

TITLE: A COMPARATIVE STUDY ON HYPER DENSITY DEVELOPMENTS IN DENSELY INHABITED DISTRICTS OF MEXICO CITY

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Summary

By 2025, more than 60 percent of the earth's inhabitants will reside in cities, a phenomenon that is now reflected in the less developed countries. Without any relation to their economic condition, big cities are taking a place in the world and the populations are growing vertiginously, creating megacities. The "megacity" is a relatively new term coined to describe not only large agglomerations of population but also a degree of physical extension not bound in the manner of the traditional city. We can find in this list Latin American, Asian and African megacities that are interesting examples, rich in culture that could make us rethink the architecture or redefine our concept of urbanism. Mexico City, even though it is the second most populated city in the world, the density has not been a seriously studied topic; and though there are several works on population and geographical data, they have not been linked. Having on mind the unbalanced economical situation of the city, and trying to show representative examples by its morphology and spatial general housing panorama, we show in this paper the study of six Densely Inhabited Districts based on the relationship between population and its area using "density" as the topic of its common urban characteristics.

1. Introduction

At the beginning of this new millennium, after experiencing in the last century the boom of over-population (from 1,700 million people in 1900 to 6,100 million people in 2000) the cities all over the world are changing day by day.

We can be sure that in the middle of last century mainly European cities such as London, Paris, Rome, Madrid, Berlin or Moscow as well as New York in the United States lead the image of the metropolis. At the end of last century new cities rose to join this group, such as Los Angeles, Chicago, Houston, Vancouver, Montreal, Frankfurt, Barcelona, Amsterdam, Tokyo, Osaka, Singapore, Hong Kong and Sydney.

At the same time, in the named "Less Developed Countries", many cities were growing step by step, creating big contrasts, conflicts and polarization, increasing significantly their population, their economic necessities and their living spaces, where the phenomenon of urbanization remained somewhat unknown, unseen, and unquantified. Mexico City, Sao Paulo, Rio de Janeiro, Buenos Aires, Jakarta, Dhaka, Bangkok, Mumbai, Calcutta, Delhi, Shanghai, Beijing, Tianjin, Seoul, Manila, Karachi, Teheran, Istanbul, Cairo, Lagos, and others have already surpassed 5 million inhabitants, some of them more than 20 million inhabitants.

In 2002, the Census Bureau of the United States reported 47% of the population living in urban zones; 75% in the Most Developed Countries and 40% in the Less Developed Countries. We find in the African region 33% of the people living in urban zones, 75% of the people of North America and 75 % in Latin America & the Caribbean Region. For Oceania, this percentage is 69%, in Asia 38% and in Europe 73%.

In the Mexican United States (Mexico), around 2/3 (66%) of the population lives in 364 cities, with different expansion rhythms. In 1900 only 1/10 (10%) were living in the few cities that existed. By 2000, 9 cities had surpassed the 1 million inhabitants: Guadalajara, Monterrey, Puebla, Toluca, Leon, Tijuana, Ciudad Juarez, Torreon and of course, Mexico City. A considerable number of Mexicans live in Los Angeles South District (United States of America), being the tenth city with Mexican population more than one million inhabitants.

Mexico City is nowadays the home of almost 22 million people –more than many countries, actually more than the actual Australia's population, though its area is less than 2% of the area of Australia-, which means more than 20 percent of the population of the whole country, concentrating 30 percent of the economic power in only 0.076% of the national territory. Mexico City's core (an average of 126.5 inhabitants/hectare) can be compared in density (+/- 10%) with Seoul (137.78), Tokyo (132.64), Tehran (131.56), New York (125.37), Osaka (117.42) and Beijing's (110.34) core (an average of 126.5 inhabitants per hectare +/- 10%).

Mexico City suffers a common illness of Latin American cities and can be studied as a sample of them. People from the countryside is migrating everyday into the big capitals trying to find a job, a dream, a new and a better way of living, but the most of the times, just find chaos, high prices, insecurity and overcrowding. This phenomenon increases the size of the city, its services, infrastructure and housing places for the new comers. The urban responses to these movements are the creation of new settlements (planned districts), the reorganization of old ones (modified districts) or simply growing without clear order (irregular districts).

We find that the population density and the building density can be studied as a unity pattern in order to categorize the economic, social and ecological gap within the city. For example we can find in Mexico City in the wealthy municipality of Huisquilucan an average of 30 houses per square kilometer, up to 23,124 houses per square kilometer in Chimalhuacan (one of the poorest); or in Nezahualcoyotl 18,816, and in Benito Juarez (inner Mexico City) 17,877; Just to have a comparison point, in Tokyo, the average of density of 11,083 houses per square kilometer, in Osaka 9,526 and in Kanagawa 8,119.

In the downtown, very compacted housing projects (777 housing per hectare) are having construction. The number of users average is 5.5, having then 4,273.5 persons per hectare in a 5 stories building; even in the same area, other not so compacted housing complexes have their place since the last five centuries, we have to consider and to research about the big impact to the zone of this kind of new settlements.

These conditions of hyper-density in Densely Inhabited Districts could give us data for a better design of future developments in the context of the rapid-city change in this world.

2. Urban Density of Mexico City

Since its foundation in 1324, the city has suffered big transformations. The size of the city, the increment on the population, the re-densification of certain zones, the natural disasters, has moulded its face. Is interesting to mention that the general average of the density in the city (called in Spanish "Coeficiente de Hacinamiento" –literally translated as "stack's quotient") has been maintained very regular throughout its seven centuries of existence -around 133 inhabitants per hectare +/- 10% (figure 1).

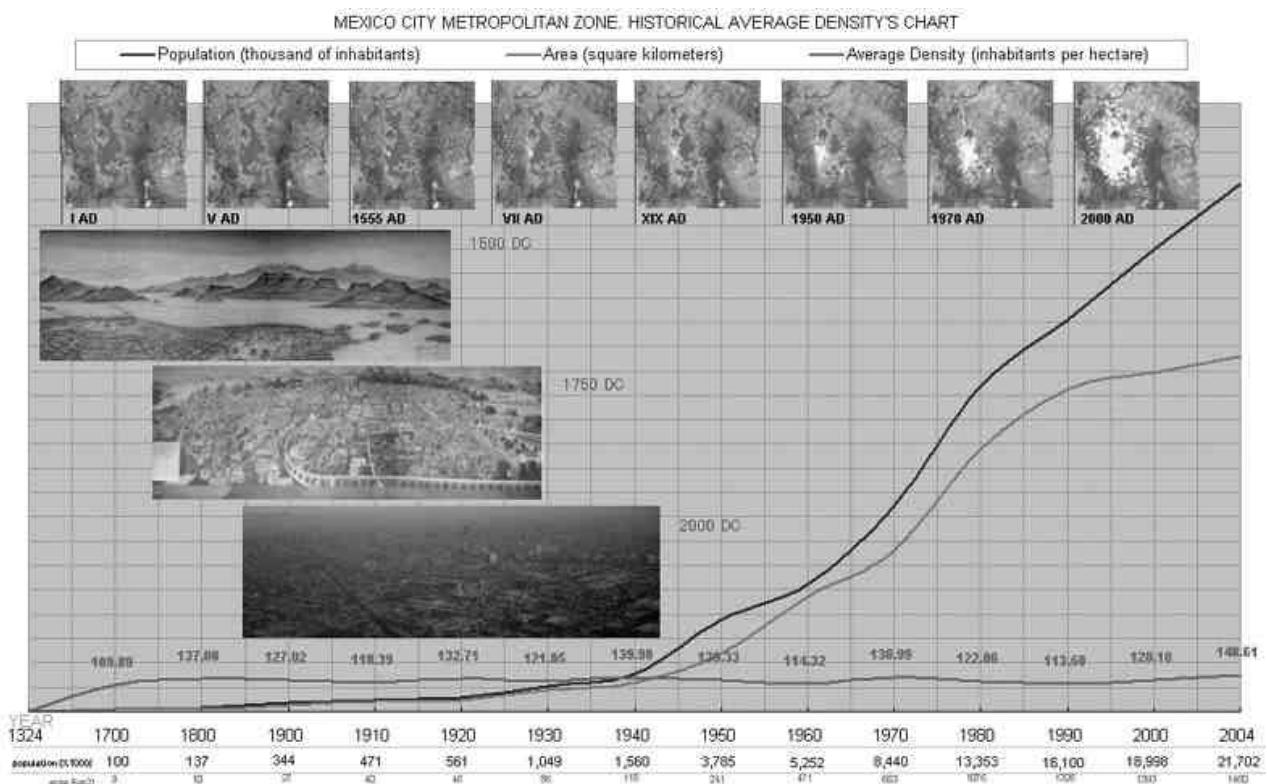


Figure 1 Historical Average Density's Chart. In the upper figures (squares) we can see the extinct "Lake of Texcoco" and how the city was expanding its footprint. The three rectangles are different views of the city's from the same point of view through the time. Year 1500, called by the Aztecs "The Great Tenochtitlan"; year 1750, called by the Europeans "Viceroyalty of New Spain"; year 2000, defined as "Mexico City Metropolitan Region" (MCMR). The lines are (from up to down), the population, the urban city's area and the density. Chart realized based on the Population Census Statistics and the territorial data by Gustavo Garza (La Ciudad de Mexico en el fin del Segundo Milenio) and Angel Mercado (Reservas territoriales para usos urbanos). Detailed information of the outer core expansion had been taken from Jean Bazan (Periferias Urbanas). The images taken from the "Lakes Rescue Project" by UNAM (National Autonomous University of Mexico).

In 1900, the Republic was consolidated and the area of the city was not more than 27 square kilometres, with a population of 344,000 inhabitants. At that time the density's average was 127.02 people per hectare. Mexico had a civil war in 1910 and the density at that time reflects this situation, with 118.39 people per hectare. The population started to grow and by 1920, this density went up to 132.71 people per hectare.

From 1920 to 1930, the population almost doubled, passing from 561,000 to 1,049,000 inhabitants. We can read here a density of 121.85 people per hectare. This apparent decrease is due to the city's area, which also increased during that time, from 46 square kilometres in 1920, to 86 square kilometres in 1930.

The highest density of the twentieth century was in 1940 (almost the same as in 1970), when the city still mainly remained in the central counties, with a density of 139.98 inhabitants per hectare.

From 1940 to 1950, the population again duplicated geometrically, from 1,560,000 to 3,785,000 inhabitants. But also around 1940, the city area started to surpass its boundaries. The end of the Second World War was an important factor that influenced this accelerated growth, so from 1950, the population growth gradually decreased. If this geometric growth had continued, the actual population of the city would by now be almost the same as the whole country's actual population.

After 1940, the city expansion pattern meant that the density in 1950 was 130.33 and in 1960 only 114.32 inhabitants per hectare. In 1970, this expansion phenomena stopped for a while, in government's effort to encourage people back to the central city, moving some industry from the inner core to the outer industrial parks and refilling this space with big housing projects, resulting in a density of 138.99 inhabitants per hectare.

In the next 30 years, after the social housing governmental programs started to gain lands on the periphery, and because of natural disasters, the inner core lost population. This movement generated more area for the city, having in 1990 a density much like that after the Mexican Revolution in 1910. So, while in 1980 the density was 122.06 inhabitants per hectare, in 1990 it was just 113.50 inhabitants per hectare.

Since 1990, the size of the city has been increasing very slowly, making the density go up, having nowadays, the highest in history: 148.61 inhabitants per hectare. The government is trying again on the one hand, to repopulate the central city, and on the other, protect the ecological reserves from illegal settlers. The politics are focused on the use of the actual infrastructure of the central districts with this re-densification, while trying to solve the problems of the settlements outside the city core.

We can conclude that just in the last century, the city's population has grown 55 times, from 344,000 persons in 1900, to almost 19 million people in 2000. The city also had an expansion of 52 times its territory, passing from 27 square kilometres at the opening of the century to 1,393 square kilometres at its close.

The Mexico City Metropolitan Region (MCMR) surpassed 1 million inhabitants in 1930, became a megacity in the middle of the 70s when it passed 10 million inhabitants, and around three decades later became a megalopolis, surpassing 20 million inhabitants (just 3 years ago).

Its urban area is 1,460.34 square kilometres considering the 16 Counties (Delegaciones) of the DF (Federal District) and the 59 municipalities (in 2 contiguous States). The "Ecological Reserves" of Mexico City have been excluded. They form approximately 60 percent of DF's territory, mainly concentrated in the mountains in the southern part of the District. Each year around 495 hectares of forest are lost -around 213 hectares due to the conurbation or irregular settlements- in this place reserved for the City's Eco-System.

Although the city is by itself a big urban network, for strategic plans, an entity that nowadays is formed by 256 municipalities (99 in the State of Mexico, 31 in the State of Morelos, 36 in the State of Puebla, 52 in the State of Tlaxcala, 31 in the State of Hidalgo and 16 Counties in the Federal District) in the Megalopolitan Precinct is called "Corona Regional de Ciudades" (Regional City's Crown) containing in 2000, 27.6 million; by 2010, 33 million; and by 2020, 38 million inhabitants (The Ecumenopolis of Mexico City).

3. Selection of the Urban Housing Developments (UHD)

The most important goal of the selection of the examples shown in this work was to find Urban Development Areas (UDA) whose situation, space, density and overall image represents influences, patterns and important changes for the megacity figure.

To unify the criteria for the analysis, different sources were consulted, managed and interlaced by computer systems that permit us to have in the same file the space and morphological image linked with the numerical information.

Having on mind the unbalanced economical situation of the city, and trying to show representative examples (examples that can be reflected in a symbolic percentage of each hierarchy) by its morphology and space, we choose six Densely Inhabited Districts containing an example of Hyper Density Community Housing using the "Socio-spatial Segregation" definition based on Rosa Maria Rubalcava and Martha Schteingart division. This hierarchy considers: 1-the human stack per house, 2-the educational level of its inhabitants, 3-the water and urban services at homes and 4-the annual income of the family members (figure 2).

Besides to divide the city in this economical divisions we search the physical areas by its municipalities, then each municipality into "geographic-statistical units" –called AGEBS, and then the blocks and inside it a project representing these five characteristics:

- To be within an area mainly for residential purposes
- To be high density communities
- To be located in a well-known urban area of the city
- To be representative of contemporary examples of the local housing architecture, and
- To be important human settlements so that its situation, space, density and overall image generate important changes, influences and patterns molding the mega city's face.

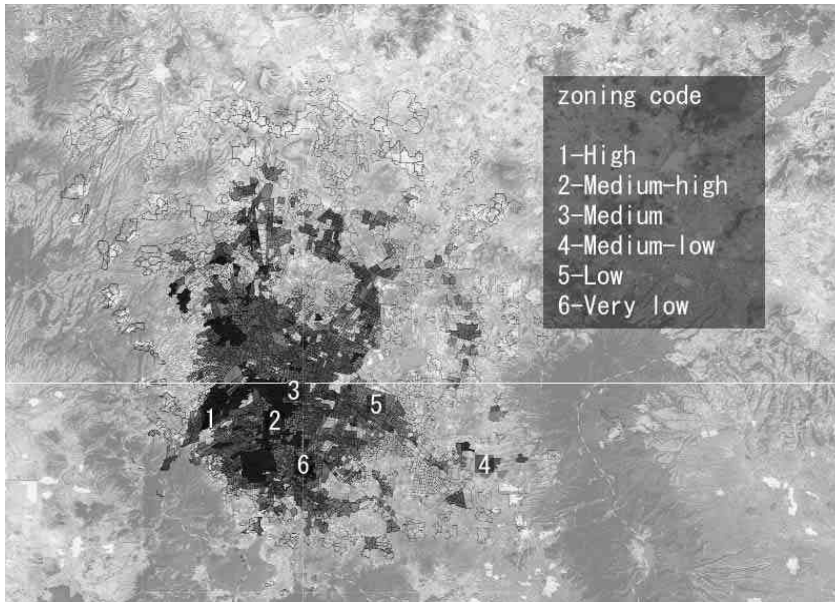


Figure 2

Socio-spatial division by AGEB

Percentage of the physical space:

1- 10.58%	(High)
2- 12.18%	(Medium-high)
3- 15.62%	(Medium)
4- 20.28%	(Medium-low)
5- 20.94%	(Low)
6- 20.41%	(Very low)

High, Medium and Low represents:

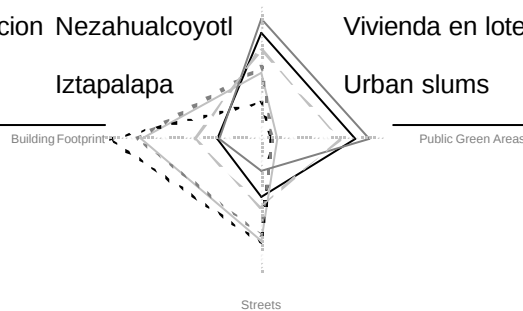
(1)	10.58%	(High)
(2&3)	27.8%	(Medium)
(4,5&6)	61.63%	(Low)

Within this division, the number of dwellings, inhabitants and the area with these projects and areas to be evaluated have extremely variations in characteristics, such as high-rise to low-rise, less than one inhabitant per room to nine, hyper-structures to garbage materials... but sharing the same city and the same hyper-density conditions with the hypothesis that in any megacity, specially in Latin America, we can find a wide range of conditions to compare in between them following the same pattern.

The name of the selected neighborhoods and the targeted projects are as follows (table 1):

Table 1

Division	Neighbourhood	County/Municipality	Housing community	Storeys	Units	Inhabitants
1	Interlomas	Cuajimalpa	Torre Altus	45	42	280
2	Del Valle	Benito Juarez	Edificio Adolf	13	10	55
3	Doctores	Cuauhtemoc	Villas de Navarro	6	140	770
4	Santa Barbara	Ixtapaluca	San Buenaventura	2.5	20,000	110,000
5	Amp. Evolucion	Nezahualcoyotl	Vivienda en lote fam.	2	40	440
6	Degollado	Iztapalapa	Urban slums	1	20	160



4. Case of study

For this section we will describe briefly the area, the neighborhood's density and housing project density.

4.1 Interlomas / Torre Altus

"Cuajimalpa de Morelos" is considered one of the MCMR sub-centers. The newly developed neighborhood of Santa Fe was built on land that had been the city garbage dump, but has been transformed by developers into an upper-class enclave, traversed by freeways and strewn with office buildings. It is virtually indistinguishable from those on the outskirts of many big American cities. The Interlomas neighborhood is classified in Mexico City as the most exclusive area. It has "Las Lomas" ("The Hills") and "Bosques" ("The Forests"), where many high-rise mansions and residences have been built (figure 3).

Torre Altus is the third tallest building in the MCMR (195 meters high), 2576 meters above sea level in a mountain emplacement. Its heliport is the highest point of construction in the city.

Around this zone and in other neighborhoods such as Polanco, Santa Fe, Bosques and Lomas, we can find this kind of construction (up to 35 floors), with huge open spaces for facilities.

The type of design is a building "without contact" to the street view, but open to panoramic views.

District density: 55.33 inhabitants/hectare; Housing project density: 4,436.50 inhabitants/hectare

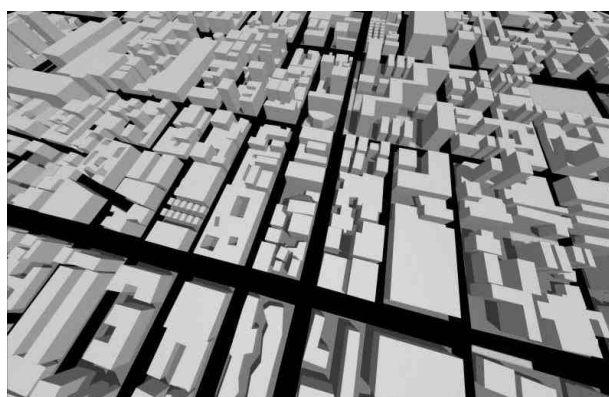
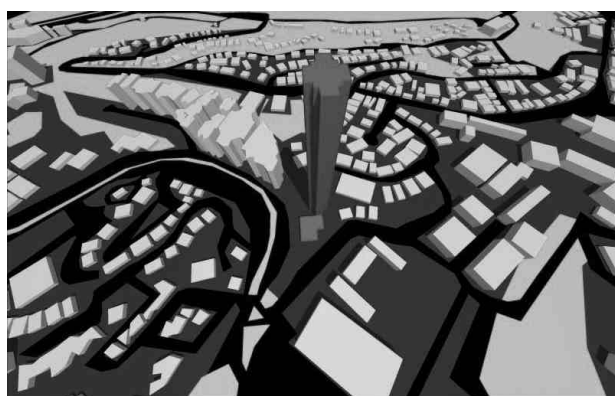


Figure 3 / 4 Computer Generated Image of Interlomas / CGI Del Valle

4.2 Del Valle / Edificio Adolf

The "Colonia del Valle" is considered part of the MCMR's busiest and most complex mixed territories. As we mentioned, before the city's vertiginous growth around the middle of last century, Del Valle was mainly a farmland conquest. In the beginning there were some catholic schools, then town houses and finally big housing projects such as "Presidente Aleman". This started to attract more population, transforming this sprawled district within one of the most prestigious neighborhoods in the central area. In the last 30 years, several medium rise buildings were constructed taking the place of these "town houses". The real estate developers made way for one of the city's current most densely inhabited districts.

Other similar areas such as Del Valle within the city are, in the "Delegacion Cuauhtemoc", "La Condesa", "Hipodromo" and "Escandon".

In the 1970s and 1980s, vertical structures were erected in zones where a medium-scale urban context had already been established. Some areas were redefined more or less harmoniously, but many others suffered from tall, invasive buildings that betrayed the lack of vision and forethought among city planners. High blind walls were built next to small-scale gardens. In this context, "Edificio Adolf" was developed an example of a solution for those plots that have a tall structure on one side and a low-rise construction on the other.

It has the same constructed area and height average of other apartment buildings in the zone, and with only 13 storeys, it is hidden within the urban context (figure 4).

This model of housing is developed in narrow plots with a very few dialogue to the street because it little area on that side, concentrating the design on the lateral edge facing other plots.

District density: 158.75 inhabitants/hectare; Housing project density: 3,235.29 inhabitants/hectare

4.3 Doctores / Villas de Navarro

We can say that this neighborhood grew incrementally from Aztec to colonial villages, colonial and neoclassical buildings, from art deco to popular high densified plots.

Thirty years ago, a governmental project aimed to create the biggest health center in Latin America. Besides the hospital, clinics and other facilities, houses were constructed for the community of doctors that would work in this brand new group of complexes. Because of its very weak subsoil, it was the most damaged zone within the city in the earthquake of 1985 and most of the buildings were abandoned. In some of the damaged plots, the government built popular housing using an architectonical distribution pattern called "Vecindad" (called in English as "deficient multi-housing building" or "popular community housing"). This is a little corridor that gives access to little apartments in one or two floors, or low-income buildings (five-six stories average) to settle most of the people who claim for housing in bigger plots. Nowadays, because of the Central District emigration, residual plots or former warehouses are used to redensify the area with the theory that the Downtown has many urban facilities that must be utilized (figure 5).

Following the idea to redensify the central area of the city in plots previously occupied by ware houses, industries, parking lots or old houses with structural damage, many big housing projects are taking place just a few kilometers from the Downtown.

Villas de Navarro is a complex designed for medium-income families and single users, with small rooms following the minimum area in the codes.

This kind of hyper-compacted UHD are nowadays very popular for the commercial housing business. Because of site regulations as well as the price of the dwellings, the budget doesn't allow for elevators. So by law, the rise of the building is set at a maximum of five storeys (plus ground floor), or six storeys (one mezzanine and ground floor). Villas the Navarro, despite its apartment-like conformation, has small but public common zones.

District density: 152.84 inhabitants/hectare; Housing project density: 4,211.33 inhabitants/hectare

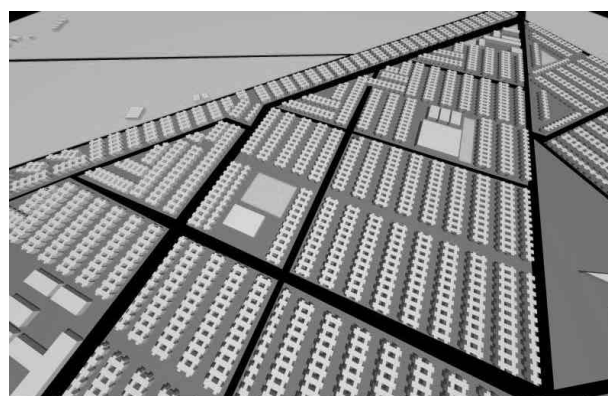
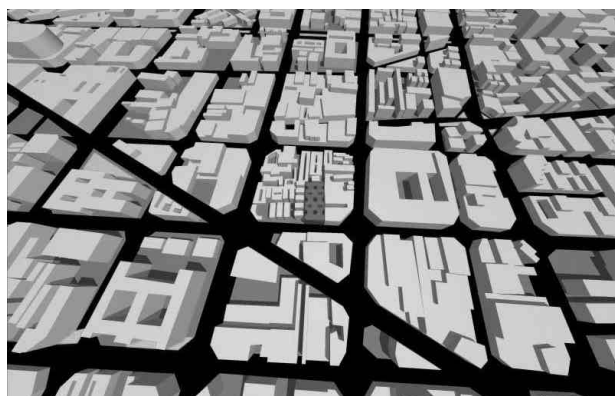


Figure 5 / 6 Computer Generated Image of Doctores / CGI Santa Barbara

4.4 Santa Barbara / San Buenaventura

Nowadays Ixtapaluca consists of little old "pueblos" (regional towns) and cheap land. The distance to the city center, the lack of urban facilities such as public lighting or paved roads, are some of the reasons for its low prices.

Its nearest sub center is Iztapalapa, but still 10 kilometers far away.

In the middle of the 1990s, the low-income house expansion sought this kind of big and cheap land to make several developments, such as "Ixtapaluca 2000", "Geo-villas de Ixtapaluca" or "Jesus Maria". They gave a "new configuration" to this territory, with low-density constructions, and creating "urban village communities" with an average of 100 houses per hectare -very small houses with lots of communal spaces (figure 6).

San Buenaventura is a sub-urban new community created in the middle of the farmlands in the east part of the MCMR. Due to the lack of housing options and high prices in the city core, governmental programs used this cheap land to generate and transform the condition of the sites with the self-named "mega-projects" because of their significant number of units.

Regarding construction the impact is low on this land (less than 40% of the area) leaving around 60% as non-constructed areas -open areas inside the project.

By law, service areas such as commercial zone, transportation, health, education and amusement, must have their place within the new dwelling zone. As the community grows, there won't be sufficient quantity of these areas.

This kind of big housing projects are mainly situated in the southeast and northern part of the MCMR, starting as lonely housing areas, but rapidly filled by services for their urgent demands.

District density: 788.58 inhabitants/hectare; Housing project density: 1,583.86 inhabitants/hectare

4.5 Ampliacion Evolucion / Vivienda en lote familiar

Beginning as an informal settlement, the land was divided within subdivisions for low-income families.

Within the last 50 years the population of Nezahualcoyotl has grown from 5,000 to 1.4 million people. This exponential growth had its boom in the 1970s when the Mexican economy was transformed from agricultural to industrial. This created an enormous influx of immigrants to the MCMR.

The plots started with a simple room and grew with the family's necessity for space. The urban morphology can be compared with the Generic Algorithm theories -any possible configuration can be found in Nezahualcoyotl (figure 7).

Despite its number of inhabitants, because of the economy they generate, Nezahualcoyotl has kept poverty levels relatively low. Other municipalities such as "Valle de Chalco Solidaridad" and "Chimalhuacan" represent almost the same physical conditions.

The term "Vivienda en Lote Familiar" ("Family's Plot Housing") was coined to express large areas divided within plots which were given to families to manage as smaller subdivisions. The constructions inside this "cell" (part of a group of cells, and this one part of a body) begins with a little self-constructed room (generally informal constructions), and over time, expands as the family necessitates, increasing the area up to two storeys (sometimes three if the original structure was planned as such). This creates a little version of the popular houses in the countryside, with a lateral, central or backyard, in almost all the cases. These houses have a relatively big space, started by a couple, and, after around 20 years, when the children get married, a new family has its place inside the same walls and is invited to live with the parents (especially with the wife's parents). Two families and sometimes three generations live under the same roof in a house that shares the same block with other relatives, sometimes with connections between the plots, without the necessity to go out to the street. The low-income level of the population creates a very informal settlement, a popular zone where the "foreigners" are not very welcomed. This "Territories of the Informality" has underground economies and notwithstanding they have particular services as electricity or water, they use to "take it" from the public distribution lines.

District density: 306.18 inhabitants/hectare; Housing project density: 1,629.62 inhabitants/hectare

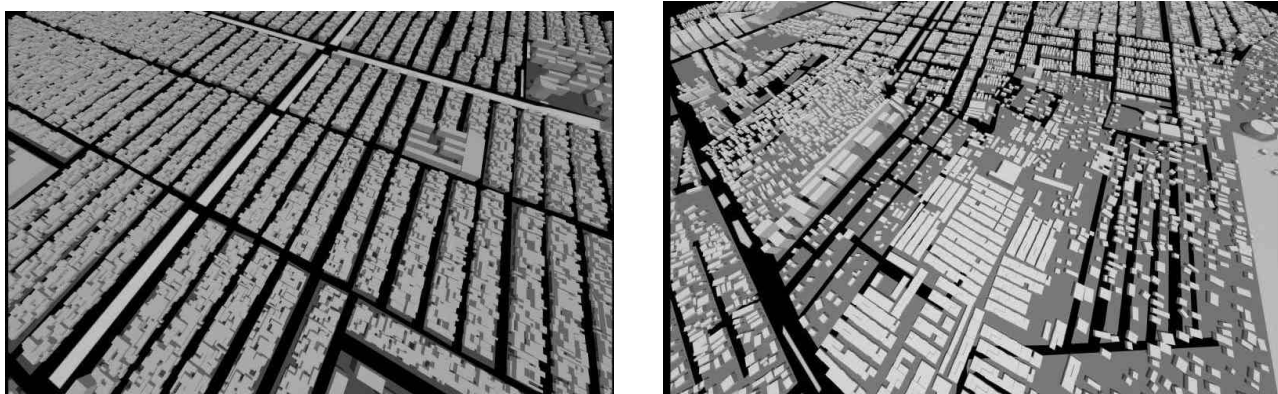


Figure 7 / 8 Computer Generated Image of Ampliacion Evolucion / CGI Degollado

4.6 Degollado / Urban slums

Its informal growth made a primarily residential district that lacks adequate social, cultural, and educational facilities. Many green spaces in this zone are severely endangered, for example, the "Cerro de la Estrella" (one of the most historically famous hills in the valley) lost more than 90 percent of its original area to unplanned developments (figure 8).

This delegation has one of the most crowded and deteriorated living conditions in the MCMR.

The informal urbanization in the MCMR has its favorite location at the end of the urbanization area, becoming the middle point between the city and nothing. The terms "ciudades perdidas", "barriadas", "slums", "favelas" express this urban phenomena that is characteristic of spaces for the extremely poor. Poor health conditions, social violence, underground ways of life have been transforming the culture of the old settlers and creating a sub-condition for their inhabitants.

In Mexico City this kind of place can be found almost everywhere, sometimes in the roof of an office building in the business districts, or inside the city's drainage pipes in the middle of the town, or in the mountains or in caves. This example is a big community located in a very well known place between the "Xaltepec" and "Yuhualixqui" volcanoes in the south of the city.

District density: 565.35 inhabitants/hectare; Housing project density: 2,644.62 inhabitants/hectare

5. Conclusions

Comparing the index of overcrowding of these regions with the general density of the city we see that the most densely populated districts are those from the medium-low, low, and very low socio-spatial areas.

With the exception of the high rate for the housing communities provided by the Government (San Buenaventura), we found a constant of this density from low levels in the wealthiest zones (55.3 inhabitants per hectare), through to medium levels in medium income zones (158.84 inhabitants per hectare) to high levels in the poorest zones (565.35 inhabitants per hectare) (figure 9 low lines). Whereas in the wealthy districts the zones are mixed with other uses (big streets, public parks, amenities and many facilities). In the poorest districts, housing is the principal use with few public facilities and green areas.

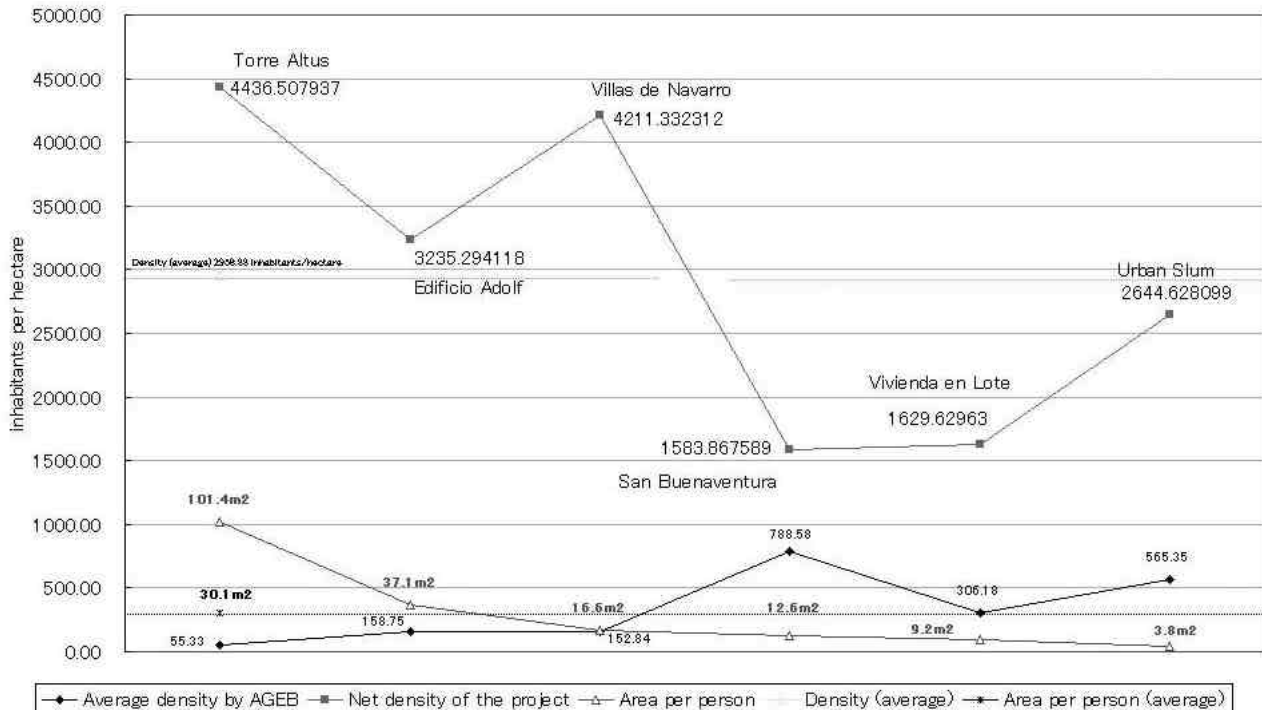


Figure 9 Average Density (urban scale) and Net Density (architecture scale) of the six selected examples.

Reading only the density of the projects we find a paradoxical relationship. Where in the low level districts the general density is high and in the high level districts the general density is low, our selected projects are (in relative terms) in the high level zone, extremely dense (between 3,235.29 inhabitants per hectare to 4436.50 inhabitants per hectare) and in the low level zone, less dense (between 1,583.86 inhabitants per hectare to 2,644.62 inhabitants per hectare). This is mainly because the intensity of the Building Area Ratio on the ground floor of each plot elevates this rate. Nevertheless, we will highlight three of these projects that have unique circumstances: Torre Altus, Villas de Navarro and the Urban Slum (figure 9 upper lines).

The strong family ties and the poor economic conditions, especially in the average Mexican communities, makes the existence of these living conditions easy to understand because they are part of the Mexican trans-cultural basis. Indeed, this phenomenon of ekistics can be observed all over Latin America.

Popular phrases such as "Mi casa es tu casa" (My home is your home) refers to this phenomena, where we don't see "one house-one family", but "one house-many families". This raises the density to these hyper-density conditions. The right and wrong solutions for housing communities of these megacities not only continue to give challenges and opportunities for architects and urban designers, but also plenty of information and data that can be useful for determining factors or relevant concepts to understand and propose ideas to keep the environment and the human settlements living together in a right balance.

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