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Spatial Analysis of Priority Attention Housing (PAH) Development Projects in the Urban Area of Cali, Colombia

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Abstract

The objective of this paper is to examine potential neighborhood effects of Priority Attention Housing (PAH) projects in Cali, Colombia. Specifically, we capture effects of neighborhood-based housing interventions on housing quality, access to public infrastructure and public services, and other social amenities via the economic rent manifested through property value differentials across the urban area of Cali. Targeted PAH neighborhood-projects are: Barrio Taller - Potrero Grande, Altos de Santa Elena, and Urbanización Casas de Llano Verde. To this end, spatial-temporal hedonic econometric analysis is conducted. The analysis assesses welfare economic principles in relation to housing policy tools for overcoming poverty.

Keywords: hedonic prices, spatial econometrics, housing programs, spatial dependence, Colombia

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Table of Contents

Figures

Tables

Maps

Abbreviations and Acronyms

AIC	Akaike Information Criterion
BSP	Bureau of Social Prosperity (Departamento de la Prosperidad Social – DPS)
CCC	Colombian Chamber of Construction (Camara colombiana de la Construcción – CAMACOL)
CEDE	Centro de Estudios sobre Desarrollo Económico
CLD	Colombian Labor Information (Fuente de Información Laboral de Colombia – FILCO)
CLI	Colombian Labor Information (Fuente de Información Laboral de Colombia – FILCO)
CENAC	Centro de Estudios de la Construcción y Desarrollo Urbano y Regional
COP	Colombian Pesos
DANE	Departamento Administrativo Nacional de Estadística (National Administrative Department of Statistics)
DAP	Cali Departamento Administrativo de Planeación
DNP	Departamento Nacional de Planeación (National Planning Department - NPD)
GDP	Gross Domestic Product
GIS	Geographic Information Systems
GWR	Geographic Weighted Regression
IDESC	Infraestructura de Datos Espaciales de Santiago de Cali
MISU	Macro Proyecto de Interés Nacional
MSA	Metropolitan Statistical Area
MT	Ministerio de Trabajo
MVCT	Ministerio de Vivienda, Ciudad, y Territorio
OLS	Ordinary least squares
PAH	Priority Attention Housing
PLU	Land Use Plans (Plan de Ordenamiento Territorial – POT)
PSM	Propensity Score Matching
SAH	Social Attention Housing (Vivienda de Interés Social – VIS)
SMMW	Statutory Minimum Monthly Wage (Salario Mínimo Mensual Legal Vigente – SMMLV)
SVS	Secretaria de Vivienda Social (Cali)

Spatial Analysis of Priority Attention Housing[1] (PAH) Development Projects in the Urban Area of Cali, Colombia

Introduction

Housing policy is considered a critical anti-poverty strategy in Colombia because poverty is measured multi-dimensionally and housing is regarded as one of the underlying conditions of poverty. In this context, Colombia's housing policy was designed to reduce the housing deficit of low income and vulnerable populations with respect to the rest of the population. Priority Attention Housing (PAH) is an important component of the national policy agenda. This national housing program provides heavily subsidized housing for the poor and disadvantaged; under certain conditions housing can be entirely free. In line with the Paretian Economic Principle, the proposed research is designed to examine the effects of PAH projects on established neighborhoods in Cali, Colombia.

Specifically, this research aims to capture the effects of three PAH projects on neighborhoods across the Cali urban area using several residential conditions (safety, housing quality, access to public infrastructure, public services, social amenities) as captured as economic rent through property value and rent differentials across city neighborhoods. At the heart of this study is the belief that location does matter and that spatial externalities exist in the residential landscape of a city. Spatial externalities are also known in spatial analysis, regional science and geography as spatial dependence. The fundamental principle of it is that near phenomena are more similar to each other than more remote ones, all other things being equal. This is also known as the first law of geography (Tobler 1970) and can be statistically assessed via metrics of spatial autocorrelation. We argue that, because of their size, fast implementation and spatial focus (a true economic shock to a neighborhood community), and because of the socioeconomic complexion of the new population, PAH developments would have an effect on existing residential communities and that this effect would exhibit a distance-based gradient from the sites of the new PAH developments. The effects would operate through the changes in demand and supply on the real estate market, changes in the demand for urban amenities (retailing, transportation, public services), and changes in the extent and nature of social interactions.

The public policy motivations of this research are as follows. While governments have a responsibility to attend to the socio-economic aspirations of all segments of the populations and to support disadvantaged segments of the population in accordance with their redistributive social objectives, democratic principles suggest the need to also avoid establishing policies that would be perceived to unfairly burden better-off segments of the population. A Paretian perspective is imperative in this respect. Thus, it is incumbent upon social science research to establish whether a government policy may be detrimental to one group of citizens (intentionally or not) for the good of another group of individuals. Pareto non-optimality may create social stresses in nations and result in lower efficiency in the delivery of government programs.

[1] Vivienda de Interés Prioritario (VIP in Spanish).

Cali, the third largest city in Colombia, has one of the nation's largest and fastest growing residential markets. Cali faces high immigration and is the destination for large numbers of rural Colombians displaced by violence and other political, social and economic instabilities. The local government has been coordinating with the national government to implement the national housing policy. The national housing policy has several components, including PAH, that benefit families with incomes under twice the minimum statutory wage. Established in 2012, the PAH program is currently the largest and most notable public housing program in the country. The PAH program aims officially to provide a home to 100,000 families across the country.

This paper is divided in several sections. The following section presents an overview of Colombian public policy on housing. The next section presents more detailed information on the PAH Program. Information on Cali and the three projects is presented in the following section. The next two sections provide a literature review regarding the housing market of Colombia and the theoretical framework of this research, respectively. Next, the empirical approach is described, including the data, methodology, and the results of the analysis. Finally, the report ends with a discussion and conclusions.

Colombian Housing Policy Background

A good overview of Colombia's housing policy in the 1990s is given by Chiappe de Villa (1999). In that paper, the author provides important background information on the Social Attention Housing (SAH),[2] the primary governmental housing program in that decade, which has remained active to this day. Since the main criteria to allocate dwellings to families in the SAH program are personal income and personal savings, Chiappe de Villa found that the constraints from the supply side (high cost of land and inputs and high interest rates on loans) created a situation where the cost of dwellings was high enough to create a barrier excluding the most vulnerable – and needy – segments of population, thus compromising accessibility to this housing option for many households.

According to the evaluation conducted by Pecha (2011), the SAH program was in fact not accessible to the poor population. With restrictive requirements such as a down payment equal to 10 percent of the dwelling price, and once access to loans was reduced, it is only from the third quintile of the income distribution that people had access to this program in a tangible way. Thus, the program benefited a smaller share of the targeted population and beneficiaries were mainly in the third and fourth socioeconomic classes.

The main goal of this program is the reduction of the household index of housing shortage. This goal was achieved partially. The general guidelines of this SAH program remain in effect today, with some implementation adjustments pertaining to the percentage of financing, eligibility of individuals, and sizes of the housing units. The National Planning Department (DNP) (2007) and later Arbelaez, Steiner, Becerra, and Wills (2011) highlighted advantages of this policy, such as the fact that families benefited by this policy are more likely to buy a house than to rent one, and also that they have more ready access to financing options – credits and mortgages.

[2] Vivienda de Interés Social (VIS in Spanish).

Several housing policy studies at the international level mention Colombian experiences in their analysis. It is the case of Held (2000) who also analyzed the housing policy experiences of Chile and Costa Rica. Held's conclusions are in line with Chiappe de Villa's and presents more detailed policy guidelines on how to incentivize personal savings to enhance access to loans, support the mortgage market, increase land for social attention housing and use the house resale market as a more effective strategy to provide housing to the population. More recently, Rojas and Medellin (2011) analyzed data for Latin American and Caribbean countries from 1995 to 2006 to find that on average the rate of shortage in urban housing has dropped; thus they concluded that housing conditions have improved, although there is still room for policy efforts to enhance access to the market. Simioni and Szalachman (2007) collected the experiences of Latin American countries on several critical policy dimensions. These dimensions are land ownership, access to utilities and urban services, dwelling quality, environmental conditions and economic development. For Colombia, the authors highlight the benefit of Law 388 of 1997 which was developed as an instrument to capture changes in land value as consequence of housing projects, among other objectives.

The Program of Priority Attention Housing (PAH) in Colombia

The program of Priority Attention Housing (PAH) – also named the program of 100 percent In-Kind Subsidy for Family Housing– is part of the housing policy of the Colombian central government. The program was inspired by a similar program in Brazil, *Minha Casa, Minha Vida,* where the Brazilian government set the goal to provide one million houses to poor and middle class families below a certain income threshold (MVCT 2014d). The Colombian program targeted the population based on criteria tailored to the household socio-economic conditions.

The program was enacted in 2012 by Law 1537 of 2012 known as *Law of Priority Attention Housing.* It is also part of the legal framework for the program set by Decree 1921 of 2012 from the Ministerio de Vivienda, Ciudad y Territorio (MVCT) that states the procedures to identify and select the eligible population, as well as the multiple steps in the allocation of the houses.

According to the MVCT, the motivation for the program was "to provide dwelling for those families classified as extremely vulnerable, without either savings or access to loans" (MVCT 2014d, 60). Two additional motivations are, first, the housing shortage which is estimated to reach 3.8 million housing units based on the 2005 Census. The second is the perspective of the comprehensive social development policy of the Colombian government, which means to integrate this program into the overall policy to overcome poverty and extreme poverty.

The program would be implemented and fully completed in two years, with an estimated cost of 4.4 billion Colombian pesos (COP).[3] Since the launch of the program, 281 housing projects in 211 cities or municipalities were executed. The program builds individual houses whose maximum cost is 70 times the statutory[4] monthly Colombian minimum wage (SMMW) each. The government set as a goal to build one hundred thousand new houses. Essentially, the

[3] 2.4 billion USD. Market Exchange Rate 06/30/2012. 1 USD = $1,784.60 COP, according to the Colombian Banco de la República.

[4] Salario Mínimo Mensual Legal Vigente (SMMLV in Spanish) is a unit of measure for legal purposes in Colombia.

program would allocate one hundred thousand houses to low-income households classified as vulnerable across the country. The following table shows the distribution of the projects across the country and participation percentages of each department.[5] The three programs of interest in this paper are all located in Cali, Valle del Cauca (see annex 1).

Table 1: Distribution of PAH housing units by Department, Colombia

Department	Number of Houses	Percentage
Amazonas	200	0.20%
Antioquia	13,718	13.72%
Arauca	864	0.86%
Atlántico	7,618	7.62%
Bogotá, D.C.	4,460	4.46%
Bolívar	3,616	3.62%
Boyacá	2,312	2.31%
Caldas	2,203	2.20%
Caquetá	1,342	1.34%
Casanare	160	0.16%
Cauca	2,854	2.85%
Cesar	3,683	3.68%
Chocó	2,187	2.19%
Córdoba	6,070	6.07%
Cundinamarca	4,025	4.03%
Guainía	244	0.24%
Guaviare	182	0.18%
Huila	2,084	2.08%
La Guajira	3,747	3.75%
Magdalena	5,515	5.52%
Meta	2,004	2.00%
Nariño	4,344	4.34%
Norte de Santander	3,694	3.69%
Putumayo	1,351	1.35%
Quindío	636	0.64%
Risaralda	2,237	2.24%
San Andrés, Providencia y Santa Catalina	174	0.17%
Santander	3,806	3.81%
Sucre	4,068	4.07%
Tolima	2,394	2.39%
Valle del Cauca	***7,752***	***7.75%***
Vaupés	150	0.15%

[5] Equivalent to states.

Department	Number of Houses	Percentage
Vichada	306	0.31%
Total	**100,000**	**100%**

Source: MVCT (2013) Table 2, pg. 21.

Eligibility and Selection of Recipient Families

The population that is eligible to participate in the program includes the following groups: families displaced as a consequence of internal conflict; families registered at the Bureau of Social Prosperity (BSP)[6] information databases; and families affected by natural disasters or living in natural high-risk zones (MVCT 2014d). This program is part of the national government's comprehensive policy to overcome poverty (See the distribution in annex 1).

Decree 1921 of 2012, chapter II, describes the identification, selection and nomination of families eligible to participate in the PAH Program. In addition, the decree defines the priority order to select the families. The order of priority is as follows: 1) Families registered at BSP in the program to overcome extreme poverty; 2) Displaced population under the following conditions: families awarded a housing subsidy without application to the program, families with approval as displaced family and a housing subsidy since 2007, and families not enrolled in any housing program; and 3) Families affected by natural disasters or living in a high-risk area.

Families apply to the program by filling out an application form; next, the information is verified by the BSP. Submitting inaccurate information may have legal consequences. After validating all the application information and applying the prioritization criteria, if the number of families exceeds the number of houses locally available as part of the program, the local government will call a public meeting where the selection of recipients is based on a lottery. This event must be attended by program staff as well as witnesses from other government agencies.

The final stage consists of communicating with recipient families. Families are made fully aware of their benefits and duties. Besides the house awarded, associated legal services are free of charge and, in some cases, families receive a water supply subsidy as well. In addition, the local governments must enroll these families in social service programs and track their evolution. The main duty of the families is to live in the awarded house; they are not allowed to rent it or sell it. The *Law of Priority Attention Housing* prohibits selling the assigned house for 10 years from the time it is granted.

Strategies for Implementation of the Program

The implementation of the program is based on three strategies to achieve the number of houses goal. With the first strategy, the Colombian central government buys houses from the private housing market (private strategy). In the second, the Colombian central government invites home building contractors to bid to build houses on undeveloped land allocated by local governments

[6] Departamento de la Prosperidad Social (DPS in Spanish) is the leading coordinating institution in charge of overcoming poverty, extreme poverty, and/or high priority vulnerability in Colombia from a multidimensional perspective.

(public strategy). In the latter strategy, Law 388 of 1997 on territorial development plays a key role because it presents the guidelines for designing and implementing the Plans of Land Use (PLU)[7] at the local level. Finally, in the third strategy, the Colombian central government buys houses from local projects sponsored by the local governments (contract strategy). The following table presents the financial distribution of the program nationally by strategy.

Table 2: Distribution of financial resources by strategy, Colombia

	Number of Houses	COP (1,000,000,000)	USD (1,000,000)
Private Strategy	49,721	2,085.6	1,168.7
Public Strategy	23,857	916.1	513.3
Contract Strategy	24,293	941.9	527.8
Total	97,871	3,943.6	2,209.8

Source: MVCT (2014a) Table 7, pg. 39.

The source of funding is mainly from the Colombian central government. However, the actual distribution of funding sources may vary on a project-by-project basis. According to the Law of Priority Attention Housing (PAH), the percentage of local funding should be no less than 20 percent in large cities (including Cali).

National Debate and Criticisms of the Program

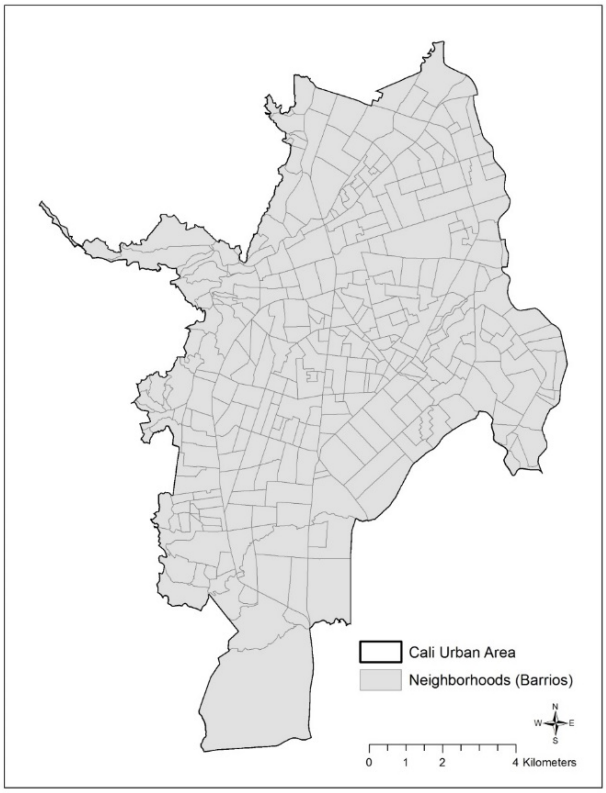
The criticisms waged at the program are based on the following arguments: 1) The overall housing-based poverty alleviation policy of the national government was underperforming in 2010 and 2011 and the PAH program was devised to compensate for the existing deficiencies; 2) Given the overall budget constraints and the larger subsidy offered to beneficiaries under PAH, the overall number of beneficiaries dropped nationally in comparison to the population supported by previous programs; 3) While it has been estimated that 1 percent of GDP should be dedicated to the program to achieve the initially projected social goals of the government, budget constraints have kept support to just 0.1 percent of GDP; 4) The legal framework is weak at the local level; since the demand for housing is significantly greater than the supply, a situation is created for potential corruption and politically inappropriate behavior; 5) The fact that the financial system perceives the low income population as a high-risk population for lending purposes, forces the government to assume the risk in this case, but without resolving the structural issue, which would provide for a more lasting outcome (Sarmiento 2012).

[7] Planes de Ordenamiento Territorial (POT in Spanish). The PLU is the local zoning plan used as framework to determine future land uses. Examples of classification are features such as zones' classification, their use, appraisal and taxation structure (Maldonado, Pinilla, Rodríguez, and Valencia 2006). Based on this plan, the local governments determine the zones of the city that are suitable for housing programs such as the PAH Program.

Cali and the Projects

Cali is the third largest city in Colombia. Its 2014 population was 2.34 million; 47 percent were male and 53 percent female. Its density index is 4,184.7 inhabitants/km^2. The urban area is divided in 22 communes and the communes are composed of neighborhoods. Cali has 322 neighborhoods (see population density by commune in annex 2). Cali has an income Gini coefficient of 0.51, inflation of 3.4 percent, and an income per capita of USD $4,540. The city of Cali also accounts for 5.1 percent of the Colombian GDP, and the total number of jobs in the city is 1,076,452 (DAP 2013). Based on statistics presented by CENAC (2015), the trend in SAH construction has been ascending since 2008, with a peak number of dwellings reached in 2013. In fact, the share of SAH constructions in the housing market of the city rose from 13.9 percent in 2008 to 42.7 percent in 2014 (see annex 3).

Map 1: Cali Urban Area and Barrios



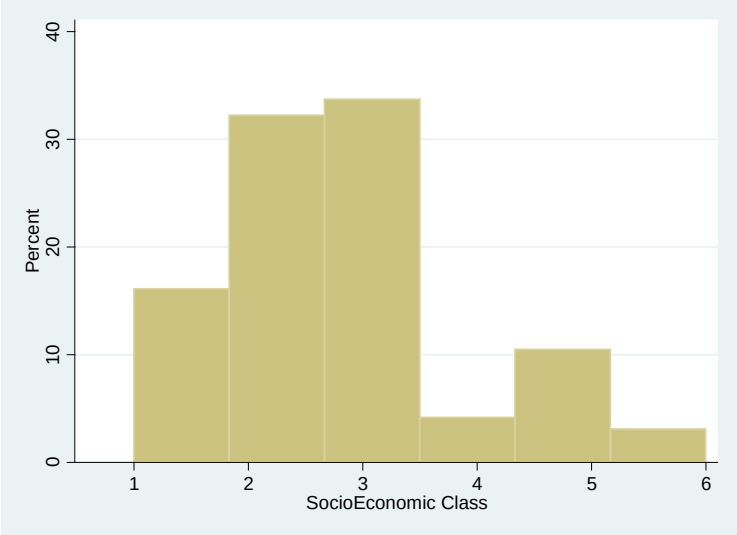
Source: IDESC.

The following statistics are based on the Colombian Labor Information (CLI)[8] database from the Ministerio de Trabajo (MT). In 2013, the MT and the Cali mayor's office commissioned a survey, which was conducted between the end of 2013 and the middle of 2014. This survey collected information comparable with the survey design of the National Survey of Living Standards, among others. This information is used here to depict a recent image of the socio-economics of the city.

[8] Fuente de Información Laboral de Colombia (FILCO in Spanish).

According to table 6 (see annex 2), the residents of Cali live primary in single-family houses (74.4 percent) and in apartments (23.6 percent). However, there are communes where the proportion of single-family houses is much higher than in others (communes 2, 4, 9, 14, 15, 18 and 21). Commune 3 shows the highest proportion for apartment living among all communes (41 percent). Table 7 shows that citywide most housing units are owner occupied and free of any mortgage (52 percent), but a high proportion of housing units is rented (38.9 percent). The proportion of inhabitants with a mortgage is low, just 3.5 percent.

Figure 1: Distribution of population in the City of Cali based on their socioeconomic class

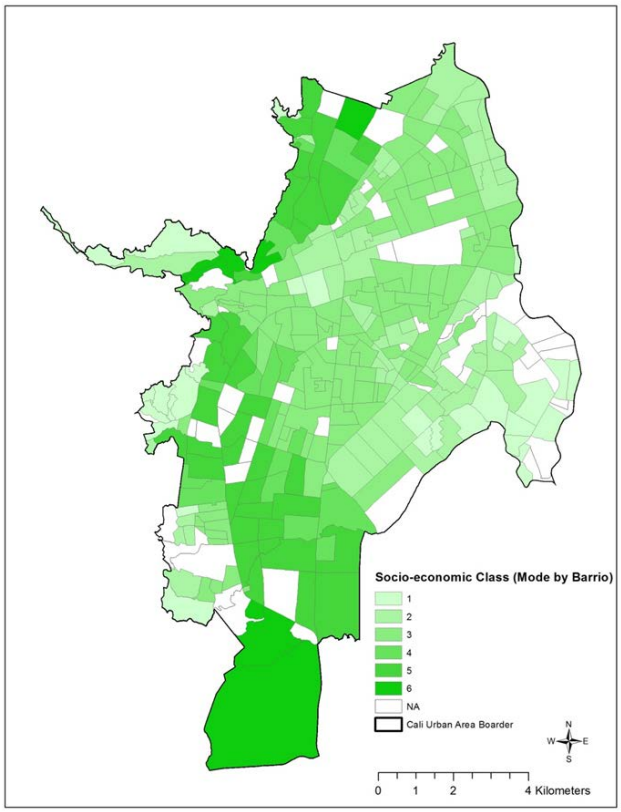


Source: CLI 2014.

Figure 1 presents the distribution of the city population according to socioeconomic class.[9] As can been seen, 80.7 percent of the population is classified in the three lowest classes. The distribution of this variable by neighborhood is also shown in map 2. It can be seen on the map that many zones in the south and northwest of the city are classified in the highest strata, while the southwest and east tend to be classified in the lowest strata. The central zone of the city has a mixture of values but for the most part fall into class 3.

[9] "Classification by classes or socioeconomic stratification is a classification into strata of residential properties used, among other purposes, to determine the applicable public services and utilities fees. It permits differential utility pricing for household, allocation of subsidies, and tax collection in the area. Thus, those who have higher financial capacity pay more for public services and enable lower strata households to pay less." The classification ranges from 1 (lowest) to 6 (highest). http://www.dane.gov.co/index.php/estratificacion-socioeconomica/generalidades.

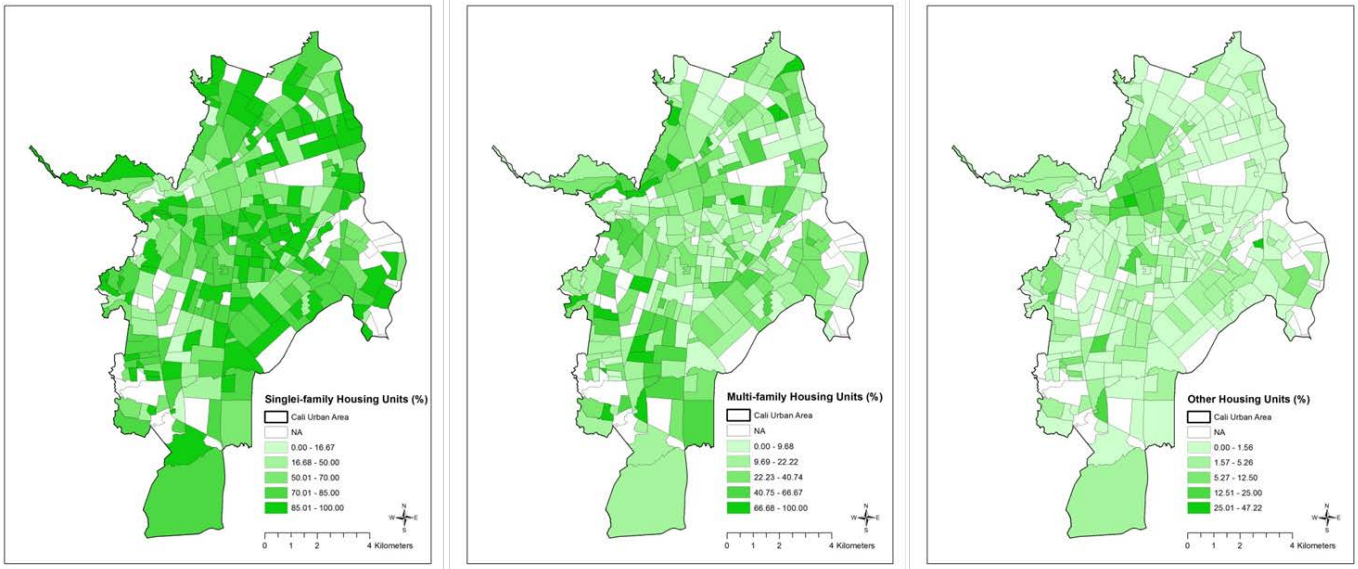
Map 2: Distribution of population by neighborhood and socioeconomic class



Sources: CLI 2014 & IDESC.

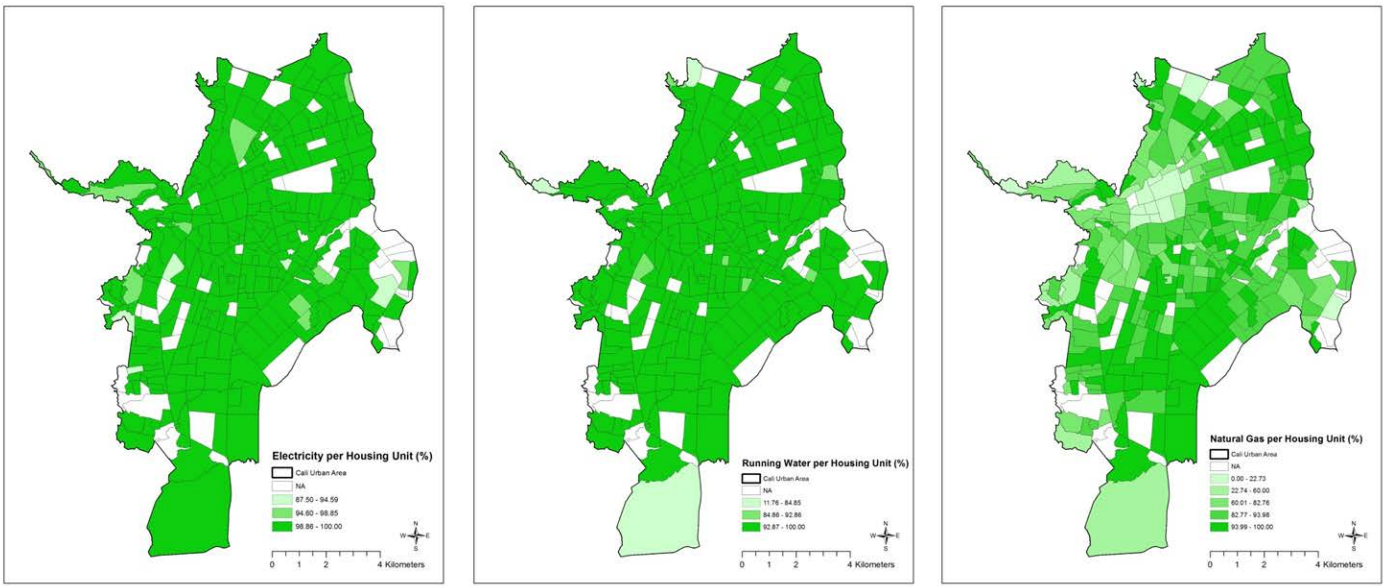
Maps 3 and 4 depict the housing market of Cali at the neighborhood level. They present information on the percentage of housing types and the coverage of basic utilities, respectively. Map 3 shows that single-family housing is predominant compared to the other categories across the whole expanse of the city, with no clearly noticeable spatial pattern. As see on map 4, running water and electricity are available to most households across the city. On the opposite, natural gas availability is lower overall, but with spots of stronger use in the north and east central sections of the city.

Map 3: Type of housing units by neighborhood



Sources: CLI 2014 & IDESC.

Map 4: Access to residential utilities by neighborhood

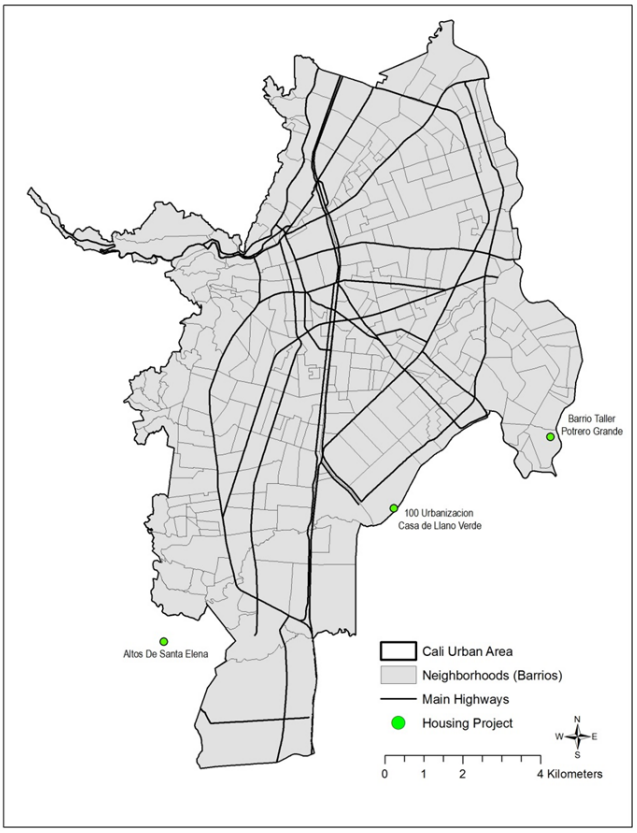


Sources: CLI 2014 & IDESC.

The Three PAH Projects

As indicated earlier, the city of Cali was projected to receive 4,591 houses funded through the PAH Program. These houses were planned to be built in three projects, which are described in this section using relevant statistics. The location of the three projects is given in Map 5. It should be noted that all three are located at the edge of Cali's urban area as the rest of the city is completely built-up and does not have plots of land sufficiently large to accommodate the projects in more central locations.

Map 5: Location of three PAH projects



Sources: CCC & IDESC.

Altos de Santa Elena

The Altos de Santa Elena project is located southwest of the Cali urban area. It is a macro-project of the national social policy[10] which was initiated before the establishment of PAH. This project was legally created in July 2009 and its implementation strategy is through contract. It is administratively located in commune 19. Dwellings are apartments of two possible sizes (50m^2 and 40m^2) targeted for families in socioeconomic classes 1 and 2. The unit cost is 70 and 60 SMMW, respectively.

[10] Macro Proyecto de Interés Nacional (MISN in Spanish).

The projected number of dwelling in Altos de Santa Elena is 3,500, divided into two phases: 1,700 in the first phase and 1,800 in the second. The potential number of people who would be housed in the project is 14,000 based on an average family size of four. By the end of 2014, the total number of apartments built was 1,850, and the total number of units assigned to a family was 1,530 (MVCT 2014a, 107).

Barrio Taller - Potrero Grande

The housing project Barrio Taller is at the western edge of the urban area, in commune 21. It is part of the fifth phase of a bigger housing project named Potrero Grande, which began in 2007. Its implementation strategy is through contract. Barrio Taller was built in 2011 and has been targeted for displaced families, classified in this condition since that year. The project aims to provide 296 dwellings to the same number of families. The type of dwelling is a single-family house of 37.12m.^{2} All houses were built by the end of 2014 and are currently inhabited. The cost per house is equivalent to 57.94 SMMW of 2011. (SVS 2012)

Urbanización Casas de Llano Verde

The Urbanización Casas de Llano Verde project is located in the southeast of Cali, in commune 15. Construction started in November 2012 and ended in December 2013. Its implementation strategy is through private development. All are single-family units of 46m^2. The total number of dwellings is 3521, and currently all houses have been built. According to MVCT (2014a), the total number of beneficiaries is 21,600 inhabitants. The final cost per house is equivalent to 70 SMMW of 2013.

Public response to PAH projects

Three groups of actors can be identified in the confines of the PAH policy. The actors include the beneficiary families, the population living in the neighborhoods surrounding the project sites, and government entities. The dynamics of interaction between these three groups and the projects can be detected through news reported in the local newspaper and information services. For instance, it has been reported that the neighbors of the newest project (Llano Verde) expressed their disapproval of the project since the beginning (Z. L. Cuervo 2012). Their main concern was the negative effect the project would have on the value of their homes, and the anticipated increase in insecurity. In fact, some of the residents of the nearby neighborhoods sold their homes and relocated in reaction to the decision made by the city to proceed with the project. In addition, homeowners in the area surrounding Llano Verde and Altos de Santa Elena (the oldest project) were looking for legal counsel in order to stop and re-locate these projects, aiming at reducing the negative effects on their neighborhood (Z. L. Cuervo 2012).

On the other hand, some of beneficiary families of Barrio Taller (the second oldest project) have expressed their dissatisfaction with the program, since the houses assigned to them have experienced structural problems (WebnoticiasTv 2012). Among the deficiencies identified by the owners of houses in PAH projects are low quality construction material, such as brick, insufficient house square-footage for an average size family. Complains were also voices regarding windows frames, toilet connections, and ceilings which were found to be deficient.

Moreover, owners expressed dissatisfaction with the high monthly charges for public services in relation to the low-income of the families the project was intended to serve.

Families living in Llano Verde have also complained because some of the public amenities expected have not been not built yet. Specifically, their main complaint was the absence of a school for children. Project inhabitants indicated that the children have to travel a long distance (at a high cost) to attend even the closest school (NoticiasRCN 2014). The residents also complained about the lack of recreational facilities and better environmental conditions.

The national government declared that the poor population should not be stigmatized, and the Llano Verde project would be built as planned. The directives to the local government to solve the concerns involved collecting information on families affected and improving the managerial process to deliver with the amenities promised.

From the government side, dissatisfaction also arose due to the non-ethical behavior of some beneficiary families. Although the beneficiary families know they should live in the house and not sell or rent, some families have rented or sold their house. There are several documented cases of families having rented their house (Redaccion El Pais 2014). For this reason, these families will be subject to legal action to return the house and any give back other subsidies received.

However, a unique phenomenon is occurring in Cali after the projects were built. On an ongoing basis, more families have arrived to Cali with the expectation of being beneficiaries of the most recent project (Melo García 2015). These families support their eligibility with documentation because they know how to navigate the system. For the local government this situation is worrisome because the housing policy created the incentive for the families to move to Cali – often from the nearby regions – to benefit from the policy. The local housing policy has limitations in terms of the funding and land availability that can be allocated to the families. Therefore, there is a competition for housing among Cali's residents that may have been on a waiting list for many years, and those who come from nearby regions. Then a negative climate has developed towards beneficiaries who are not longtime residents of Cali.

A fourth actor can be referred as the "public opinion" –including academic experts and former government planners. This group of actors has pointed out that in general a policy of free housing is not enough (Correa Pablo 2014). They argue that it is not enough because the design of some of the projects – not only in Cali –lack urban amenities. Some of the projects are not integrated into the cities. Building these types of projects implies many times changing the way families used to live, which could negatively impact the communal living. Using this argument they call for improvement to the "old idea" of these housing projects, and to replace them with a more multidimensional model that would take into account dignifying living condition.

Housing Market in Colombia

A significant proportion of studies related to housing analysis have been focused on Bogotá, the country's capital. Among the reasons are the fact Bogotá accounts for the largest share of the

Colombian economy (24.7 percent) of all cities in the country (DANE 2014). Also, both the Bogotá local government and the academic community have developed extensive data sources to study this topic.

Some of the studies of Bogotá have focused on the evolution of housing policies and their consequences on both housing price and residential land (N. Cuervo and Jaramillo 2009; Jaramillo 2014; Jaramillo and Cuervo 2014). Using data mainly from CEDE,[11] these authors' descriptive analyses shows that the free market policies implemented in the housing market have maintained the limited access of the low income population, have brought about a decline in housing quality, and in many cases have incentivized the growth of the informal sector. Using time series analysis, the authors disentangled the dynamic behavior of land prices under three fundamental modalities, namely: the structural movement that accompanies long-term economic trends; the general cyclical movement; and the specific structural movement tied to particular space-time characteristics. This classification enables the authors to isolate the effects on price with more accuracy. On this basis, the authors conclude that housing prices are pro-cyclical; however, between 1970 and 2013 the housing price trend line decreased, while the land price trend line increased.

Also for Bogotá, Aguilar and Yepes (2013) and Aguilar (2014) address the relationship between poverty, people's location, and their housing preferences. In the first study, the authors use a Oaxaca-Blinder decomposition to compare the urban periphery with the rest of the city. They found that the effect of segregation is stronger than the effect of individual characteristics, and it accounts for almost one-third of the average income differences between those located in the periphery and the rest of the city. Aguilas uses the city cadastral census information and a geo-referenced multipurpose survey, which allows her to test the hypothesis of prevalence of individual socioeconomic effects versus contextual effects. The empirical strategy was based on hedonic prices and discontinuity regression. The findings support the conclusion of explicit territorial patterns in housing consumption which is related to the contextual effects hypothesis.

Hedonic price modelling and spatial analysis are empirical approaches used to analyze topics related to housing as well as others. Morales and Arias (2008) estimate the social valuation of house features using the hedonic price methodology adjusted by spatial econometrics. The analysis for Bogotá was based on the National Survey of Living Standards of 2003. The authors found evidence to support the relationship between the social valuation – as an indirect measure of individual welfare – and the housing price distribution across the city. In a similar vein, Santana and Núñez (2011) test the hypothesis of preference for segregation in Bogotá using hedonic price modelling and spatial econometrics. The proxy variable to capture this phenomenon is the distance between the neighborhoods based on their socioeconomic classification. Based on their estimations, the authors conclude that there is a relationship between distance and the price per square meter. In addition, land price decreases more (percentage-wise) if the dwelling is far from the highest socioeconomic class, than if the dwelling is closer to the lowest class.

Morales and Medina (2007) and Casas (2014) share the use of hedonic price modelling to verify if the housing market accounts for cross-subsidies in public utility services delivered to

[11] Centro de Estudios sobre Desarrollo Económico - Observatorio del mercado del espacio construido en Bogotá.

residences. In the first study, the authors aim to measure if the market accounts for the effect of subsidized utilities and if it is reflected in the housing price. After performing estimation in Bogotá, the authors conclude that the housing market neutralizes the effect of utility subsidies for low income populations. In the second study, the author estimates for Bogotá a hedonic price model. However, in addition she applies the Bajari and Kahn (2003) tree step methodology which is useful to infer preferences based on a specific utility function. She focuses on the effect of electricity prices on the choice of dwelling size. She found the presence of subsidies induce the selection of bigger houses.

Medina, Morales, and Nuñez (2008) perform an analysis of quality of life in Bogotá and Medellin, which are the two largest cities of Colombia. The authors develop hedonic models for housing value and life satisfaction, which account for spatial effects on segregation. Segregation was captured based on individual levels of education, coverage of residential public utilities services, and the composition/structure of households, especially when headed by a female. The findings support the existence of spatial segregation in both cities and the relevance of education, utilities, and household composition.

Another study that includes Medellin data is by Duque, Ceballos, and Agudelo (2011) who estimate the effect of the existence and closeness to metro stations on dwelling prices. After using the geographically weighted regression (GWR), they found that distance is a statistically significant factor and its impact on the housing price is inversely related within 600 meters. In a similar vein, Perdomo-Calvo et al. (2007) estimate the value of properties close to public bus rapid transit service in Bogotá. In this case the authors use Propensity Score Matching (PSM) for their analysis. They found that prices and value of properties close to the transit lines are higher compared to those further away in the zones selected as part of this study.

Lozano-Gracia and Anselin (2010) estimate property prices for Bogotá using a hedonic price model. They use a classification of submarkets (based on socioeconomic classification, localities and economic activities) to improve the accuracy of out-of-sample forecasting. The data come from the cadastral census for Bogotá and local GIS databases. The out-of-sample forecasting improved once distance to various facilities was taken into consideration, and heterogeneity captured by the submarket classifications was accounted for. Nonetheless, the estimations where inconsistent across the socioeconomic classes.

An application of spatial analysis for Cali is presented by Vivas (2013). The research focuses on housing segregation and its relations to human capital. In his paper, the author estimates global and local Moran's indices using Census databases for 1993 and 2005. The findings of this research support the hypothesis of spatial segregation, and identify the geographical patterns of this segregation towards the periphery of the city.

Finally, Carriazo, Ready, and Shortle (2013) focus on improving the hedonic price modelling by addressing the existence of heteroscedasticity. They posit that the estimation bias caused by the unmeasured quality features can be reduced by the frontier regression model. Based on their empirical application for quality of the air in Bogotá, the authors suggest that it is important to account for unobserved quality features, since the conventional techniques can overestimate the

real value of parameters. They also test the frontier regression model as an adequate alternative econometric approach.

Theoretical Framework

Since Alonso (1965), considerable research has been developed in this line of analysis. Durlauf (2004) presents a historical description as well as a classification of neighborhood effects by topic of analysis. Nonetheless, Blume et al.(2010) theoretical development frames individual choices taking into account house allocation, choices over who their neighbors are, as well as the type of interactions they want to experience. Similarities in their socioeconomic characteristics make it difficult to identify which differences are due to their characteristics or their interactions.

The hedonic price approach is based on the assumption that goods can be described by a vector of measurable attributes: $Z = (z_1, z_2, \dots z_n)$ where z_i represents the quantity for each attribute z (Rosen 1974). Therefore, each price is explained by these attributes. In a competitive market, suppliers and consumers can identify these quantities, thus they can make optimal decisions based on this information. In 1979, Freeman III presented an accurate description of a basic model applied to the housing market. In this case, the housing unit (h_i) is defined as a heterogeneous good and its price ($P(h_i)$) can be explained by the following expression: $P_{hi} = P_h(S_{i1}, \dots S_{ij}, N_{ik}, \dots N_{ir}, Q_{i1}, \dots Q_{in})$ where S_j describes the structural features of the unit, Q_j the attributes of the neighborhood, and N_j the environmental conditions.

One relevant analysis is presented in Ioannides and Zabel (2008). In this paper, the authors aim to capture the housing demand from neighborhood effects and neighborhood choice. According to their findings, the neighborhood effects play a key role in housing demand. Hardman and Ioannides (2004) study segregation by race and income in residential neighborhoods finding “the mix of household incomes in US residential neighborhoods, like the mix of races and ethnicity, is determined by the housing market, planning and other elements of public policy.”

On the other hand, Bayer, Ferreira, and McMillan (2007) focus on schooling preferences and their relationship to residential location. After correcting the identification problem, the authors find low price-elasticity of house prices with respect to the average performance of schools, as well as correlation between willingness to pay, and the education level and wealth of residents in given neighborhoods. Zabel and Kiel (2004) use a hedonic price technique to model housing prices using three levels of geographical analysis, namely Metropolitan Statistical Area (MSA), town, and street where the house is located. Characteristics at all three levels are significant explanatory factors. Finally, a consequence of programs that aim to turn poor people into home owners is presented by Field (2007). She found that when vulnerable populations hold land property titles, their participation in the labor market increases and child labor drops. Her research was performed with data from Peru.

Econometric Approach

Spatial Analysis Models

The application on the data of spatial econometrics estimations is based on there being spatial interaction that can create dependence and/or spatial correlated errors, or both simultaneously. Following are presented the structure for these specifications (Dubé and Legros 2014; LeSage and Pace 2009).

Spatial Error Model - SEM

This model incorporates spatial effects through the error term,

$$y = X\beta + u \qquad \text{Equation 1}$$
$$u = \lambda W u + \varepsilon \qquad \text{Equation 2}$$

After substituting equation 2 in 1 and rearranging the terms, the expression is,

$$y = X\beta + (I - \lambda W)^{-1}\varepsilon \qquad \text{Equation 3}$$

Where *u* is the vector of error terms, spatially weighted using the weights matrix (W); λ is the spatial error coefficient; and ε is a vector of uncorrelated error terms. Therefore, if there is no spatial correlation between the errors, then λ = 0.

Spatial Lag Model - SAR

This model incorporates spatial effects by including a spatially lagged dependent variable as an additional predictor,

$$y = X\beta + \rho W y + \varepsilon \qquad \text{Equation 4}$$

After rearranging the terms, the expression is,

$$y = (I - \rho W)^{-1} X\beta + (I - \rho W)^{-1}\varepsilon \qquad \text{Equation 5}$$

Where *Wy* is the spatially lagged dependent variable for weight matrix W; *x* is a matrix of observations on the explanatory variables; ε is a vector of error terms; and ρ is the spatial coefficient. Therefore, if there is no spatial dependence, and *y* does not depend on neighboring *y* values, $\rho = 0$.

SARAR, the combination of SAR and SEM

This model incorporates spatial dependence by adding a spatially lagged dependent variable and spatially correlated errors. It assumes that there is a lag process at work, but that error must be factored out too.

$$y = X\beta + \rho W_1 y + u \qquad \text{Equation 6}$$
$$u = \lambda W_2 u + \varepsilon \qquad \text{Equation 7}$$

W_1 and W_2 can be the same or different spatial weight matrices.

The Dataset

The Colombian Chamber of Construction (CCC)[12] is a private institution that represents the common goals and interests of the construction sector of the economy. CCC has presence in the main cities; for this study, information pertaining to Cali's housing market was provided by the Cali office of CCC. This is the main dataset used to perform the analysis, which includes information for all the housing development projects in Cali for 2010 to 2013. The CCC dataset includes information about location (geographic coordinates) of each housing project developed in Cali by year. It also includes the asking price by house unit, house unit attributes, the number of housing units sold by year, among others. In the Colombian context, the asking price is a very good proxy for the sale price of new housing units as it is customary that no price negotiations occur at the time of the closing of a sale.

Map 6 in **a**nnex 4 shows the geographic distribution of the housing developments in Cali, while Map 7 depicts the number of housing units sold per year in each development between 2010 and 2013. The total number of new housing units for sale during 2010-2013 is 47,092, distributed in 1,450 developments; this includes both housing units sold and funded by the government through the programs. A random sample of 22.5 percent of housing units of the original dataset that were not part of the three PAH projects was selected to apply the spatial econometric analysis. In addition, information about the distances from each housing unit to each PAH project and other urban amenities was calculated based on the maps from IDESC[13] in December 2014. The information on homicides and density for all years was collected from the summary statistics from Cali's official city website (DAP 2013).[14]

Econometric Expression and Model Specification

Equation 8 shows the model to estimate

$$lnP_j = \alpha + \sum_{i=1}^{n} \beta_i S_i + \sum_{i=1}^{n} \beta_i Q_i + \sum_{i=2011}^{2013} \beta_i T_i + \sum_{i=1}^{3} \beta_i I_i \; u_i \qquad \text{Equation 8}$$

Where lnP_j is the natural log of the sale price of new housing in thousands of pesos; S_i is a set of structural attributes of the housing unit; Q_i is a set of amenities of the neighborhoods mainly captured by the distances to the closest in each class of amenities; T_i is time effects; I_i is spatio-temporal interactions for each project; and u_i as stochastic error. The I_i independent variables serve to test the premise of this study, that is that distance from a housing unit to the PAH projects is internalized by the sale price of the unit in the form of a rent. All the other independent variables serve as controls in this model. The I_i variables are operationalized as

[12] Cámara Colombiana de la Construcción (CAMACOL in Spanish).
[13] Infraestructura de Datos Espaciales de Santiago de Cali - IDESC. http://www.cali.gov.co/planeacion/publicaciones/idesc_pub
[14] Cali en cifras (several years). http://www.cali.gov.co/publicaciones/cali_en_cifras_planeacion_pub.

follows. Each variable index one of the PAH developments. For a certain housing unit, it is measured as the distance to the indexing PAH project, provided this project had been inaugurated by the building year of the unit. Otherwise, it is zero.

The basic estimation is performed with Ordinary Least Squares; however, since the literature has established the pervasiveness of spatial effects in housing markets, three additional estimations are performed to account for auto-correlated errors, spatial dependency and both phenomena simultaneously. SAR, SEM, and SARAR estimation results are reported for each of these alternative econometric formulations. The criterion for creating the spatial weight matrix is based on the ten nearest neighbors of each housing unit in the estimation dataset.[15] Following customary practice, the matrix is row standardized.

Descriptive statistics on the variables used in the model are provided in table 3, while maps of dependent and select independent variables are provided in annex 5.[16]

Table 3: Descriptive statistics of variables in the model

Variable	Mean	Standard Deviation
Ln sale price (in 1000 pesos)	11.08	0.59
Number of bedrooms	2.67	0.58
Number of bathrooms	1.86	0.65
Socioeconomic class	4.10	1.06
Size of the housing unit (square meters)	74.44	35.68
Type of housing unit: House/Apartment	-	-
Type of housing program categories: No-SAH/ PAH/ SAH	-	-
House condition categories: Fully built/Intermediate/Basic	-	-
Exterior material categories: Concrete/ Cinder Blocks/ Metal and Glass/ Brick/Synthetic Material/ Synthetic Stucco/ Arrocillo/ Natural Stucco/ Natural Stucco, Paint[17]	-	-
Interior material categories: Basic/ Concrete/ Polished Concrete/ Tableta/ Wood/ Porcelain Tile/ Marble/ Ceramic Tile[18]	-	-

[15] Alternative specifications of the spatial matrix were also tested to establish the robustness of the results of the analysis to the conceptualization of spatial effects through the W matrix. Another specification involves consideration the 20 nearest neighbors. Also, we tested specification based on distances of 250, 500, and 1000 meters. All the estimations results are stable in terms of significance and direction of effects on the variables of interest.

[16] Some predictors that have been found to be significant in hedonic price modeling have been tested, but left out of the final specification as the effects were not found to be significant. This includes a metric of educational achievement (average score of nationwide tests for senior high school students—like SAT score—per commune. It should be noted that a landfill disamenity variable was not included because all landfills are located outside the urban perimeter of Cali. Property crime data could not be used due to missing data points are the neighborhood level.

[17] See annex 2 for interior and exterior material categories.

[18] Idem.

Variable	Mean	Standard Deviation
Distance to the PAH project in Altos de Santa Elena (meters)	6,736.76	3,766.47
Distance to the PAH project in Potrero Grande (meters)	7,676.37	1,934.49
Distance to the PAH project in Casas de Llano Verde (meters)	4,607.27	2,924.78
Distance to closest bike path	239.64	286.75
Distance to closest educational institution	459.77	369.26
Distance to closest bus station	1,586.72	811.06
Distance to closest health institution	662.99	484.56
Distance to closest police station	834.60	476.75
Distance to closest recreational facility	1,032.70	611.24
Distance to closest main street/road	285.97	227.91
Distance to closest social service	853.47	583.67
Density index (Inhabitants/hectare) per commune t-1	135.73	88.20
Number of homicides per commune t-1	58.79	40.06
Dummies variables per built year, time2010, time2011, time2012, and time2013	-	-

Source: CCC 2014.

Estimation Results

Table 4 presents the estimations of four regression models, the ordinary least squares (OLS), SEM, SAR, and SARAR. The Moran's I test for spatial randomization over OLS residuals leads to estimate some model that accounts for spatial effects. The Lagrange test is not conclusive as to which model should be estimated (see annex 4). The AIC leads us to choose the SARAR model. None of the models show evidence of collinearity or heteroscedasticity. The software used for the following estimation was R.[19]

Table 4: Estimation results

	OLS	SEM	SAR	SARAR
(Intercept)	9.679321***	10.277114***	2.902350***	6.999396***
	(0.031616)	(0.070042)	(0.060637)	(0.172596)
Bedrooms	0.040066***	0.024385***	0.021506***	0.027093***
	(0.003116)	(0.002729)	(0.001942)	(0.002716)
Bathrooms	0.013008***	0.019905***	0.017573***	0.017433***
	(0.003260)	(0.002923)	(0.002016)	(0.002891)
Socioeconomic Class	0.168529***	0.106843***	0.035902***	0.090113***
	(0.003435)	(0.006715)	(0.002319)	(0.006419)
Dwelling Size (sq. mts)	0.007799***	0.006433***	0.003184***	0.006272***
	(0.000074)	(0.000085)	(0.000066)	(0.000085)

[19] For control purposes, new property value records as of 2009 (date preceding the implementation of the first PAH project in Cali) have also be used in analyses as a baseline. All statistical analyses were conducted using the same model specifications as reported in this document. Results were of the same nature as the results reported in detail in this report. Thus, the authors are very confident in the robustness of the conclusions.

	OLS	SEM	SAR	SARAR
Type of Dwelling	-0.047454***	-0.145993***	-0.045954***	-0.154913***
	(0.007068)	(0.010457)	(0.004405)	(0.009807)
Type of program_PAH	-0.471586***	-0.375830***	-0.132727***	-0.234929***
	(0.013717)	(0.076878)	(0.008934)	(0.040016)
Type of program_SAH	-0.242493***	-0.112375***	-0.070061***	-0.115929***
	(0.005496)	(0.006320)	(0.003700)	(0.006190)
Dwelling condition_Intermed	-0.076194***	-0.055013***	-0.035202***	-0.059590***
	(0.005079)	(0.005372)	(0.003180)	(0.005275)
Dwelling condition_Basic	0.044413***	-0.096321***	-0.004751	-0.088725***
	(0.012748)	(0.018515)	(0.007883)	(0.018001)
Ref. Categ.:Concrete				
Ext materials_cate2	0.171227***	0.028175	0.079548***	0.090998
	(0.026116)	(0.058358)	(0.016178)	(0.053699)
Ext materials_cate3	0.187085***	0.116256	0.125381***	0.166818*
	(0.037465)	(0.089686)	(0.023200)	(0.081979)
Ext materials_cate4	0.087004***	-0.033283	0.040311**	0.028959
	(0.024431)	(0.057827)	(0.015115)	(0.053102)
Ext materials_cate5	0.080482***	-0.076374	0.025390	-0.014591
	(0.024384)	(0.057760)	(0.015082)	(0.053082)
Ext materials_cate6	0.170814***	-0.322002***	0.001863	-0.191976**
	(0.029493)	(0.067295)	(0.018249)	(0.061013)
Ext materials_cate7	0.356260***	0.303023***	0.047768	0.374027***
	(0.047835)	(0.072314)	(0.029648)	(0.070176)
Ext materials_cate8	0.091866***	0.031354	0.017024	0.073712
	(0.025773)	(0.058772)	(0.015951)	(0.054019)
Ext materials_cate9	0.090665***	-0.031552	0.027030	0.032897
	(0.024994)	(0.058104)	(0.015468)	(0.053411)
Ref. Cat.: Concrete				
Int materials_cate3	-0.035506***	-0.009698	-0.001955	-0.008291
	(0.007494)	(0.011268)	(0.004638)	(0.010702)
Int materials_cate4	-0.016579	-0.291629***	-0.032448*	-0.213482***
	(0.022901)	(0.035627)	(0.014160)	(0.032204)
Int materials_cate5	-0.091518***	-0.090549***	-0.032151***	-0.088614***
	(0.006634)	(0.007383)	(0.004152)	(0.007242)
Int materials_cate6	0.065929***	-0.010882	0.009178	-0.006233
	(0.007644)	(0.010111)	(0.004732)	(0.009689)
Int materials_cate7	-0.107291***	-0.079742***	-0.053172***	-0.076435***
	(0.007892)	(0.010114)	(0.004930)	(0.009776)
Int materials_cate8	-0.054271***	-0.024641***	-0.008662*	-0.022158***
	(0.005725)	(0.006392)	(0.003558)	(0.006260)
Int materials_cate1	0.002175	-0.015415	0.015755**	-0.006250
	(0.009855)	(0.012477)	(0.006093)	(0.011978)
near_dist_bikepath	-0.000089***	-0.000041***	-0.000031***	-0.000039***
	(0.000008)	(0.000006)	(0.000005)	(0.000007)
near_dist_educ	-0.000098***	-0.000049***	-0.000035***	-0.000051***
	(0.000007)	(0.000005)	(0.000005)	(0.000005)
near_dist_busstop	-0.000008**	0.000000	-0.000003	0.000000
	(0.000003)	(0.000002)	(0.000002)	(0.000002)
near_dist_health	-0.000037***	-0.000015**	-0.000029***	-0.000018***
	(0.000006)	(0.000005)	(0.000004)	(0.000005)

	OLS	SEM	SAR	SARAR
near_dist_police	0.000060***	0.000020***	0.000036***	0.000024***
	(0.000007)	(0.000005)	(0.000004)	(0.000005)
near_dist_recre	0.000018***	0.000028***	0.000014***	0.000029***
	(0.000004)	(0.000003)	(0.000003)	(0.000004)
near_dist_mainstreet	0.000066***	0.000028***	0.000032***	0.000026***
	(0.000009)	(0.000007)	(0.000006)	(0.000007)
near_dist_social serv	0.000014**	0.000028***	0.000012***	0.000027***
	(0.000004)	(0.000003)	(0.000003)	(0.000003)
Density Index (Inh/ha) in t-1	0.000063	-0.000555***	0.000035	-0.000176*
	(0.000046)	(0.000119)	(0.000028)	(0.000087)
Homicides in t-1	-0.000747***	0.000241*	-0.000085	0.000226
	(0.000100)	(0.000123)	(0.000062)	(0.000119)
Distance to Altos de Santa Elena	0.000018***	-0.000001	0.000005***	0.000000
	(0.000001)	(0.000001)	(0.000000)	(0.000001)
Distance to Barrio Taller – Potrero Grande	0.000013***	-0.000005***	0.000003***	-0.000002*
	(0.000001)	(0.000001)	(0.000000)	(0.000001)
Distance to Urbanización Casas de Llano Verde	0.000007***	-0.000006***	0.000001*	-0.000004***
	(0.000001)	(0.000001)	(0.000001)	(0.000001)
Dummytime2011	0.048955***	0.003674	0.012365***	0.004883
	(0.005203)	(0.003180)	(0.003223)	(0.003216)
Dummytime2012	0.106338***	-0.015887**	0.017320***	-0.012203*
	(0.007059)	(0.005196)	(0.004383)	(0.005144)
Dummytime2013	0.069375***	-0.024833***	0.009093*	-0.022371***
	(0.007120)	(0.005176)	(0.004408)	(0.005128)
R^2	0.935729			
Adj. R^2	0.935470			
Num. obs.	10,004	10,004	10,004	10,004
RMSE	0.150775			
Parameters		43	43	44
AIC (Linear model)		-9421.388571	-9421.388571	-9421.388571
AIC (Spatial model)		-21438.5177	-18391.0856	-21610.1763
Log Likelihood		10762.258869	9238.542815	10849.088173
Wald test: statistic		121528.91116	13879.725653	18351.214327
Wald test: p-value		0.000000	0.000000	0.000000
Lambda: statistic		0.932252		0.859979
Lambda: p-value		0.000000		0.000000
Rho: statistic			0.693700	0.291654
Rho: p-value			0.000000	0.000000

Source: CCC 2014. Authors' Calculations. $^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$ Statistical models

Accounting for spatial effects reduces the estimation coefficients when the output is compared with OLS estimation. This happens in almost all the variables. The SARAR model has significant rho and lambda values; thus both spatial dependence and spatial error have to be accounted. In the column containing the SARAR results, the variables bedrooms, bathrooms, socioeconomic class, and house size are significant and with the expected signs. Regarding the type of housing unit, type of program, and house condition, all estimates are significant and with

the expected sign. Some of the variables of categories for external and internal materials are significant.

Regarding the distances as a proxy of amenities, the expected sign was negative for all variables (the closer, the higher price), although this did not happen in all the controls. The only distance that is not significant measures closeness to bus rapid main stops. This could be explained mainly because the calculation considers only the bus stops located on the main lines. The remaining variables are all statistically significant. The variables of closeness to bike path, educational institutions, and health institutions have a positive effect on house price. The opposite effect is associated with closeness to police station, main street/roads, recreational services, and social services.

The variables describing conditions in the previous period attempt to capture the lag time effect in the decision of potential house buyers. In this sense, the density index in the previous year is weakly significant and the number of homicides in the previous year is not significant.

The market effect of the PAH projects is captured by the three variables of distance to each of the three projects, given the localized nature of real estate markets, often in the form of spatially defined sub-markets. While all three effects are statistically significant in the OLS estimation, these effects weaken and even disappear once spatial effects are considered. In the SARAR model, the oldest project (Alto de Santa Elena) is found not to have any statistically significant price effect. The other two projects exert a significant effect and with a negative sign. This means that sale prices in developments close to these two projects are higher than in more remote developments, all other things being equal. However, the magnitude of this effect is very small and below 0.01 percent. This suggests that the housing market has not responded much, if at all, to the establishment of the PAH projects. When a response is observed, the response is not negative. While early concerns may have been that the quick settlements of large populations of lower socioeconomic classes would be detrimental to adjacent residential neighborhoods (negative spillover effect) and deflate real property values, the opposite trend seems to be emerging (positive spillover effect). This large influx of settlers may bring new urban amenities to peripheral areas of the city in the form of health centers, recreational and educational facilities, and better transportation services.

Finally, the time dummies control for time fixed effects. These effects are estimated to be more significant and more negative on sale price for more recently built housing units. This may reflect the price trends of the real estate market of Cali in the early years of the decade, or possibly a dissipation of the effect of PAH social housing on the overall housing market.

Conclusion

This report explored the hypothesis of the effects of the free housing programs (PAH) on the price of the housing market in Cali, Colombia, mainly measured by the closeness to these specific projects. The hypothesis wanted to measure not only the magnitude of these effects but also their direction. Since the housing market is affected by the spatial distribution of housing developments and housing projects, the spatial estimation accounts for it. Based on this

framework, the findings from the spatial econometric analysis of a fully specified model show a null effect of the oldest project on the housing price market. Nonetheless, the effects of the two other projects is significant and with a negative sign, which mean the closer the distance the higher the effect on market price, although their magnitude is below 0.01 percent. In this sense, it can be concluded that the effect of these projects on the housing market is close to zero or no effect is detected at all.

While the conclusions reported here rest on the use of a large real estate dataset and on a methodology that has been extensively tested in hedonic price analyses in many other urban contexts, their stability has also been extensively demonstrated in response to alternative specifications of the models (specification of the W matrix, 2009 baseline data, additional explanatory variables). Thus, results show strong robustness.

Notwithstanding, the limitations linked to the empirical estimation can also be related to the short time period used for estimation. It may be that the same analysis carried out over a longer time series would either validate our present conclusions or refute these findings. Also, while the present study focused on the sale price of new housing, the analysis of rental rates may provide a complementary set of empirical conclusions. While longitudinal data on residential rents are not available in Cali, we envision that the cross-sectional CLI data for Cali's barrios would be a good substitute. Future research should also be directed to externality effects in other cities of Columbia where the national housing policy may have been implemented somewhat differently, and with effects that may have been different as well. Lastly, the econometric analysis reported here would benefit to be extended to include a qualitative component involving interviews with different agents involved directly or indirectly in the PAH policy implementation. A mixed-method approach would help identify relationships that may not be discernible through strict econometric analysis.

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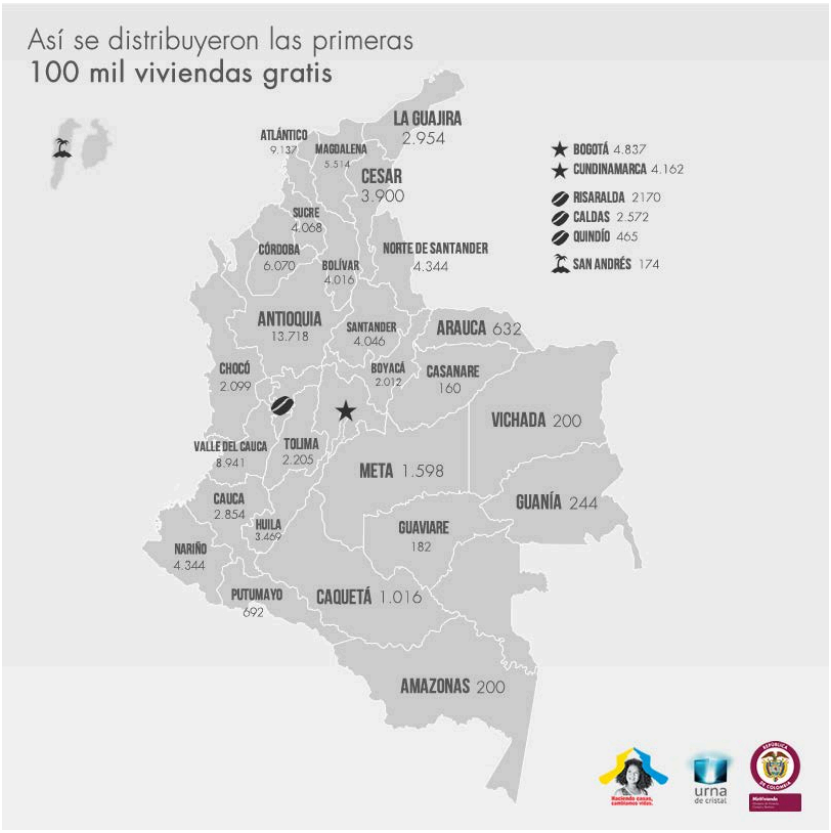
Annex 1

Figure 2: Projected Distribution of the 100,000 PAH Houses



Source: http://www.minvivienda.gov.co/viviendas-100-por-ciento-subsidiadas/abc

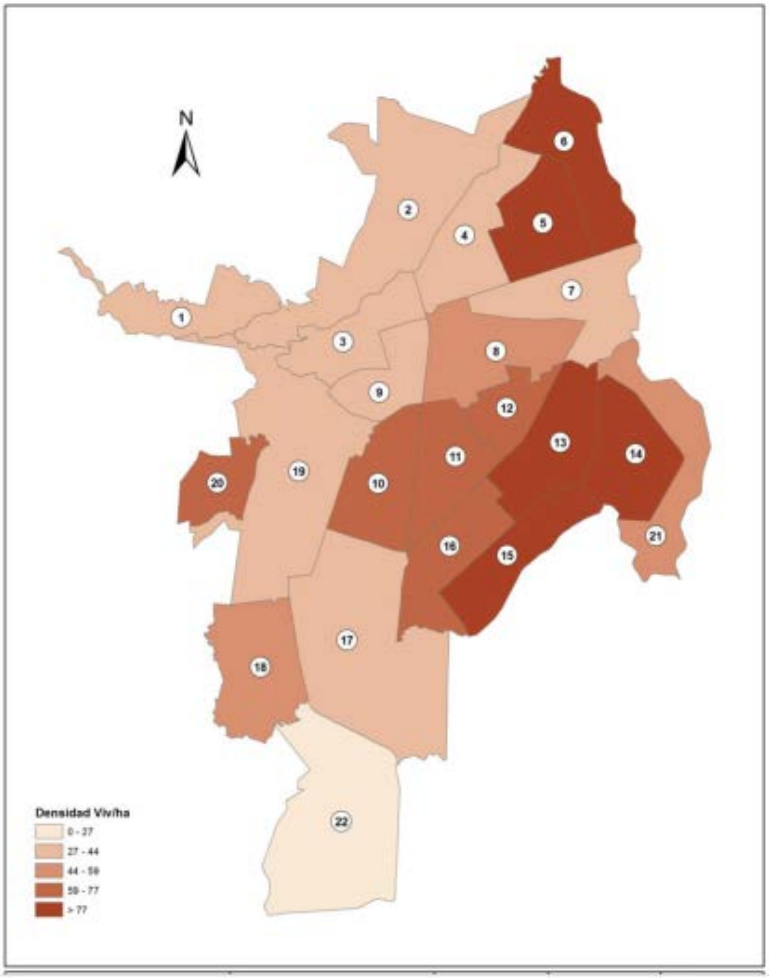
Table 5: Projected distribution of PAH houses, Valle del Cauca

City	Number of households
Cali	4,591
Andalucia	200
Buga	620
Guacari	159
Jamundi	1,000
Palmira	896
Pradera	91
Buenaventura	700
Alcala	98
Sevilla	128
Yumbo	458
Total	8,941

Source: http://www.minvivienda.gov.co/viviendas-100-por-ciento-subsidiadas/abc

Annex 2

Figure 3: Population density by commune in Cali, 2012



Source: DAP (2013)

Table 6: Types of housing per commune, and count and percentage by row

Commune	Single-family Houses	Apartments	Rooms	Other Types of Room	Other Type of Housing	Total
1	1,303	352	73	0	0	1,728
	75.41	20.37	4.22	0	0	100
2	10,154	1,668	12	112	56	12,002
	84.6	13.9	0.1	0.93	0.47	100
3	72,989	52,902	2,247	479	272	128,889
	56.63	41.04	1.74	0.37	0.21	100
4	16,133	3,515	0	119	0	19,767
	81.62	17.78	0	0.6	0	100
5	11,671	2,355	24	98	49	14,197
	82.21	16.59	0.17	0.69	0.35	100
6	20,128	6,064	184	0	0	26,376
	76.31	22.99	0.7	0	0	100
7	10,688	3,363	0	0	0	14,051
	76.07	23.93	0	0	0	100
8	17,843	4,327	473	0	0	22,643
	78.8	19.11	2.09	0	0	100
9	10,621	1,432	669	108	0	12,830
	82.78	11.16	5.21	0.84	0	100
10	18,858	4,439	475	81	0	23,853
	79.06	18.61	1.99	0.34	0	100
11	23,129	4,785	1,371	125	50	29,460
	78.51	16.24	4.65	0.42	0.17	100
12	12,940	3,334	329	235	53	16,891
	76.61	19.74	1.95	1.39	0.31	100
13	20,789	4,951	179	0	0	25,919
	80.21	19.1	0.69	0	0	100
14	34,336	5,823	1,016	24	0	41,199
	83.34	14.13	2.47	0.06	0	100
15	28,591	4,547	179	0	192	33,509
	85.32	13.57	0.53	0	0.57	100
16	16,777	5,594	399	282	0	23,052
	72.78	24.27	1.73	1.22	0	100
17	52,535	14,060	809	7	384	67,795
	77.49	20.74	1.19	0.01	0.57	100
18	13,488	2,175	527	0	23	16,213
	83.19	13.42	3.25	0	0.14	100
19	36,803	12,692	189	175	11	49,870
	73.8	25.45	0.38	0.35	0.02	100
20	5,430	1,455	133	25	0	7,043
	77.1	20.66	1.89	0.35	0	100
21	10,486	1,771	31	0	0	12,288
	85.34	14.41	0.25	0	0	100
22	4,114	1,003	82	0	0	5,199
	79.13	19.29	1.58	0	0	100
Total	449,806	142,607	9,401	1,870	1,090	604,774
	74.38	23.58	1.55	0.31	0.18	100

Source: CLI 2014

Table 7: Dwelling status per commune, count and percentage by row

Commune	Owner Occupied, Paid Off	Owner Occupied, Mortgaged	Rented	Other Condition	Total
1	824	0	630	274	1,728
	47.69	0	36.46	15.86	100
2	6,789	482	4,076	655	12,002
	56.57	4.02	33.96	5.46	100
3	61,589	4,551	56,666	6083	128,889
	47.78	3.53	43.96	4.72	100
4	9,918	442	8,617	790	19,767
	50.17	2.24	43.59	4	100
5	7,561	854	4,634	1148	14,197
	53.26	6.02	32.64	8.09	100
6	13,106	1,385	10,159	1726	26,376
	49.69	5.25	38.52	6.55	100
7	6,548	464	6,081	958	14,051
	46.6	3.3	43.28	6.82	100
8	12,431	518	8,648	1046	22,643
	54.9	2.29	38.19	4.62	100
9	5,311	221	5,530	1768	12,830
	41.4	1.72	43.1	13.78	100
10	12,284	1,232	8,321	2016	23,853
	51.5	5.16	34.88	8.45	100
11	15,629	552	11,911	1368	29,460
	53.05	1.87	40.43	4.65	100
12	8,068	754	6,562	1510	16,894
	47.76	4.46	38.84	8.94	100
13	13,202	675	11,153	889	25,919
	50.94	2.6	43.03	3.43	100
14	23,740	930	13,991	2538	41,199
	57.62	2.26	33.96	6.16	100
15	18,227	1,481	12,311	1490	33,509
	54.39	4.42	36.74	4.44	100
16	13,887	683	7,083	1399	23,052
	60.24	2.96	30.73	6.07	100

Commune	Owner Occupied, Paid Off	Owner Occupied, Mortgaged	Rented	Other Condition	Total
17	35,931	2,807	25,731	3326	67,795
	53	4.14	37.95	4.9	100
18	8,544	370	6,987	312	16,213
	52.7	2.28	43.1	1.92	100
19	27,381	916	17,989	3584	49,870
	54.9	1.84	36.07	7.19	100
20	3,650	0	3,150	243	7,043
	51.82	0	44.73	3.45	100
21	6,511	1,856	3,731	190	12,288
	52.99	15.1	30.36	1.55	100
22	3,375	114	1,380	330	5,199
	64.92	2.19	26.54	6.35	100
Total	314,506	21,287	235,341	33643	604,777
	52	3.52	38.91	5.57	100

Source: CLI 2014

Table 8: Average number of rooms per housing unit by commune

Commune	Average number of rooms	Commune	Average number of rooms
1	4.1	13	4.0
2	4.3	14	3.8
3	3.9	15	3.8
4	4.1	16	4.1
5	4.3	17	4.3
6	4.0	18	4.2
7	4.5	19	4.1
8	4.2	20	4.0
9	4.1	21	3.9
10	4.2	22	4.9
11	4.0	Total	4
12	4.1		

Source: CLI 2014

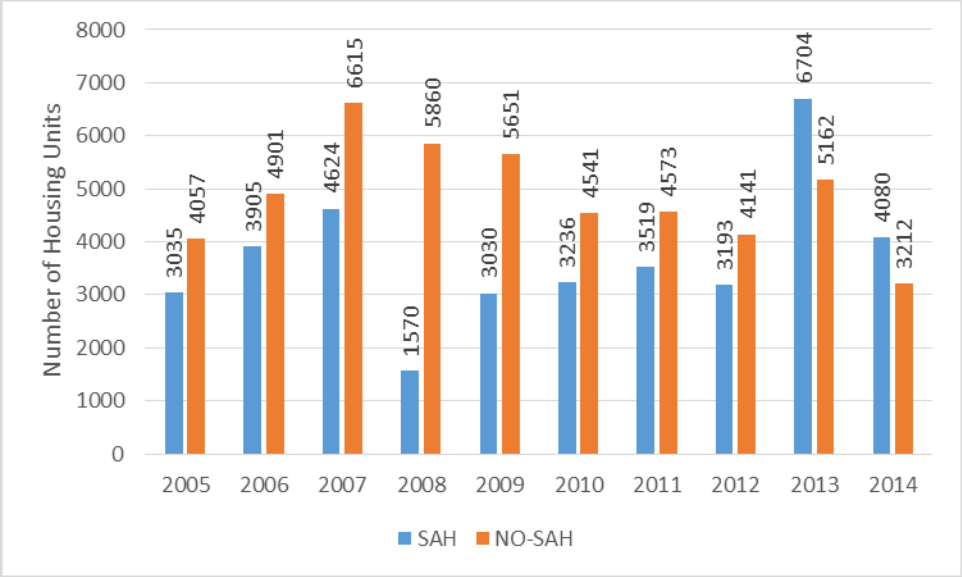
Table 9: Summary statistics by type of housing materials

	Freq.	Percent	Cum.
Exterior materials			
Concrete	41	0.41	0.41
Cinder Blocks	301	3.01	3.42
Metal and Glass	30	0.30	3.72
Brick/	5,150	51.48	55.20
Synthetic Material	3,115	31.14	86.34
Synthetic Stucco	94	0.94	87.28
Arrocillo	14	0.14	87.42
Natural Stucco	704	7.04	94.45
Natural Stucco, Paint	555	5.55	100.00
Total	10,004	100.00	
	Freq.	Percent	Cum.
Interior Materials			
Basic	389	3.89	3.89
Concrete	1,782	17.81	21.70
Polished Concrete	1,159	11.59	33.29
Tableta	59	0.59	33.88
Wood	1,328	13.27	47.15
Porcelain Tile	1,547	15.46	62.61
Marble	805	8.05	70.66
Ceramic Tile	2,935	29.34	100.00
Total	10,004	100.00	

Source: CCC 2014.

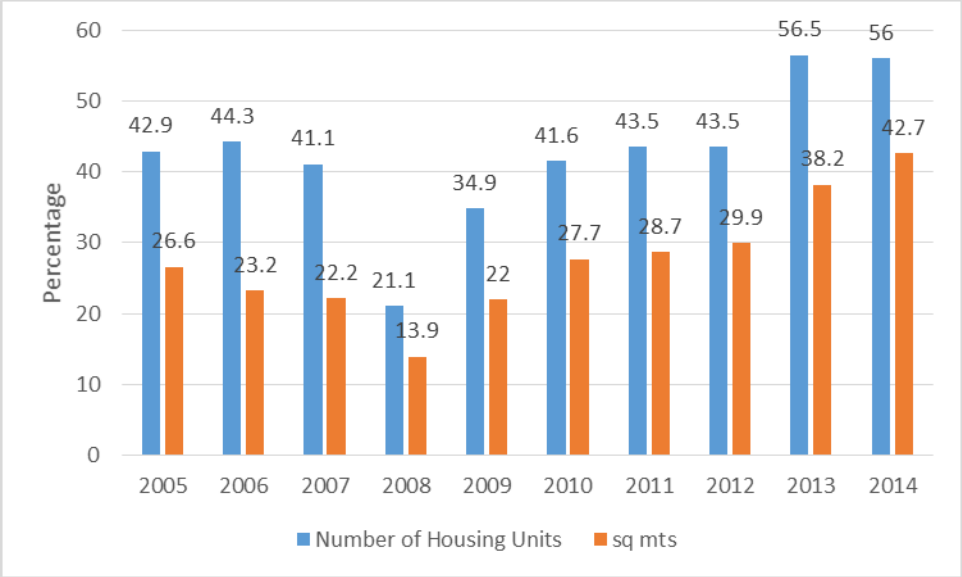
Annex 3

Figure 4: SAH and non-SAH housing built in the Cali urban area



Source: CENAC (2015). DANE Censo de Edificaciones

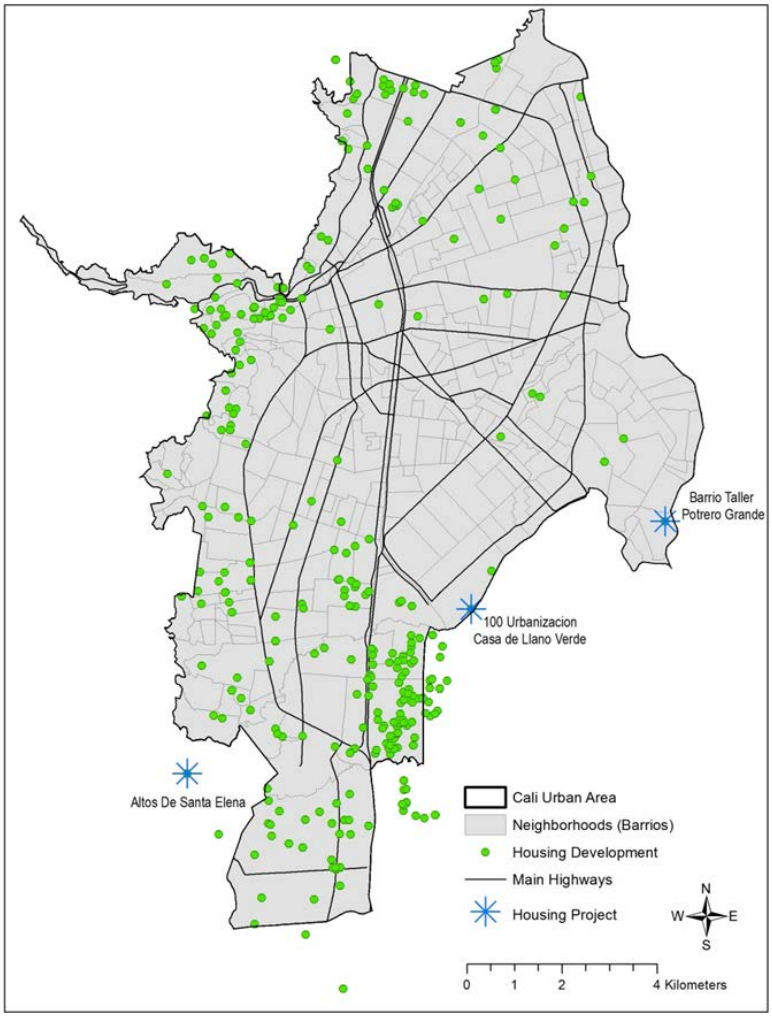
Figure 5: SAH Housing as a percentage of total number of units built in the Cali urban area



Source: CENAC (2015). DANE Censo de Edificaciones

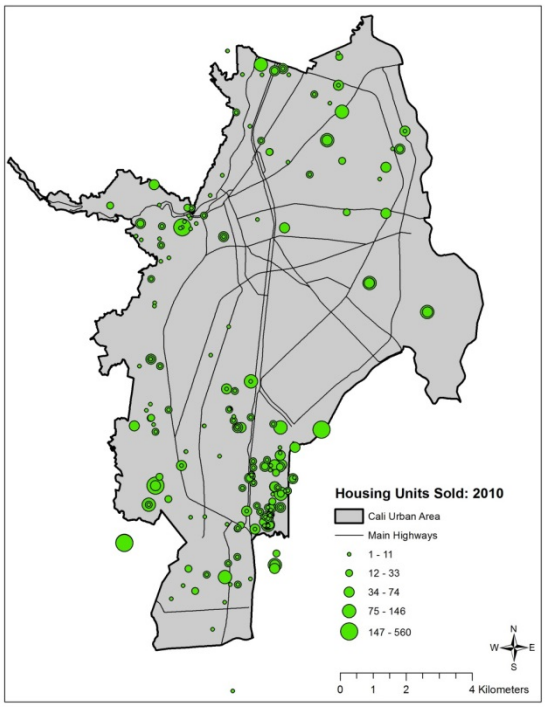
Annex 4

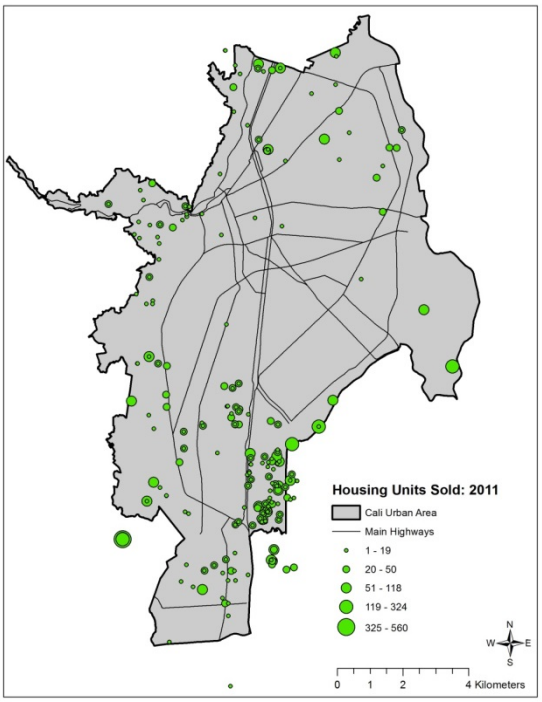
Map 6: Distribution of housing developments, Cali

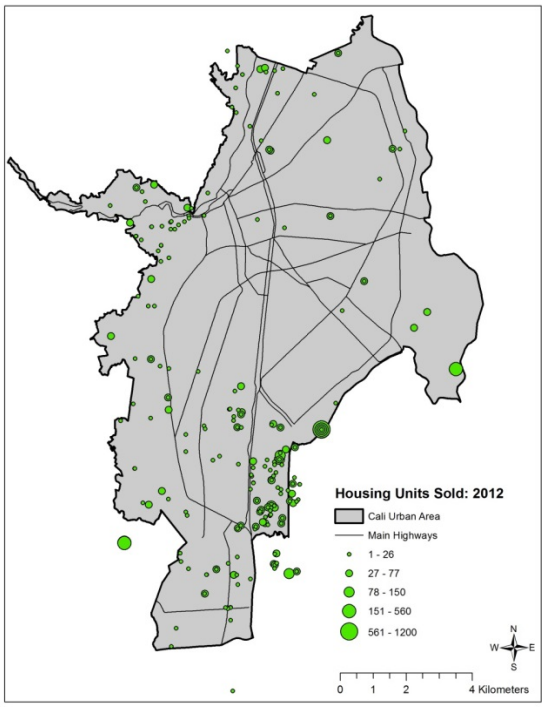


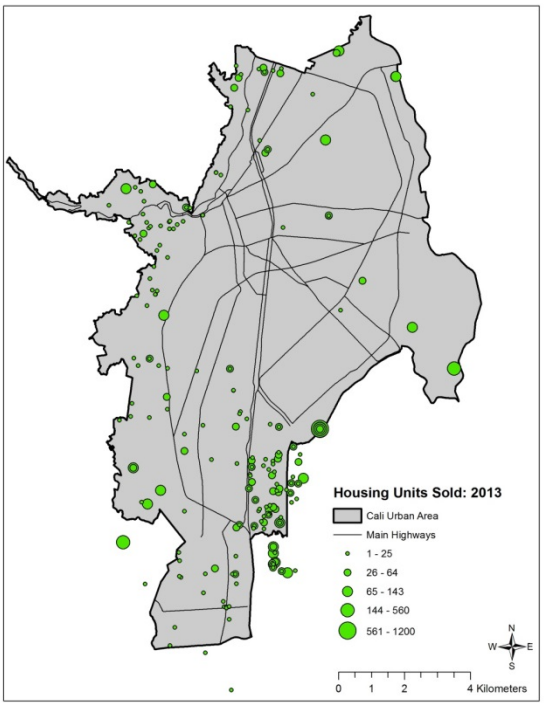
Source: CCC 2014 & IDESC

Map 7: Number of housing units sold in each development per year between 2010 and 2013









Diagnostic Test for Spatial Effects

Moran's I test under randomization

Moran I statistic standard deviate = 229.533, p-value < 2.2e-16
alternative hypothesis: greater
sample estimates:

Moran I statistic	Expectation	Variance
9.691786e-01	-9.997001e-05	1.783229e-05

Global Moran's I for regression residuals

OLS model

Moran I statistic standard deviate = 165.5842, p-value < 2.2e-16
alternative hypothesis: greater
sample estimates:

Observed Moran's I	Expectation	Variance
6.837487e-01	-3.018071e-03	1.720207e-05

Lagrange multiplier diagnostics for spatial dependence

LMerr = 26184.54, df = 1, p-value < 2.2e-16

LMlag = 12156.47, df = 1, p-value < 2.2e-16

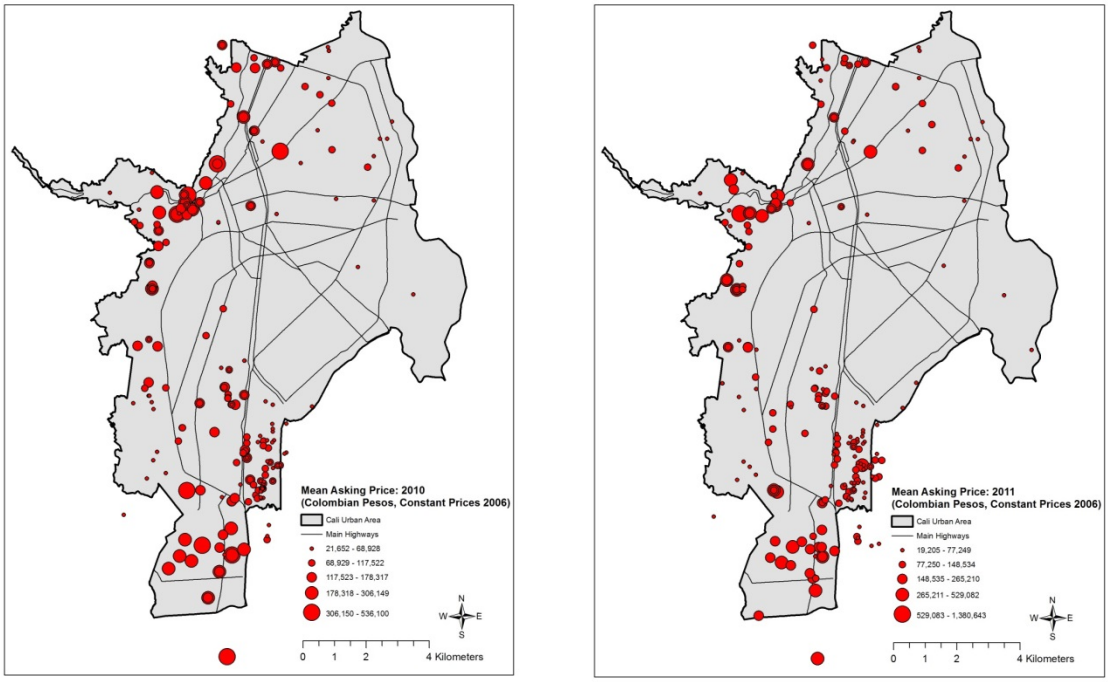
RLMerr = 14641.32, df = 1, p-value < 2.2e-16

RLMlag = 613.2485, df = 1, p-value < 2.2e-16

SARMA = 26797.79, df = 2, p-value < 2.2e-16

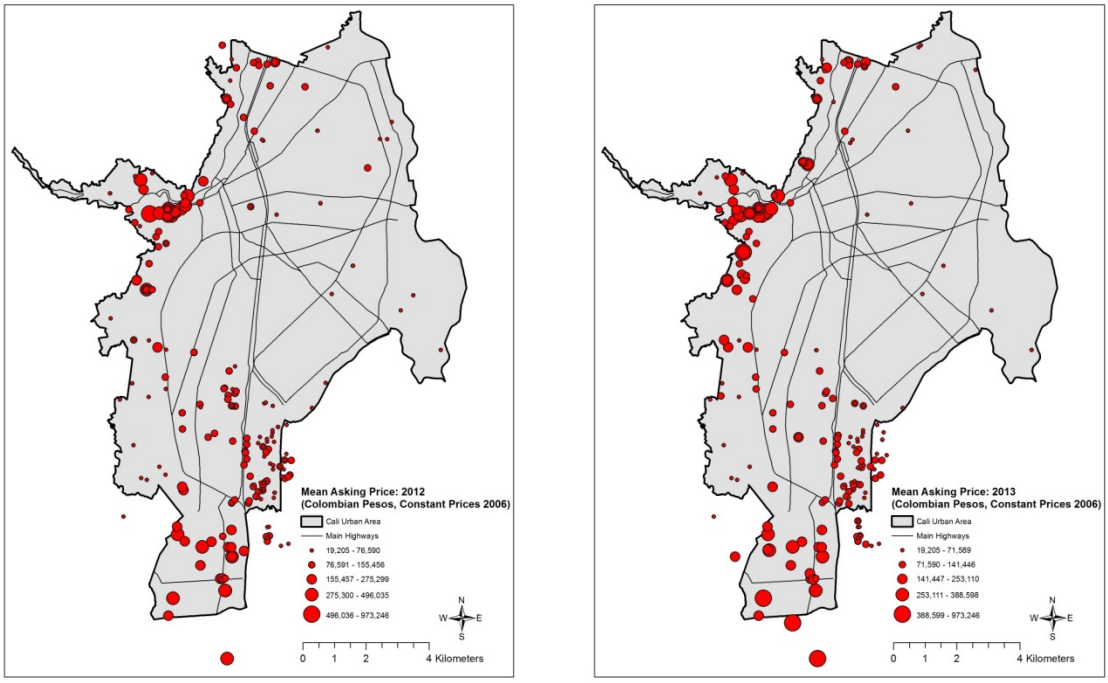
Annex 5

Map 8: Mean asking price of new housing units by development: 2010 and 2011



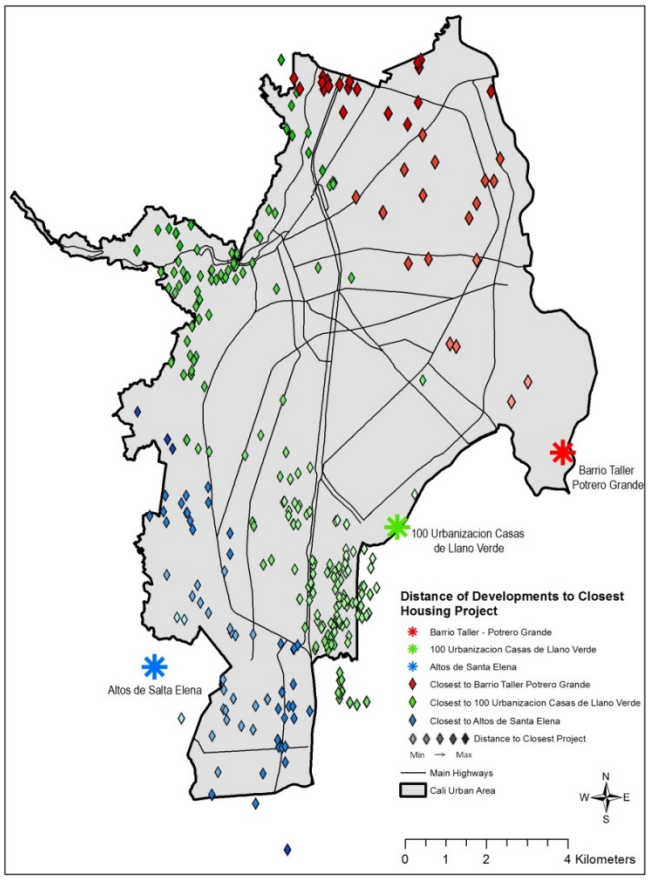
Sources: CCC & IDESC

Map 9: Mean asking price of new housing units by development: 2012 and 2013



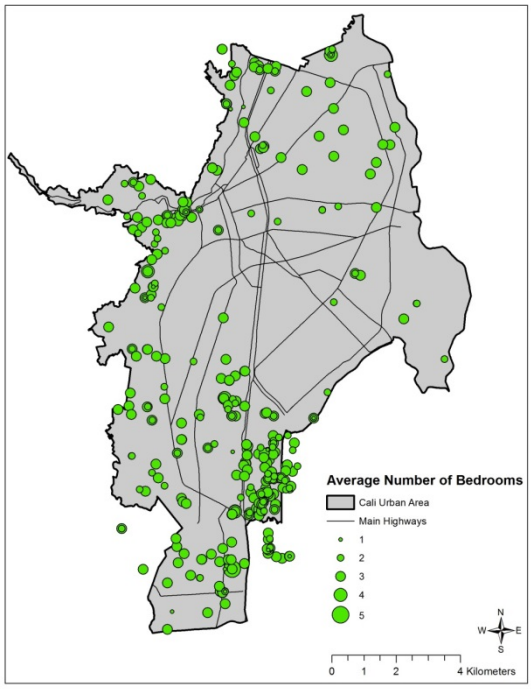
Sources: CCC & IDESC

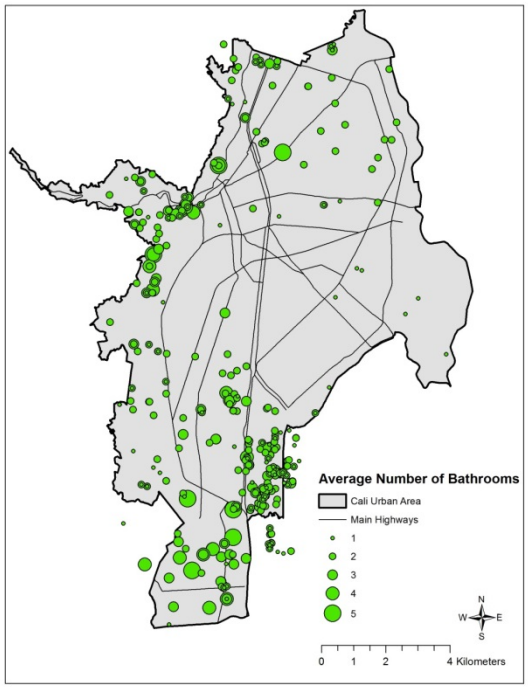
Map 10: Distance of developments to closest housing project



Sources: CCC & IDESC

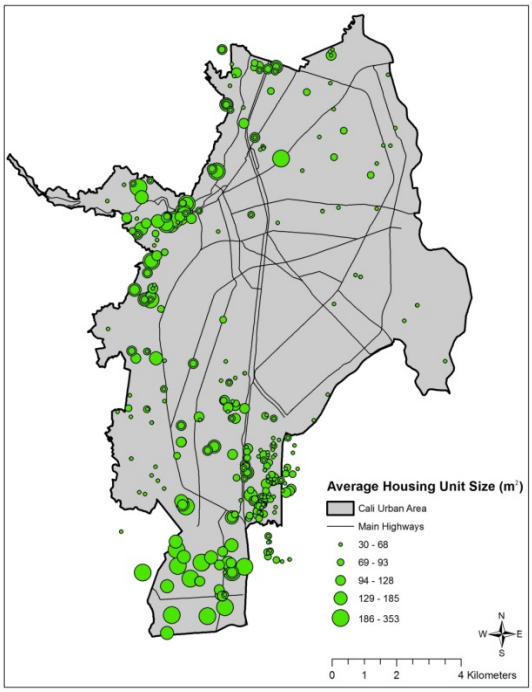
Map 11: Average number of bedrooms and bathrooms in housing developments





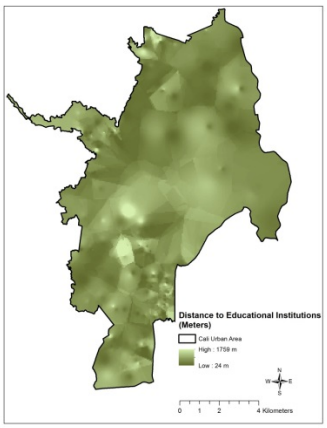
Sources: CCC & IDESC

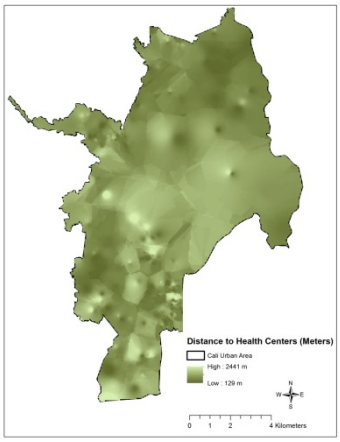
Map 12: Average housing unit size (m^2) in housing developments

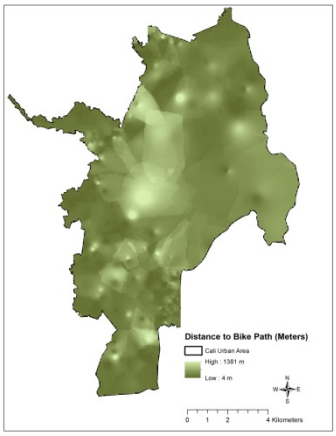


Sources: CCC & IDESC

Map 13: Distance to closest educational institution, health Institution, and bike path







Sources: CCC & IDESC