (2) the efficiency in the use of nonrenewable resources such as land and fuel, and (3) in a rather contrary sense, as the cause of negative externalities, such as congestion and pollution. However, when we look at density definitions, the concept becomes richer and gains more complex variables. Certainly, in the concept of density are woven various dimensions, from the explicit quantitative formula, to the less obvious, such as the notion of human perception.

A first complexity lies in the difficulty of measuring density, resulting not only in many ways to calculate it, but also in various definitions of the concept: gross and net density, residential density and adjusted density, population density, spatial density, edificatory density and social density, among others.

A second complexity lies in the meaning of density and its implications on urban form, which also differ on the scale of analysis. It has been mentioned that in the regional and city scale, density is a planning tool that guides the growth of urban areas. It is also an instrument for analyzing and comparing the processes of development of regions and cities at a national, continental and even a global scale.

On the scale of the neighborhood, the urban fragment and even the lot, it is a common agreement that density is the most important variable in determining the condition of "urbanity", which is a necessary requirement to ensure urban vitality, livability and, according to Bernard Declève, proximity (Decléve, 2009: 293). On this scale, density is related to some urban functional relations, such as traffic or the provision of public transport and public facilities; as well as to design variables that define the dimensions and arrangement of buildings in the lot. Thus, the concept of density is extended and associated with edificatory conditions, such as floor area ratio, setbacks, height and lot occupation. Different combinations of these variables may be manifested in a variety of urban forms. In this sense, it is interesting how the Dutch firm
MVRDV understands density: since density reflects the degree of utilization and exploitation of land, it can be defined as the third dimension of the city.

Interestingly, combinations of these variables have historically been a mechanism of spatial segregation, out of zoning ranges of minimum and maximum edificatory densities which separate different social groups in the territory. In such way, when a land use plan imposes high minimum lot sizes, it segregates the population segment who cannot afford those properties.

Beyond these approaches, density, as a quantitative indicator, is not a term sufficiently descriptive of the condition of urban life, as our perception of density is not necessarily quantifiable. Accordingly, a third complexity associated with the phenomenon of density is its subjective and qualitative condition, which is possible to explain not only out of the intensity of use and activities, but also from the relation of people with the spatiality of the built environment. Indeed, a residential complex may be perceived as too dense or not, depending on its design features, the relationship between public and private spaces and the surface of green areas, among other morphological characteristics.

On the other hand, people’s cognitive and socio-cultural characteristics are also determinants of this interaction (Lynch, 1981), which, according to Cheng, has been defined as social density (Cheng, 2010). As Declève pointed out, density might even be defined as a cultural construct, as the parameters that define what high density is, for example, rely on the activities an urban space defines and our own perception of such space. This fact refers to the relative nature of the concept of density (Declève, 2009: 5). In this manner, it is necessary to make the distinction between high density and overcrowding, which refers to a state of psychological stress associated with negative perceptions of density.

There is a debate about the concept of density and its implications: among those who seek to reduce urban growth and those who argue that low densities are not only inevitable, but also would be desirable or positive. A better understanding of the meaning and importance of density and the statements that underlie the debate, lets delve into the complexities recently mentioned.

For instance, Marcial Echenique argues that as population income grows, families’ demand for space increases (Echenique, 2006). In other words, people demand more square meters, not only in housing, but also in commercial services. In such a way, the decrease in density in the contemporary city is a product of a sum of individual decisions. It is implicit in this argument that state regulations on density are constraints to urban development trends of city growth as a result of higher income residents. In contrast, other authors note that it is required to implement density regulations that preserve the balance and variety of buildings, in order to achieve a hierarchy of density thresholds.

On the other hand, Eduardo Lozano argues that density is the most important factor for building communities (Lozano, 1990). Lozano claims that to understand the effects of density in what he calls "urbanity" is essential to recognize certain density thresholds and their relationship with urban morphology. This relationship is particularly relevant in the context of this work: the forms of residential density. In his chapter "Density in Communities, Or the most important factor in building urbanity", Lozano makes an interesting analysis of the relation of density thresholds and urban forms, commonly found in US cities. For

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4 It is important to clarify that this is not a polarized debate, and that it is possible to find shades which are part of the issue of density’s complexities. For example, the Report "Making Room for a Planet of Cities", by Schlimo Angel and others, would be pro diminishing densities, but in those cities in developing countries that present extremely high densities, overcrowding and congestion. Eduardo Lozano also agrees on lowering densities in congested central areas, but associated with an increment in the suburbs’ densities.
example, he states that a net density of 29 hab/ha\(^5\) is the first urbanity threshold, since below this density it is difficult to provide services close to each dwelling in a neighborhood. This is the reason why the townhouse and attached housing typologies constitute “raw material” of many cities. Another threshold stated by Lozano is the 48 dwellings/ha\(^6\): above this density, some dwellings in a compound do not have access to the ground level. In a superior range would be the threshold of 180 to 192 viv/ha\(^7\), above which each dwelling is close to a variety of services and activities. Lastly, the threshold of 480 to 960 hab/ha\(^8\) correspond to high density buildings in central areas.\(^9\)

Actually, a series of authors refer to various forms of density and the possible relationships between quantitative indicators and their morphological and qualitative implications. Along these lines, Lozano notes that although density cannot be straightly related to a building type, the same density can amount to many formal possibilities, as well as a single urban typology can present different densities.

While there is no consensus as to what is the optimum residential density, it is a common understanding that densities are related to certain urban and residential living conditions.\(^10\) Therefore, it is a variable that has significant effects on the conformation and transformation of the city.

\(^5\) 12 dwellings per acre in the original text, that is, 29 dwellings/ha (4 residents per dwelling)
\(^6\) 20 dwellings per acre in the original text
\(^7\) 75 to 80 dwellings per acre in the original text
\(^8\) 50 to 100 dwellings per acre in the original text, that is, 120 to 240 dwellings per hectare
\(^9\) Lozano, 1990: pp.163, 180-1
METHODOLOGY

The topic of density and its relation to urban form, orientation and meaning, is inserted into the field of analysis of the urban space, which, according to Panerai, "falls within the scope of objective analysis, so as to achieve a first level of architecture significance. It can be the foundation in which to articulate other contents accessed through other readings. Similarly, when revealing differences, gaps and conflicts, it may give rise to further analysis: historical, economic and sociological." (Philippe Panerai, 1980). Thus, the following is an exploratory work, which was conducted through the morphological analysis of selected fragments (frames) of the city of Santiago, Chile.

The methodology used was the representation of 10 urban frames of the city of Santiago\textsuperscript{11} and their overall morphological characteristics, followed by the definition of gross densities and general observations. The frames, of 250 x 250 meters, are located in the central and pericentral areas of Santiago, around the ring of Américo Vespucio and new developments on the outskirts of Santiago. All these fragments are representative of residential building types that recur in the city, and are part of both extension and densification growth patterns.

\textsuperscript{11} Survey of cases was conducted from the following sources: (1) cadastre plans, (2) satellite images and aerial photographs taken from Google Earth, (3) Universidad Católica’s Cities Observatory (OCUC) (infrastructure, property subdivision, etc.), (4) secondary sources such as web pages with information on real estate projects, among others, and (5) field observations.
Figure 1. Location of selected urban fragments in the City of Santiago, Chile

Work was done in 3 scales of analysis: the scale of the fragment (1: 500); the scale of the immediate context (1:1000) and the scale of the overall context (1:2500). In the scales of context, the analysis was focused in linking the fragment with the urban road structure and the main public spaces and collective facilities.

In the fragment scale, analysis was made from the categorization of the elements of urban morphology, according to the categories established by Manuel de Sola Morales in "The Forms of Urban Growth" (Solá Morales, 1997): (1) urbanization: hierarchy of road infrastructure, green areas and in some cases, public facilities, (2) parcel subdivision and (3) edification. Urbanization, parcel subdivision and edification compound the layers that allow a better understanding of the city structure and its spatial logics.
The breakdown in these categories reflects the fact that each one presents different logics. For example, if we analyze two residential fragments, one of social housing and other of high income housing, it can be observed that in the second case the parcel subdivision is an element of urban design, while in social housing it is a result of development logics that seek the maximum profit. This difference lies in precarious urban livability and lack of elements that allow identity and a sense of place.

In this sense, the methodology used corresponds to that indicated by Solá Morales, in terms that graphic production is also the production of knowledge.

THE FORMS OF RESIDENTIAL DENSITY IN SANTIAGO

What Do we Mean When we Talk About Density in the City of Santiago, Chile

Before presenting the results of field work on the forms of residential density, it is necessary to make a brief review of secondary sources that establish some parameters of analysis. As noted, density is both a recurrent term in the assessment and analysis of cities, as well as an urban planning tool. It allows comparing and defining urban development policies, to the extent that these seek to increase, maintain or reduce existing densities. For instance, in Chilean urban regulation, the surface of green areas, circulations and public facilities are subject to the density achieved by residential projects. 12 We have mentioned that density is important because it implies certain levels of urban and residential livability. However, as it was mentioned, there are several ways to measure density: for example, while the residential density of Santiago corresponds to 142 persons/ha, the adjusted density corresponds to 85 persons/ha, the urban density is 72 persons/ha and the territorial density is 7 persons/ha (Poduje, 2006).

While density in Santiago has had some variations, according to the data gathered by Iván Poduje, it has remained relatively constant over the past 70 years: between 85 and 96 persons/ha (Table 1). Is the density of Santiago high or low? One way to answer this question is by comparing it with the density of other cities. For example, density in Santiago is greater than the New York’s metropolitan area (19.2 persons/ha), but well below its central city area, which corresponds to 226.6 persons/ha. It is similar to densities in the central city of Singapore (82.8 persons/ha) and the inner city of Brussels (91 persons/ha). However, is there a consequence between these cities’ morphological patterns and urbanity conditions?

From a different perspective, looking at Santiago’s statistics, we can also recognize very different densities in each commune. What does it imply that the communes of Santiago (172 persons/ha) and Providencia (214 persons/ha), which represent the city’s largest investment in densification projects, present lower or similar densities than periphery communes such as Lo Espejo (218 persons/ha), Lo Prado (224 persons/ha) or Cerro Navia (215 persons/ha)? It may be assumed that, since gross density incorporates public space and facilities within the calculated area, neighborhoods with better standards of public spaces have lower densities (Figure 2). In other words, the same gross area (and that includes public spaces) is “shared” among fewer people.

<table>
<thead>
<tr>
<th>Year</th>
<th>Adjusted Gross Density (persons per hectare)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1940</td>
<td>89.2</td>
</tr>
<tr>
<td>1952</td>
<td>93.6</td>
</tr>
<tr>
<td>1960</td>
<td>94.3</td>
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<tr>
<td>1970</td>
<td>88.6</td>
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<tr>
<td>1982</td>
<td>92.7</td>
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<tr>
<td>1992</td>
<td>96.5</td>
</tr>
<tr>
<td>2002</td>
<td>85.1</td>
</tr>
</tbody>
</table>

Source: Poduje, 2006

12 Article 2.2.5, Ordenanza General de Urbanismo y Construcciones, Chile, 2011.
Figure 2. Gross density in selected communes in Santiago. Below, images show a sample of the morphology in each commune.

Source: The author, based on (Echenique, 2006)
Besides, the Metropolitan Plan of Santiago establishes a minimum gross density of 150 persons/ha for the city.¹³ That is, when this minimum density threshold was defined, it was considered that the density of Santiago was low and, therefore, infill development and densification projects should be prioritized over low rise housing (Poduje, 2006). In turn, the Plan sets out areas of high, medium and low density, in order to distribute population growth according to localization and the characteristics of each commune (Figure 3). Minimum standards of density by area are:

1. High density areas (+ of 42.5 dwellings/ha): minimum average of 200 persons/ha (50 dwellings/ha) with a tolerance of 30 persons/ha. According to this threshold density, there are communes as Conchalí, San Miguel or Quinta Normal, which density should rise in order to meet the standard imposed by the Metropolitan Plan.

2. Medium density areas (between 31.25 and 42.5 dwellings/ha): minimum average of 150 persons/ha (37.5 dwellings/ha) with a tolerance of 25 persons/ha.

3. Low density areas (between 25 and 31.25 dwellings/ha): minimum average of 100 persons / ha (25 dwellings/ha) with a tolerance of 20 persons/ha. Less than 80 dwellings/ha are not allowed in the communes of Greater Santiago.

¹³ According to the Plan, each commune sets maximum gross densities in its local land use plan and ordinance.
However, these densities correspond to averages. What morphological patterns, typical of the city of Santiago, may be associated with different indicators of density? In order to answer this question and better understand the relationship of density with urban space, 10 fragments of residential neighborhoods of Santiago are analyzed in the following chapter, with its corresponding gross densities and urban morphologies.
The Forms of Residential Density in The City of Santiago

The following Figure shows a total of 10 urban fragments in Santiago, organized according to their gross residential density, which range from 2 dwellings/ha in the gated community "Hacienda Chicureo" in the north hinterland of greater Santiago, to 1220 dwellings/ha in the area of “Almagro” in the central district of the city.
Figure 4
With this respect, it is possible to make the following observations:

1. Density in the scale of the urban fragment (250 x 250)

1.1 In the first place, it is possible to observe that density does not have a location pattern. Several authors note that density decreases at a constant rate as we move away from the city center (phenomenon known as density gradient)\(^\text{14}\). For example, Angel found that the density gradient of Paris in 2000 declined by 10.3% with each kilometer away from the center (Angel, 2010). However, this gradient is valid in the aggregate, covering large areas of the city. When we look at densities on the scale of the urban fragment or the neighborhood, this indicator does not always show these logics of location. Thus, in the city of Santiago very low densities can be found in a relatively central neighborhood as Jardín del Este in Vitacura (8 dwellings/ha) and relatively high densities on the outskirts of the city, in social housing complexes (51 dwellings/ha in Buin or 80 dwellings/ha in Puente Alto).

\[\text{Figure 5. Selected fragments in Santiago}\]

5.1 Jardín del Este, Vitacura 8 dwellings/ha
5.2 “Bajos de Matte”, Buin 51 dwellings/ha
5.3 Puente Alto 80 dwellings/ha

1950’s Garden City residential neighborhood. It is located a few blocks from Américo Vespucio belt and Costanera Norte urban highway and it is only 3 kms from El Golf business district. It counts with first level educational and health facilities and walking distance parks. Lots average 2000 m\(^2\). Urban design features, consolidated gardens and street vegetation make of this neighborhood one of the most priced residential neighborhoods in the city.

New social housing neighborhood in Buin, a rural town located 30 kms south of the foundational center of Santiago. It is alongside agricultural fields and has been designed with some garden city features, such as parkways, common green areas, curve streets and a hierarchy of circulations that structures the dwellings’ localization. Blocks are 25 x 70 meters, almost half of the typical social housing project.

Source: The author

14 (Angel, 2010: 10), (Cheng, 2010: 6) and (Echenique, 2006: 82).
1.2 It has also been stated that there is an inverse correlation between income and the density gradient. For example, Marcial Echenique found that for every additional US$1000 per capita GDP, density drops an average of 8.5% (Echenique, 2006). While one might assume that this is also a general conclusion, looking at densities on a smaller scale of analysis, it is also possible to find an inverse density/income association. This is because, in general terms, as the level of income grows, the surface of either dwellings and public spaces also increases, consequently decreasing density. If we look at examples of low-density housing, Hacienda Chicureo, Jardín del Este or Lo Barnechea, which correspond to high income neighborhoods, present densities up to 3 or 4 times lower than urban fragments located in Buin, Puente Alto and Maipú, which belong to social housing tracts.

2. Urbanization

2.1 It is possible to observe that the longitudinal block, quite recurrent in social housing projects in Santiago, is a result of density regulation standards. Social housing compounds made up of single family housing units, frequently comply with the minimum lot size required by the ordinance (60 m²), thus resulting in lots of 12 meters deep and blocks of only 24 meters wide. That is the case of Maipú, for instance.

2.2 It has been mentioned that Santiago’s Metropolitan Plan sets standards for high, medium and low density for the city. If we look at the range of densities raised in this work, high and low densities are clearly evidenced in the extremes of the metropolitan area of Santiago. On the one hand, high densities can reach up to 1220 dwellings/ha in the center (even up to 3,000 dwellings/ha in some residential densification projects in the area of Almagro). On the other, low densities range from 2 dwellings/ha (Chicureo), reaching up to 20-25 dwellings/ha (Lo Barnechea). However, it is difficult to relate the range of middle densities found in this work, with the ones established by the Metropolitan Plan.

3. Parcel Subdivision

The maximum net density for low rise single family housing approaches the 90 dwellings/ha (with plots of 5 x 12 meters on average). This density responds to social housing regulations, which state that single family housing projects cannot be subdivided into plots of less than 60 m². These density indicators are achievable because the same regulation states that social housing projects may not comply with local urban ordinances. This morphology pattern of social housing is present in almost all the south and west periphery of Santiago (Figure 6.2).

3.2 There is a difference between densities reached by historical and new examples of social housing. In this sense, the gross density reached by the José María Caro tract (48 dwellings/ha, with lots of 7 x 18 meters approx.) is lower than the density reached by new social housing developments (a little over 90 dwellings/ha in Maipú, with lots of 5 x 12 meters and alleys up to 5 meters wide). José María Caro not only presents higher lot surfaces, but also, at the neighborhood level, public spaces are larger, which, in aggregate, clearly helps to reduce gross density. Though the occupation of land on each lot is higher in José María Caro (80%-100%), it is attributable to a higher level of housing consolidation, which is expected to occur in the short run in the new social housing developments.

As noted, in Figure 6.2, Maipú’s parcel subdivision emulates José María Caro’s, but with smaller lots, narrower streets and the minimum public facilities and green areas:
Figure 6. Comparative schemes of Población José María Caro in Lo Espejo and a recent social housing complex in Maipú

6.1 Población José María Caro (1959)
48 dwellings/ha

Lot Size: 180 m²
Dwelling surface: 60 m²
Lot occupation: 90% approximately
Floor Area Ratio: 1.2 approximately

6.2 Población en Maipú (2000’s)
93 dwellings/ha

Lot Size: 60 m²
Dwelling surface: 60 m²
Lot occupation: 50%
Floor Area Ratio: 1

Fuente: Elaboración propia en base a Google Earth, 2011
4. Edification

4.1 For a given density, there are various urban morphologies, which in turn correspond to very different types of housing. We have mentioned that the density of a typical case of social housing, the block of 3 floors, rounds the 150 dwellings/ha. On the other hand, most of the blocks that have been densified in the Providencia district (of about 12 stories high) and high-rise housing projects in Vitacura (up to 20 stories high), also correspond to densities of about 150 dwellings/ha (Figure 7).

Not only the size of the dwellings, but also public space allocation and urban design standards, make the difference between this three examples of the compact city model.

![Figure 7. Similar densities, different urban forms.](source)

These examples present significant morphological differences, in terms of lot occupation, floor area ratio or heights, just to name some of them; as well as public transit infrastructures, services and facilities. Also, those features and their relation with the urban context, determine that the experience of these neighborhoods` residents is very different. For instance, residents of Villa La Esperanza in Maipú, live in the city’s periphery, away from service sub-centers and educational, commercial or health facilities. These residents live in a segregated neighborhood, extremely homogeneous in social terms: only poor people live in Villa La Esperanza. Most of public spaces are not used as such, are not maintained and constitute focus of crime and waste. Residents feel insecure and suffer a series of social problems, such as scholar desertion, violence, unemployment and teenage pregnancy.
In contrast, residents of Providencia and Vitacura benefit from tightly kept green areas (private gardens, public parks), a privileged view of the geographic landscape and an excellent connectivity to metro lines (Providencia) and urban highways (Vitacura). Residents use the neighborhood, practice sports, meet friends and neighbors in plazas and cafés, shop in the area and walk to the most important business district of the country.

4.2 It was noted in the previous point that different morphologies may have similar densities. We may also question if a given morphology may have different densities. The cases analyzed in Las Condes and Providencia provide an interesting example. While both communes were established as garden city suburbs during the second half of the twentieth century, they diverge in how they have developed over the past two decades. Both communes have suffered a significant densification process with multifamily housing for middle income groups. However, Providencia, through its land use plan, has emphasized that the process of urban renovation preserves the original character of the commune. For this, the plan defines requirements and standards for lot occupation, setbacks, porches, fences and gardens, among other urban design elements (Figure 8.1). In 2007 it also introduced net density controls, which range from 195 to 625 dwellings/ha.

In the case of Las Condes, the operation for densification is very similar (out of merging 2 or 3 lots which used to allocate a single house, for raising a building of 12 to 15 stories), but with the minimum morphological and density restrictions. As a result, the block’s street level is practically 100% paved for parking lots, original gardens and greenery are not preserved and buildings are as closest as they are allowed by ordinance codes. Therefore, not only declines the public space’s quality, but also depreciates the apartments’ habitability conditions.

As a result, in an average block in Providencia net density rounds the 150 dwellings/ha, while in Las Condes net density reaches the 270 dwellings/ha (almost 80% more than in Providencia) (Figure 8.2). As it can be observed in the following figure, two blocks with similar housing typologies (12-15 stories apartment buildings for middle-income segments) present contrasted densities and morphological characteristics.
Similarly, it can be noted that some morphological features that are proper of the garden city model, are quite transversal, independently of socio-economic and density indicators. An example of this are the cases of Hacienda Chicureo (2 dwellings/ha), Lo Barnechea (18 dwellings/ha) and social housing in Buin (51 dwellings/ha). Hacienda Chicureo is a “private neighborhood” in Greater Santiago’s expansion north area, in which 2000-2500 m² lots gather around a golf course. Although ornamental vegetation and greenery abound in this housing complex, there are really no public spaces at all. Lo Barnechea (which is also the name of the commune where it is located), is a mid-high income residential community in Santiago’s east limit. With lots of 300-550 m², houses gather around small playgrounds. Finally, “Bajos de Matte” in Buin, presents lots of 180 m², which we already described in point 1.1.

In these three examples, which belong to high, mid-high and low income residential neighborhoods, prevail curvilinear roads, public space hierarchy and an important surface assigned to green areas (Figure 9).
Figure 9. Different densities for the garden city model

9.1 Hacienda Chicureo
2 dwellings/ha

9.2 Lo Barnechea
18 dwellings/ha

9.3 Bajos de Matte, Buin
51 dwellings/ha

Source of images: Google Earth, 2011

4.3 We have mentioned that, because the gross residential density incorporates the area for public spaces (roads and green areas) and collective facilities such as commercial services and schools, neighborhoods that have better standards of public areas have lower densities, even if the parcel subdivision is fragmented and dwellings present lower surfaces.
4.4 Within the cases presented in this work, it is of particular interest the one that reaches the highest density: 1220 dwellings/ha in the area of Almagro in the central district of Santiago. This sector has undergone a major urban transformation and residential densification process, which has had a significant impact on the neighborhood’s morphology. Currently, the Resettlement Program prompted during the early 90’s and promoted by flexible regulations and an urban renewal housing subsidy, has undergone a significant development activity with high levels of density.

The lack of investment and activation of public space and community facilities, poor legibility of architectural and urban design elements and the null consideration of the block as an urban piece; are all elements that contribute to a possible deterioration of the neighborhood (Figure 10).

Figure 10. A critical block in Sector Almagro in the central area of Santiago, 1220 dwellings/ha

Source: Google Earth, 2011 and pictures taken by the author.
CONCLUSIONS

As noted, the analysis of density and the spatial structure is a systemic one, since it integrates constitutive elements of urban form, such as the lot size, edification features (height, floor area ratio), public space, and the relation between them (proportionality, for instance). In other words, in the density indicator it is implicit a proportional relation between residential land and the rest of the land uses in a city.

It is possible to conclude that the elements that shape spatial form, especially the ones that determine density, such as the minimum lot or dwelling size, constitute an important factor in the city’s social segregation or integration.

Also, we can confirm that for intense urbanity qualitative density is more significant than the quantitative one (De Solá Morales, 2008: 148). Variables such as intensity, variety, diversity and connectivity are determining factors of quality urban space. In this sense, space syntax constitutes a technique that can contribute to understand density as a phenomenon.

This research contributes to the discussion on contemporary forms of urban growth, as an attempt to clarify the meaning and limits of density as a planning tool and its ability to define the form and modes of urban life. In this sense, this research can shed light for the evaluation and discussion of current density standards in planning instruments.

Indeed, not many studies approach density and its relation to the urban form. In this sense, the research of the forms of residential density in Santiago, can illuminate a discussion that is becoming increasingly important in relation to the ways in which cities, especially large urban areas, should lead their development. There is a growing consensus that city growth is inevitable and that the urban-rural relationship is growing continuously (we no longer speak of cities, but rather of extended metropolitan regions). It’s just the way that this growth should be conducted, where there are different views and models. New knowledge on the forms of density and its implications for habitability is clearly a contribution to the discussion.

In the words of Solá Morales, we can read the city out of the approach to aesthetic, theoretical and cultural values of the urban fabric in its generality, beyond its exceptional moments. Accordingly, it is possible to explore the complexity and scale of the urban fragment, its elements of language and action on a larger context: the commune, the intercommune, the city.

Indicators of density obtained here can be related to a number of qualitative variables associated to urban form. Indeed, in the scale of the fragment, density urban indicators do not show the same logical location as when obtained from inter-aggregate or metropolitan level. This is because gross densities incorporate public spaces (streets, plazas and parks, sidewalks), facilities and infrastructures. Communities with higher incomes not only present larger dwellings, but also a greater amount of green space and facilities, so their densities tend to be lower. In the city of Santiago, these communities are not necessarily at the periphery.

Exploring the forms of density in the city of Santiago allows the generation of unprecedented knowledge. As stated by Panerai, "if the urban space conclusively reflects a social order, it must be questioned, then, how it is transmitted and transformed in its field of production." In this sense, research on density and urban form, as a reflection of a social and political project of a society, also offers an insight into the logics of the production of space.
REFERENCES


