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Thesis
Title: Assessing the impact of Green Infrastructure on Land Values through Hedonic Pricing Model - Cañaveralejo River case.

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Assessing the impact of Green Infrastructure on Land Values through Hedonic Pricing Model
Cañaveralejo River case.

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Summary

For centuries, traditional approaches for waste and storm water had as main purpose removing water from the urban environment as quickly as possible (CWAA, 2011). These initiatives, still in use, are traditional grey approaches such as pipes and conduits, which may had worked for the main goal of taking water out of streets, nevertheless, they never took into account water resources and natural environment, which lately would become the reason of their decline.

In recent years, variety of strategies for tackling water issues and environmental problems across cities have been discussed and implemented across the globe, however, Green Infrastructure (GI) strategies have become lately the preferred ones for their multiple benefits and integral approach in comparison to the sectorial and Traditional Grey Infrastructure (TGI) solutions (Naumann et al. 2011; University of Wisconsin Milwaukee 2013). Recently, the city of Cali in Colombia has decided also to use GI (Environmental Corridor Cañaveralejo - ECC) as a way to tackle public issues. Unfortunately, despite GI's financial, social and environmental benefits, developing countries like Colombia are limited to implement GI techniques due to the lack of budget, planning, municipal capacity and smart financing strategies.

Therefore, the main objective of this thesis is to provide reliable information about the positive impact that GI can have on Land Values (LV), which can be used to encourage private and public stakeholders to invest in the ECC. Based on papers from Jim and Chen (2006), University of Wisconsin Milwaukee (2013), D'Acci 2014 and Noor et al. (2015), this research combines the Hedonic Pricing Model (HPM), Ordinary Least Squares (OLS) regressions and GIS analysis to calculate the actual impact of GI elements in LV across Cali at neighborhood and block scale. Then, using the resultant regression coefficients, the potential impact of the ECC in the LV adjacent to the project areas is forecasted.

Analyses at neighborhood and block scales showed congruent results in the direction and significance of GI's indicators as well as variations in the coefficient magnitudes related with the analysis scale. The results for the control variables scored similar and as expected. The block scale analysis provided more in detail results about GI, showing GI's indicators had a high significant and positive impact. However, the unexpected positive impact that Exposure to Fluvial Flooding (EFF) had in block models turned negative after carrying a third model analysis where Contact to water bodies was controlled. The results from this third analysis showed that the positive aspects of closeness to water are more important for the LV than the chance of flooding (Barford, 2012) but that the potential of flooding does decrease the LV of blocks with comparable closeness to waterbodies.

OLS results showed that when comparing GI's regression coefficients per unit increased, number of trees have the highest impact in $COP[1]/m², meaning e.g. one additional tree causes a major impact in LV than adding one meter of bike line. However, the overall impact in the forecast assessment indicated that bike lines contribution is bigger since it has more presence in ECC than trees. Summing up the potential increases in LV from trees, vegetation coverage,

[1] Colombian pesos (COP)

pedestrian and bike lines, the average increase in the adjacent areas to the ECC is about 23%[2].

All these results can provide hints to stakeholders about ECC marketability and potential profit margin, incentivizing them to invest. They also provide useful insights to government for future development projects, improvements in land valuation systems and Land Value Capture (LVC) tools as well as for green spaces protection programs. In a nutshell, this thesis provides evidence of GI's positive impact on LVs and translates it into a language that decision makers feel familiar with, such as money (de Groot et al. 2012).

Keywords

Climate Change (CC), Traditional Grey Infrastructure (TGI), Green Infrastructure (GI), Environmental Corridor Cañaveralejo (ECC), Land Values (LV), Hedonic Pricing Model (HPM).

[2] Result taken from the forecast analysis table, for further information check Annex 12.

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Foreword

This thesis is written as a consummation to the Master in Science in Urban Management Development with specialization in Urban Environment and Climate Change (UECC) at The Institute for Housing and Urban Development Studies (IHS) of the School of Economics (ESE) and the Faculty of Social Sciences (FSS) at Erasmus University Rotterdam.
The master program focuses on theoretical and practical aspects around the creation and implementation of strategies in environmental and climate change issues, providing examples from all over the world.

Therefore, my work focuses in capturing the joint impact of Green Infrastructure (GI) such as the Environmental Corridor Cañaveralejo on Cali' property values through Hedonic Pricing Models and use it as a tool to incentivize stakeholders to invest. The lack of capacity, budget and financial strategies is one of the main responsible for the low implementation of GI projects in Latin American cities, therefore is necessary to advertise the potential benefits that GI can have in a language like money, so private and public stakeholders can understand it and feel attracted to.

This thesis is an attempt to provide cities with financial implementation challenges like Cali an alternative to advertise and attract stakeholders to invests in GI solutions. I hope the results here found can reach the necessary people to pull strings in Cali and boost the implementation of GI projects.

Abbreviations

BS1	Block Simple 1
BS2	Block Simple 2
BC1	Block Complex 1
BC2	Block Complex 2
CC	Climate Change
COP	Colombian Pesos ($)
ECC	Environmental Corridor Cañaveralejo
EFF	Exposure to Fluvial Flooding
ES	Ecosystem Services
GDP	Gross Domestic Product
GHG	Green House Gas
GI	Green Infrastructure
HPM	Hedonic Pricing Model
LV	Land Value
NGBH	Neighborhood
NS1	Neighborhood Simple 1
NS2	Neighborhood Simple 2
NC1	Neighborhood Complex 1
NC2	Neighborhood Complex 2
RE	Real Estate
TGI	Traditional Grey Infrastructure

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Chapter 1: Introduction

1.1 Background

Traditional Grey Infrastructure (TGI), such as dams, sewage, drains, roads and public transport are elements that play a key role in the economic and social development of cities. By promoting prosperity and growth, TGI improve several aspects of the urban quality of life such as social well-being, health and safety of citizens (Stevens et al. 2011).

Property development is one of the most profitable sectors to promote economic growth through TGI (Benjamin et al. 2001). Using infrastructure's impact on residential and non-residential property values, profits can be gained in short and long term. This impact works as a domino effect, benefiting developers, investors, homeowners and municipalities by exploiting the effect of infrastructure investment on enhancing property values (Turner 2015).

However, the constant changes in cities' needs and the rising demand for a more sustainable approach has made TGI an insufficient solution. Known as sectorial strategies, designed for a limited set of functions, TGI require significant capital for construction, operation and maintenance, and are quite inflexible when looking for future reuse (Gartner 2015). Furthermore, in the particular case of waste and storm water, pipes and conduits were designed with the purpose of removing water from urban environments as fast as possible, neglecting their devastating effects on the natural environment and water as natural capital.

Because of these limitations, many cities have started looking for alternative approaches that allow to complement and eventually replace TGI. One of the most popular alternatives is Green Infrastructure (GI), which offers the opportunity to "integrate into or directly replace TGI while performing other valuable tasks" (Gartner 2015, p.2). GI has also been identified as the "best practice" at local level to achieve greater urban sustainability due to its multiple benefits such as increasing land value (LV), urban quality of life , public health, hazard mitigation, regulatory compliance and adaptation to the emerging and irreversible impacts of Climate Change (CC) (Foster et al. 2011). According to Foster et al. (2011) examples of GI such as green corridors, rain barrels, and tree planting can be 3 to 6 times more effective in managing storm-water per $1000 USD invested than conventional methods (see figure 1). Its benefits increasing property value have become into cities' favorite technique to attract a flux of capital towards GI investment (Foster et al. 2011).

The urban Environmental Corridor Cañaveralejo ECC[3] is a GI project that looks for rehabilitating and enhancing the rivers ecosystem services (ES) across Cali (see Annex 1). The project connects the Farallones mountains in the west with the most important water element of the city, the Cauca river located in the east. The transformation in the Cañaveralejo's course from a river into a canal and its connections with the sewage systems and canals like Sur and Ferrocarril make ECC a corridor uniquely well connected.

[3] In Spanish the project Environmental Corridor Cañaveralejo (ECC) is called "Corredor Ambiental Cañaveralejo (CAC)" therefore ECC and CAC are used as synonyms.

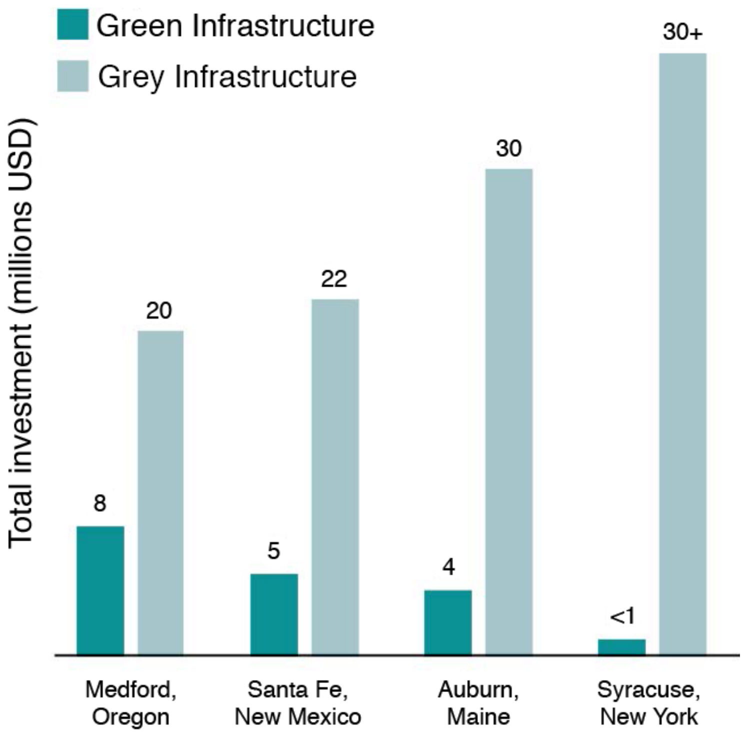

Figure 1 Comparison of green vs. grey infrastructure costs for cities to meet water quality requirements in the US. Source: McKinsey report, Dobbs et al. 2013.

The ECC project is divided by different zones depending its type and use (see figure 2). Referring to its type, section ECC-S01, ECC-S02 and part of ECC-S03 remain on the natural riverbed. The section ECC-S04 is the canalized part of Cañaveralejo river along Carrera 50[4] which works as connection between to Canal Sur and Canal Ferrocarril. Sections ECC-S05 and ECC-S06 are the Interceptor Canal CVC Sur, which are the last section before reaching Cauca River.

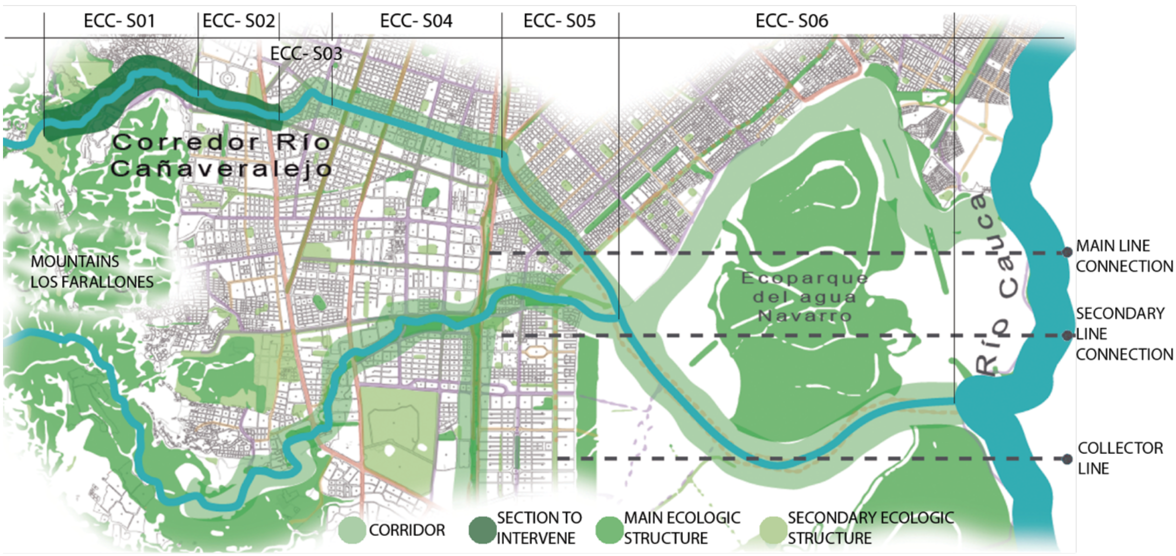

Figure 2 ECC project design. Source: CVC, Ceding SAS and Grupo Cuna SAS, 2014. Edited by Author, 2016.

[4] In Colombia streets are referred to as "Carrera".

From a use perspective, ECC offers 3 modalities (see figure 3): a contemplative- recreation zone, educational zone and a passive sport zone. Despite its use, ECC proposes to increase the eco- friendly infrastructure such as pedestrian lines, bike lines, trees and coverage vegetation. With this interventions ECC would contribute to cover some of the community challenges such as the 500,000 tree deficit according to the trees per capita established by the World Health Organization and UN-Habitat (2016), the demand for more walking and biking lines, and limited availability of quality public spaces.

Figure 3 Graphic description of ECC uses: 1) Contemplative/recreational, 2) Educational, 3) Passive sportive. Source: CVC, Ceding SAS and Grupo Cuna SAS , 2014.

GI projects such as ECC allow local governments to make the most of the limited public budgets and achieve multiple goals with a single investment (Epa et al. 2014). However, despite being an innovative solution to cover a group of problems with the same "medicine", the lack of budget, planning and municipal capacity as well as the absence of a smart strategy to finance the project is what discourages private stakeholders and decreases the possibility of implementation.

Fortunately, there are ways to help developing countries to overcome the challenge of collecting resources to finance these type of projects. Using methods like Hedonic Pricing Model (HPM), the influence that GI ejects in LV can be capitalized and used as a tool to encourage stakeholders to invest and redevelop the area. This later would generate revenues due to the increase in LV than can be collected through instruments as Land Value Capture (LVC) and redirected to vulnerable sectors (see figure 4).

Figure 4 Expected line of action of thesis results. Source: Author, 2016.

1.2 Problem Statement

"The four-pound sabaletas[5] of twenty years ago are gone, today we stick a hook in the Cañaveralejo and the only thing we fish are those art masterpieces produced by the stomach"
Local fisherman, (El Pais, 2014).

Cali, also known as "The city of seven rivers" is the third most populated city in Colombia with 2.369.821 inhabitants (Gobierno de Colombia 2014) and a hydric richness that few cities can compare. However, the city's industrial success, rapid urban growth and inadequate planning caused its rivers to have one of the highest levels of erosion and pollution in Colombia (El Pais 2015).

Cañaveralejo is one of the rivers highly affected by the uncontrolled illegal activities that discharge residuals into its basin. These activities are responsible for the increase in the flooding issues in the adjacent areas to the river as well as the interruption in the supply of its Ecosystem Services (ES) to the community (El Tiempo 2014). In order to solve Cañaveralejo's problems, Santiago de Cali Municipality and the Adaptation Found signed the Plan Jarillón de Cali. Among its GI proposals is "Environmental Corridor Cañaveralejo "(ECC) which includes green and recreational areas and the dredging from the river bed (Alcaldia de Santiago de Cali 2015). Unfortunately, the project's future is not promising due to budget and planning issues (El Pais 2016).

Despite Cali's municipality willingness to implement GI as a solution for its rivers problems, many cities around the world, especially those in developing countries face challenging limitations when trying to implement this type of approaches. Their lack of capacity regarding planning, financing and unawareness of GI's benefits cause many of these projects to die on a shelf (HRWC 2014).

In the particular case of Cali, the lack of information about GI multiple benefits and a good financing strategy is undermining the future of the ECC project. Without the awareness and the information about the potential impact that this project could eject in sectors such as land values (LV), it's unlikely that private stakeholders would join to finance the project. A proper supply of reliable information about the potential benefits that ECC can have in attractive sectors can encourage stakeholders to join in a financial strategy that generates revenues for all the parties involved (EPA 2016). Moreover, providing information in a language that decision makers and stakeholders can understand and feel attracted to, like money, can make the difference between an implemented or non-implemented project (de Groot et al. 2012).

Therefore, this thesis will be conducted to provide information about the potential benefits of ECC in LV in order to encourage stakeholders for financing.

If a man fails to honor its rivers, he cannot make a living from what emanates from them.
-Unknown author

[5] The *Sabaleta Brycon henni* is the scientific name for an endemic fish from the family of Characidae in Colombia. This species is important for food security of the adjacent human populations inhabiting nearby their habitat.

1.3 Research Aim

The aim of this research is generate reliable information about the impact that GI has on LV through the use of Hedonic Pricing Model (HPM).

1.4 Research Objective

The main objective of this research is to isolate the positive or negative effect of GI and measure its influence in LV in order to forecast the ECC impact on the areas adjacent to the project. The intention is that by forecasting the GI-ECC impact on LV, the results can be used to encourage private stakeholders to invest and redevelop the adjacent land to the project as well as provide the municipality a basis for LVC (see figure 4). Therefore, the research objectives are the following:

1. To provide the regression coefficients that explain the influence of the independent variable (GI) on the dependent one (LV).
2. To forecast the possible increase in LV due to ECC interventions (trees, vegetation coverage, bike lines, pedestrian lines.)
3. To provide recommendations for future GI projects based on the LV impact of each of the factors increased by the ECC.

1.5 Research Questions

1.5.1 Main Research question

- How much does Green Infrastructure (GI) affect Land Values (LV) in Cali?

1.5.2 Research sub-questions

- Which are the urban factors that affect LV?
- How much can ECC potentially affect the LV of the areas adjacent to the project?

1.6 Significance of the study

Since its apparition in early 40's, HPM has been the preferred election to assess the components that conform and influence an item price (Court et al. 1939), nevertheless its application in the field of LV and GI is recent. Cases from Hendon (1973), Correll et al. (1978), Tyrväinen (1997), Bengochea-Morancho (2003) and Bazyl (2009) confirm that studies of HPM-LV nature have been carried out mostly in European countries and United States, leaving Latin American countries out from the picture.

In this scenario, Colombia has only few studies carried out, from which three can be considered as relevant, Universidad del Valle (2005), Carrillo (2012) and Castaño et al. (2013). However, neither of them were focused on Cali or its rivers zones, pointing the lack of information regard this topic in the area. Therefore, the results here obtained can contribute to fulfil that lack of knowledge regarding the topic.

From a financial perspective, this thesis results can be useful for realtors, architectural and urban firms, government and other stakeholders interested to see which areas are going to increase their values in relation to GI projects like ECC. The information about the potential increase in LV can also help to provide a different set of tools to calculate land revenues from land owners, and at the same time can be the door to redirect this capital into more infrastructure that could generate a positive feedback into other fields like tourism and economic development (Davies et al. 2015).

Despite their willingness, Cali's lack of capacity, planning and budget is constraining GI plans from tackling public problems. By assessing the potential impact that GI projects such as ECC can have on LV through HPM, more stakeholders besides public ones can join to the project and make it a sustainable business from which citizens can benefit in many ways (DEFRA 2011).

Many studies have effectively demonstrated the positive impact of TGI on economic activities, job growth, property values and considerable spillover effects that affect directly the quality of life in cities (Ontario Ministry of Finance 2012; Efthymiou and Antoniou 2013; Perdomo Calvo 2016). However, since all these studies have been mainly focusing only in TGI, the fiscal impacts of GI haven't been deeply studied neither their potential to become a tool for encouraging investment. For this reason, this thesis will focus on assessing the impacts of GI on the LV on Cali, Colombia.

1.7 Scope and limitations

The ECC is part of a bigger project included in the Territorial Arrangement Planning[6] (POT) 2014 and Plan Jarillon de Cali 2012, which objective is to provide safety, public and green space to Cali's citizens. However, giving the big number of projects includeded in the POT, this research will only focus on the ECC project.

Secondary quantitative data sets are used to generate the analysis models, however, since this data was collected from different sources and for different purposes, it might not match the purposes of the research perfectly which could diminish its validity. In this case, the research design will require to be modified, especially the research questions and the operationalization in order to fix them to the nature and the quantity of the material available. Other problems related to the nature of the data are influences or alterations during the collection/coding process, confusion on the attributes values and meanings, contradictions and data holes which can affect the results of the analysis.

The differences from one data package to another regarding the time periods when they were collected is one of the major problems since merging data collected at different times lacks reliability. Merging data sets with different time and measurements is complicated and sometimes impossible (Verschuren 2010). For this research, data must be in neighborhood and block scale in order to get enough observations for the regression, meaning that data sets in function of cities or municipalities cannot be merged directly.

One of the main advantages of using OLS regression analysis is the optimization in time and cost when managing broad scopes, however, in order to get a parsimonious and effective model its necessary to choose the variables and indicators selectively (Box 1976). This means

[6] POT is the acronym in Spanish for "Plan de Ordernamiento Territorial"

that not “all” the variables can be included in the model, reflecting an external validity issue since it might be possible that some of these non-included variables eject an influence on the dependent variable. Excluding variables from the model can lead to bias in conclusions, which eventually would reduce the external but also the internal validity of the research.

However, bias limitations due to exclusion of independent variables can be taken out of sight if the excluded independent variable x is highly correlated with another x or, if these x's are obviously not correlated with the dependent y, then, their exclusions would not cause bias. This is represented in the following equations:

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2$$

Equation 1 Example of a linear regression equation where $\boldsymbol{\beta_0}$ is the constant, $\boldsymbol{\beta_1}$ and $\boldsymbol{\beta_2}$ are the regression coefficients and x are the independent variables. Source: Wooldridge, 2003.

$$Bias\ (\tilde{\beta}_1) = E\ (\tilde{\beta}_1) - \beta_1 = \beta_2 \tilde{\delta}_1$$

Equation 2 Omitted variable bias equation. β are the regression coefficients, E is the general error, $\tilde{\delta}_1$ is the regression slope and the accents on each β mean that come from and unspecified model. Wooldridge 2003.

Equation 2 presents two possible scenarios, the first one were β_2= 0, meaning that x_2 is excluded from equation 1, giving an unbiased $\tilde{\beta}_1$ (Wooldridge 2003).The second scenario also gives an unbiased $\tilde{\beta}_1$ considering $\tilde{\delta}_1 = 0$, even in the case that $\tilde{\beta}_2 \neq 0$ (Wooldridge 2003). Therefore, an unbiased $\tilde{\beta}_1$ can be possible if x_1 and x_2 are uncorrelated in the sample.

Another limitation linked with OLS regression and statistical analysis is causality. When using statistical methods to analyze relationships among variables, the results presented indicate the “correlation” of x on y, not necessary meaning that x causes y (Aldrich 1995; Tufte 2006)

Despite the cost – effectiveness advantages, secondary quantitative research can have limitations in the very root of the “benefits”, meaning that in some cases access to data might be restricted, costly or outdated.

"An approximate answer to the right problem is worth a good deal more than an exact answer to an approximate problem." -- John Tukey.

Chapter 2: Literature Review

2.1 Introduction

Climate change impacts are a reality that many cities around the world have to face every day. The economic, social and political nature of these impacts is what demands a bigger variety of solutions. GI is not a panacea for urban problems but, in the recent years it has become into an interesting alternative given its capacity to manage natural capital and tackle multiple issues (MA 2005). Urban heat island effect, water excess and shortages, water and air pollution, reduction of energy consumption, urban quality of life, sustainable development, public spaces are just some examples of the issues that can be approached through GI (Center for Neighborhood Technology 2010).

Nevertheless, its impact on LV is definitely one of the most interesting due to its public revenues generation and economic impact in cities. The particular situation that Cañaveralejo River in Cali is suffering, offers the opportunity to test this influence of GI on LV. A project such as ECC can generate positive influence on LV, which translated to a public meaning can represent an increase in general wealth, land taxes and investments from different stakeholders.

These possible revenues can be allocated in order to generate more infrastructure and amenities across the city, which not only will provide a bigger capacity for economic development but also will improve the urban quality of life for citizens (see figure 5). Generally, economic development and quality of life are perceived as different things, but in fact they are two homologues symbiotic concepts, since features such as parks, corridors or trails contribute to cities economy by attracting citizens and helping retain those who might otherwise leave (Wong 2001; Peach & Petach 2015).

In order to generate policies and attract stakeholders that can invest and collaborate towards this sustainable economic development it is necessary to provide reliable data about to which extent GI projects such as ECC can affect LV. This can be done by developing an analysis on the adjacent areas to the project using a Hedonic Pricing Model (HPM).
This chapter will provide the definition of GI, LV and HPM, their interrelationships and evidence based on academic literature of previous research that back up the connections and assumptions previously described.

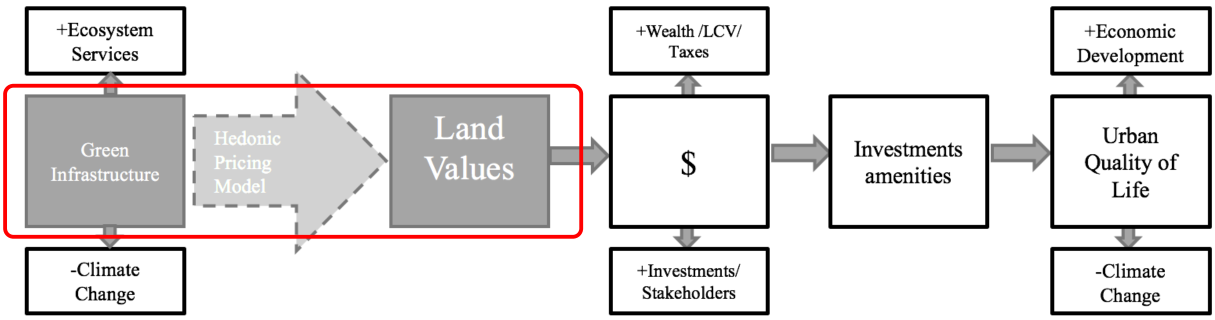

Figure 5 General framework of connections between concepts. The red rectangle includes the main concepts to be discussed in this thesis. Source: Author,2016.

If one way be better than another, that you may be sure is Nature's way.
Aristotle (384 BC-322 BC) - Nicomanachean Ethics, 1099B, 23.

2.2 Green Infrastructure (GI)

2.2.1 Origins and Evolution

The concept of GI has recently gained popularity across the world thanks to authors like Benedict & McMahon (2006), Lennon (2014), and the European Comission (2013). However, it was in hands of the NY Central Park from Frederick Law Olmsted and the "Garden City" from Ebenezer Howard that the foundations of GI as a concept were given (Davies et al. 2006).

In the core, all GI definitions are similar, but, they do differ in the way they emphasize and prioritize certain components, services and functions. Therefore, given its constant evolution and plenty definitions, it can be hard to restrict to just one. GI's metamorphic skill gives space for changes in its definition depending on the context, e.g. trees in inner city can be considered as GI due to their green benefits, while others use GI to refer to engineered structures such as water treatment plants or green roofs (Benedict and Mcmahon 2001). However, GI must have a certain critical mass, meaning that trees should form part of a larger habitat like a corridor or network instead of just a single and isolated component (Naumann et al. 2011).

Despite the multiple variations in GI definitions, its core relies on four main principles described below (Benedict and McMahon 2006; Kambites and Owen 2006; Lindley et al. 2011; European Comission 2013) :

- Network/connectivity: It aims for added values derived from interlinking green spaces functionally and physically.
- Delivery of ES/multi-functionality: Providing several ecological, socio- cultural, and economic benefits concurrently.
- Integration: It considers urban green as a kind of infrastructure and seeks the integration and coordination of urban green with other urban infrastructures in terms of physical and functional relations (e.g., built-up structure, transport infrastructure, water management system).
- Multi-Scale: Urban GI planning can be considered for different spatial levels ranging from city-regions to local projects. GI planning aims at linking different spatial scales within and above city-regions.

Authors like Naumann et al. (2011) also mention the importance of GI's substitutability with TGI, and Davies et al. (2015) remarks the importance of GI to be strategic, inter- & trans disciplinary as well as socially inclusive. The following table provides some examples of documents discussing GI's composing elements allowing to observe that more than three elements can be approached by the same document.

Elements of Green Infrastructure	Authors
Assessibility	Countryside Agency and Groundwork (2005); Gallent et al. (2004); Hidding and Tenuissen (2002)
Concept and a resource	Davies et al. (2006); Benedict and McMahon (2006)
Connectivity and networks	TEP (2005); Benedict and McMahon (2002); TCPA (2004); Williamson (2003); Countryside Agency (2006)
Integration of different cross-boundary people, places and policies	TEP (2005); TCPA (2004); Weber, Sloan and Wolf (2006); Countryside Agency (2006)
Scale (GI size, political, physical landscapes)	TEP (2005); TCPA (2004); Countryside Agency (2006)
Multiple benefits	TEP (2005); Benedict and McMahon (2002); ODPM (2003); Williamson (2003); Lindsey et al. (2001); Countryside Agency (2006)
Multi-functionality	TEP (2005); ODPM (2003); TCPA (2005); Gobster and Westphal (2004); Countryside Agency (2006); Davies et al. (2006)
* TEP is an environmental consultancy firm based in the northwest of England.	

Table 1 Green infrastructure elements from research documents (1999-2006). Source: Mell, 2008

The reports from Ecologic Institute, GHK Consulting (Naumann et al. 2011) and Davies et al., (2015) make clear that GI can also be used through its synonyms, such as green spaces, green areas, open spaces, green systems, green networks, biological interfaces, biotope areas, biotope networks, corridors, ecological hubs, ecological networks, habitat networks, living spaces, green belts, etc. Holistic and coordinated approaches that look for conservation values and actions in combination with land development, growth management and built infrastructure planning are likely to be identified as GI initiatives (Naumann et al. 2011).

Both definitions from Benedict and McMahon seem to be the most used nowadays, the one from 2006 where they describe GI as “an strategically planned and managed network of wilderness, parks, greenways, conservation easements, and working lands with conservation value that supports native species, maintains natural ecological processes, sustains air and water resources, and contributes to the health and quality of life for America’s communities and people” ; and the one from 2001 as an “interconnected network of green space that conserves natural ecosystem values and functions and provides associated benefits to human populations”. However, despite remarking the core components of the concept, both definitions lack the specification in scale required for this research.

In order to fill that gap, two other definitions are proposed, one from Almada's Master Development Plan (2011) and one from Lisbon's Master Development Plan (2012). Those define GI respectively as “municipal ecological structure which constitutes an ecological network at the local level in order to preserve the connectivity and ecological features in natural, rural and urban environment”. Moreover, in the case of Lisbon, the idea of including natural systems as well as man-made green is added. A combination of Benedict and McMahon (2006), Almada's (2011) and Lisbon's Master Development Plan (2012) is used to define Cali’s GI component in the ECC project[7].

[7] For further detail about the definitions see Section 3.3

2.2.2 Green Infrastructure benefits.

There is no transaction done in the world without an expectation for reward. Cities need to invest in infrastructure with the potential to pay off economically in private investments and job growth (Mcnichol 2016). Moreover, the unawareness of GI's benefits limits the amount of investments, therefore the quantification and diffusion of GI's benefits is a fundamental necessity.

GI benefit communities by providing land for resource protection and restoration, recreation and other public values. More important, strategic placement of GI reduces the need for TGI, freeing up public funds for other community needs (Benedict and Mcmahon 2001). According to ECOTEC (2008) and Naumann et al. (2011) GI can have multiple impacts in ecologic, social and economic sectors, some of which are mentioned below:

- Reduces pollution and health risk.
- Recreation and changes in the provision of public spaces - the extent and quality of habitats, corridors, ecosystems, green spaces and features (measured in purely environmental terms).
- Improvement in the work environment: green spaces near work reduce sickness absence, which leads to increased productivity, and employees are thus more highly motivated.
- Property values: GI increases property values through pleasant views and proximity to green and blue bodies. GI scarcity in the urban context can make it highly demanded by investors.
- Socioeconomic impacts: impacts on employment, Gross Domestic Product (GDP) and local communities (measured in terms of output and employment).
- Ecosystem: Provides primary habitat for various species, increase biodiversity, reduce pressure on drainage, provide fundamental flood defense, and reduce temperature amplitude in the city.

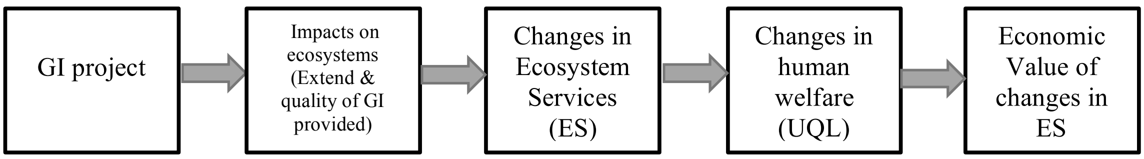

Figure 6 Description of GI benefits provision. Source: Adapted from (Defra, 2007).

These previous GI benefits which add to cities are known as Ecosystem Services (ES), which according to the Millennial Ecosystem Assessment (2005, p.5) are "the contributions that ecosystems make to human wellbeing, including goods such as raw materials, food, freshwater, etc. but also services like flood reduction and carbon sequestration".

Urban ES can be generated by all the green and blue elements under the GI umbrella such as: parks, urban forests, cemeteries, gardens, landfills, rivers, streams, lakes, ponds, artificial swales, storm water retention ponds among many others. Depending on their service, they can be classified into four basic categories suggested by the Millennium Ecosystem Assessment (2005, pp.56–60) :

1. Provisioning services: goods, such as food or freshwater that ecosystems provide and humans consume or use.

2. Regulatory services: services such as flood reduction and water purification that e.g. wetlands can provide.
3. Cultural services: intangible benefits such as aesthetic enjoyment or religious inspiration often provided by nature.
4. Supporting services: basic processes and functions, such as soil formation and nutrient cycling that are critical to the provision of the first three types of ES.

The diversity of ES and benefits of GI are measurable indications that emphasize the importance of GI in the pursuit of sustainability in cities. The following table presents examples of GI implemented strategies that generated benefits in different sectors such as health, property values and violence reduction, etc.

GI benefit	Used GI strategy	Publication	Country	Results
Air/water pollution	Use of Bioswales along a 20,000sq² office building	EPA ,2014	USA	Capture, filtration and reincorporation of storm water runoffs from roofs to soil while adding greenery to the neighborhood.
Air/water pollution	Urban forest vs air pollution	Francesca Bottalico 2016	Italy	Contribution of urban forests in abating O3 and PM10 air pollution in the city of Florence
Health	Green spaces (green corridors, parks, gardens, trees, etc.)	Magdalena van den Berg 2015	Netherlands	Significant positive associations between the quantity of green space and perceived mental health and all-cause mortality.
Health	Green spaces (green corridors, parks, gardens, trees, etc.)	Regina Grazuleviciene, 2014	Lithuania	Proximity to green spaces positively affect women's blood pressure.
Violence reduction	Green spaces (green corridors, parks, gardens, trees, etc.)	G.H. Donovan and J.P Prestemon, 2010	USA	A study of 2,813 single-family homes in Portland, Oregon found that large trees in lots and in the public right-of-way decreased the occurrence of crime.
Violence reduction	Community garden	M.R. Herod, 2012	Canada	Crime reduction of 75% after a community garden was built.
Property values	Green spaces (green corridors, parks, gardens, trees, etc.)	Bazyl, 2009	Poland	Positive impact of urban green areas on property prices
Property values	Green corridor	Bengochea-Morancho (2003)	Spain	Urban green corridor increases the prices of dwellings.

Table 2 Empirical evidence of GI benefits in different sectors. Source: Author, 2016.

In terms of valuation and assessment, authors like Benedict and McMahon (2006), Barthel et al. (2010), Ernstson et al. (2010), Schäffler and Swilling (2013) and Davies et al. (2015) have concluded that due to GI benefits diversity, the assessment can be done in many different ways and at different levels in order to understand the extent of each action.

Depending on how results need to be reported, methods to assess GI can go from using a demand curve valuation such as travel cost methods, HPM, contingent valuation, etc. (Dubgaard et al. 2003). This thesis pursuits to provide reliable data to decision makers in order to encourage them financing a GI project or not, in this sense, this paper must translate the information in a language that decision makers feel familiar with, such as monetary values (de Groot et al. 2012). Therefore, the chosen method for the purposes of this thesis is HPM.

The lack of support that is seen towards GI projects is consequence of the lack of awareness that comes from scarce information in a proper language, people would not demand or protect these assets if they are not aware of their benefits (Naumann et al. 2011). The city of Cali is not yet aware of the potential benefits that ECC can provide in raising property values and private investment, which makes the aim of this thesis to provide this information for the cause of the project.

Buy land, they are not making it anymore.
--Mark Twain

2.3 Land Values (LV)

2.3.1 Origins and Evolution

From conquering the land like Alexander the Great in 334b.c. to choosing it from a catalog via smartphone, land property has been present in human civilization and evolution since ancient times. Oxford dictionary (Oxford 2011) defines Real Estate (RE) as a " property consisting of land and the buildings on it, along with its natural resources such as crops, minerals or water". Therefore, land is a component of RE defined as the resulting of removing buildings, equipment or anything that does not occur in a natural way in the RE. When referring to land as an asset, it also includes everything that is underground, e.g. trees, water, and any natural resource like gas or oil[8].

The business of RE[9] is defined as buying, selling, or renting land, buildings or housing. Regarding RE markets, they are formed from people who identify the factors and conditions that create and add value to each property, and take the quest to find something or someone whose needs are fulfilled by it and is willing to pay for it (McDonald & McMillen 2010).

The particular features of land that make it incomparable with other assets also make it valuable. Uniqueness in location, which means that there are not two parcels identical in terms of location; uniqueness in composition, referring to its geological composition; durability, which makes it long-lasting; finite in a sense of supply, that is not continually created and what is actually disposed is what exist; and usefulness, that has utility or use to people (R. Cortesi 1996). Usefulness is the feature that allows markets to dispose it in the most convenient way, ensuring that land is put to its highest and best use (Alonso, 1963; Munizzo & Virruso, 2010).

In the RE market there is no autonomy regarding a piece of land, each property is affected and interdependent from the value of the rest as a whole network, which means that an event that happens in China can have impacts on markets in the other side of the planet (Chen, 2016). Geographic dependencies can be from the own neighborhood (individual), regard the

[8] The ownership of natural resources like gas, oil or precious metals located underground a property might be allowed or not depending the land ownership laws of each country.

[9] The use of Real Estate (RE) and Land Value (LV) terms will be interchangeable since property markets cannot make transactions that do not include the land, therefore when referring to RE, attributes and characteristics the implicit meaning is referring to land and land values which is the purpose of this research.

values of nearby estates (peer), and the prosperity going on the closets business area (zone) (Fu et al. 2014). This particularity means that the forces that generate impact on the RE value most be identified in order to forecast the variations on prices. The identification of these forces can turn confusing since some of them might overlap, however authors like Geschwender (2000) ,Rockwell (2006) and Carr et al. (2003) agree that this forces can be classified in the following four categories: social, economic, Physical/Environmental and governmental.

Social forces are in relation with trends in society or culture (social context), which means they can be spontaneously generated or on the other hand, based on actual facts and figures (Carr et al. 2003). Examples of social forces that impact RE values include the following: family composition, population's aging, evolution of home offices, environmental consciousness, security consciousness, leisure time, the family and house space functionality (usage) and population trends, such as growth, decline or stability (Carr et al. 2003). An empirical example of social forces is the reduction from 65 to 80% on property values seen in Latin American cities like Chihuahua (Vega 2011) and Belem (Duarte et al. 2013) due to violent events such as drug cartels and gangs. These cases work as an example of how events not directly related with RE markets can affect dramatically property values.

Economic forces rely on the LV that comes from its productivity. The variety of land uses creates a virtual figure of use, which makes it desirable, and as a consequence valuable (Carr et al. 2003). Consumers acquisitive power and RE use can also influence the market in all levels: national, regional, and local. Examples of economic forces such as income levels, housing construction cost, interest rates, etc. influencing RE markets are discussed by Peyton and Pierzak (2016), Reed and Ume (2016) and Zhang et al. 2016).

The presence of governmental forces at local, state or national level can impact the RE market dramatically due to its legal power. Local rent control policies, environmental impact laws and building codes are examples on how governmental forces can condition what buyers could do and how an area is developed (Carr et al. 2003). Authors such as Naylor (1967), Schill (2005) and England et al. (2013) provide insights in how governmental forces like Taxes and federal monetary policies affect RE markets.

Environmental forces on RE values might be the easiest to be identified. They strictly referred to the physical context of the property like variances in location, transport, topography, climate/weather, etc. (Carr et al. 2003). These forces can be easily seen in properties with privileged views and high accessibility, making it suitable for commercial/ retail use, but often unaffordable for residential housing (Cheshire 2014). Environmental forces might be the most underestimated one, but according to authors such as Wolf (2003) and Forest Research (2010) is an exceptional source of utilitarian profits for human kind.

The natural assets and conditions provided by land tend to be marginalized in prior of location (Balchin et al. 2000). However, at the time to assess buyers intentions, the relevance that aesthetics, green areas and water bodies play influences highly the final estimated value of certain property as well as buyers' willingness to pay for it (D'Acci 2014).

The inventory of studies regard the impact that social, economic and governmental forces eject on the RE values across the world is vast and deep, authors such as David Ricardo (1821) and Adam Smith (1776) among others, have deeply discussed about the weight that each force ejects in the balance of global properties. Yet, research about the influence that environmental forces have on RE values is still immature. Therefore, in light of the new urban economic and urbanization trends its necessary to fulfil this lack of information regarding the impact of environmental forces on RE.

2.3.2 Real Estate, wealth and economic growth.

The correlation between RE and GDP is a well establish and deeply discussed relationship, however the direction of their causality is still uncertain (Harvey 2012; Tibaijuka 2009). Since ancient times, RE has offered the opportunity to own a piece of land, giving with this simple fact the basis for all the investment opportunities we see today, providing a set location to trade and commerce easily. Formed by the building assets, RE represents a fundamental key in every environmental, economic and social aspect of cities. The services that provide are indispensable for entrepreneurship to succeed, support business and societies to run properly on daily basis (EPRA 2012).

RE investments contribute to create a domino effect in surplus by triggering not only construction market but also sectors such as finance, design, furniture, raw materials, manufacturing, etc. which are indispensable in order to keep RE market going (Harvey 2012) (Cushman & Wakefield 2014). Therefore, RE represents a major source of jobs and economic growth, and thus may help to overcome the principal challenges of our era: "providing livable and functioning cities for a growing urban population and reducing the environmental footprint of the built environment" (EPRA, 2012, p.1).

RE concept sets value to the earth itself per piece of land, considering each attributes that conform it. Following this path, Savills (2016), a London RE advisor quantified the value of all global property, including commercial, residential, forestry and agricultural land. The results gave $217 USD trillion total, from where housing covered 75% of the total. In order to give some perspective to it, the value of all the gold that has ever been extracted is approximately 6 USD trillion, which means that the total value of the worldwide RE is 36 times the one from all the gold transacted (Hackett 2016).

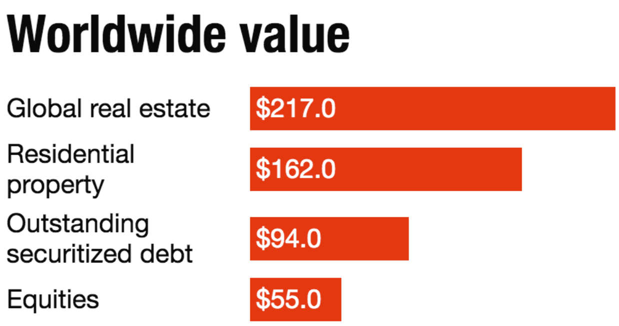

Figure 7 Worldwide values directly and indirect related to RE. Source: Hackett, 2016.

In 2014, RE commercial and residential industry generated an estimated of $3 trillion, where 35% of the total amount came from leasing activities (Ross 2015). Most global GDP estimates are around the $75 trillion to $90 trillion range, showing that RE contributes between 3.33% and 4% of total world output (Ross 2015). Just in London, the RE boom added $1.5 USD trillion to the British houses values in the last five years (CNN 2015). This implies that London houses and apartments are worth 8.7 USD trillion, which is worth as much as Brazil's annual GDP (CNN 2015). In addition, residential properties in the neighborhoods of Westminster, Kensington and Chelsea sum a total $345 USD billion, which is more than Denmark's GDP (CNN 2015).

These facts support the idea that a significant portion of people's wealth across the world is captured in their homes (Lowe 2015). Tang and Chau (2006) discussed that in Hong Kong people's wealth is captured in housing, since the value of a house is worth more than twenty times the average yearly household income. Several authors found out that residential investment is correlated to GDP growth, turning RE investment in a good indicator for GDP (Green 1997; Podenza 1988). Ganesan and Tse (1996) study demonstrated that GDP tends to lead construction flow in Hong Kong, at the contrary of what happens in USA and UK markets. Aschauer (1989) argued that RE public investment (building investment) was a key component of growth, and that the productivity slowdown after 1973 was consequence of the budget cuts to public capital investment.

Cities have become the host and niche of growth in many ways, their need to become more competitive in market is what triggers growth spots inside urban areas (Nallari et al. 2012). This growth if not planned, might create an uncontrollably and disproportional process of demand-supply where population grows much faster than the speed infrastructure can cover demands of services (Muzzini & Aparicio 2013). This unplanned growth causes a domino effect that impacts among other sectors, RE markets, which affects GDP and population, generating retro feedback, loss of human capital and investments.

Recent studies from Kong et al. (2016) and Lv (2012) concluded that RE positively affects economic growth in a national level as consequence of the indirect benefits created at local scale. This indirect benefits contributed into the RE Chinese markets growth from 4% to 14% of the GDP in less than fifteen years. All this evidence highlights the key role that RE played and still plays in the global economy and how its size, scale and depth make it a highly attractive and profitable sector.

2.3.3 Possible negative externalities of Land Value strategies.

The main objective of this thesis is to assess the impact of GI on LV as a strategy to encourage private stakeholders to invest in ECC, however, it is important to note that it might have negative externalities when the redevelopment is not done in an integral and inclusive way.

Upgrading a vulnerable area through a project such as ECC implies to see beyond the short term desired benefits, which in this case is the increase in LV and the redevelopment of the area by stakeholders.

Using David Ricardo (1821) definition about the rental gap as "the difference between the actual price of land and the potential one after an event " it can be concluded that it is exactly that "rental gap" which can generate interest among stakeholders to invest or not in ECC. The increase in these gaps means higher RE values, which is not necessarily good for the tenants since it might lead to gentrification. Gentrification happens when an area that is upgraded increases its prices at such level that the local residents become incapable to afford, leading to massive displacements, eviction and deep damages in the social capital and in what Harvey (2012) describes as "social commons".

If not planned properly, gentrification can be disguised with the green dress of GI projects (Janoschka & Sequera 2016) displacing and evicting the same local people, lower- income homeowners, and racial minorities that were supposed to get benefited in first place.
In order to prevent locals' displacement and replacement with upper class residents driven by speculation and impunity, policy defense mechanisms and integral planning are imperative.

Despite that these issues go beyond the scope of this research, is vital to consider them in order to create the policies and tools that can defend local resident's interests parallel to GI - LV interventions. Ensuring that every stakeholder in the community has a place on the decision making table before the process starts, sharing operation and development planning process in a clear and suitable language and using or create policy tools such as Realty Transfer Tax, low income housing tax and anti-speculation tax can be some of strategies to protect local residents and preserve housing diversity (Rose 2015; PCAC 2015).

"Money drives decisions, it's the necessary evil of the game"
David Nowak, ecological economist (2015)

2.4 Hedonic Pricing Model (HPM)

2.4.1 Origins and evolution

In 1922 and 1926 respectively, Hass and Wallace et al. were the first to use HPM method for valuating farmland in the Midwestern U.S, however is not until 1939 that Court et al. is named the father of HPM due to his paper "Hedonic price indexes with automotive examples, The dynamics of automobile demand, GM." Despite that his paper was not related with RE and land valuation, he deconstructed the price of an asset into the asset's component parts, in this case a car, giving the basis for future uses in the field of property and non-market valuation.

The first attempt of giving a theoretical basis to HPM was done by Lancaster (1966), where he introduced his revolutionary idea of hedonic utilities, arguing that "it is not necessarily a good itself that creates utility, but instead the individual characteristics of a good that create utility". Unfortunately Lancaster's paper missed the point about pricing, and is until Rosen (1974) that the idea of a theory in hedonic pricing is introduced. He discusses that "an item can be valued as the sum of its utility generating characteristics; that is, an item's total price should be the sum of the individual prices of its characteristics ".

HPM fundamental premise is that properties are constituted by a set of complex features, which are part of the selling price composition. This heterogeneous features can be the divided into intrinsic and extrinsic characteristics of the property (D'Acci 2014). Intrinsic characteristics are those strictly connected to the building, whereas the extrinsic include all the location area attributes, like proximity to city center, transportation facilities, green areas, etc. (Lancaster 1966; D'Acci 2014). This group of characteristics is what shapes a property price, specially the attractive the ones, which lead to higher market prices. This explains why people pay more for a beautiful view even when two houses are identical in their intrinsic characteristics, allowing to estimate and translate this "extra" benefit into a monetary value of an aesthetic service (Jim & Chen 2006).

As consequence of the variety of features that form a selling price, many statistical techniques have been developed to weight separately the contribution of each attribute to the total value. HPM shapes the house price as a function of its characteristics, deriving a marginal[10] price of each attribute, which reflects homeowners' willingness to pay for it (D'Acci 2014). Through assigning an implicit price to each constituent attribute, HPM is the preferred and most convincing approach when it comes to monetize non- market values. Since it is based on actual transaction behaviors in the market (Hidano 2002), it makes it relatively less controversial and less subject to interference by extraneous influences (Jim & Chen 2006).

2.4.2 Theoretical foundations.

Despite that since 1922 authors like Hass were already doing analysis of agricultural markets, HPM was not relevant for assessing housing attributes and consumer decision making until Rosen's (1974) work. The hedonic framework proposed by Rosen consisted in two-way analysis stages, the first one would estimate the hedonic equilibrium equation based on market prices and the characteristics of the property. This procedure is the most common one used since the data requirements are minimal and the major economic insight required is information about marginal prices. Therefore, is not surprising that most hedonic analysis only estimate till this first stage, however once that this first price function is available it can be used to complete the second stage of analysis where fundamental property attributes are predicted. This prediction, which is an estimation of the most demanded characteristics in a property, requires a combination of the implicit prices for each house' attribute obtained from the first stage of analysis with the observed quantities of attributes (Taylor 2013; D'Acci 2014).

The HPM as any other statistical tool has a set of basic assumptions to be met in order to ensure the reliability of its results. The first one is assuming there is a perfectly competitive market with plenty offers and demand, and second, that there is enough supply of house attributes (Taylor 2013). It's important to remark that the market behavior and attributes relationships can be of any possible nature, e.g. linear or non-linear functions. This is relevant for the hedonic price function since it has an "envelope nature" meaning that "there is no theoretical guidance for its specification, except in limiting cases" (Taylor 2013, p.35). One of the most common specification used is the semi-log (see Equation 3), where the natural log of a house price P_i is a function of the sum of all the J characteristics that influence it, with α and β as coefficients and ε for normally distributed errors. Another common specification goes to independent variables that are transformed with logarithmic or quadratic roots in order to fix a normally distribution of the data values and stability of the model (Taylor 2013).

$$\ln(P_i) = \alpha + \sum_{j=1}^{j} \beta_j + \varepsilon$$

Equation 3 Example of the most common used specification: semi-log.

[10] Marginal price is also known as "hedonic or implicit price" (D'Acci 2014, p.536).

When estimating the price function of a property, there is a wide umbrella of options to do so. Nevertheless, the preferred option is Ordinary Least Squares (OLS) regression since their results are more easily interpreted when trying to assess the impact of particular attributes in property prices (Malpezzi 2008). OLS is a form of linear regression that consist of minimizing the average squared difference between the actual values of y (dependent variable) and the prediction based on the estimated line (Malpezzi 2008). This procedure has as outcome regression coefficients known as β_0 and $\beta_n\chi_n$ (see equation 4). β_0 is known as the value where the fitted line crosses the y-axis[11], while $\beta_n\chi_n$ is the regression coefficient for every single attribute (independent variable) that affects positively or negatively the dependent variable (Wooldridge 2003).

$$\mathbf{y} = \boldsymbol{\beta_0} + \boldsymbol{\beta_1\chi_1} + \boldsymbol{\beta_2\chi_2} + \boldsymbol{\beta_n\chi_n} + \cdots \boldsymbol{\varepsilon}$$

Equation 4 Example of a regression equation. Source: Wooldridge 2003.

Despite the function selected for the analysis, all of them rely on the principle of the relationships among the independent and dependent variable. The estimation and generation of a hedonic equation relies on two vital steps, the first one is the selection of the variables that will serve as characteristics and second, securing a full and accurate data package on the property attributes and transaction prices. Categorization and organization is the third step which makes the identification of relevant variables easier (Monson 2009) .

When categorizing and organizing data for HPM and LV analysis authors like Chiarazzo et al. (2014), Glaesener and Caruso (2015), Halvorsen and Pollakowski (1981), Chasco and Le Gallo (2012) and Jim & Chen (2009) agree in the following categories: structural, accessibility, neighborhood, socio-economic and environmental. Depending of the selected indicators and type of data selected to fulfil them, each classification can present weak points at the time to run an analysis that might cause bias or compromise the final results.

Depending of the case, specific tools can be applied to fix the errors, e.g. the Shannon land-use diversity index to account for differences in the valuation of diversity regard proximity to the available land, or the spatial- cross regressive procedure to test nested levels and spatial dependence used by Glaesener and Caruso (2015).

However, its necessary to point out that there is no perfect model, despite the tools and methods to fix errors in the analysis, trade-offs must be done in order to get accuracy in the variables that are more relevant for the research purposes. Researchers have to be clever enough to not attach too much to their models so they do not fall in "overelaboration and over parameterization, which is often a mark of mediocrity" (Box 1976, p.792).

2.4.3 Advantages and Limitations

In order to get the best practice of HPM it is necessary to know the advantages and limitations of the method for preventing future complications. Methods with a quantitative basis like HPM are data intensive and depend completely on this availability, which is one of the major limitations in achieving best practice in HPM, even for professional statistical

[11] β_0 can also be interpreted as the mean response when all the independent variables are equal to zero.

agencies. Collecting all the transaction values and the whole package of attributes for each property is a demanding task, and in some cases an expensive one. The following table describes some of the advantages and disadvantages that HPM can represent to academic and statistical studies.

Advantages	Disadvantages
HPM can in principle adjust for both sample mix changes and quality changes of the individual properties.	Difficulty to control sufficiently location if property prices and price trends differ across detailed regions. However, a stratified approach to HPM can help overcome this problem.
Price index can be constructed for different types of dwellings and locations through a proper stratification of the sample. Stratification has a number of other advantages as well.	HPM estimates people's WTP[12] for variations in environmental qualities and their consequences. However, if there is no awareness of the benefits into the property, then the value will not be reflected in the property price.
The hedonic method is probably the most efficient method for making use of the available data.	Despite the objectivity of being a quantitative method, the choices of characteristics included in the model can lead to variations in the estimates for overall price change.
The imputation variant of the HPM is analogous to the matched model methodology that is widely used in order to construct price index.	Multicollinearity - A high correlation between some of the included variables that increases the standard errors of the regression coefficients turning them unstable.
It can be adapted to take into consideration the several probable interactions between environmental quality and the marketed goods.	The scope of applying this model is restricted and limited to measuring the environmental benefits related to housing prices only.
Allows to approximate values based on the actual choices of the people.	HPM assumes that market prices will automatically adjust to any changes in the attributes.
The RE market is a good indication of the values as it is relatively efficient in responding to information.	Requires a prior knowledge of the potential positive and negative externalities that are associated with purchasing the RE property.
Accessibility to property sales data and characteristics allows easy comparison to secondary data sources in order to acquire the descriptive variables for the regression analysis.	HPM assumes that, given their income, people have the opportunity to choose the combination of attributes they prefer, ignoring external factors such as interest rates, taxation, etc.

Table 3 Advantages and disadvantages of HPM. Source: Von Der Lippe 2001, Triplett 2004, Sopranzetti 2010, de Haan and Diewert 2013.

2.4.4 Green Infrastructure, Land Values and Hedonic Pricing Model

The use of HPM as a tool to forecast, assess and unbundle the value of certain object into its conforming elements has been done since 1939 when Court et al. used it for a car of General Motors Co. Nevertheless, its incursion in the environmental assessment is new, and is gaining popularity among economist and urban planners because of the benefits that it provides for monetizing non- market values such as environmental amenities (Chiesura 2004).

[12] Willingness to Pay

The provision of leisure opportunities, ES and aesthetic enjoyment that urban GI provides to properties ejects high impact on its values. Yet, all these benefits lack monetization, and therefore tend to be ignored or underestimated in urban development plans (Noor et al. 2015). This quantitative information about the implicit non-market price benefits from GI in LV is required in order to approach the appropriate stakeholders to encourage GI initiatives. HPM combined with technologies like GIS have become powerful tools to fill this lack of data and its translation into the language that planners and decision makers are familiar to use (Kronenberg 2015). Unfortunately, they still remain underutilized in urban and environmental economics (Brasington and Hite 2005).

The following table shows research examples of assessments about GI influences on LV through HPM, which can provide valuable and useful insights for RE developers, governments and policy makers.

Country	Year	Author	Results
Poland	2016	Piotr Czembrowski, Jakub Kronenberg	Positive impacts on apartment prices related with distance, type and size of a GI + percentage of greenery within a 500 m radius
Malaysia	2015	M.Zainora Asmawi Alias Abdullah	Increase between 3-12% in house prices based on GI size and their proximity to the property.
Malaysia	2015	Noriah Othman, Abdul Hadi Nawawi	GI positive contribution towards house and property price. Concluding that GI provides benefits towards the community in term of economic, social and environment.
Poland	2015	Robert Zygmunt, MichalGluszak.	Strong evidence of positive impact of GI proximity on undeveloped property prices, 100m increase in distance from the green land decreases land value by approximately 3%.
USA	2014	Marisa J. Mazzotta, Elena Besedin and Ann E. Speers.	Increased RE values due to improved ES, in particular augmented landscape and GI features.
Italy	2014	Vincenza Chiarazzo, Luigi dell'Olio, Ángel Ibeas and Michele Ottomanelli	The estimated models highlighted how environmental quality affect the prices of RE properties, showing positive signs if the buildings were located near beach areas and GI.
USA	2013	I-Hui Lin, Changshan Wu, Christopher De Sousa	Green facilities mainly for passive recreation, with exception of gardens, were likely to have positive impacts on property values.
USA	2012	Jean-Daniel Saphoresa, Wei Lic,	Comprehensive analysis to-date of GI capitalized benefits in the housing market, recommending targeting private owners to invest on GI.
China	2010	C.Y. Jim, W.Y. Chen	GI in the residential area was highly valued by Hong Kong people, adding a sizable premium for apartments located within the service area of a park and with a view of it.
China	2006	C.Y. Jim, W.Y. Chen	A semi-log HPM provided accurate housing price estimates regard GI view and the proximity to water bodies, which notably enhanced residential housing price.

Table 4 Examples of researches about GI influence on LV using HPM. Source: Author, 2016. Based on the authors previously described.

The combination of HPM with tools such as GIS and real time geo-mapping makes the science of property valuation easier, contributing directly to the better understanding of issues related with properties transactions, taxes assessment, RE investment and development.

However, as it is shown on the table, Latin-American countries do not figure in the list, showing that USA, European and Asian countries are leading in the use of these assessment tools. Particularly in Colombia, in the last ten years only little research was done on the field, considering papers from Universidad del Valle 2005; Carrillo 2012; Castaño et al. 2013; as the most relevant ones. Yet, neither of this research were focused on Cali or its rivers zones, exhibiting the lack of data and the necessity of it for informed decision making.

HPM has become in a useful tool to comprehend the value that urban GI adds to properties, which can be used to promote green space investment, its preservation and allocation in cities as well as reducing trade-offs between sprawl, leap frogging and urban quality of life. HPM offers an opportunity to position GI as a priority in governance, urban and CC issues through its capitalization in marketable goods, making it an adequate strategy for a capitalized neoliberal world (de Groot et al. 2012).

2.5 Conceptual framework

In the previous sections, a detailed description of the main concepts included in the conceptual framework of this thesis was provided in order to make clearer the relationships among them.

Green Infrastructure (GI) is one of the two main concepts to be analyzed, and it works as the independent variable that ejects certain influence on the second concept and dependent variable, Land Values (LV).

That influence, if existing, would be analyzed and measured through the Hedonic Pricing Model (HPM), which unlikely GI and LV, works as a method rather than a variable. Its presence in the main conceptual frameworks (see image 8) is highly important since it provides information about how their relationship will be analyzed and reported.

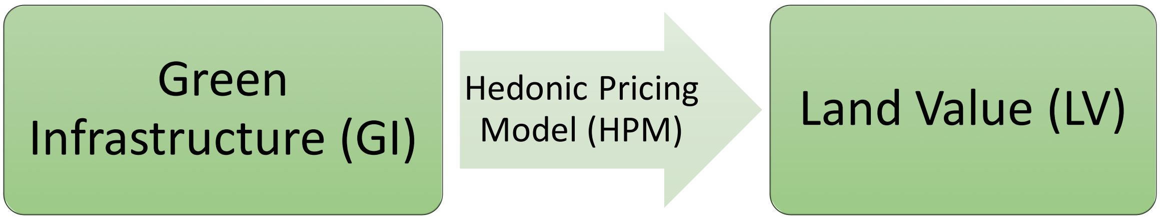

Figure 8 Conceptual framework diagram. Source: Author, 2016.

Chapter 3: Research Design and Methodologies

3.1 Introduction

This chapter will include the transition from the abstract and conceptual level previously approached in chapter two to an empirical one, where the concepts become variables and these into indicators that allow to measure aspects of the concept. Despite that these indicators do not reflect 100% accurately the concept for what is used for, at the end, the main goal is to use indicators and figures that can provide a valid and reliable way to represent them.

Research questions will be checked and tuned so they be in line with the conceptual framework and the operationalization. Then, a description of the research strategy, data collection methods, instruments and the sample size will be approached. All these descriptions are meant to provide future researchers the necessary information to replicate the analyses here performed.

3.2 Revised research questions

How much does Green Infrastructure (**GI**) affects Land Values (**LV**) in Cali?

- Which are the urban factors that affect LV in Cali?
- How much can ECC potentially affect the LV of the areas adjacent to the project?

3.3 Framework's concept construction and definition

The two main concepts in which this thesis is based (see image 8) are GI as independent variable and LV as dependent variable. The third component in the conceptual framework diagram is the Hedonic Pricing Model (HPM), which is the selected method to analyze the relationships among the variables, widely known and described by authors like Allison (1999), Wooldridge (2003), D'Acci (2014), etc. Therefore, in order to build GI and LV definition in a way that could fit the purposes of this thesis, several references were taken from the literature review, giving as result the following constructions:

Based on Benedict and McMahon (2006), Almada's (2011) and Lisbon's Master Development Plan (2012) *Green Infrastructure (GI)* is defined as a municipal ecological planned structure of natural and man-made systems of green and blue elements which aims to preserve connectivity and natural features, native species, restore & maintaining ES and improve the urban connectivity through green and sustainable mobility networks.

Land Value (LV) is defined as the most likely selling price of the bare land at the date of valuation including bare land development work such as drainage, retaining walls and levelling and excluding buildings or other improvements (Verheye 2009; Auckland Council 2014).

3.4 Operationalization

Table 5 Operationalization table

Dependent/ independent	[Concept]	Definition	Indicators	Unit	Description	Source of data	Reference To Literature	Original unit of data	Source year
Dependent	Land Value (LV)	The most likely selling price of the bare land at the date of valuation. Includes bare land development work such as drainage, retaining walls and levelling. LV excludes buildings or other improvements. (Verheye 2009; Auckland Council 2014)	Land value (LV)	$COP[13] / m²	Average price of land per m²	GIS_#164_LonjaPropiedadRaiz_Precio_del_suelo_x_Subareas_2010	University of Wisconsin Milwaukee 2013; Glaesener and Caruso 2015; Zygmunt and Gluszak 2015.	Subareas and Normative polygons[14]	2010
Independent	Green Infrastructure (GI)	GI is a municipal ecological planned structure of natural and man-made systems of green and water elements which aims to preserve connectivity and natural features, native species, restore & maintaining ES and improve the urban connectivity through green and sustainable	Number of Trees	Trees	Count of trees per block or neighborhood	GIS_#280_RAPOT_2013 ARBOLES_CENSO_CALI	Luttik 2000; Donovan and Butry 2010; Zygmunt and Gluszak 2015.	NGBH[15] & BLOCK	2013
Independent			Vegetation Biodiversity	Number of Species	Count of trees species per block or neighborhood. (This indicator is only used in the composition of the GI index, therefore, is not present in the regressions)	GIS_#280_RAPOT_2013 ARBOLES_CENSO_CALI •GI_GA02_Especies arboles comunas 2 12 17 19 •GI_GA02_Especies flora identificadas e inventariadas •GI_GA02_Estatuto arboreo Cali 2013	Penrose 2006; Fischer et al. 2007; de Groot et al. 2012.	NGBH & BLOCK	2013

[13] Colombian pesos (COP)
[14] For further details about the size and descriptions of data units please check Annex 13.
[15] Neighborhood (NGBH)

Independent		mobility networks. Benedict and McMahon (2006), Almada's (2011) and Lisbon's Master Development Plan (2012).	Green m²	m²	m² of public Green areas, parks and green squares accessible to the people (neighborhood scale only)	GIS_#268_GIS LAYER_Espacio Publico	Jim and Chen 2010; Song et al. 2015.	NGBH & BLOCK	2013
Independent			Vegetation coverage	m²	m² of vegetation coverage mapped from satellite view (only block scale)	LILP_HEDONIC_RISK/ URBAN VEGETATION COVER (.shp file)	Jim and Chen 2006; Jim and Chen 2010; Song et al. 2015.	NGBH & BLOCK	2013
Independent			Bike lines	meters	meters of bike lines per block and neighborhood	http://idesc.cali.gov.co/download/pot_2014/mapa_31_red_basica_de_ciclo_rutas_priorizadas.pdf	Racca and Dhanju 2006; Salt et al. 2015.	NGBH & BLOCK	2013
Independent			Pedestrian lines	meters	Meters of pedestrian lines per block and neighborhood	GIS_#16_Ejes Peatonales	Hass-Klau and Crampton 2002; Cities 2009.	NGBH & BLOCK	2013
Independent			Exposure to fluvial flooding (EFF)	Yes / No	Blocks and neighborhoods under or in direct contact with the risk polygons.	GIS_FR_CANAVERAL EJO GIS_FR_CALI GIS_FR_CAUCA GIS_#421_BARIOS GIS_#634_MANZANAS CATASTRO	Bin et al. 2008; Jessica Lamond, David Proverbs 2009; Posey and Rogers 2010.	NGBH & BLOCK	2013
Control	Mobility and accessibility	Indicators taken from literature that have shown repeatedly impact on LV and which were taken as control for the analysis	Public transport efficiency	Likert scale 1-5	Customers satisfaction about public transport efficiency	Encuesta Cali como vamos 2013 (Affairs 2014)	Ibeas et al. 2012; Jäppinen et al. 2013; Chiarazzo et al. 2014.	PUR	2013
Control			Public roads quality	Likert scale 1-5	Customers satisfaction about public roads quality	Encuesta Cali como vamos 2013 (Affairs 2014)	Ibeas et al. 2012; Jäppinen et al. 2013; Chiarazzo et al. 2014.	PUR	2013

Control			Public transport stops	Number of bus stops / public transport stops	Count for public transport stops at neighborhood and block scale	GIS_#21_Estaciones de parada GIS_#631_Estaciones MIO GIS_#421_BARIOS GIS_#634_MANZANAS CATASTRO	(Jim and Chen 2009; Demers 2011; Ibeas et al. 2012)	NGBH & Block	2013
Control			Distance to CBD	meters	Distance from the center of each NGBH and block to the CBD	Computation done in QGIS	(Hui et al. 2007; Balchin et al. 2000)	NGBH & Block	2013
Control	Socioeconomic		Commercial activities	Number of places/activities	Number of commercial places/activities like restaurants, hotels and sales at NGBH and block scale	GIS_RAPOT_2013 Actividades_Economicas _Camara_Comercio_2012 any	(Balchin et al. 2000; Ibeas et al. 2012; Yang et al. 2016)	Block	2013
Control			Cultural amenities	Number of places	Number of cultural amenities	GIS_#127_Equip Cultura GIS_#152_Equip Cultura GIS_#421_BARIOS GIS_#634_MANZANAS CATASTRO	(Damigos and Anyfantis 2011; Glaesener 2014; Glaeser et al. 2001)	NGBH & Block	2013
Control			Health amenities	Number of places	Number of health amenities	GIS_#158_Equip Salud GIS_#585_Equip Salud GIS_#421_BARIOS GIS_#634_MANZANAS CATASTRO	(Źróbek et al. 2015)	NGBH & Block	2013
Control			Floor Space Index (FSI)	m²	The quotient of the total of all over ground story area and the plot surface on which the building stands.	GIS_#164_LonjaPropiedadRaiz_Precio_del_suelo_x_Subareas_2010 GIS_#421_BARIOS GIS_#634_MANZANAS CATASTRO	Zygmunt and Gluszak ,2015	Predio/Plot	2012
Control	Security		Homicides	Number of homicides	Homicides per NGBH and block	(Cali, 2010)	Troy and Grove 2008; McDonald and McMillen	NGBH	2010

							2011; Donovan and Prestemon 2012.		
Control			Robbery rates	Number of robberies	Robberies per NGHB and block	(Cali 2011)	Troy and Grove 2008; McDonald and McMillen 2011; Donovan and Prestemon 2012.	Comuna	2010
Control	Environment		Noise pollution	decibels (db.)	average noise per NGBH and block measured in db.	GIS_#622_Ruido GIS_#421_BARIOS GIS_#634_MANZANAS CATASTRO	(Duarte and Tamez 2009; Chasco and Gallo 2012; D'Acci 2014)	NGBH & Block	2013
Control			Contact to water bodies (In an 80m radius)	Yes / No	blocks with direct contact to a water body within a radius of 80m	GIS_#88_RIOS_dg07 GIS_#421_BARIOS GIS_#634_MANZANAS CATASTRO	(Luttik 2000; Hansen and Benson 2013; Makinde and Tokunboh 2013)	NGBH & Block	2013
Control	Other		Life Satisfaction Index	Likert scale from 1-10	A proxy for housing, education, security, health, public spaces, water and air quality, etc. satisfaction per comuna	(Giraldo and Zapata Toro 2014)	(Haase et al. 2014; D'Acci 2014; Tsurumi and Managi 2015)	Comuna	2010
Method	Hedonic Pricing Model (HPM)	HPM is a method that models the property price as a function of its characteristics, deriving a marginal implicit price of each attribute (intrinsic or extrinsic attributes (D'Acci 2014), offering the possibility to monetize non- market values. It is based on actual transaction behaviors in the market (Hidano, 2002), which makes it relatively less controversial and less subject to interference by extraneous influences (Jim and Chen, 2006).							

3.5 Research strategy

3.5.1 Introduction

This section will discuss the research strategy selected based on the main objective of this thesis which is to do statistical analysis of the factors that affect LV across the whole city of Cali at neighborhood and block scale, especially those under the category of GI.

3.5.2 Secondary quantitative research and survey

This research uses a secondary quantitative strategy since it allows to cover the breadth and amount of analysis in time and cost required for this thesis scope. Its major advantage is the possibility of using literature, secondary data and official statistical material and process them from the commodity of the desk, reducing the time and cost of collecting it personally. It also offers the possibility for generalization due to the use of large sets of quantitative data as well as providing external validity and reliability (Verschuren 2010).

Complementary to secondary quantitative research, an online survey is carried out in order to triangulate the statistical results with opinions from people with knowledge about Cali's urban environment. An important remark of this survey is that in order to be compared with the regression results, it has to reach a minimum of 30 responses to be statistical significant, otherwise its results can only be used as representative figures rather than a formal comparison reference (Neuman 2006).

3.6 Data collection methods

The secondary quantitative data for building the analysis models has two data sources, the main one is a geo database file for GIS use, available directly in the municipality website[16] .This GIS database is a collection of census and data from different governmental organizations that has been digitalized in a geographic format allowing to see the variety of concentration points across the whole city. The file has 653 layers with a wide diversity of information from dependencies like the Commercial Chamber of Cali (CCC), The Colombian Chamber of Construction in Cali (CAMACOL), Cadaster, Administrative Department of Environmental Management (DAGMA), etc. However, since the process of digitalization in Cali is still in early stages, not everything has been uploaded or updated to the latest version, therefore a secondary data source had to be found in order to fulfil the holes in this geo database.

This secondary data source is formed by a group of reports and statistics carried out by the municipality of Cali or other governmental dependencies[17] like the National Department of Statistics (DANE) or the Social Observatory of Cali. From the 21 operationalized indicators, only 6, which are part of the control variables, use data collected from these sources.

[16] http://www.cali.gov.co/planeacion/publicaciones/pot__pub

[17] For more information about the different sources of data used for the models please check the operationalization table in the section 3.3

In the case of the survey, responses are obtained via email by sending it to the main design and planning companies across Cali as well to people with renowned positions in fields related to the research such as architecture, urban planners or professors.

3.7 Data analysis methods

3.7.1 Statistical Analysis –Hedonic Pricing Model & OLS

In order to assess to which extent urban factors, including GI, affect LV across Cali, a statistical analysis is carried out through the use of secondary quantitative data and HPM at neighborhood and block scale. HPM is a method that isolates the impacts of individual attributes of a good or a service on the price of that good or service. Therefore, in this scenario HPM would be used to deconstruct LV into its component parts (control variables and GI). Later, by using OLS regression results, β coefficients would be obtained, indicating how much that attribute contributes to the overall LV.

The OLS models would be constructed based on the two scales of observation: neighborhood and block, using the variables in the operationalization table (see table 5), which include four control variables supported by literature for having impact on LV (see figure 10) plus the critical GI variable. After having isolated the influence of GI in LV through the HPM, these coefficients will be used to forecast the potential impact that GI elements included in the ECC can eject on the LV in the areas adjacent to the project.

This will be done in a matrix table where the β coefficients from the GI indicators will be combined with the current status and the future scenario with ECC implemented (see Annex 11). This will allow to compare the impact on LV of GI elements before the project and their potential effect after the ECC intervention.

3.7.2 GIS Analysis

Despite that the HPM and OLS regressions would be based on numeric quantitative data, the main source of all that data set is a geographical database from GIS. This GIS format allows to see graphically the concentrations of elements that sometimes becomes harder to see in a table of thousands of numbers and codes. The GIS analysis allows to see graphically and geographically where the major concentration of trees, vegetation coverage, public transport stops or cultural amenities are located across all the 336 NGBHs and more that 10 000 blocks in Cali.

When analyzing LV, location and the accessibility to amenities that come with it are highly relevant factors to take in consideration. Balchin et al. (2000) remarks how increasing distance to the main amenities and CBD can affect negatively LV across the city. The distance factor is an indicator that despite of being numerically included in the models its impact can only be fully understand through the graphic analysis from the distance matrixes in GIS. Therefore, GIS is a highly valuable complementary tool for understanding the impact of each indicator in LV.

3.8 Preliminary procedures for Hedonic Analysis

3.8.1 Introduction

Using a Hedonic Pricing approach to analyze the influence of GI on LV requires a series of tests in order to confirm the suitability of the indicators, samples and sets of data that would build the model analysis. Therefore, section 3.8.2 will discuss the assumptions under which the two samples from Cali were taken, one at neighborhood scale and the second at block scale. Afterwards, section 3.8.3 describes the OLS selected statistical model and its aptness to analyze the data. Lastly, section 3.8.4 will discuss the Gauss – Markov assumptions under which the OLS model works as well as the conditions that data has to meet in order to fit in (Wooldridge 2003).

3.8.2 Data collection/preparation results; sample description

In order to make possible the generalization of the obtained results in the hedonic models and forecasting tables, the selected sample had to be big enough to represent the whole city. Besides the generalization goal, several factors as the availability and quality of data were the main determinants of the samples' final size at neighborhood and block scale.

From the 336 existent neighborhoods (Alcaldia de Santiago de Cali 2014), five were removed beforehand due to missing data. Therefore, the simplest and most parsimonious models ran optimally with 331 NGBHs, whereas the most complex and least parsimonious ran with 281 NGBHs due to incomplete data in the additional indicators.

The block sample was formed by 10543 blocks from a total of 13882 registered in the GIS database. This reduction of 3339 blocks was done since these blocks were located in settlements outside the defined urban perimeter, and therefore are not officially considered as part of the municipality of Santiago de Cali.

In the case of the online survey the sample was built including renowned local firms and people related with the fields of urban planning, architecture or municipal planning department as well as professors of universities related to the field. In order to achieve a statistical relevance, 30 responses were required, therefore, 45 surveys were sent.

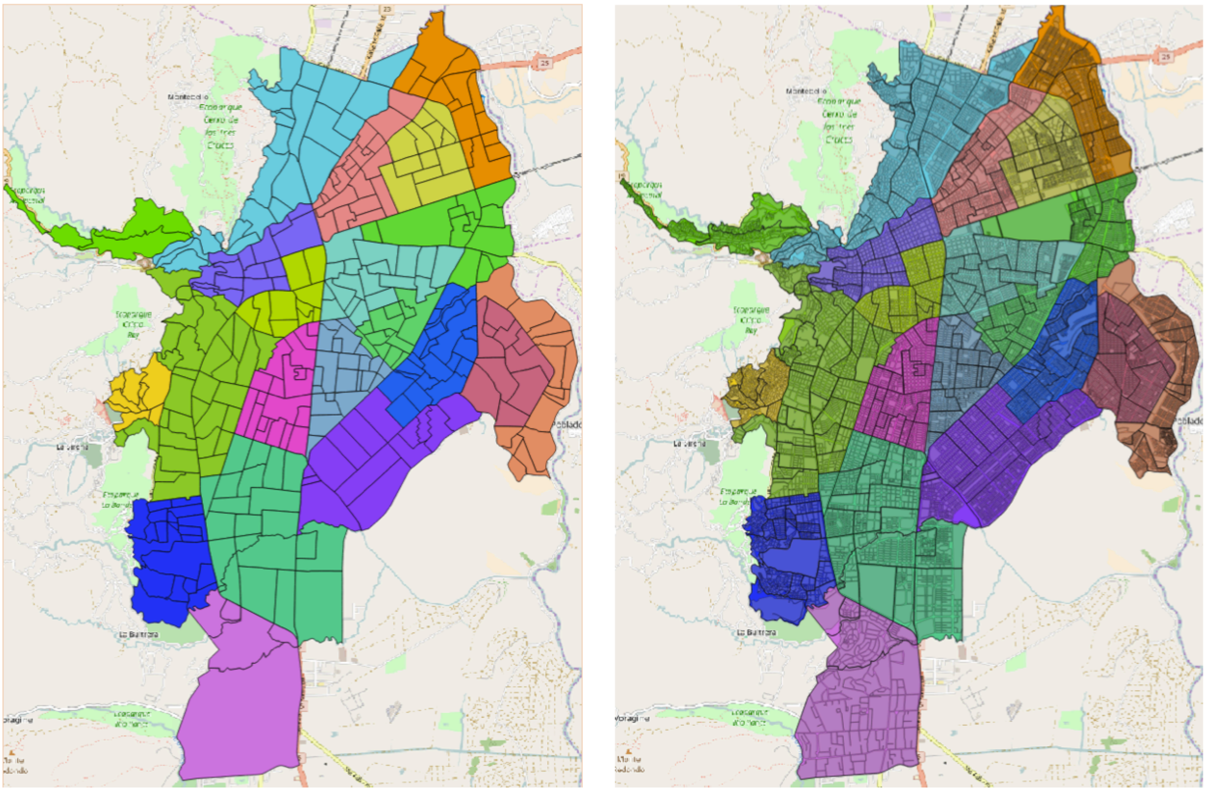

Figure 9 Neighborhood sample with 331 NGBHs colored by comuna (left). In the right, block sample with 10543 blocks across 331 NGBHs. Source: Author, 2016. Based on GIS-RAPOT2013 file.

3.8.3 Choice of statistical model

Since the dependent variable is formed by continuous data (see table 6 and 7), this research uses OLS regression techniques to estimate coefficients for HPM. This is in line with many authors such as Cho et al. (2006), Jim and Chen (2009) de Groot et al. (2012), Zygmunt and Gluszak (2015) and Tyrväinen and Miettinen (2000).

A HPM has as main goal to create a predictive model using different type of regression to forecast the y values by measuring the influence (β coefficient) that certain x ejects on the transaction price. However, since regressions can be used for prediction and causal analysis is important to point out the difference between these two modalities and which one is used in this research.

When doing a predictive study, the main objective is to generate an equation that can predict the value of the dependent variable based on the values of the independent ones, e.g. Equation 5:

$$y= \beta_0 + \beta_1\chi_1 + \beta_2\chi_2 + \beta_3\chi_3 + \cdots \varepsilon$$

Equation 5 Example of regression equation as the outcome in a predictive study. Source: Wooldridge 2003.

But when the case is a causal analysis, the independent variables are considered as causes of the dependent variable. This means that what is looked for is to test if certain independent variable(s) have an effect on the dependent and if so, estimate its magnitude (β regression coefficient) (Allison 1999). Therefore, in this thesis, OLS regressions would be used not to get a predictive equation but for getting the magnitude (β regression coefficient) of the effects caused by the independent variables to the dependent variable (causal analysis). These coefficients would be used to forecast the potential impact of the GI indicators which are related with ECC project by summing up the projected increases due to ECC times the β of that indicator (see Annex 11).

Y / X	Indicators	Classification	Type
y	• Average price of land per m²	Continuous	Ratio
X	• Public transport efficiency (1-5) • Public roads quality (1-5) • Life Satisfaction Index (1-10)	Continuous	Interval
X	• Number of Trees • Green m² • Pedestrian Lines (m) • Number of Public Transport Stops • Number of Health Amenities • Number of Cultural Amenities • Number of Homicides • Number of Robbery • Noise Average (Db) • M² Vegetation Coverage • Bike Lines (m) • Floor Space Index (FSI) • Number of Commercial Activities	Continuous	Ratio
X	• EFF • Contact with water bodies	Discrete	Binomial

Table 6 Classification of variables according to their type of data based on Thiel (2014) scales of measurement.

Independent variable(s) X	Continuous y	Discrete y
Continuous	OLS regression	Logit/ Probit regression
Discrete	ANOVA	Chi Square
Mix of continuous and discrete	**OLS regression/ ANOVA**	Logit/ Probit regression

Table 7 Choice of model according to type of data. Source: (UCLA, 2016)

3.8.4 Gauss – Markov assumptions – Conditions for OLS analysis.

Before running any regression, the data was tested in order to check if it met the required assumptions for OLS. According to Wooldridge (2003) these four main test are: checking for unusual data, heteroskedasticity, multicollinearity, normality and residuals, which are commonly known as Gauss – Markov assumptions.

When checking for unusual data, what normally comes out are outliers, which are observations with irregularities in the dependent values related to the given independent values. The most important thing with outliers is to identify whether they are an error on the data capture or they are indeed an anomaly in the set. In the NGBH data set, these outliers where identified in an early stage in the excel tables. NGBHs 704, 1997, 2097 showed errors due to missing or wrong data in some of the independent variables. Later on STATA, with the help of the scatterplots graphs (see Annex 2) a couple of neighborhoods were detected way distant from the main group. In these cases, it was decided to keep them in the analysis since the peaks were caused by a project intervention from municipality.

In the block data set, only the blocks that were outside the urban perimeter were removed as well as those inside the urban perimeter that didn't meet the $26m^2$ minimum required for social housing according to the national decree #2060 from 2004.

OLS works based on the assumption that the variance of the error term is constant (Homoskedastic), reason why is necessary to test in case of possible heteroskedasticity, meaning that the variance in the error terms are not constant (Long & Trivedi 1992). Block and neighborhood models were tested in STATA by using the Cameron &Trivedi's test and plotting the residuals, which made easier the detection of plots along the reference line. Both models had a symmetrical distribution, slightly skewed to the left (see Annex 3), with a tendency towards the middle of the plot, clustering around lower single digits. These characteristics mean that data is normal and in general there are not clear patterns on the distribution, concluding a positive result for no heteroskedasticity.

Collinearity implies that there is a perfect linear relationship among the predictors (UCLA 2007) meaning that they are related to each other. When more than two variables present this interrelationship is called "multicollinearity". Having a high degree of multicollinearity means that the coefficients obtained from the regression turn unstable, which has a direct impact inflating the standard errors. STATA offers the vif command, which stands for *variance inflation factor* with a rule of thumb that any variable with a vif higher than 10 should be reconsidered or excluded from the model. The results from the collinearity diagnosis in both models gave a vif of 1.16 - 1.14 meaning no significant correlation between the variables (for further detail check tables 11,12 and Annex 4).

The assumption behind normality and residuals is that the errors should be normally distributed, which can be graphically observed with the command kdensity r and resid in STATA, which shows in a red line the normal behavior overlapped with the estimated one. The diagnostics results from both scales showed a normal distribution of the errors and homoscedastic residuals, meaning that model's residuals do not vary with changes in the independent variables (see Annex 5). All these diagnostic results allow to conclude and confirm the validity of obtained results from the regression analysis. For further detail of histograms for the distribution of the priority indicators in both scales please check Annex 6 and Annex 7 .

"All generalizations are false, including this one."
-Mark Twain

3.9 Research limitations

3.9.1 Introduction

The need to cover a big scope in a limited amount of time requires the use of certain research strategies to accomplish the target. In the case of this thesis, the analysis of the urban factors that affect the LV across the whole city of Cali made it suitable for secondary quantitative research. Therefore, the main limitation of this type of research comes with the implications of using statistical models like regressions and secondary quantitative data.

3.9.2 OLS Limitations

"Since all models are wrong, the scientist must be alert to what is importantly wrong. It is inappropriate to be concerned about mice when there are tigers abroad."(Box 1976, p.792)

Using a statistical method to carry a desk research requires a set of conditions that must be meet in order to ensure the reliability and validity of the results. In the case of OLS regressions, this conditions are known as the Gauss-Markov assumptions that look for linearity, unusual data (outliers), heteroskedasticity, multicollinearity, normality and residuals (Wooldridge 2003). However, some decisions were taken for the sake of the research that could be considered against the primary assumptions of OLS regressions.

In the case of linearity, the behavior of some indicators presented a spectrum of changes, like trees or vegetation which are highly dependent on the context. This means that the behavior of trees could not be completely linear, instead, it could follow a non–linear behavior after reaching a limit point (see figure 21). This is related with adding a tree in an area with few, which would have a bigger impact compared to adding a tree in an area that already has many. This situation is in line with Gossen's laws and the diminishing in the marginal utility of GI elements such as trees (Heinrich Gossen 1854).

When talking about outliers, after taking out those caused by missing or wrong data, cases like the one from neighborhood 2296 were approached in a different way. Instead of taking it out, it was decided to leave it since its high scores in GI features were connected to a previous intervention carried out by municipality to cover the trees and vegetation deficit (DAPM, 2008). Therefore, it was decided to include them in the model even when according to the assumptions they should have not.

3.9.3 Green Infrastructure limitations

The construction of the GI concept was done in order to fit its components within the ECC project in Cali. This is because besides testing if GI had an influence in LV across the city, this thesis also looks for forecast the potential impact that ECC could have if implemented. Therefore, it was necessary to count with an assessment of the GI indicators included in ECC as they are now in order to compare their impact with the future interventions. This means that the GI concept that is used in this research is focused in those GI elements included in the ECC project and not in all the umbrella of GI.

Moreover, is important to remark that all the GI results do not reflect the whole impact that they eject in LV. This is related with the difficulties that come when trying to assess nonmarket-traded attributes or benefits like ES (Benotto 2002). All this benefits that are implicitly provided by trees, vegetation, reduction to flood exposure, pleasant view, etc. are there affecting the LV, however their quantification and monetization requires a deeper analysis that should be taken into consideration for further research.

This non- market attributes in addition to the impact that all the GI indicators represent as a whole is what Aristoteles describe as "The whole is more than the sum of its parts".
The sum of the absolute influence values of each single GI indicator is not an accurate image of the potential influence that as network could eject on the LV across Cali, which might be higher than what can be predicted in this thesis. Therefore, is not recommended to take the regression coefficients as an absolute influence indicator.

3.9.4 Data limitations

Building a model for regression analysis demands a huge amount of data that first has to be collected and cleaned in order to fill the indicators that would provide the final outcomes of the analysis. These indicators work as "an economical description of a natural phenomenon" (Box 1976, p.792), therefore is impossible to expect a 100% accuracy in what they are measuring since something is lost in the description process carried out by the collector, which consequently affects it's reliability.

These indicators were collected from different sources and sometimes the specified year of analysis was not the same in all of them. This is the case of the indicators taken form the GIS data base in comparison with the ones from secondary group of municipality reports. Despite that both authors are the same (Cali's municipality), the GIS database was updated till 2013 and the report documents just till 2011. This implies an inconvenient for the internal validity of the research. Fortunately, from the 21 indicators used in the models, 15 are from the same GIS document (including the priority ones) and the rest are control indicators taken form municipalities' publications.

In the case of the dependent variable, the data used for its construction are general reference values and not a specific value for each sector (normative polygon) (see Annex 13) analyzed across Cali. This reference value takes into consideration extrinsic factors like location, regulations, stratification, basic public services, complementary services, etc. (Lonja and CCC 2008). However, this data only provides a final value from all these components and not an individual score for each, which would had had helped to increase the reliability by helping to control all the involved aspects of the dependent variable.

When analyzing the scores for efficiency of public transportation and quality of roads is important to remark that they represent only a proxy for people satisfaction on a Likert scale, and therefore their coefficient cannot be translated literally as an increase in one point of satisfaction is equal to β per m^2 of land. These indicators are only general figures showing the relevance of transportation and the quality of roads, thus, in case of needing an accurate coefficient for marketability is recommended to carry a deeper analysis in further research.

EFF also presents important limitations, the first one is regarding the rivers that are included in the indicator. From the seven rivers across the city, the indicator only included areas with

flood exposure across Cali, Cañaveralejo and Cauca river. In the case of Pance, Lili and Melendez rivers, they were not included since their exposure areas where outside the urban perimeter of Cali (see Annex 14). For the Aguacatal river, the mapping from its exposure area was no included due to an inconvenient with the format where the maps where found.
EFF's second limitation is about the time frame at what the events were mapped. For Cauca river, the exposure areas were mapped in a time frame of 500 years of events with a classification from high to low exposure, while Cali and Cañaveralejo river are mapped in a time frame of 50 years with no classification of the exposure. Therefore, it was decided to homologate the three maps and become them a dummy variable (0/1).

Concerning to trees, the GIS layer used was based on a census that is currently being carried out in Cali, therefore the results in there are preliminary and presented some data holes like the ones in comuna 10,11 and a part from 17. These holes were covered using sources like the tree inventory from DAGMA (SAF-LTDA and DAGMA, 2000) and the annual census from DANE (National Management Department of Statistics) which provides a percentage of the trees per capita per comuna. By using the population per neighborhood in each of the three comunas and the percentages in the documents from DAGMA and DANE a proxy, the missing values were generated.

All the limitations previously mentioned are common when realizing a research with such a big scope and large secondary quantitative data sets (Verschuren & Doorewaard 2010). However, since "all models are wrong", it's the researchers' duty to "worry selectively" (Box 1976, p.792) and identify those issues that are critically wrong to put in danger the final outcomes. Therefore, given the previous limitations in the models, decisions were taken in order to fill the gaps in the data sets in the most valid and reliable way, always looking for building the most parsimonious models (Box 1976).

Chapter 4: Research Findings

4.1 Introduction

This chapter presents the results and the corresponding interpretation from the different statistical analyses that were carried out to answer the research sub questions discussed in Chapter 1. A total of eight regression models is carried out on two different scales (neighborhood and block) in order to understand the urban factors that affect LV and the behavior of the priority indicators addressed in the ECC project. The neighborhood models worked as a generalizable scenario for urban factors affecting LV given the size of the observation unit. However, these models didn't allow to see in detail the impact of GI in specific areas. Block models provided an insight of every single GI feature addressed in the ECC project and its impact on LV, providing detailed coefficients for the forecasting section. Section 4.2 presents a detailed description about each of the indicators in the independent and dependent variable. Then, section 4.3 presents the description of the main indicators that showed significance for explaining the urban factors affecting LV and specifically the behavior of the priority indicators involved in ECC. Lastly, a third model will address the conflicting results showed between Contact with water bodies and Exposure to Fluvial Flooding (EFF).

4.2 Dependent and independent variables description: scale and number of observations, measures of central tendency and spread.

In order to construct the models that will help to answer the main question and sub research questions discussed in Chapter 1, twenty indicators classified in three categories are used (see figure 10). This section will provide detailed information about their nature and characteristics.

Twenty indicators are used to build a total of eight regression models, four at neighborhood scale and other four at block scale. From the four regression models at neighborhood scale, NS1 and NS2 are the more parsimonious models including just the GI indicators and the most essential indicators for control. The difference between the two parsimonious models is that in the NS1 model, the analysis runs using Trees and Green m^2 independently, whereas in model NS2 they were replaced by the Green Infrastructure Index (GI Index). This index sums up the normalized values of Trees, Green m^2 and an additional indicator for Vegetation biodiversity into one total value. The other two models, NC1 and NC2 are more complex and use 18 indicators instead of the 13 used in NS models. These additional five indicators used in the NC models are extra control variables included to compare the behavior of GI in a different scenario where more factors are taken into account.

At block scale, the classification works in the same way, the first two models, BS1 and BS2, are more parsimonious. These include only the priority indicators and main control ones, including also the modality of using the GI indicators independently or as an index. Models

BC1 and BC2 are the more complex versions with 18 indicators instead of 14, including the modality of the GI Index in the model BC2 as well.

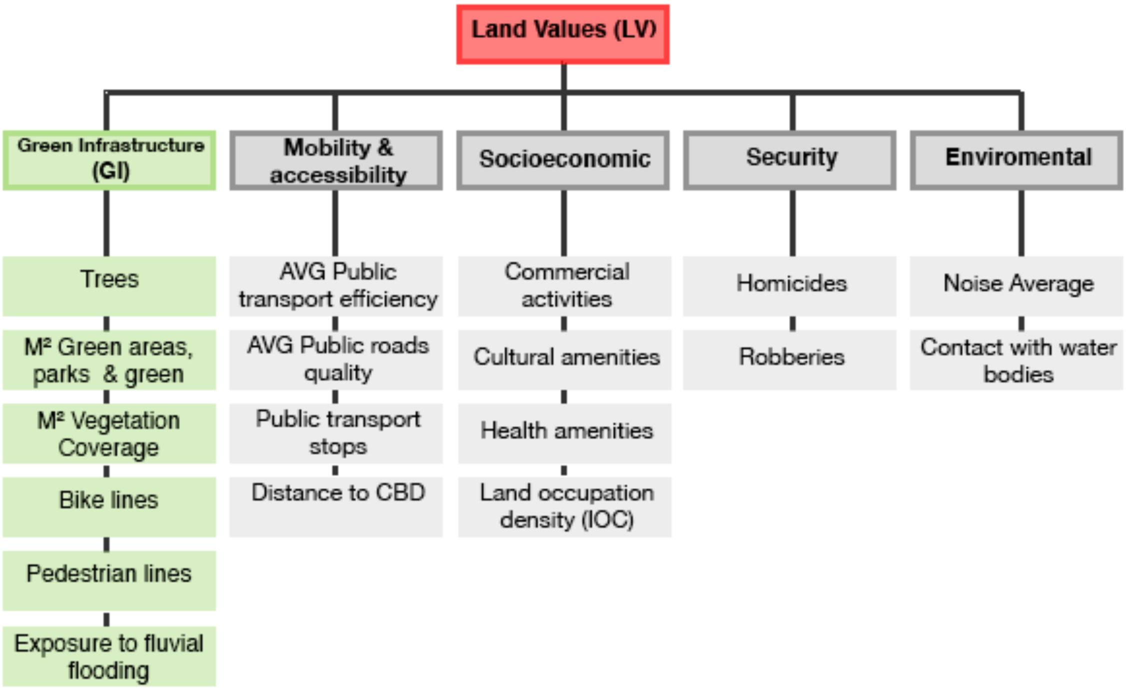

Figure 10 Classification of indicators into dependent (red), independent (green) and control (grey) variables. Source: Author, 2016.

LV is the dependent variable and is measured through the average price in COP[18] per m² of land. With 331 observations at neighborhood scale, it registered an average value of 14% higher compared to the one scored at block scale (see table 8). However, when comparing the maximum price per m² registered at neighborhood vs block scale it can be observed that the block model had a maximum value that was twice as high (see tables 8 and 9).

These distortions happen when inside a neighborhood most areas have a low LV, while a small part registers a high price (or vice versa). Then, when all the values are averaged to get a unique value for all neighborhood, the result is higher than it could be without those peaks in the calculation, giving a blurry idea of the actual land market values in that neighborhood. This situation can be appreciated in the figure 11, where the distribution of land price in neighborhood 1791 consists mainly of low prices between $200,000 and $400,000 per m², however, a small portion has a peak of $1,600,000 to $1,800,000, which at the time to get the total average value of the neighborhood distorts the results by showing a higher average price than the one that could have been obtained without the peaks. This can be fixed at the block level, where blocks allow to see in more detail the variations in the price within a same zone.

Among the priority variables for the ECC project are Trees, which scored a mean of 523 and 0,04 at neighborhood and block scale respectively. Pedestrian lines with a mean of 827m at neighborhood scale and 32.96 m at block scale, which is consistent with the dimensions of a small block in Cali. Bike lines is one of the priority indicators that showed big discrepancies at running the regressions in both scales. It scored averages of 76.29 m and 6.14 m at

[18] COP is an abbreviation for Colombian Pesos $

neighborhood and block scale respectively it, while the maximum values in both scales remain almost the same at the limit of one kilometer, which denoted the small presence of the variable across the whole city.

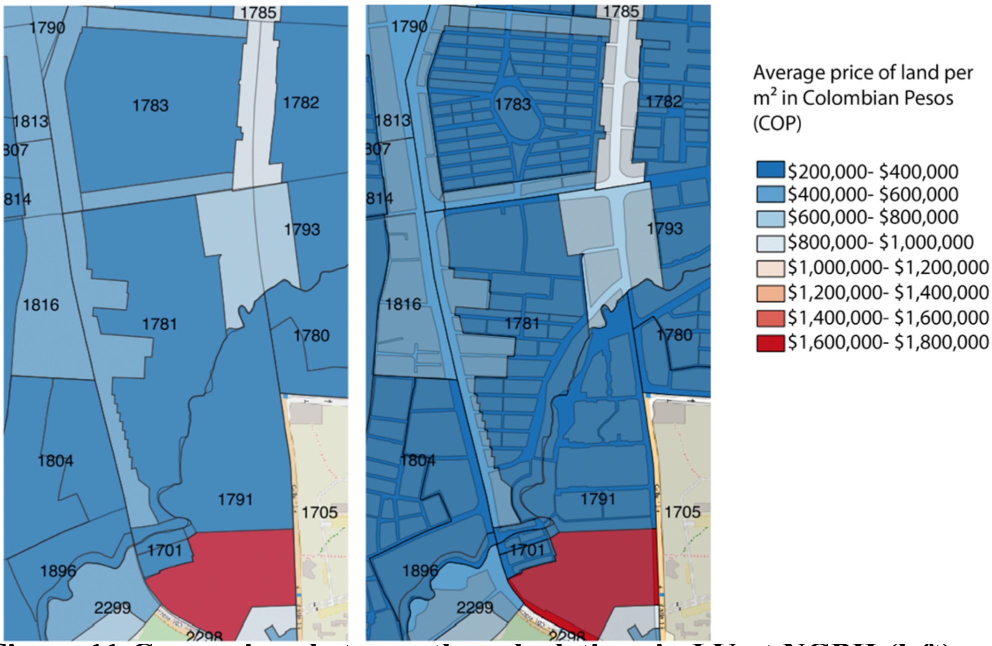

Figure 11 Comparison between the calculations in LV at NGBH (left) and block scale (right). Source: Author, 2016. Based on GIS-RAPOT2013 file.

Green m² and M² Vegetation Coverage are two interchangeable indicators used to measure the green presence in the city in both scales. However, the Green m² indicator only takes green public spaces into account whereas the m² vegetation coverage uses satellite images to assess both public and private green areas. Green m² is an indicator that works better at a neighborhood scale since it could register the impact of public spaces with green presence around the city, which in this sense could be appreciated across the whole neighborhood. However, at block scale, using this same indicator does not work since there are only few public spaces that fit in a block and still leave space for land properties. This inconvenience would have caused most of the green public spaces to become imperceptible. Therefore, the indicator M² Vegetation Coverage was used at block scale since it allowed to register all the green presence in all the blocks including the ones from private properties and small vegetation between streets.

Green Infrastructure Index (GI Index) is a figure that is used to see the overall impact of the vegetation components in the ECC project. This index is built by normalizing Trees, Green m² (M² Vegetation Coverage in the case of blocks) and Vegetation biodiversity in a range from 0 to 1 and summing up the resulting values, leaving a possible max score of 3[19]. As it can be observed, the means were 0,56 and 0,02 at neighborhood and block scale respectively. As described before, this indicator works just as an overall figure to see if the vegetation aspects of GI have or not an impact on LV, however, since its values were normalized to construct it, the use of its regressions coefficient to measure the impact in a tangible way turns into a difficult task due to the different units in which the components of the index are measured,

[19] The GI index used a unity-based normalization, with values from 0 – 1 and an equal weight for each of the components, meaning that none of the standardized values was multiplied by any percentage.

therefore GI index is not used in the ECC forecast. The Floor Space Index (FSI)[20] measures the amount of built floor area divided by the plot size. This indicator is averaged per neighborhood and block size, giving a figure of how densified each neighborhood / block is.

Life satisfaction index is an indicator based on the "better life index" from OECD (Giraldo & Zapata Toro 2014) which gives a proxy for housing, education, security, health, public spaces, water and air quality, etc. In a rough way, it can map where people are more satisfied with the urban quality of their area in a scale from 1 to 10, where 10 is the highest score and 1 is the lowest. However, the purpose of this indicator is only to be an indicative figure of the urban quality and satisfaction in general, which means it would not be used in the forecast section.

Exposure to Fluvial Flooding (EFF) and Contact with water bodies are two dummy variables that are included only at block scale. In the case of the EFF, this indicator is built using the maps from the areas with record of previous flood events in a range of 50 to 500 years. These maps included the flooding events from the Cañaveralejo, Cali and Cauca river. On the other hand, contact to water bodies is an indicator that registers every single block that has a direct contact with a water body such as rivers, canals or streams in a radius of 80m, which is the average depth for a block in the city. The reason of using them only at block scale is because the risk of getting bias due to the size of the neighborhood. This means that at neighborhood scale, even when just a small area of the neighborhood was touching one of the risk polygons it would account as if the whole neighborhood were in risk, which is not necessarily correct. The same applies to contact with water bodies, where a small section of the neighborhood could have contact to a water body, which would account for the whole neighborhood. For this reason, only the blocks that had a direct contact with a water body in a radius of 80m would be accounted in the analysis. In the case of EFF, only those blocks or sections of blocks covered by the risk polygons would be registered in the analysis.

Neighborhood indicators	Obs	Mean/ Average	Standard deviation	Min	Max
AVG Land Price Per M²	331	318456,2	149363,9	106000	867857,1
Number of trees	333	523.813	536,6706	0	3314
Green m²	333	4,31e+07	4,11e+08	0	4,98e+09
Vegetation biodiversity	281	51.20641	31.27847	1	128
GI Index	281	.5662955	.4007082	-2.28e-08	1.830176
Bike lines	333	76.29066	224.8364	0	1746.62
Pedestrian Lines (m)	333	827,7787	1.259.507	0	17794,46
Public Transport efficiency (1-5)	333	3,672673	0,1189983	3,5	3,8
Public Roads quality (1-5)	333	2,58048	0,0694887	2,5	2,7
Life Satisfaction Index (1-10)	333	7,075075	0,3604011	6	8
Number of Public Transport Stops	333	7,930931	8,448892	0	73
Number of Health Amenities	333	1,474474	7,195429	0	120
Number of Cultural Amenities	333	0,8918919	2,815677	0	28
Number of Homicides	333	5,093093	7,623702	0	47
Number of Robbery	333	18,20193	17,5832	0	112,6764
Noise Average (Db)	333	68,65791	4,46999	53,75	80
Distance to CBD (m)	333	4.636.341	2122,71	106,8132	11732,78

Table 8 Descriptive table of dependent and independent variables at neighbourhood scale. Author, 2016. Calculated based on HPM - Cañaveralejo River Case 2016.

[20] Also sometimes called Floor to Area Ratio (FAR).

Block indicators	Obs	Mean/ Average	Standard deviation	Min	Max
AVG Land Price Per M²	13,210	278784	148501.6	10000	1750000
Number of Trees	13,210	.0445555	2.0235	0	661
M² Vegetation Coverage	13,882	755.407	5781.82	0	325876.6
Vegetation biodiversity	13,882	1.21337	3.9419	0	73
GI Index	13,881	.0259912	.0930	0	2.3699
Bike Lines (m)	13,882	6.14419	41.1813	0	1901.33
Pedestrian Lines (m)	13,881	32.9662	94.6866	0	3910.92
EFF	13,882	.1019	.3025	0	1
Contact with Water Bodies	13,882	.1810	.3851	0	1
Public Transport efficiency (1-5)	13,881	3.6601	.1122	2.4	3.8
Public Roads quality (1-5)	13,881	2.5786	.0663	2.5	3
Floor Space Index (FSI)	10,925	22.9500	317.4468	.0040	22034.24
Number of Commercial Activities	13,881	3.0224	9.4583	0	620
Number of Cultural Amenities	13,881	0,0376	0,3240	0	12
Distance to CBD (M)	13,881	5.075.795	2.074.836	14.9892	13216.44
Number of Homicides	13,812	8.8452	10.9022	0	47
Number of Robbery	13,800	24.40722	18.7636	.3517	112.6764
Noise Average (Db)	13,847	6.843.847	6.364.055	42.5	82.5

Table 9 Descriptive table of dependent and independent variables at block scale. Source: Author,2016. Calculated based on HPM - Cañaveralejo River Case 2016.

4.3 Urban factors affecting land value.

In order to determine the urban factors that affect LV hedonic models based on eight OLS regression are carried out on two different scales. A first analysis at neighborhood scale was done to get a general view of the impact of the GI indicators (Trees, Green m², bike lines, pedestrian lines) as well as the relevant control indicators. After this first analysis, indicators like bike lines and EFF presented some anomalies that required a deeper analysis. A second analysis was carried out at block scale to asses in detail the GI indicators and their impact on LV. Lastly, an extra model was run to assess in detail the unexpected results of Exposure to Fluvial Flooding (EFF).

4.3.1 Neighborhood analysis

One of the main aims of this research is to provide reliable information about the impact that GI can have on LV in order to be used as strategy to redevelop areas and get revenues from LVC. Using a preliminary regression model at neighborhood and block scale (see table 10) including only trees as GI indicator and LV as dependent, it was shown the positive impact that this single GI feature could eject on LV. The validity of this results are supported by a correlation test among the omitted independent variables (see Annex 4), which showed that as expected, there was no correlation among them, enabling to use the results from this preliminary test. Since the goal is to measure the effect that independent variables eject on the dependent variable and not the regression equation itself, the coefficient obtained by this regression is valid to be used in assessing the impact of trees in LV.

The results of table 10 are also supported by equations 1 and 2 discussed in section 1.7, presenting two scenarios where the exclusion of x_s does not necessarily mean that the results are biased. The first scenario considered β_2= 0, meaning an excluded x_2 from equation 1(Wooldridge 2003).The second scenario considers $\tilde{\delta}_1$ = 0, even in the case that $\tilde{\beta}_2 \neq 0$ (Wooldridge 2003). Therefore, an unbiased $\tilde{\beta}_1$ can be possible if x_1 and x_2 are uncorrelated in the sample.

Model scale	Neighborhood model	Block model
	AVG LV \$COP/M²	AVG LV \$COP/M²
Trees	57.67***	644.94***
	(15.01)	(81.10)
Constant	288064.27***	276680.11***
	(11280.99)	(1315.89)
Observations	331	13210
Vif	1.00	1.00
Adjusted R^2	0.04	0.00

Table 10 Preliminary models including only trees and LV. Author, 2016. Calculated based on HPM - Cañaveralejo River Case 2016.

NSs and NCs models showed significance for 3 of the 5 GI priority indicators, trees, Green m² and pedestrian lines, leaving bike lines with no significance at this scale. In models NS1 and NC1 trees reached a high significance and a positive impact on the LV. This impact, in addition to the significance obtained by Green m² accounts for the overall impact that GI vegetation elements have as a whole on the LV at NGBH scale.

Despite that Green m² obtained a small regression coefficient, it does not imply that it has no impact on LV. This can be easily checked in the GI index results, which scored a high significance and a positive impact of \$92,374.11 in the NS2 model (see table 11). As discussed before in section 4.2, GI index is not meant to be used in the hedonic models and forecast analysis, however it allows to see the integral impact of the vegetation elements in the GI group, which in this case is highly significant and positive when assessed as an integral entity. As many GI elements, the extra benefits provided by GI are mainly neglected in this type of studies due to the complex process of monetization of ES (Costanza et al. 1997; Benotto 2002; Millenium Assessment 2005). However, their impact and competitive edge to contribute to property values has been widely discussed and documented by authors like Anderson and Cordell (1988), Jim and Chen (2006) and Batabyal et al. (2003).

Table 11 Neighborhood models.

NEIGHBORHOOD MODELS	(NS1) AVG LAND $/M²	(NS2) AVG LAND $/M²	(NC1) AVG LAND $/M²	(NC2) AVG LAND $/M²
Trees	**54.41*** (12.92)**		**38.39*** (12.93)**	
Green m²	**0.00** (0.00)**		**0.00* (0.00)**	
Public Transport efficiency	425577.86*** (60036.10)	529175.20*** (69404.95)	422710.14*** (58129.69)	513677.39*** (66920.82)
Public Roads quality	1205407.49*** (105721.55)	1295644.51*** (114810.04)	1113707.16*** (105878.49)	1193185.38*** (116822.99)
Life Satisfaction Index	41573.28** (17464.90)	57456.81** (22954.89)	39363.67** (17306.24)	53398.17** (23104.71)
Pedestrian Lines	**14.36** (5.83)**	**13.92** (5.82)**	**10.84* (5.76)**	**10.67* (5.70)**
Public Transportation Stops	-813.24 (981.38)	-1063.81 (1000.20)	-997.06 (952.66)	-1366.14 (964.57)
Health Amenities	1873.61** (849.65)	1557.11* (826.91)	1952.89** (822.78)	1625.97** (793.67)
Cultural Amenities	10054.23*** (2337.07)	9476.75*** (2338.23)	10043.52*** (2259.49)	9530.23*** (2239.67)
Homicides	-2419.68*** (835.94)	-1647.53* (858.69)	-3149.62*** (833.95)	-2370.28*** (843.44)
Robbery	-1127.91*** (431.85)	-1399.95*** (446.49)	-1208.13*** (423.75)	-1467.62*** (435.77)
Noise Average	-1543.09 (1401.59)	-1449.05 (1483.67)	-2097.18 (1385.28)	-2085.58 (1463.46)
Distance to CBD	-10.94*** (3.38)	-13.72*** (3.79)	-7.97** (3.51)	-10.39*** (3.84)
GI Index		92374.11*** (17762.49)		71438.30*** (17628.40)
Bike Lines			18.21 (26.18)	21.88 (26.24)
EFF			14777.03 (15885.17)	15876.49 (17008.73)
Commercial Activities			141.25*** (31.65)	142.19*** (31.38)
FSI			91.91** (44.62)	99.31** (42.53)
Constant	-4506371.63*** (428251.23)	-5233701.24*** (535713.21)	-4228079.23*** (424510.34)	-4862195.85*** (543050.16)
Observations	331	281	328	278
Vif	1.41	1.53	1.41	1.50
Adjusted R^2	0.50	0.54	0.53	0.57

Standard errors in parentheses
* p<0.10, ** p<0.05, *** p<0.01

Significant positive impact   Significant negative impact

Author, 2016. Calculated based on HPM - Cañaveralejo River Case 2016.

Figure 12 Distribution of trees and LV in neighborhoods adjacent to Cañaveralejo River. Author, 2016. Based on GIS-RAPOT2013 file.

Currently, Cali has no more than 25 km of bike lines across the whole city, meaning that in case a neighborhood could have access to one of these lines, it would be only in a section between 500m and 1km (see figure 13). This length in proportion to the size of the barrio is what probably causes the lack of significance in the four models at neighborhood scale. However, that doesn't necessarily mean that bike lines have no effect on the adjacent land, it means that the impact can only been seen in a smaller scale, reason why a second group of models was carried out in block scale. The issue that the neighborhood scale represents when trying to assess the effects of certain indicators in the dependent variable affects not only bike lines but also average noise and EFF. Therefore, these inconsistencies will be approached in section 4.3.2.

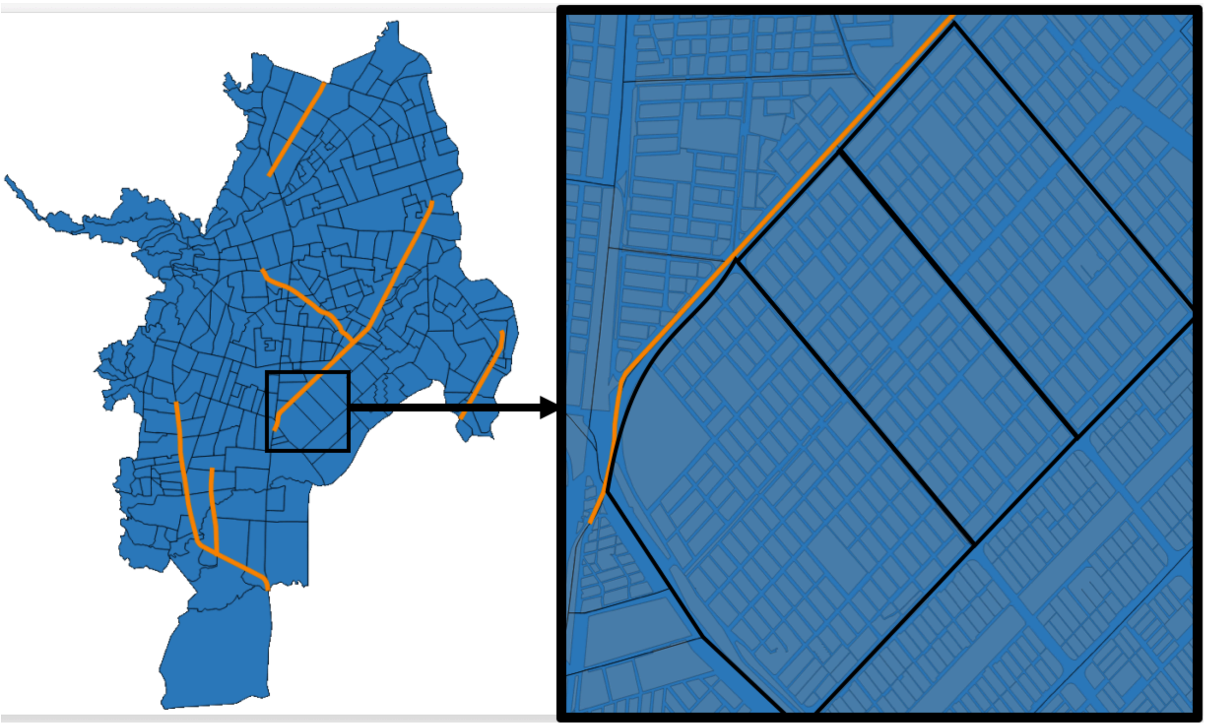

Figure 13 Existent bike lines across the city and a detailed view of the proportion at block scale. Author 2016. Based on GIS-RAPOT2013 file.

Most of the indicators included in the control group for mobility and accessibility scored as was expected based on the literature review. For example, Public transport efficiency and quality of roads have a significant positive impact on LV whereas distance to CBD has a high significant negative impact. This is also in line with the results of the survey "Cali Como Vamos" where mobility infrastructure ranked in the top 5 of priorities (Affairs 2014). This can be seen as an corroboration of the axial development theory which states that LV is concentrically formed around the CBD, but distorts along infrastructural axes (Balchin et al. 2000). Increasing mobility infrastructure such as roads, pedestrian or bike paths can increase the connectivity from farther areas in the city to the CBD improving their chances to attract more activities and services which would have a direct effect in the LV.

Commercial activities, cultural and health amenities and the FSI are the indicators that shape the socioeconomic control group. Each of them scored high significant and positive impact on LV. This indicates that, besides the provision of the basic services, a property has other extrinsic elements and amenities that increase its value. For example, closeness to a museum, a nice view, or a popular shop are elements that increase the attractiveness and as consequence the value of a property (D'Acci 2014). Cultural amenities are a factor that can enhance the attractiveness and popularity of a place, this may work as a magnet of business and activities, which consequently can increase the value of the properties around them (Glaeser et al. 2001; Brueckner et al. 1999; Damigos & Anyfantis 2011). Health amenities as well, registered a positive significant impact on LV in all neighborhood models. This is in line with Źróbek et al. (2015) findings where these type of amenities show relevance, however the importance is expected to differ per demographic group.

Commercial activities show a high significant positive impact on LV. These could be seen as contradictory in the past since traditional zoning systems aimed to separate residential uses from the side effects that commercial properties could eject on houses such as crowding, noise pollution, congestion, trash, etc. (Platt 1991; Fischel 2004). However, this idea has recently shifted, revealing that neighborhoods with a mix of retail, dining, and other commercial activities can be attractive to residents interested in reducing automobile use, fuel consumption, air pollution and increasing a walking, biking and healthier life style (Cervero & Kockelman 1997; Yang et al. 2016). This shift in planning strategies and people's behavior is what supports the high significance and positive impact for a unit of increase in commercial activities in the neighborhood models.

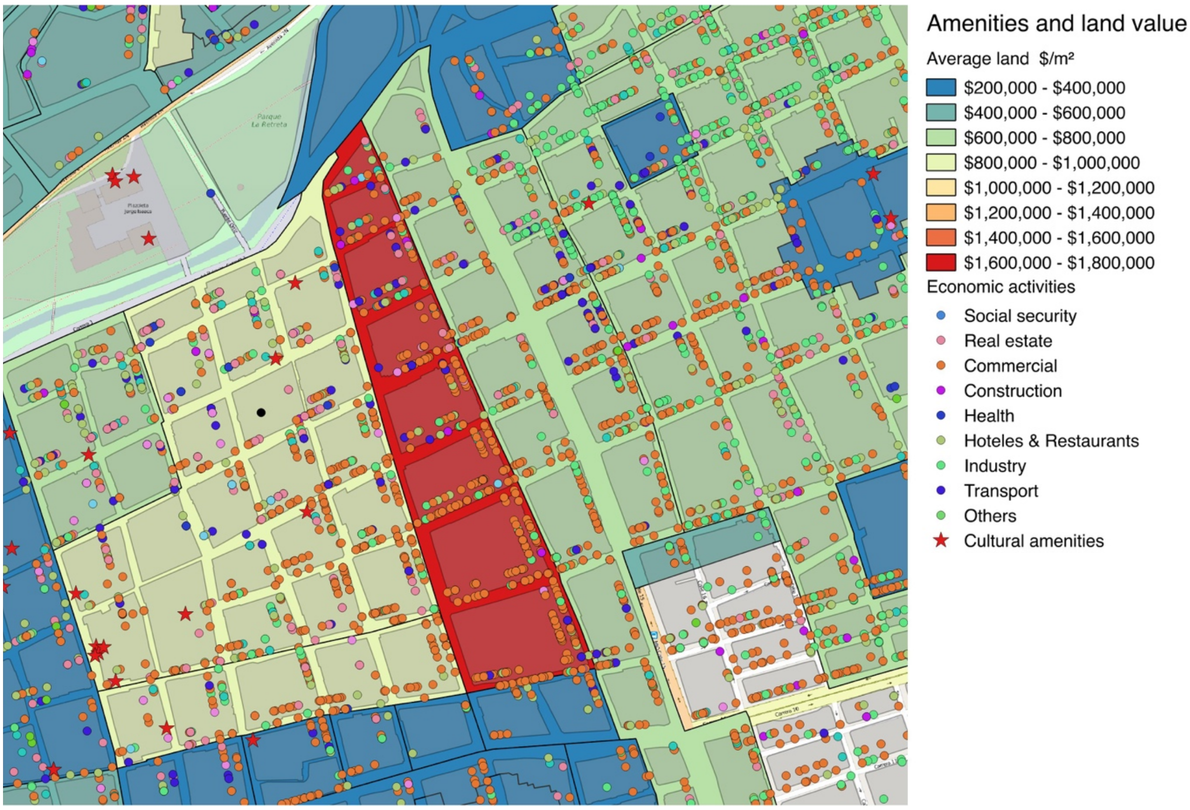

Figure 14 Map showing LV in Cali's CBD and the location of amenities & commercial activities. Author, 2016. Source: GIS-RAPOT2013.

The access that mobility infrastructure and closeness to the CBD provide for services and amenities is correlated with the highest LV in the heart of the city (see figure 14). Working as a loop, an area with good connectivity and amenities attracts people, which attracts jobs and activities, increasing its desirability and density. This increases LV, making it more attractive for certain business to be in these zones, rising their demand and rent value which is in line with the theory of land reaching its highest and best use (Alonso 1963; Munizzo & Virruso 2010).

The security control group consists of homicides and robberies, which indicates how the safety of a neighborhood can affect LV. As expected, neighborhoods with higher rates of homicides and robberies registered lower land prices. Criminal activity such as robberies and homicides generate an immediate impact in people's perception of safety about the neighborhood, which sooner or later ends in people moving out from it in search for a less threatening environment (Cullen and Levitt 1999; Dugan 1999; Tita et al. 2006). Because of this search of safety, an increase in homicides and robberies can have a highly significant negative effect on LV (Tita et al. 2006; Morenoff & Sampson 2001).

Both indicators for the environmental control variable, average noise and EFF were insignificant and had a negative and positive direction respectively at neighborhood level. These indicators suffer from a similar imperceptibility on the neighborhood scale as bike lines and will be analyzed and discussed in further detail in section 4.3.2.

As it was observed, the neighborhood models showed in a general way which factors significantly affected the LV across Cali. The control variables groups aligned with the expected results predicted by the literature. Variables such as mobility, socioeconomic factors as well as security scored high significance and are shown to have notable impacts on the LV of neighborhoods. This was also observed in the GI group where trees, Green m² and pedestrian lines scored high significant and positive impacts on the LV. However, some variables were difficult to assess given the scale of the neighborhood models. Indicators like bike lines, EFF and average noise did not figure in the significant results, a situation that would be further addressed and discussed at the block scale analysis in the next section.

4.3.2 Block analysis

The main purpose of the block analysis is to approach in detail those critical indicators that did not show significance at neighborhood scale and check if the ones that did score significance and impact changed their behavior. Bike lines, average noise and EFF were the three indicators that did not show significant impacts in LV at neighborhood scale. Similar to the neighborhood analysis, this one is also composed by four regression models that count and assess each of the indicators at block level. The first two models are Block Simple 1 (BS1) and Block Simple 2 (BS2) which are more parsimonious versions, including only the priority GI indicators and the main control ones. Models BC1 and BC2 are the more complex versions using 17-18 indicators respectively. Similar to the neighborhood models, BS2 and BC2 also present the modality of displaying the GI indicators[21] as an index.

The four models on the block scale (see table 12) work as a solution to the inaccuracies previously discussed about the influence of the neighborhood scale to appreciate certain indicators. In these models the impact that GI indicators such as bike lines and EFF eject on LV can be assessed in more detail.

Consistent with the neighborhood results, all the control variables as well as Trees, M² Vegetation coverage, and pedestrian lines showed high significance and positive impact on the LV (see table 12). However, unlike the neighborhood results, bike lines, average noise and EFF all had a high significant and positive impact.

Compared to the impact obtained at the neighborhood scale, trees, M² Vegetation coverage, and pedestrian lines increased their significance and impact on LV (see table 11 and 12). This is caused by the proportional impact that a tree can have considering both scales. In the neighborhood scenario, the increase of one tree had an impact of $38.39 COP per m² whereas in the block scale it goes till $307.16 COP, almost ten times more impact than at neighborhood scale. The assumption is that if a tree is added in the whole neighborhood, its impact is almost invisible since the radius of influence compared with the surface of the neighborhood is completely disproportionate (see figure 15).

[21] It's important to note that the M² Vegetation coverage is used instead of indicator Green m² (see section 4.2)

Figure 15 Visualization of marginal effect of trees on block and neighbourhood scale. Source: Author, 2016. Based on GIS-RAPOT2013 file.

However, when a tree is increased in a block, the radius of influence in proportion to the size of a block is closer, meaning that the land in that block would get a direct benefit from that tree. Put in other words, a bigger number of trees is required to perceive an impact at neighborhood scale than at block scale since at block scale the contact is immediate, the same goes for M^2 Vegetation coverage, and pedestrian lines (see figure 15).

Table 12 Block Models

BLOCK MODELS	(MS1) AVG LAND $/M²	(MS2) AVG LAND $/M²	(BC1) AVG LAND $/M²	(BC2) AVG LAND $/M²
Trees	307.16***		275.37***	
	(88.38)		(88.30)	
M² Vegetation coverage	2.67***		2.52***	
	(0.35)		(0.35)	
Bike Lines	92.27***	193.71***	120.32***	216.59***
	(33.79)	(31.28)	(33.84)	(31.29)
Pedestrian Lines	27.17*	32.72**	28.99**	34.26**
	(14.18)	(14.19)	(14.37)	(14.38)
EFF	19338.91***	19378.84***	22978.85***	23129.55***
	(4528.32)	(4542.19)	(4569.78)	(4582.65)
Contact with water bodies (80m radius)			2537.86	2813.88
			(3436.72)	(3444.40)
Public transport efficiency	656394.36***	666004.10***	702452.18***	712811.13***
	(21511.32)	(21560.49)	(22123.87)	(22150.59)
Public roads quality	308599.65***	312847.63***	293762.82***	297140.15***
	(12580.51)	(12606.45)	(12701.56)	(12729.18)
FSI	26.52***	27.42***	26.29***	27.13***
	(4.01)	(4.01)	(3.99)	(4.00)
Commercial Activities	1836.49***	1848.69***	1857.03***	1869.34***
	(120.73)	(121.03)	(120.39)	(120.66)
Cultural Amenities	31566.90***	32019.13***	30883.19***	31293.76***
	(4086.27)	(4096.68)	(4084.74)	(4094.13)
Distance to CBD	-20.21***	-19.90***	-20.92***	-20.65***
	(0.66)	(0.66)	(0.66)	(0.66)
Homicides	-1896.59***	-1934.56***	-1755.58***	-1787.87***
	(136.07)	(136.40)	(136.70)	(137.02)
Robbery	723.87***	745.48***	685.73***	704.58***
	(70.24)	(70.37)	(70.17)	(70.29)
Noise Average	-1169.80***	-1176.77***	-985.62***	-987.82***
	(202.22)	(202.83)	(203.15)	(203.69)
GI Index		71282.19***		63648.33***
		(14331.51)		(14326.02)
Life Satisfaction Index			31356.49***	32405.58***
			(3480.96)	(3487.29)
Public Transportation Stops			3591.55	3706.86
			(4645.26)	(4654.42)
Health Amenities			-12858.59	-13638.97
			(14134.83)	(14176.56)
Constant	-2366244.01***	-2408220.68***	-2662994.85***	-2711242.78***
	(86419.28)	(86611.17)	(92961.39)	(93018.69)
Observations	10543	10543	10543	10543
Vif	1.16	1.13	1.15	1.14
Adjusted R^2	0.29	0.29	0.30	0.29

Standard errors in parentheses
* p<0.10, ** p<0.05, *** p<0.01

Significant positive impact   Significant negative impact

Author, 2016. Calculated based on HPM - Cañaveralejo River Case 2016.

As opposed to the neighborhood scale analyses, bike lines have a positive significant impact on LV at block scale. This is contrary to Racca and Dhanju (2006) research, whom showed that on a neighborhood scale, bike lines caused a slightly significant negative impact on property values. It is believed that this difference in results is caused by the scale of analysis, because in similar studies carried out in Toronto and NYC the conclusion was that at neighborhood scale the impact was almost imperceptible (Sztabinski 2009; NYC Department of Transportation 2013). And when the analysis was carried out at street/block scale, residential and commercial properties registered an increase on LV and sales respectively. Even more, in the case of NYC at first, the inclusion of a bike line was opposed by small business and house owners in the nearby areas to the line. However, after the complementation of the bike line with what they call "enhancement of the streetscape"[22] (NYC Department of Transportation, 2014, p.39) the traffic flow, economic vitality and property values where visibly improved. This supports the obtained results in the block models for bike lines where it reached high significance and a positive impact of $92.27 COP in the average price per m² of land for one meter of bike line increased.

The indicators included in the mobility - accessibility group did not change their significance nor the direction of the impact. Public transport efficiency and quality of roads are in both scales the control group whose indicators have the biggest coefficients from all the models. In the case of distance to CBD, the coefficient at block scale increased in comparison with the one at neighborhood scale, which can be mainly caused by the accuracy of the calculated distance in both scales. At neighborhood scale, the distance is calculated by locating a point in the center of the neighborhood, which can be not as regular shaped as it would be expected, whereas at block scale the distortion rate of this point is less since blocks are more regularly shaped.

The socioeconomic control group also kept its significance and impact, however, Commercial activities and Cultural amenities showed increases in their coefficients 13 and 3 times respectively, which is related with the neighborhood scale and the radius of impact of these indicators. This means that if a commercial place or a cultural amenity is added to a neighborhood, the benefits obtained from it are limited by the proximity of the neighbors to them. If a museum or a restaurant is located in the northernmost part of the neighborhood it is highly probable that the southernmost neighbor in the neighborhood would not register any direct changes due to it. This situation gets fixed at block scale where the size of the block does not inhibit surrounding blocks from getting benefits (see figure 16).

Another indicator that is included in the socioeconomic control group is the FSI, which increased its significance compared to its results obtained at neighborhood scale. Emphasizing that higher density is correlated with higher LV. Also, this indicator is correlated to less vacant land, this is highly relevant because vacant and abandoned properties eject negative externalities that impact blocks, neighborhoods and if clustered, it can undermine entire cities. Vacant or poorly occupied properties are a magnet for crimes that generate the broken window effect: "one sign of abandonment or disorder (a broken window) will encourage further disorder" (Wilson & Kelling 1982). Since nobody likes to live in risky neighborhoods, the externalities caused by the vacant land only encourages other neighbors to go, leaving fewer neighbors to fight back the criminal activity until there is no one left to defend or be defended.

[22] Which includes green safety islands and tree planting.

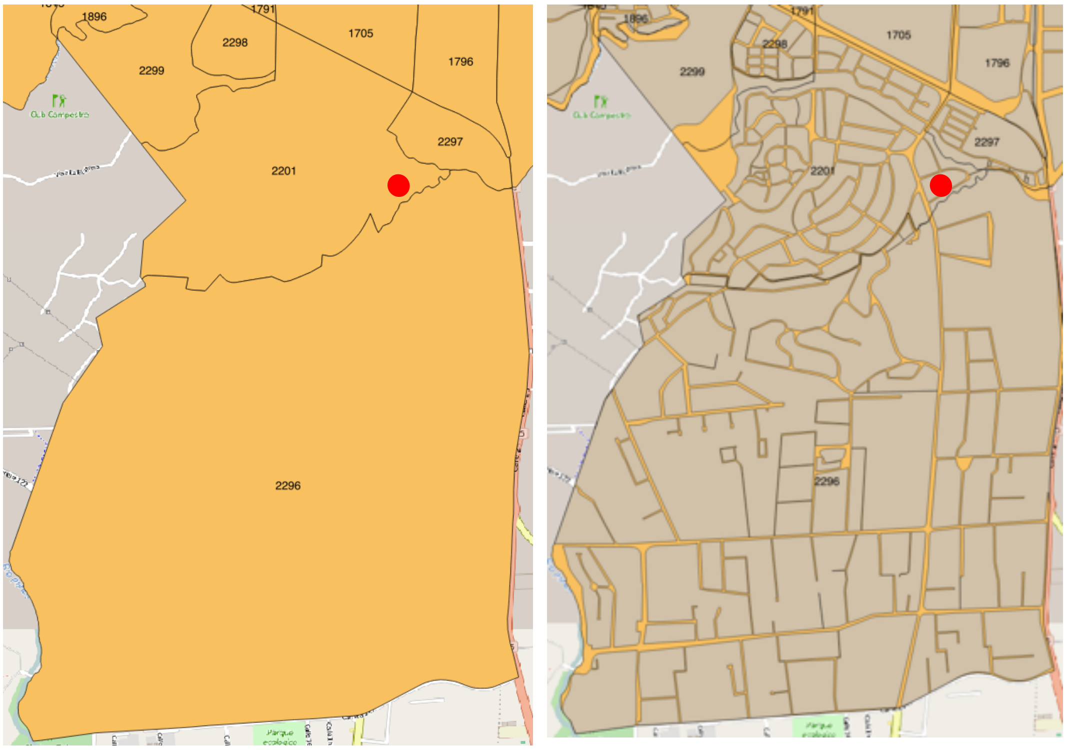

Figure 16 Comparison of the differences in scales and impact of one commercial activity across neighbourhood (left) and blocks (right). Source: Author, 2016. Based on GIS-RAPOT2013 file.

From the security control group, Homicides kept its negative impact, however Robberies changed from its negative impact at neighborhood scale to a positive one at block scale. This might be because for a whole neighborhood, getting a negative effect may be more linked with a high amount of homicides in poverty conditions affected by cartels and drugs. But at block scale, it is possible that blocks out from conflictive neighborhoods with high robberies are straight related with closeness to centralidades[23] or activities cores and not with general violence. Thus, as in any city around the world, CBD's or centralidades generate so much activities, that people is attracted to them, including thieves. When a group of blocks generate these mount of activities it comes also with more valuable items, so robbery becomes more profitable (Drum & Sacerdote 2013).

From the environmental control group, average noise scored high significance and negative impact in all block models. This is opposite to its previous scores at neighborhood scale where despite the negative direction of the coefficient, it did not get enough significance to cause any impact. This is related with the noise waves behavior through distance described by Hendriks (2002). He points that after a radius of 300 m in urban conditions, the noise starts to lose impact, meaning that if the source and recipient of noise are in opposite sides of a neighborhood, the chances of impact are lower (see figure 17). This scenario is less probable to happen at block scale, where given the smaller size of a block, the radius of 300m can easily affect more than 3 blocks from the noise source. The rapid growth of cities and the densification of urban areas are making noise pollution to grow exponentially, causing a

[23] "Centralidad" is a Spanish term used in Cali to refer those areas in the city besides de CBD with high number of activities that work as sub centres. Cali has 20 centralidades across the city, and each one has a main vocation, e.g. Centralidad "San Bosco" its specialized in automobile services.

negative impact on resident's wellbeing which subsequently hits property values (Duarte & Tamez 2009).

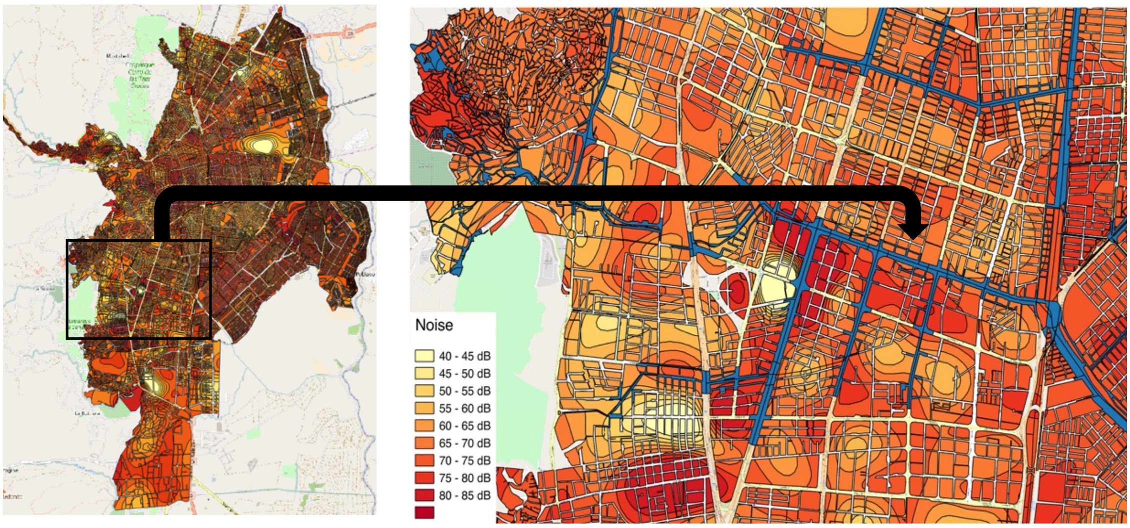

Figure 17 Noise map at city level (left) and zoom in on ECC area (right). Source: Author, 2016. Based on GIS-RAPOT2013 file.

The second indicator from the environmental control group is EFF, which at neighborhood scale had showed a positive direction but no significance, which are probably related with the inconsistencies of the observation scale. However, at block scale it scored a high significance and a positive impact on the LV. These results, which are contrary of what was expected, would technically mean that being inside an area with exposure to flooding could bring benefits for the LV.

Despite that the idea of getting benefits from being close to a river that can flood might sound illogical, it also points a relevant fact. Being close enough from a river to get flooded can also mean having a direct contact to the river view which is considered as a pleasant factor that increases property values. This is supported by authors like Hansen and Benson (2013), Makinde and Tokunboh (2013), Associates and Beach (2013) and Luttik (2000) whose research showed the positive effects that proximity to water bodies such as rivers and canals had in property values. However, being close to a river that provides a pleasant view without the risk of flooding compared to one that is in risk of flooding are two different things. Therefore, an additional model is made to measure the impact of exposure to flooding while controlling for contact with water bodies. This enables a measurement of these two indicators and asses their impact on LV more accurately.

Figure 18 Flood risk areas inside the ECC intervention zone. Author, 2016. Based on GIS-RAPOT2013 file.

This model included the control variables from the BCs models but instead of running on all the blocks across the city, it controlled for those in direct contact to water bodies, reducing the observations from 10543 to 2282. The results showed as expected from the previous analysis, high significance and impact for the control variables, however, EFF changed from a significant and positive impact (see table 12) to a significant negative one (highlighted in red in table 13). This supports the previous hypothesis that being close to a river without a EFF can impact positively the LV due to the pleasant view factor. However, being close to a river with EFF is not compensated by the possible benefits from the pleasant view (Harrison et al. 2001; Eves 2002). In coefficient terms, the change went from $22,978.85 at the BC1 model to the -$31,778.29 in table 13.

Water contact control model	AVG Land $/M²
EFF	**-31778.29*****
Commercial activities	2052.91***
Restaurants & hotels	13526.23***
Cultural amenities	39092.23***
Distance to CBD	-4.07**
Blocks in 1km radius from a Centralidad	26816.08***
Homicides	-2422.28***
Robbery	1035.63***
Noise Average	-1911.97***
Constant	406213.35***
Observations	2282
Vif	1.34
Adjusted R2	0.19

Standard errors in parentheses
* p<0.10, ** p<0.05, *** p<0.01

Table 13 Control model for contact with water bodies. Red shows significant negative impact. Source: Author, 2016.

The presented results from the block analyses helped to verify the indicators that at neighborhood scale had already showed significance, as well as for clarifying the behavior of bike lines, average noise and EFF.

The analysis remarked the importance that location and accessibility to certain amenities or types of infrastructure included in the control groups can eject in increasing or decreasing the LV (Balchin et al. 2000). Trees, bike lines, pedestrian lines, m² of vegetation coverage, also scored high significance and positive impacts which stands for the hypothesis that properties with presence of GI can get increases in their LV. This means that a GI intervention (such as ECC) that could increase these features is expected to affect the LV positively (see figure 19).

However, despite the multiple benefits that GI can provide to cities (ECOTEC 2008; Center for Neighborhood Technology 2010; Wise et al. 2010; Clements et al. 2013; Forest Research 2010) if there is not a way to quantify and present these benefits in a language that political and private decision makers can understand, the probabilities that GI projects get implemented is low. Therefore, this thesis besides quantifying and presenting the impact that GI has on LV in the city of Cali, looks for giving light to the question of how much is the potential impact that ECC could eject on the LV in the areas adjacent to the project.

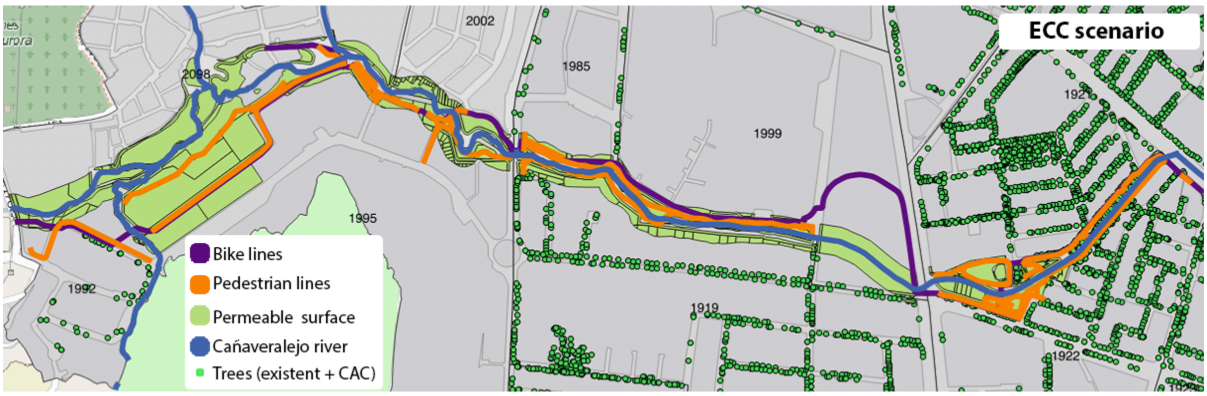

Figure 19 Priority indicators to be intervened by ECC. Author, 2016. Based on GIS-RAPOT2013 file.

4.4 Forecasting the potential impact of the Environmental Corridor Cañaveralejo (ECC) in the areas adjacent to the project.

This section will discuss the potential impact that the Environmental Corridor Cañaveralejo (ECC) can have on the LV in the adjacent properties to the project location. In the two previous sections it was discussed the impact that urban factors such as mobility, socioeconomic, security, environmental and GI had on the LV across the city. As it was expected, most of the indicators in the control groups for mobility, socioeconomic, security and environmental showed high significance and impact on the LV, including the ones on the GI group, which is the priority group of analysis for the purposes of this thesis. Through these results it was possible to test the correlation of GI elements on LV (regression coefficients), which are a main component to forecast the LV impact on the areas adjacent to the ECC interventions.

When forecasting with a hedonic model, first is necessary to carry a series of regressions in order to obtain the coefficients that will determinate the predicted values for the chosen variables. For the purpose of this thesis, the selected coefficients to perform the forecasting model were the ones obtained in the model BS1, since they were the most parsimonious of all four. This means that creating a model with “excessive elaboration” does not result in a “correct” model (Box, 1976). In a nutshell, model BS1 is as Albert Einstein would say: “as simple as possible but not simpler”.

The results from the forecast model show that the potential impact that ECC can have varies depending the block and neighborhood that is been observed. Not all the blocks are affected in the same way, depending on their location, some blocks were benefited by two or four of features included in the ECC project, which would reflect a higher impact in the average price per m² of land in that neighborhood. Table 14 presents the forecast in neighborhood scale per element of intervention whereas table 15 gives a final percentage of the total increase in LV for ECC as a whole.

Number of trees was the variable that scored the highest regression coefficient, however, the number of trees that would be added by ECC is small and focalized in one area (see figure 20), thus, its overall impact was at the bottom of the list with just $62.660,64 COP. The forecast for bike and pedestrian lines was the highest in the overall, reporting an increase of $351.606,83 and $127.769,64 COP respectively. M² of Vegetation coverage occupied the third place in the ranking with an overall score of $101.945,91 COP.

Figure 20 Additional green areas and trees in the ECC scenario. Author, 2016. Based on GIS-RAPOT2013 file.

At the last column in the table 14 a percentage shows the proportional increase in comparison with the actual average price per m² of land, meaning that if ECC project is implemented, the intervened area in neighborhood 1919 would have an increase in its average price of 7% and so on. This number is based on the original price of land in each neighborhood, so, if the absolute impact of ECC is big in comparison to the impact in others neighborhoods, but its original average price of land per m² is high, the percentage of increase might be low. This is the case of neighborhoods 1921 and 2002, were both registered an increase of 24% but since the original price of the land in the neighborhood 1921 was almost the double than in the neighborhood 2002 it was necessary an overall impact of $103.852,87 instead of the $41.675,34 that neighborhood 2002 needed to increase its 24%.

N_ID	Trees	Bike lines	Pedestrian Lines	M² Vegetation Coverage	Original AVG Land $/m²	ECC increase AVG Land $/m²	TOTAL ECC increase % per m² Land
1919	$0,00	$942,08	$9.927,92	$16.821,73	$416.111,11	$27.691,72	7%
1921	$31.330,32	$50.465,23	$19.902,84	$2.154,48	$430.625,00	$103.852,87	24%
1922	$31.330,32	$22.905,10	$22.940,17	$3.313,35	$408.250,00	$80.488,95	18%
1985	$0,00	$24.628,71	$7.244,61	$5.742,86	$475.000,00	$37.616,18	8%
1992	$0,00	$38.613,15	$8.769,12	$266,60	$369.166,67	$47.648,87	13%
1995	$0,00	$96.267,14	$42.402,05	$5.198,55	$272.638,89	$143.867,73	46%
1999	$0,00	$82.334,37	$13.379,05	$17.951,42	$450.000,00	$113.664,84	25%
2002	$0,00	$27.039,72	$3.203,89	$11.431,73	$230.625,00	$41.675,34	24%
2098	$0,00	$8.411,33	$0,00	$39.065,19	$142.352,94	$47.476,52	38%
Gran Total	**$62.660,64**	**$351.606,83**	**$127.769,64**	**$101.945,91**	**$289.375,00**	**$643.983,02**	**23%**[24]

Table 14 Forecast table with ECC features increases per $/m². Author, 2016. Calculated based on GIS-RAPOT2013 file.

NGBH ID	BLOCK COUNT	Current AVG Land $/m²	ECC increase % per m² Land	Total land value per block COP (m²x$)	Additional land value due to ECC COP (m²x$)
1919	3	$416.111,11	7%	$17.358.444.162,03	$482.908.059,74
1921	6	$430.625,00	24%	$6.910.887.277,40	$239.689.354,85
1922	5	$408.250,00	18%	$9.915.402.380,47	$752.371.299,72
1985	2	$475.000,00	8%	$9.829.145.890,97	$394.658.578,06
1992	2	$369.166,67	13%	$3.033.185.505,31	$153.928.493,04
1995	6	$272.638,89	46%	$26.187.196.208,59	$3.354.021.858,19
1999	3	$450.000,00	25%	$20.508.973.906,74	$1.753.177.612,98
2002	4	$230.625,00	24%	$6.749.484.786,63	$180.520.487,55
2098	17	$142.352,94	38%	$43.702.316.799,77	$483.953.690,83
Grand Total	**48**	**$289.375,00**	**23%**[25]	**$144.195.036.917,90**	**$7.795.229.434,96**

Table 15 Forecast with ECC features increases per block. Author, 2016. Calculated based on GIS-RAPOT2013 file.

A practical example of how much the increase due to ECC affects the LV per block[26] is described as follows: The block with the id 1995-74454 located in the NGBH 1995 has a total occupied surface of 23123.12 m² with an average price per m² of $338,333,33 COP, meaning that the LV of all that surface is $7.823.323.306,44 COP. In this block and according to the elements added due to ECC project (bike lines, pedestrian lines and vegetation) there is a

[24] Average of the total ECC increase % per m² Land
[25] Average of the total ECC increase % per m² Land
[26] For further detail of the forecast results per block see Annex 11 and Annex 12

predicted increase of 23,04% per m² of land which means $1.802.704.026,98 additional to the current LV of $7.823.323.306,44 COP (see Annex 12).
The obtained results of this forecast analysis show the potential effect that the ECC can have in the LV of the areas to intervene. It also provides relevant information about which GI factors affect the most the LV, which can be used to reconsider and increase their presence in the project. The use of this results can be highly beneficial for private stakeholders and public parties since they allow to see how much is the potential increase in LV which is directly connected to the potential increase in property tax, future revenues and the time that would take to recover the initial cost of investment. Furthermore, it's important to remark that the results obtained in this forecast model might be understated since not all benefits provided by the ECC where assessed. This is mainly caused by the implicit difficulties that come when trying to monetize the non-monetary benefits that open spaces and ES provide to the city. Thus, is highly probable that the results showed in this model would be higher than predicted if including all this benefits.

4.5 Survey results

In order to compare the results from the hedonic model with the current preference of people, a survey (see Annex 8) was sent to 45 individuals and companies with knowledge about Cali's urban environment, urban planning and architecture. They were asked about which areas considered to have a better urban environment, which places attracted masses and a description of the attributes that they considered were the responsible of that attraction and finally a suggestion of places considered to be a perfect place to live according to certain parameters like accessibility to amenities, public spaces and safety. Unfortunately, the rate of response was so low that it could not account for being statistically significant, however, there were some patrons in the respondents' answers that provided a general idea of the urban environment in Cali. For instance, among the answers it could be observed the repetition of the same group of neighborhoods (see Annex 10). From this group, neighborhoods 1780, 1910, 210, 294, 1783 and 303 are on the top ten of the neighborhoods with most presence of trees and vegetation across Cali according to GIS database used in the neighborhood and block models. In the particular case of neighborhood 303, which is the CBD, it also matches with the highest LV per m² and the location with more accessibility to diverse amenities (see figure 14). The comments and responses from the respondents allowed to reinforce the preference of the property markets for areas with accessibility to the control variables and GI elements.

4.6 Reflections

The previous analysis allowed to identify the urban factors that affect LV across Cali (see table 16). Mobility and accessibility, socioeconomic, security and environmental control groups scored as it was expected from the arguments of Balchin et al. (2000), Glaeser et al. (2001), Yang et al. (2016), Tita et al. (2006), Duarte and Tamez (2009). However, when analyzing the results from GI at neighborhood scale some inconsistencies were found among some indicators, demanding a more detailed analysis. Thus, a second analysis at block scale was carried out, confirming the positive and high significant impact from GI in LV in line with the findings of Wise et al. (2010) and Clements et al. (2013). A relevant result from this block analysis was that EFF, contrary to the results from U.S.A.C.E.S (1998), Lambley & Cordery (1997) and Tobin and Montz (1994) scored a highly significant and positive impact

on LV. The cause of these results was directly connected with an interference between the EFF and Contact to a water body indicator. To understand the relation among this two indicators, a third model was carried out where contact to water bodies was controlled.
After this analysis (see table 13), it was shown that if a block is directly in contact with a river that has no risk of flooding, it accounts for a positive impact on the LV due to the pleasant view that the river provides (Luttik, 2000). However, if a block has direct contact with a river with flood exposure, the positive impacts related with the pleasant view are not larger enough to compensate the negative impact of being in risk of flooding, which leaves a negative impact on the LV.

INDICATORS	Model NC1	Model BS1
Trees	+38.39***	+307.16***
Green m²	+0.00*	+2.67**
Bike Lines	**NS**	**+92.27*** **
Pedestrian Lines	+10.84*	+27.17***
EFF	**NS**	**+19,338.91*** **
Satisfaction average public roads	+1,113,707.16***	+308,599.65***
Satisfaction average public transport	+422,710.14***	+656,394.36***
Average of land occupation index	+91.91**	+26.52***
Commercial Activities	+141.25***	+1836.49**
Cultural Amenities	+10043.52***	+31566.90***
Distance to CBD	-7.97**	-20.21***
Homicides	-3149.62***	-1896.59***
Robbery	-1208.13***	+723.87***
Noise average	**NS**	**-1169.80*** **
Life Satisfaction Index	39363.67**	+71282.19***
Public transportation stops	NS	NS
Health Amenities	NS	NS

Table 16 Comparative table of neighborhood and block scale models. (+) Significant with positive impact, (-) Significant with negative impact and (NS) Not Significant. Author, 2016. Calculated based on GIS-RAPOT2013 file.

The results in the survey allowed to triangulate the hedonic results reinforcing people's and markets' preference for GI in what is considered a pleasant urban environment.
The hedonic results also provided the regression coefficients for each one of the GI indicators used to forecast ECC's potential impact on LV if implemented as projected. The predicted results showed an overall increase of $7.8 billions[27] COP distributed across 48 blocks in 9 neighborhoods, meaning an average increase of 23% on the LV in the intervened area.

[27] For further detail see Annex 12

Chapter 5: Conclusions

The main objective of this thesis is to assess the impact that GI can have on LV in Cali and use these results to predict the potential impact that the Environmental Corridor Cañaveralejo (ECC) could generate in the LV adjacent to the project. These predictions could play an important role for the external goal of this research, which is to combine the positive impact of ECC on LV with LVC and distribute this increase wealth across the vulnerable sectors of population. Therefore, it is essential to generate a set of information that can work as an incentive to encourage private stakeholders to invest in the project and redevelop the land.

By combining a HPM and OLS regression, a *ceteris paribus* analysis is carried out allowing to isolate the influence that GI ejects on the LV. However, since the main assumption of the OLS analysis is that the relationship among the indicators are linear, it is necessary to point out the limitations that come with that. For example, if the number of trees and LV are linear, an increase in the number of trees would proportionally increase or decrease LV, which is not necessarily true. This assumption neglects the concept of diminishing marginal utility described by Gossen's economic laws (1854). Having few trees and adding just one or two would barely make a difference, the same if there are so many that adding some extra could be barely seen reflected in the LV (see figure 21).

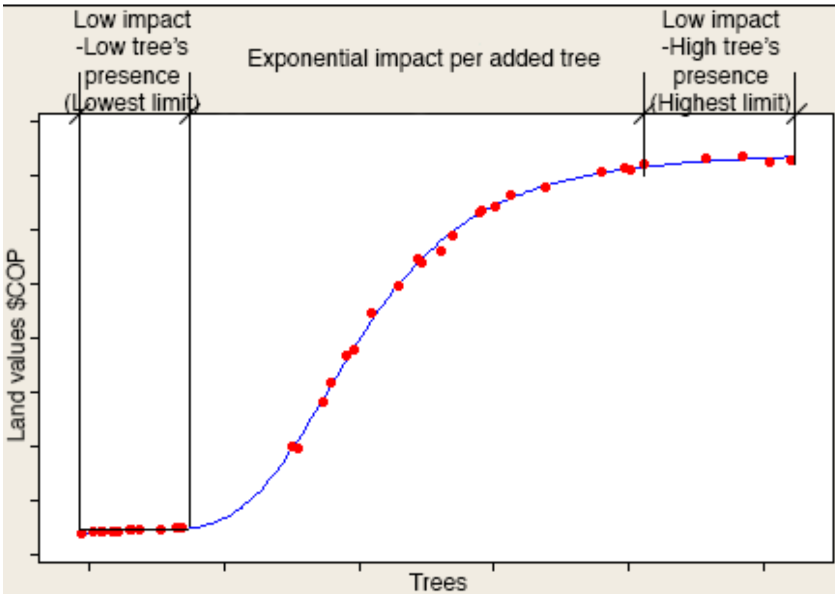

Figure 21 Weibull graph describing an example of a possible scenario among LV and trees. Author, 2016.

The lowest left point of the graph shows a steady behavior of the LV against the increase in trees on a neighborhood scale, till it reaches a breaking point where each added tree has an exponential impact on the LV before reaching again the balance in the superior right corner. Therefore, the limitation comes because the HPM only accounts those values registered in the slope of the graph, leaving out the ones in the corners.

5.1 The impact of Green Infrastructure on Land Values in Cali

In order to isolate the impact of GI on LV an additional 4 control variables are used. These variables are all based on the literature review in chapter 2 (Balchin et al., 2000, Glaeser et al., 2001, Yang et al. ,2016, Tita et al. 2006, Duarte and Tamez, 2009).
From all the five indicators included in the GI variable, four scored a high significance with a p value < 0,01, leaving no space for impacts by chance, and one indicator with a moderate significance of p value <0,05, meaning a 95% certainty of effect on the dependent variable.

The models used to answer the main research question included the four control variables, mobility and accessibility, socioeconomic, security and environment besides the GI variable. In general, the results from the models in both scales were consistent with the literature, pointing in majority the same indicators as significant (see table 16).

Results at block scale showed trees scoring high significance and positive impact, being the second highest indicator affecting the LV from the GI variable after EFF. This impact is supported by the results of The University of Texas (2008), Wolf (2007), Hastie (2003) and Donovan and Butry (2010) who used an HPM to show that a single tree added in average $7,130 USD to the value of the property located directly in front of it, plus additional value to neighboring properties within 30m radius. This means that the average combined value is of $12,828 to the properties lying within that radius. In Cali's situation and according to the results from model BS1, each single tree ejects an impact of $307.16 COP per m² of block land in contact with it. Taking as an example the neighborhood ID 1780 "El Ingenio", the impact that its current trees[28] generate in the neighborhood land is of almost $27,000 million[29] COP ($8 million USD). However, and as Benotto (2002) discuss, " the combined economic value of the network of urban trees is bigger than the net sum of the individual trees" which means that the actual impact of the trees on LV across Cali might be larger than the models results show.

Vegetation coverage also scored a high significant and positive impact. Its regression coefficient showed that 1 m² of vegetation coverage could increase LV in $2.67 COP per m² of land. Compared to trees, the vegetation coefficient seems low, however, it's presence across the city is much bigger than tree's. This explains the big impacts observed in neighborhoods like id 2296, where 25% of its surface is of vegetation coverage, representing a high participation in the total LV of the neighborhood. These results are consistent with authors like Morancho (2003), Poudyal et al. (2009), Melichar and Kaprov (2013) that showed the relevance of green areas on property values depending on their surface and proximity to the plot.

When analyzing bike lines at neighborhood scale, the models registered a positive direction in the coefficient regression but no significance. This situation was caused by the interference between the small amount of bike lines across the city and the big size of the neighborhood in comparison to them. This does not necessarily mean there was no impact on the LV, because when analyzed at block scale, the impact that bike lines ejected on their adjacent blocks became clear. This radius of impact (150 m in average) is big enough to affect the blocks in direct contact, but not enough to be registered in the neighborhood models. According to the

[28] According to the GIS RAPOT2013 layer "#280_RAPOT_2013 ARBOLES_CENSO_CALI" the neighbourhood 1791 has a total of 3314 trees.

[29] Proxy calculated using the regressions coefficients from model NS1

official maps from Alcaldia de Santiago de Cali (2014b) there is a little bit less than 25 km of bike lines distributed across 58 neighborhoods and 536 blocks, with an average of contact per block of 50 m. Based on the results from BS1 model, each meter of bike line has an impact of \$92.27 per m² of property, which is in line with the results showed by the NYC Department of Transportation (2014). In the particular case of Cali, bike lines' presence is low, making difficult to see its impact in all the land values across the city. This is because they are manly introduced as recreational and not as transport infrastructure, therefore bike lines appear isolated, by segments and roughly connected to a bigger network. In order to maximize their benefits its necessary to implement them in combination with "enhancement of the streetscape" (NYC Department of Transportation, 2014, p.39) which is greenery and tree planting. After taking this strategy NY's rents along pedestrian and bicycle paths increased 71% (APTA, 2010) and local businesses registered a 49% increase in retail sales (NYCDOT, 2013).

Scoring a significant and positive impact, pedestrian lines ranks fourth based on its coefficient. Each meter of pedestrian line affects \$27.17COP per m² of land property. This positive impact on LV is in line with the results from CEO's for Cities (2009) which showed a positive correlation between pedestrian infrastructure and property prices. Their report concluded that an increase of one point in the walkability score could have an impact between a \$500 and \$3,000 increase in property values. The importance that pedestrian lines have for property values is directly connected to the accessibility and convenience that comes with them, which is having all the necessary amenities and services at walking distance from the property.

Compared to the tree coefficient, pedestrian lines' impact seems low, however, it is important to take into account that Cali is car oriented and relies on motorized transportation vehicles neglecting pedestrian infrastructure. Even though, the results from BS1 model have shown the markets' preference for properties with this type of connectivity due to the multiple benefits that come with it (Litman, 2014). When the pedestrian infrastructure allows users to walk comfortably without competing for space against motorized vehicles it has a positive feedback in more people walking, which is a signal that the area is safe and interesting (Jacobs, 1961). It can be concluded from the effect of pedestrian lines on LV value and their presence in Cali that, as most cities around there globe there is a "high demand and low supply for human-friendly streets" (APTA, 2010). And as Gossen's (1854) third law states, scarcity is an essential part of economic value.

The results from EFF obtained in the model BS1 scored a high significant and positive impact. This would indicate that, contrary to what was expected, a property located in an area with fluvial flooding exposure is worth \$19,338.9 COP per m² more, all else being equal. However, after running a third model where contact to water bodies was controlled, the results in EFF became negative. This controlled model for contact to water bodies helped to differentiate between the benefits of being close to a river that provides a pleasant view without being expose to flooding, and one with exposure (Eves 2002; Harrison et al. 2001). This is consistent with the findings from Bin et al. (2008), Posey and Rogers (2010) that found a decrease of 11% and 8,6% respectively in the LV of properties located in a flood plain or flood prone area.

The versatile and wide scope that HPM covers is what allowed to generate the previously compound of information about the participation of the obvious and inadvertent factors that shape the value of a property. The results from neighborhood and block models gave a detailed idea of the indicators influencing the LV and to which extend. By isolating and quantifying the influence of GI through green elements and other environmental amenities it can be concluded the existence of a positive correlation between GI and LV.

5.2 Future research directions

In order to generate a more in depth research about the benefits that GI provides to cities besides LV increases, it is required some complementary strategies which are suggested as follows.

ES valuation with tools such as i- tree can count the elements included in GI projects and help to persuade stakeholders and governments to invest in GI instead of TGI, which is often more expensive and only covers one problem (Naumann et al. 2011; J. Foster et al. 2011). It would also be interesting to combine the ES valuation with a deeper geo- analysis by using the spatial weighted matrixes from QGIS. This method would allow to see the impact radius and the distance tolerance of each indicator, providing attractive insights for choosing the locations of future GI projects.

Based on the possible limitations regarding the non-linearity in certain GI indicators, it would be valuable for contributing to the grounds of knowledge to carry an assessment based on models with non- linear assumptions for the correlation calculations with the dependent variable. Moreover, it would be highly beneficial for Cali's interest to carry an assessment with non-linear profile of the potential impact of a whole GI network across the seven rivers of Cali. Assessing the potential impact of the envisioned seven green corridors along the seven rivers as a whole network would provide more accurate result than just assessing independently each project and summing up their net increase (Benotto 2002).

According to the results of this thesis, it can be concluded that EFF has a negative influence on LV, which emphasizes the necessity for an intervention to mitigate and reduce EFF's externalities, especially given its wider negative impacts on the people of Cali. Therefore, among all its targets, ECC includes a strategy to mitigate flood risk across Cañaveralejo river. The strategy also aims to replace the current urban surface for permeable ones (see figure 22), which would contribute to reduce run offs and improving soil water absorption (Konrad, 2003) (Sampson, 2008). However, since the focus of this research was not to assess risk and its reduction, it's important to point out the relevance that this surface change strategy could have in reducing the risk of flooding and consequently its impact on LV, reason why is highly recommended to take into account for further research.

It's also of great significance to keep a track of the project's impact after implemented. Most of the times when projects are implemented there are not monitoring process, which is highly negative for the future development of similar projects. Monitoring helps to measure the efficiency of the project through the costs and benefits gained, report to involved stakeholders and generate a positive and transparent publicity of the outcomes (Naumann et al. 2011). Therefore, it would be highly useful to create a monitoring sharing system across cities in Colombia and Latin America about the performance of GI projects implemented, contributing to replicate the successful ones and improve the existing ones.

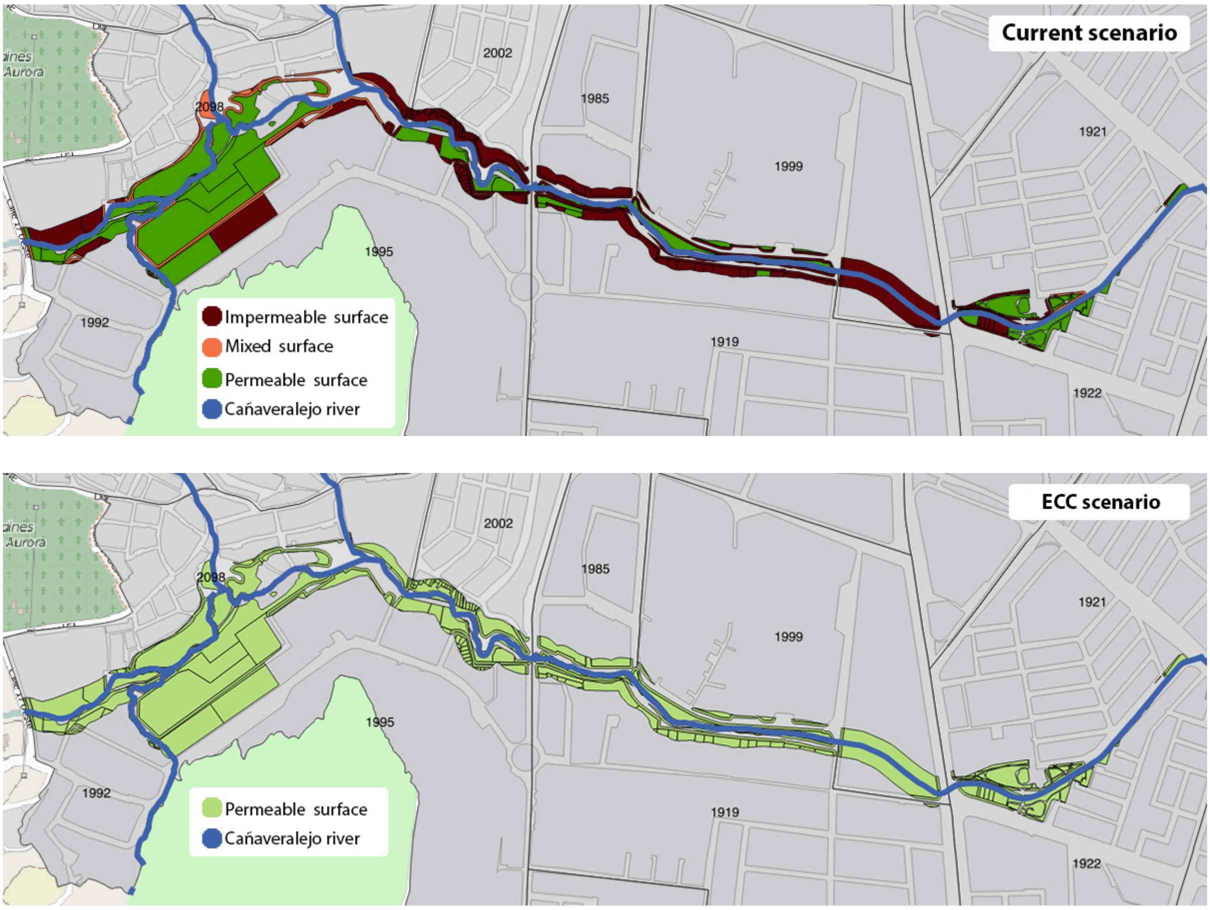

Figure 22 Intervention area before and after ECC. Author, 2016. Based on GIS-RAPOT2013 file.

5.4 Policy recommendations

The positive correlation between GI and LV across Cali found in this thesis can work as valuable hints for RE developers and government stakeholders about land investments. Moreover, the application of these results in fields of policies can help to prevent the tradeoffs between densification and green urban spaces commonly seen in cites without awareness of GI benefits.

The results previously presented in Chapter 4 allow to conclude that besides the impacts from control variables such as mobility or security, GI has a significant positive impact on LV across Cali. This can work as the basis for a supporting policy for GI, where green spaces can be protected from the tradeoffs of urban growth and sprawl (Philipsen, 2015). It would also be necessary to take into account that the potential impact of increasing GI can be higher in those areas with a GI deficit. According to the preliminary results from the tree census carried out by DAGMA and CVC, 17 from the 22 comunas in Cali are below the percentage of trees per inhabitant suggested by the World Health Organization (Cali et al., 2016), meaning an approximate deficit of 470,000 trees in the city. Comunas 20, 21, 1, 14 15 and 18 are the ones with the highest tree deficit as consequence of the uncontrolled urban expansion and population growth. Therefore, these comunas would be the prefect scenario to start a GI intervention with potentially higher results in comparison with the ones that could be obtained in comunas 17 and 19 that have no tree deficit.

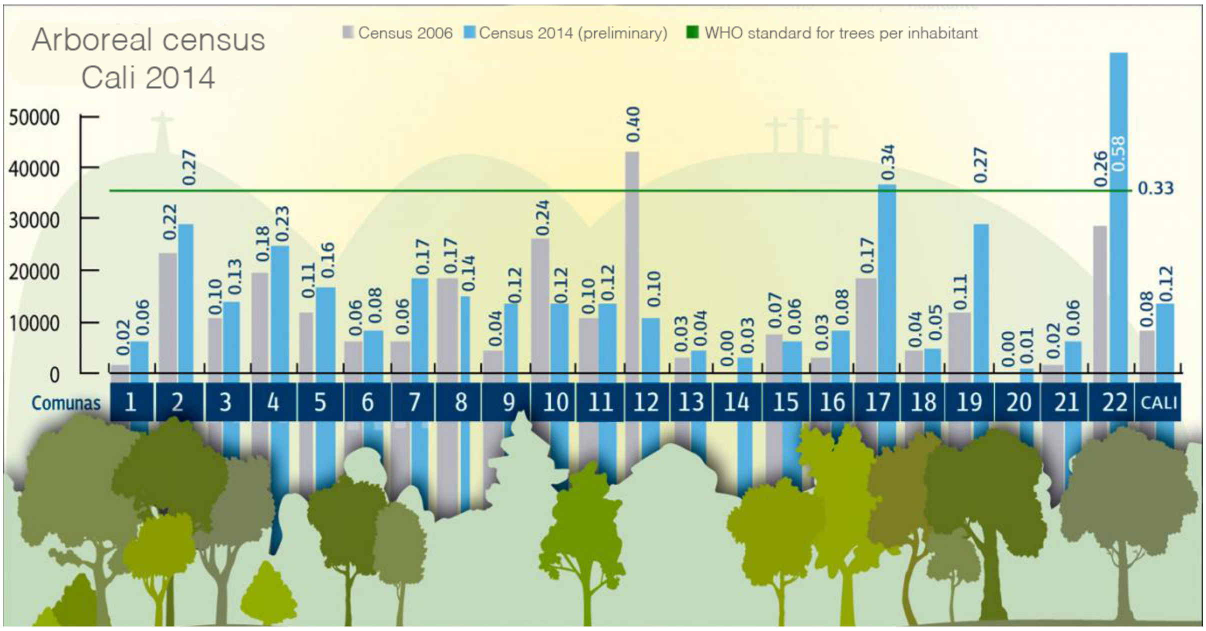

Figure 23 Arboreal census per comuna Cali 2014 and 2006. Source: El Pais.

After controlling for contact to water bodies, EFF showed to have a negative impact on LV, which needs to be approached besides the local interventions suggested by ECC. According to Konrad (2003), Sampson (2008), Pineo (2009) permeable surfaces can reduce run-offs and increasing the absorption of fluvial and pluvial flooding. This means that a program to promote changes in the existing impermeable surfaces plus a reformation in the construction regulations for new developments to include permeable surfaces instead of traditional non-permeable pavements would be beneficial for reducing the flooding externalities.

Among the multiple benefits that GI has (Epa et al. 2014; Van Den Berg et al. 2015; Bottalico et al. 2016) its potential to minimize the occurrence of crime is something to take into consideration for Cali's policy, especially for neighborhoods like Siloé, Mojica y Potrero Grande[30], which have the highest crime rates (Cali, 2010). In the particular case of trees, Donovan and Prestemon (2012) pointed a crime reduction correlated with them, since thieves feel a tree implies a property "is better cared for and, therefore, subject to more effective authority/vigilance than a comparable house with fewer trees". Also neighborhoods with higher levels of public trees, vegetation and illumination motivate people to walk more, which has an impact in crime since more people walking means the area is safe, which creates a positive feedback loop attracting more people and giving a higher sensation of safety (Gehl 2010; Litman 2014).

GI and mobility were the variables that scored the highest impacts on LV, which points an opportunity to explode them in a more integrated way. A scenario could be to combine the river network with green corridors[31] and a sustainable public transport system parallel to the GI network. This GI- transport network could guarantee access to the CBD and centralidades even from the farthest points in the city (see image 24) but more important, it could work as a catalyzer for job creation, urban development and accessibility to amenities and social housing.

[30] http://www.elpais.com.co/elpais/judicial/noticias/estas-son-211-zonas-calientes-delincuencia-cali
[31] such as Cali Green Corridor http://www.elpais.com.co/elpais/cali/noticias/agosto-inicia-primer-tramo-corredor-verde

Figure 24 Potential connectivity through rivers network and Cali Green Corridor. Author, 2016. Based on GIS-RAPOT2013 file.

Sustainable transport in combination with a green/blue network of infrastructure across the seven rivers of Cali can become in a Green Transport Oriented Development (GTOD), by generating economic corridors and boosting the urban growth in city. Their impact as one whole network would be, as Aristoteles describe "more than the sum of its parts". Therefore, all this growth would generate revenues that could be collected through instruments like Land Capture Value and betterment taxations. However, upgrading land without taking precautions for the current owners could create a problem as well as a solution. Gentrification is a common externality when these type of policies are "successfully" implemented. Using GI as a tool for land improvement without appropriate policy precautions can enable to stakeholders and people in privileged positions to act with impunity, displacing lower- income homeowners, renters, and racial minorities. This happens because with the land upgrading, neighborhoods become more expensive, forcing original owners to move out since they cannot afford the increase in services cost.

It is imperative to take all the stakeholders into consideration when planning and integral policy, if important parties are not aware of the taken decisions, GI projects can turn into a green disguise for gentrification, that far away from helping the vulnerable sectors it can worsen their living situation. However, there are options to prevent gentrification taking over such as realty transfer tax, low income housing tax and anti-speculation tax, which can be used as protection for local residents and housing diversity (Rose, 2015; PCAC, 2015). The state has to ensure that developers stick to these regulations, making them keep in mind that projects must offer property diversity, including a percentage of affordable housing for the vulnerable sectors. These regulations must come also with a proper punishment or fines in case of being broken, otherwise their rate of effectiveness would be highly compromised.

"A law without penalty is just poetry"
Carlos Morales-Schechinger

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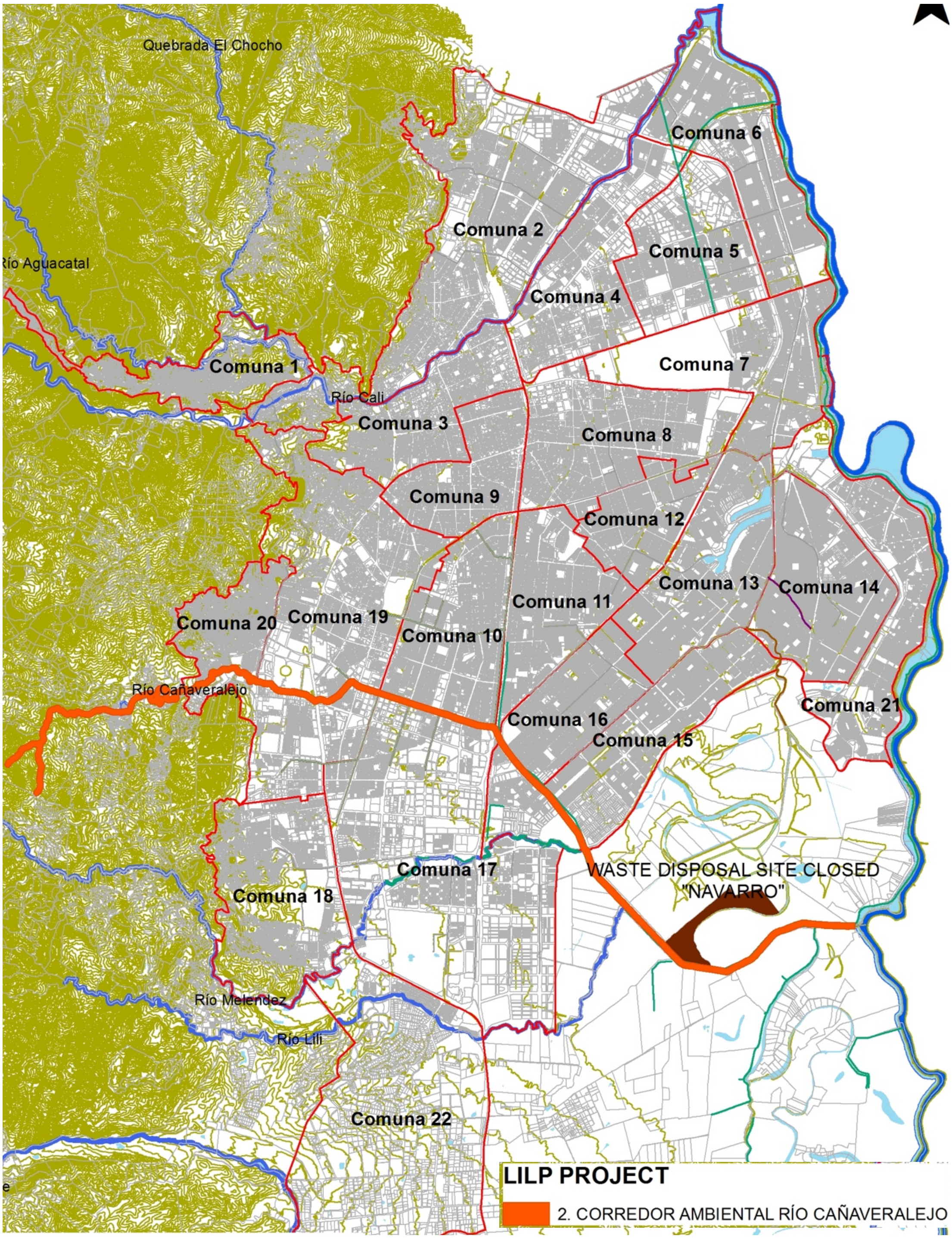
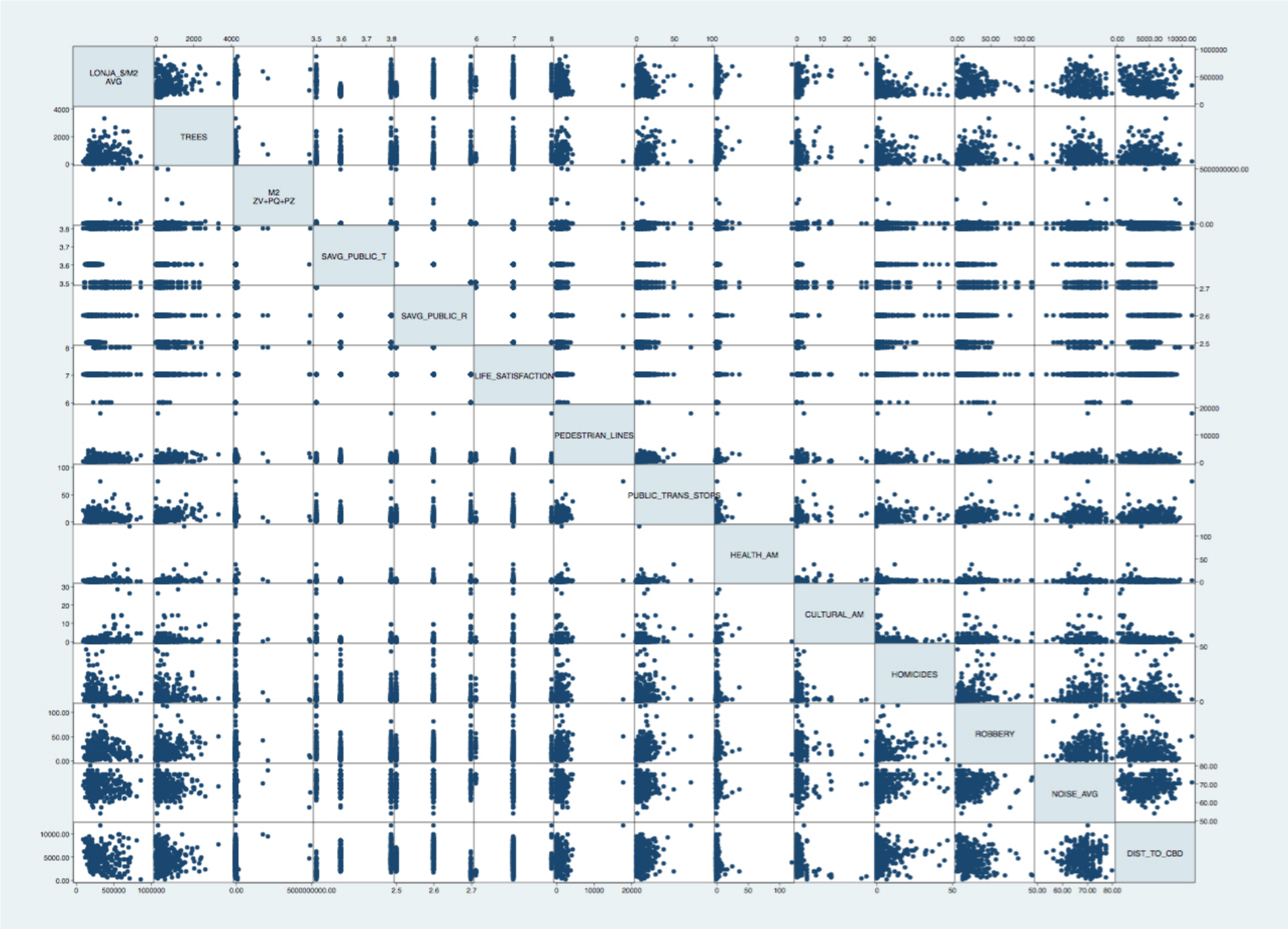
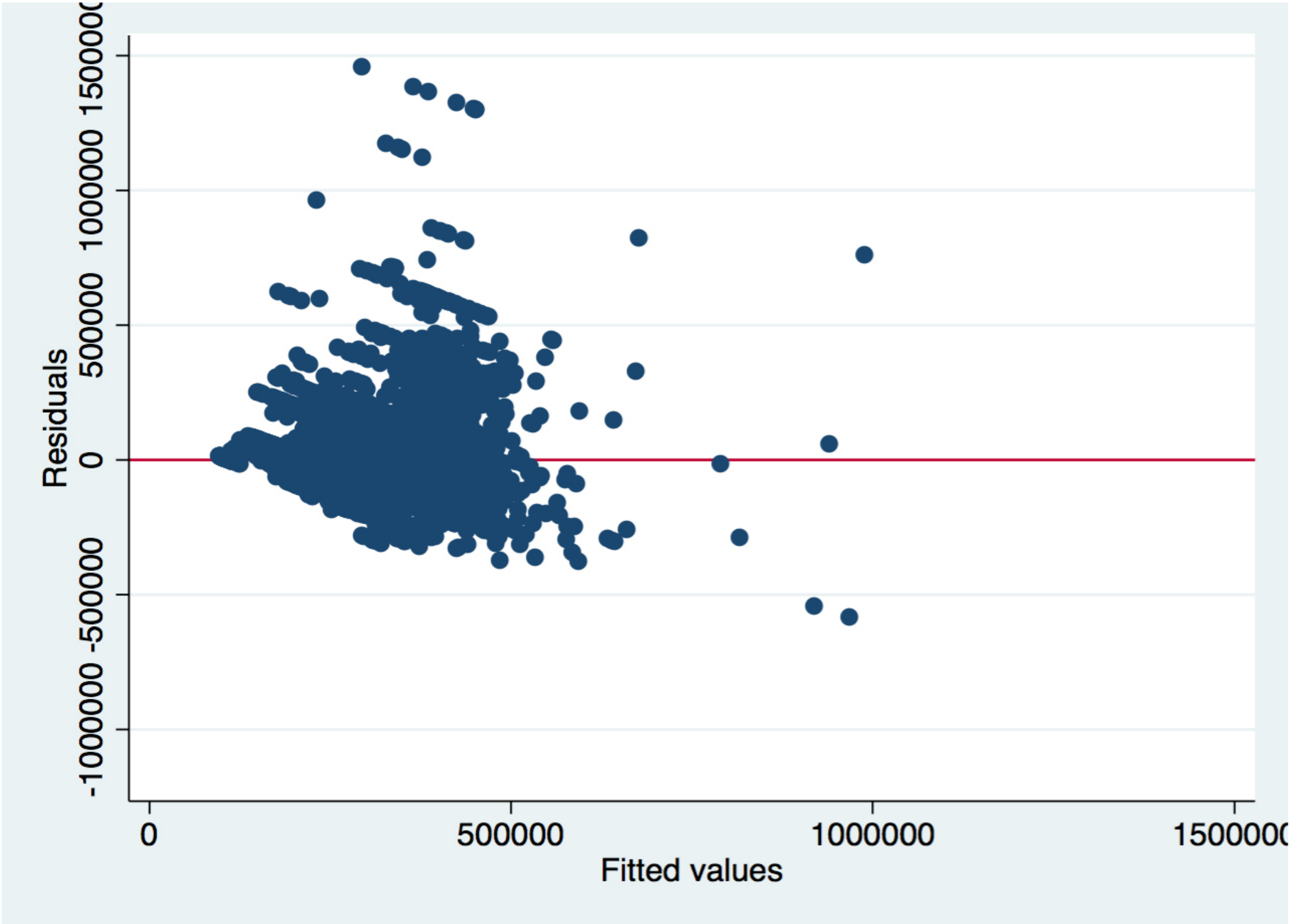
Annex 1: Map from Cali with the location of ECC in orange



Annex 2: Scatterplot for unusual data MS1



Annex 3: Scatterplot for residuals / heteroskedasticity MS1



Annex 4: Correlation tables at neighborhood and block scale

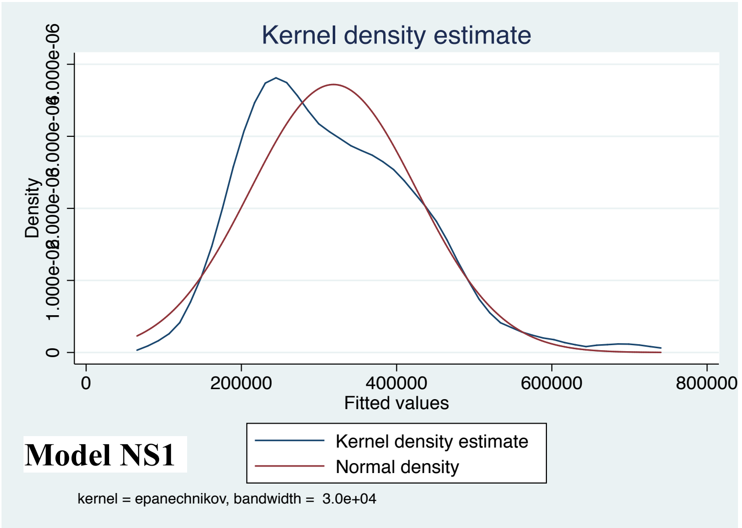
Correlation table - Neighborhood scale - observations = 328

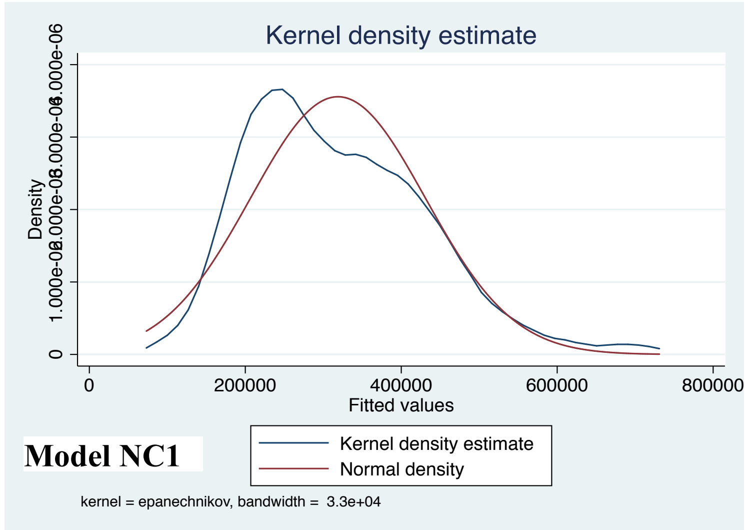
	LV $COP/m²	Trees	m² Vegetation Coverage	Bike lines	Pedestrian lines	EFF	Contac to water bodies	Public roads quality	Public Transport efficiency	AVGIOC	Commercial activities	Cultural amenities	Distance to CBD	Homicides	Robbery	Average Noise	Life Satisfaction Index	Public transport stops	Health amenities
LV $COP/m²	1																		
Trees	0,2074	1																	
m² Vegetation Coverage	0,1272	0,0801	1																
Bike lines	0,0405	0,0899	0,0396	1															
Pedestrian lines	0,1232	0,2245	0,2104	0,1337	1														
EFF	-0,045	0,0885	-0,1473	-0,1066	-0,0549	1													
Contac to water bodies	0,119	0,0514	-0,0824	0,0331	-0,0231	0,305	1												
Public roads quality	0,4429	-0,0642	0,1283	-0,026	-0,0054	-0,1705	0,1763	1											
Public Transport efficiency	0,1419	-0,0434	-0,094	0,1183	0,0343	0,0725	-0,017	-0,3324	1										
AVGIOC	0,1679	0,1	-0,0491	0,0409	-0,0294	-0,0101	0,0749	0,1201	-0,0292	1									
Commercial activities	0,2589	0,2739	0,099	-0,0031	0,2539	-0,0224	-0,0051	0,2186	-0,2247	-0,0534	1								
Cultural amenities	0,3727	0,1342	0,1729	-0,0395	0,0574	-0,0858	0,0995	0,3081	-0,1889	0,0118	0,1837	1							
Distance to CBD	-0,2187	-0,1077	-0,3456	0,1659	0,115	0,1108	0,1734	-0,1687	0,3349	0,0235	-0,3065	-0,3074	1						
Homicides	-0,2497	0,0028	0,0171	-0,0133	0,054	0,0024	0,1101	0,0087	-0,1132	-0,0906	0,2397	-0,059	0,1673	1					
Robbery	0,1231	0,2762	0,1352	0,042	0,2823	-0,0501	0,0796	0,422	-0,1733	-0,0625	0,3763	0,1218	-0,1085	0,2433	1				
Average Noise	-0,1858	-0,1272	-0,0748	-0,0675	0,0511	-0,0721	-0,0285	0,0731	-0,2566	-0,0576	0,15	-0,0002	0,0116	0,215	0,109	1			
Life Satisfaction Index	0,0887	0,1906	0,009	-0,0538	0,0818	0,1207	0,0095	-0,2155	0,2571	0,0152	-0,0863	-0,0445	0,1383	-0,09	-0,0494	-0,1399	1		
Public transport stops	0,0552	0,3672	0,0942	0,0969	0,567	0,0561	0,1903	0,0878	-0,1236	0,0208	0,2403	0,17	0,1953	0,163	0,3659	0,0273	0,0996	1	
Health amenities	0,2463	0,2243	0,2355	-0,0134	0,1012	-0,0384	-0,0161	0,0869	0,0495	-0,025	0,1151	0,1258	-0,0946	-0,0207	0,0484	-0,0816	-0,023	0,1043	1

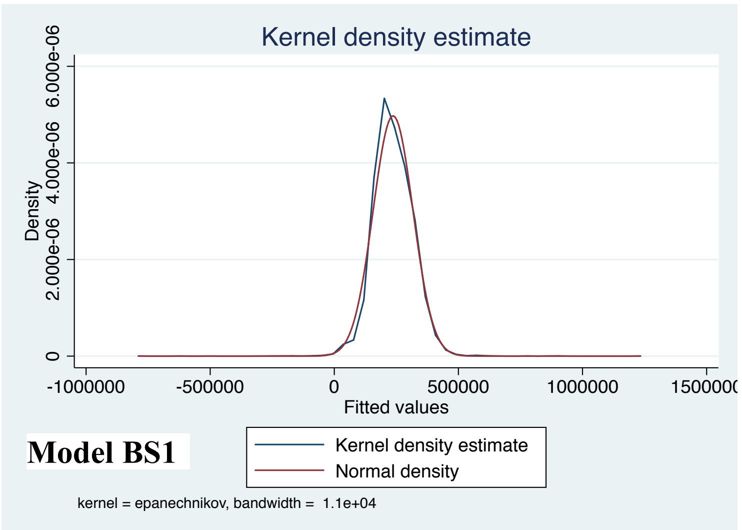
Correlation table - Block scale - observations = 10,543

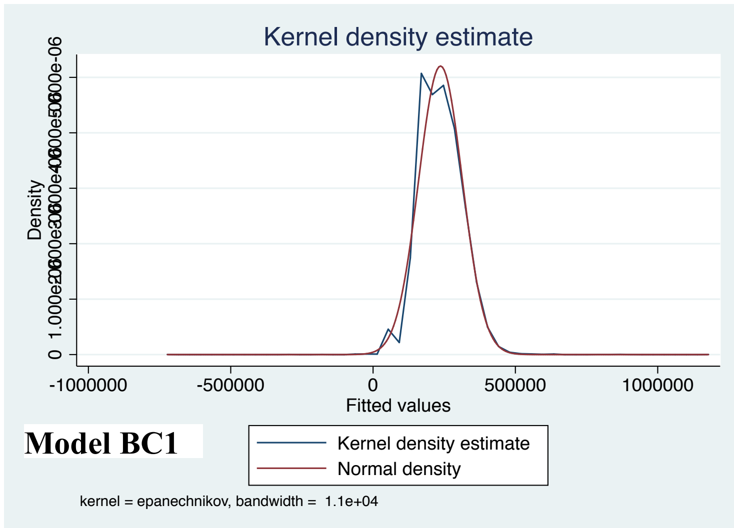
	LV $COP/m²	Trees	m² Vegetation Coverage	Bike lines	Pedestrian lines	EFF	Contac to water bodies	Public roads quality	Public Transport efficiency	AVGIOC	Commercial activities	Cultural amenities	Distance to CBD	Homicides	Robbery	Average Noise	Life Satisfaction Index	Public transport stops	Health amenities
LV $COP/m²	1																		
Trees	0,0497	1																	
m² Vegetation Coverage	0,1082	0,178	1																
Bike lines	0,0588	0,039	0,3878	1															
Pedestrian lines	0,0888	0,1069	0,0782	0,0452	1														
EFF	-0,1158	0,032	-0,0092	-0,0289	-0,0097	1													
Contac to water bodies	0,0149	0,0343	0,0355	0,0293	0,0959	0,11	1												
Public roads quality	0,2811	-0,0403	0,0303	-0,0175	-0,0274	-0,206	0,0252	1											
Public Transport efficiency	0,0839	-0,0138	0,0628	0,0663	0,0422	-0,069	0,0715	-0,33	1										
AVGIOC	0,0824	0,0549	0,0398	0,0021	0,0368	-0,0178	0,0114	0,047	0,021	1									
Commercial activities	0,1968	0,0364	0,004	-0,0068	0,1283	-0,0324	-0,0298	0,0093	-0,0363	0,0087	1								
Cultural amenities	0,1331	0,0027	0,0136	-0,0076	0,105	-0,0245	0,0054	0,0954	-0,0549	-0,002	0,023	1							
Distance to CBD	-0,3339	-0,0053	0,0559	0,0203	-0,0895	0,1611	0,0605	-0,0887	0,1863	0,0104	-0,2122	-0,1393	1						
Homicides	-0,2092	-0,0649	-0,0485	-0,0242	-0,0668	0,1578	0,0808	0,0477	-0,114	-0,0371	-0,0245	-0,0574	0,2454	1					
Robbery	0,1978	-0,0108	0,0323	-0,0092	0,0163	-0,0522	0,0658	0,3599	-0,0837	0,0023	0,0698	0,0002	-0,1036	0,1718	1				
Average Noise	-0,1377	-0,0557	-0,0486	-0,0316	-0,0311	-0,02	0,0503	-0,0737	-0,118	-0,0385	-0,0062	-0,0337	0,017	0,188	0,0043	1			
Life Satisfaction Index	0,0263	0,0522	0,0363	-0,0535	-0,0136	-0,0505	0,0079	-0,2714	0,2609	0,0086	-0,0386	-0,0164	0,1124	-0,1443	-0,0745	-0,1162	1		
Public transport stops	0,0195	0,0775	0,0336	0,0321	0,1642	0,0257	0,0429	0,0065	-0,0097	0,0126	0,032	0,0429	0,0218	-0,0182	-0,0157	-0,0324	0,0042	1	
Health amenities	0,0202	0,0228	0,0043	-0,0066	0,0241	-0,0055	0,0029	0,0127	0,0055	-0,0028	0,0136	0,0806	-0,0433	-0,0149	0,0092	-0,0197	-0,0143	-0,0013	1

Annex 5: Normality and residuals at neighborhoods and block scale

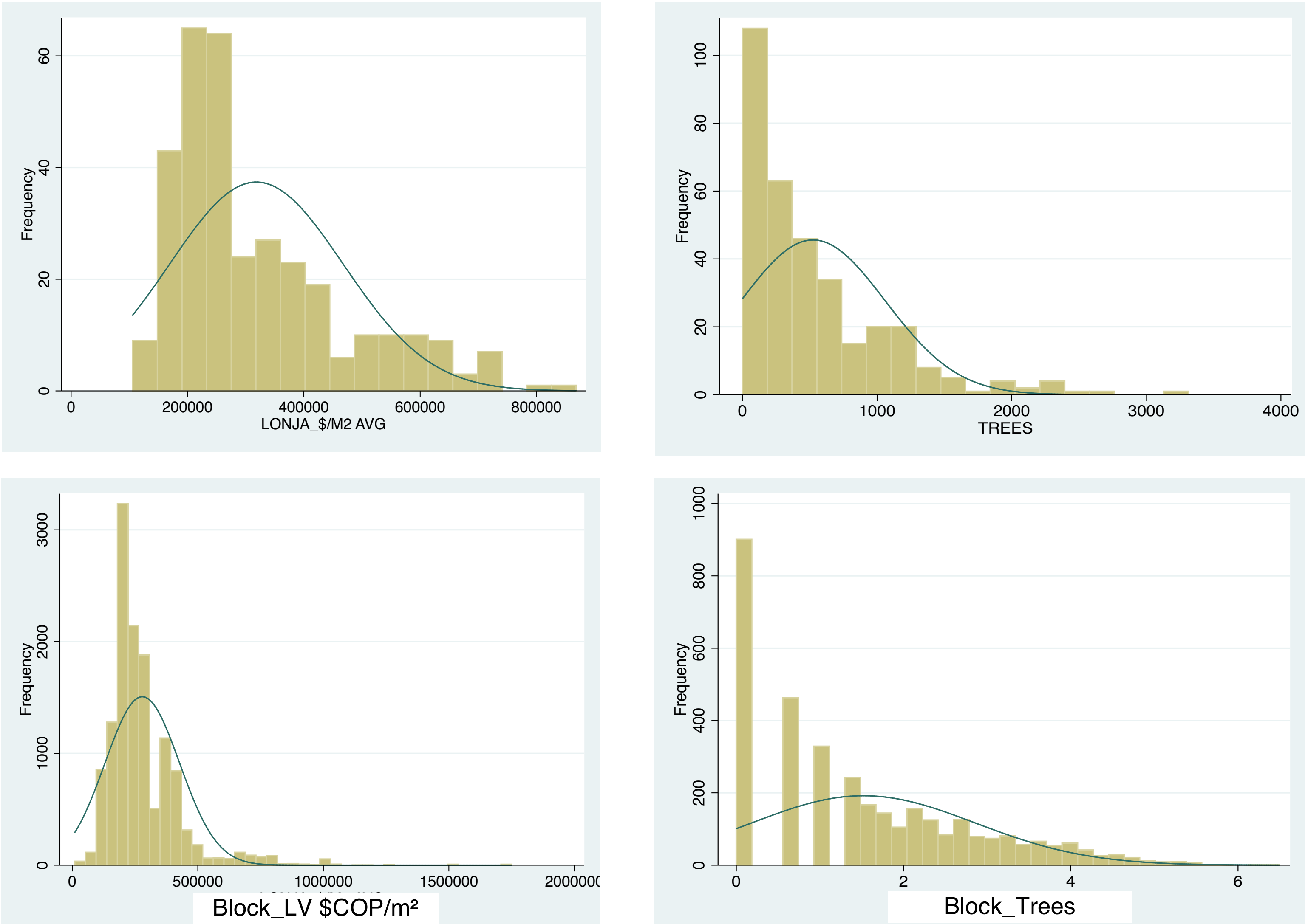




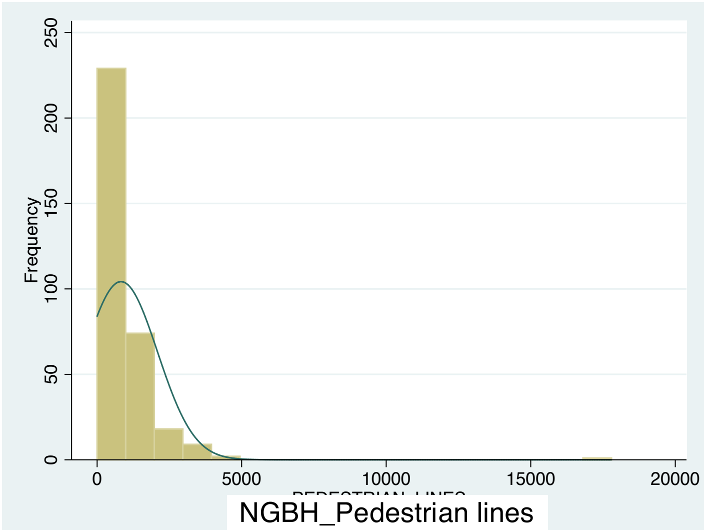


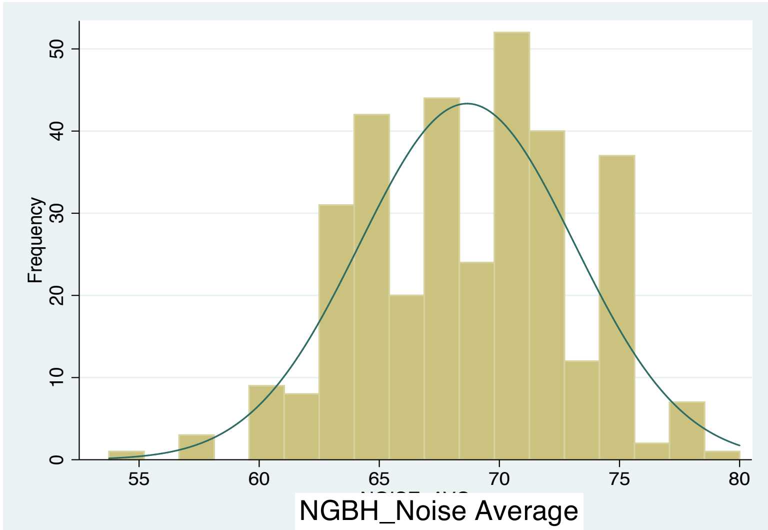


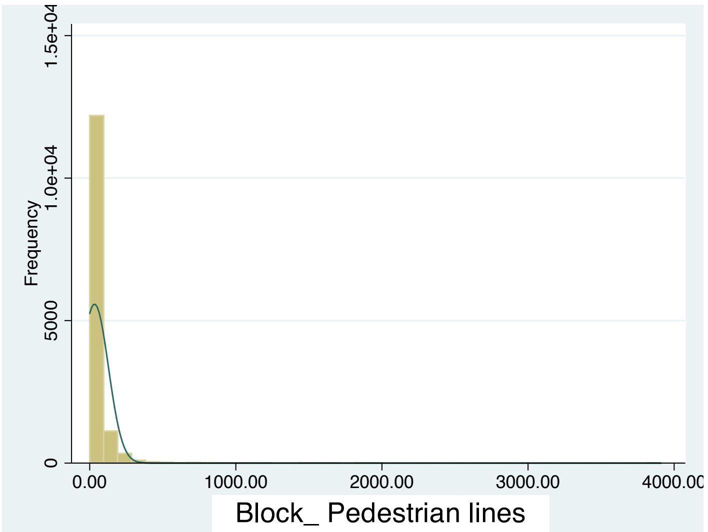
Annex 6: Normality histograms in critical variables

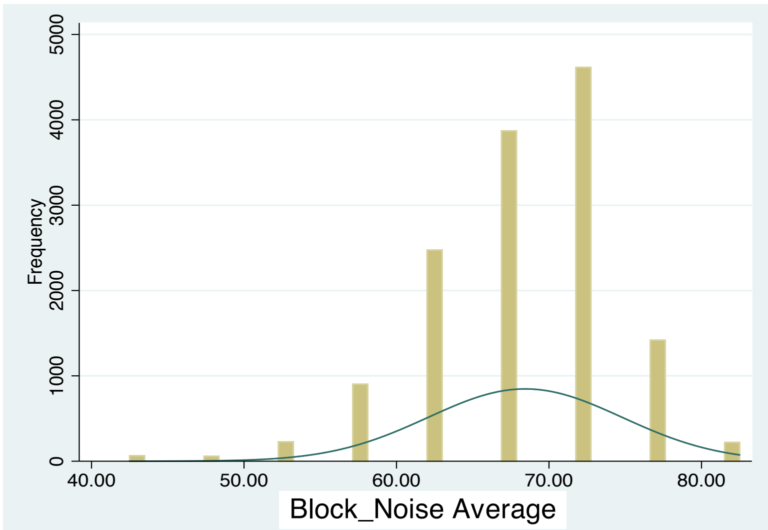


Annex 7: Normality histograms in critical variables









Annex 8: Survey format

Green Rescue - Encuesta de calidad urbana

Green Rescue es una investigación que forma parte de un proyecto conjunto entre Universidad del Valle, Institute for Housing and Urban Development of Erasmus University y el Lincoln Institute of Land Policy, el cual esta enfocado en el Corredor Ambiental Cañaveralejo (CAC) en Cali. Green Rescue research tiene como objetivo calcular el impacto potencial que proyectos de infraestructura verde (tal como lo es el CAC) pueden ejercer en los valores de la propiedad. Esta encuesta es parte de una serie de herramientas para calcular ese impacto, por lo que nos complacería contar con su apoyo y su conocimiento para evaluar de una forma objetiva* la calidad urbana de las comunas en Cali.

*Los resultados de esta encuesta son totalmente confidenciales, ningún dato personal o empresarial será utilizado o distribuido. El computo final de respuestas será procesado y estandarizado para su posterior uso en el modelo hedónico, por lo que ningún dato bruto será publicado. En caso de tener dudas y aclaraciones acerca del manejo de confidencialidad de datos o si desea recibir los resultados del estudio, favor de comunicarse a nohemi_ra@student.eur.nl de antemano muchísimas gracias.

* Required

Universidad del Valle

IHS Making cities work

LINCOLN INSTITUTE OF LAND POLICY

Nombre completo
Your answer

Edad
Your answer

Profesion *
Your answer

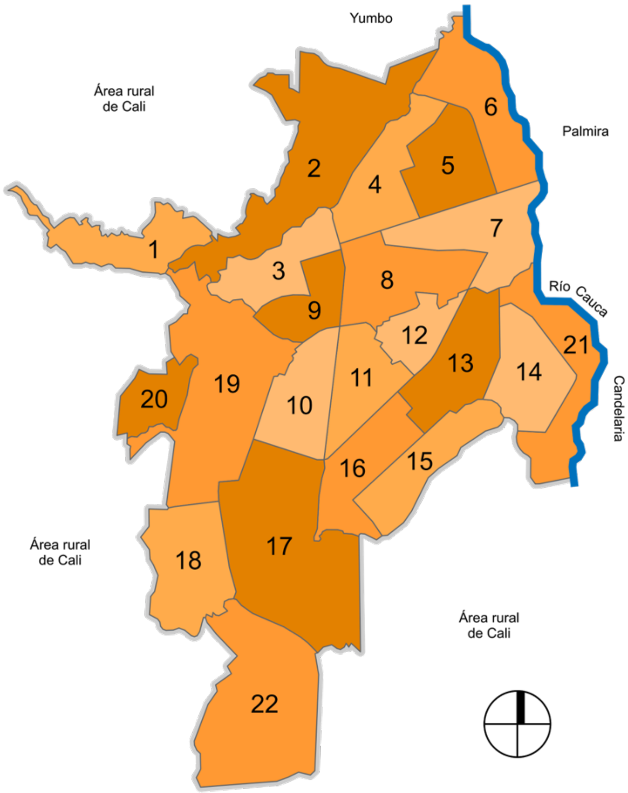
Cargo / Posición laboral *
Your answer

Compañia *
Your answer

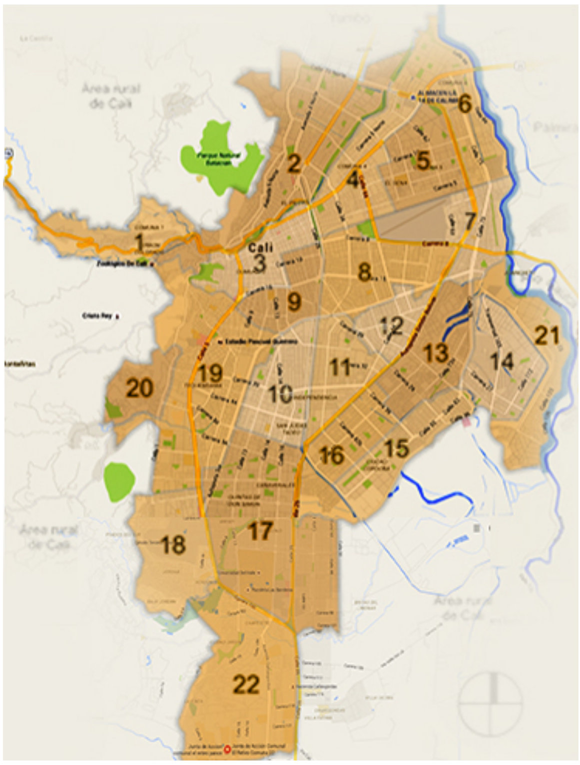
Contacto y sitio web de compañia *
Your answer

Evaluación de calidad de vida urbana por comunas

Mapa comunas Cali



Cali maps con comunas



1. Siendo que la calidad estética de una comuna se compone de la percepción y estado de las áreas verdes, calles y pavimentos, predios, infraestructura urbana

como andadores, alumbrado publico, bancas, botes de basura, arboles, alcantarillas, etc. De un puntaje a cada una de las 22 comunas de 1 a 5, donde 1 es muy baja calidad, 2 es baja calidad, 3 es aceptable, 4 es buena calidad,5 es muy buena calidad y al extremo derecho de la tabla se ubica la opcion "No Sabe". *

Situacion a nivel barrio

2. Sabe de algún(os) barrio(s) que tenga un mayor o menor puntaje al que recibió la comuna? Si es así, favor de mencionar el barrio, la comuna (C) a la que pertenece, el puntaje (P) y las causas que cree influyen en ello. Ejemplo : C1- Aguacatal - P2- Violencia pandillas, etc. Puede ser tan extenso como lo desee. *
Your answer

3. Mencione los barrios (y su comuna) donde considere que las condiciones son optimas para vivir (cercanía a escuelas, parques, paraderos de transporte publico, supermercados, valor arquitectónico y cultural, etc.) En caso de que Ud. considere algún otro factor determinante favor de mencionarlo.
Your answer

Centralidades

Definimos centralidad como una parte de la ciudad que contiene un alto nivel de concentración de lugares de interés como lo son bienes culturales públicos, ej. bibliotecas, museos, galerías de arte, edificios públicos, espacios abiertos, comerciales y minoristas, edificios históricos notables, espacios memorables, etc. (Bianchini 1990, Evans 1997).

4. Mencione* lugares (nombre del lugar, barrio y comuna) en la ciudad que cumplan con las características de una centralidad. Deles un valor segun su importancia o nivel de centralidad(siendo 1 el menos importante o central, 5 mas importante, así sucesivamente). Mapa para poder corroborar la ubicación de sitios en caso de ser necesario:planeacion.cali.gov.co/caliencifras/Graficos_cec/Cap12_image002.jpg *Es importante aclarar que no estamos pidiendo que indique sus lugares preferidos en la ciudad, le estamos pidiendo que indique los lugares donde generalmente la mayoría de los ciudadanos se reúnen o frecuentan para diversos propósitos dentro de la ciudad. *
Your answer

5. En cuestión de calidad visual, mencione lugares (nombre del lugar, barrio y comuna) dentro de Cali que considera placenteros o agradables a la vista y que por esta razón atraigan a un mayor numero de visitantes.

Your answer

MENSAJE DEL AUTOR:

Si conoce de alguien interesado o cuya opinión pueda aportar a esta investigación, le pido de favor le comparta el enlace de esta encuesta, un mayor numero de respuestas nos dará una mejor perspectiva de la situación, de antemano, muchísimas gracias.

Atentamente

Arq.Nohemí Ramírez Aranda

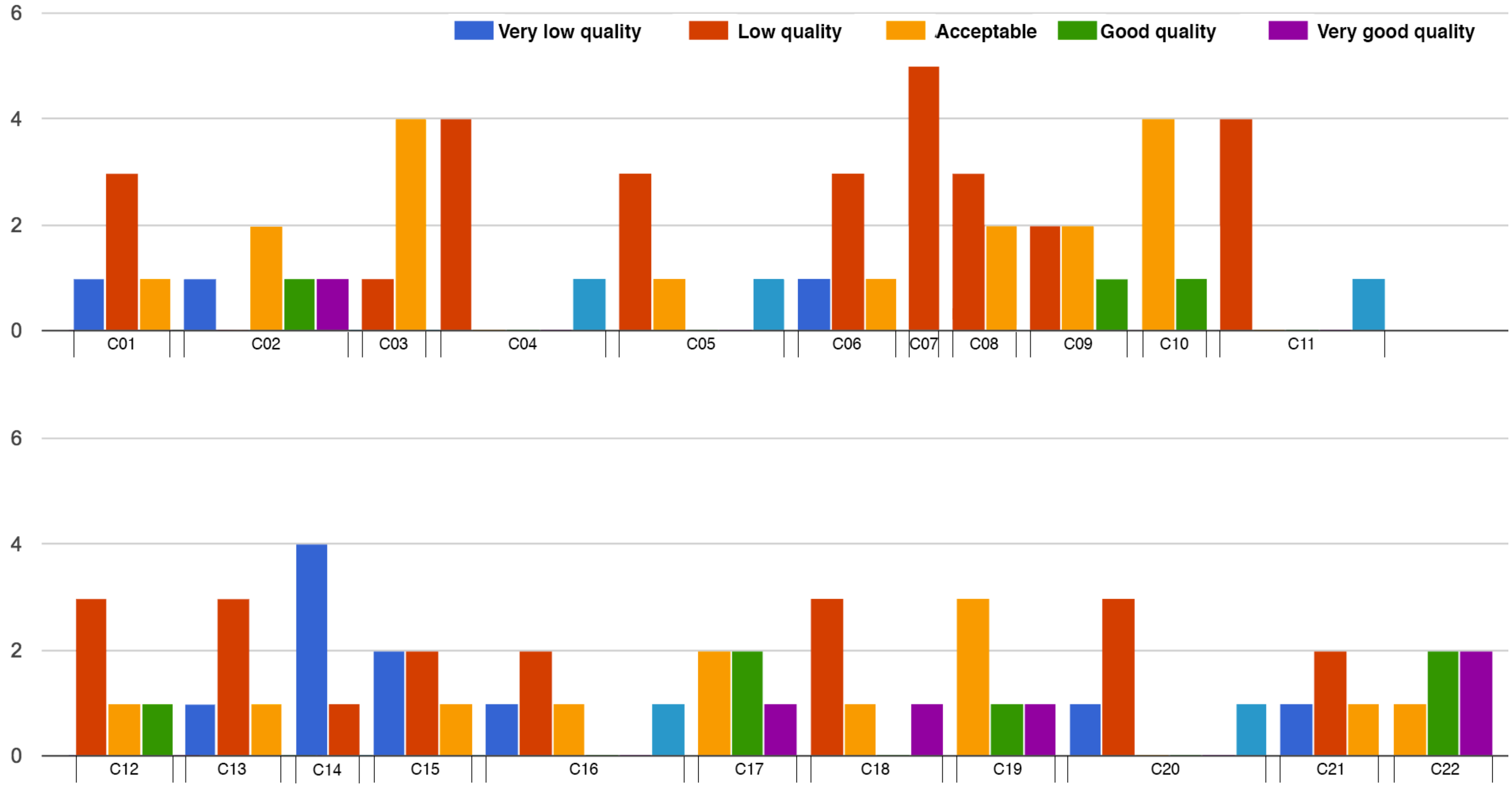
Investigadora de especialización UECC

IHS Erasmus University Rotterdam

SUBMIT

Page 1 of 1

Annex 9: Survey responses – Question 1



Annex 10: Survey responses – Questions 2-5

Responses QUESTION 2

GOOD NEOGHBORHOODS:
302-Peñón
1783-Capri
1780-Ingenio
C19-San Fernando
C02-Granada
C03-San Antonio
C10-Olímpico
C17-Limonar

BAD NEIGHBORHOODS
C3 Calvario P3

Responses QUESTION 3

303_San Antonio
Zona occidental del Centro
1910_San Fernando
1911_Miraflores
1783_Capri
302_Peñón
817_La Base
1780_Ingenio
207_Granada
210_Santa Mónica.

NGBH with better pedestrian accessibility and urban security:
1008_Olimpico
1787_El limonar,
1783_capri,
2201_ciudad jardín,
216_menga ,
212_la flora,
294_vipaza,
218_Chipichape;

Comments: The neighborhoods that are close to the street 5, have a better mobility due to access to the main public transport line.

1910_San Fernando
1911_Miraflores
1009_Cristóbal Colón

903_Junín
904_Guayaquil
1994_Pampalinda
1906-1910_San Fernando

Responses QUESTION 4

Centro, Norte (Granada-Versalles-Centenario),
Unicentro-Universidades,
Estadio-Plaza de Toros,
14 de Calima.

En primer lugar el centro tradicional nivel 5, Granada y Centenario 3, Menga 3, Imbanaco y Tequendama 3, Univalle- Unicentro- Holguines y jardín plaza 4, Santa Elena 3, Alfonso Lopez 2, Sameco 2

La mayor oferta cultural se encuentra justamente en el centro de la ciudad, barrios como san fernando, san antonio, nueva tequendama, bretaña, alameda, entre otros. tienen mayor acceso a sitios de interés cultural, espacios adecuados de la ciudad, vías y medios de transporte.

Centro de Cali, Comuna 3.
El centro histórico de Santiago de Cali, en el cual está ubicado el museo la merced - C2 (puntuación 4), La parte de la avenida del río en el oeste, y el museo la tertulia - C3 (puntuación 4), Sector de la ermita C3 (puntuación 3), El sector de parque de las banderas y el estadio C19 (puntuación 4).

Responses QUESTION 5

2201_Ciudad Jardín
1783_Capri
1780_Ingenio
303_San Antonio
1306_Sebastián de Belalcázar
2296_Pance
210_Santa Mónica
1903_El lido
1910_San Fernando viejo
1787_El limonar
294_Vipaza
212_La flora
208_ Versalles
302_El Peñón
--Cristo Rey
--Río Cali
--Sector alcaldía, comuna 3
--Las Tres Cruces .

Annex 11: Forecast table per GI indicator.

NGBH ID	BLOCK ID	Original number	Δ CAC	β BLOCK	ORIGINAL IMPACT IN y	INCREASE IN y	AVG LV $COP/M²	INCREASE IN AVG LV $COP/M2
				TREES				
1921	19214375,71	36	3	307,16	$11.057,76	$921,48	$412.500,00	0,22%
1921	19215179,33	0	16	307,16	$0,00	$4.914,56	$425.000,00	1,16%
1921	19215223,4	3	4	307,16	$921,48	$1.228,64	$425.000,00	0,29%
1921	19216081,37	0	1	307,16	$0,00	$307,16	$425.000,00	0,07%
1922	19224375,71	0	2	307,16	$0,00	$614,32	$400.000,00	0,15%
1922	19225949,52	0	2	307,16	$0,00	$614,32	$400.000,00	0,15%
1921	192123934,9	69	54	307,16	$21.194,04	$16.586,64	$455.000,00	3,65%
1921	192127174,6	0	24	307,16	$0,00	$7.371,84	$441.250,00	1,67%
1922	192227174,6	199	98	307,16	$61.124,84	$30.101,68	$441.250,00	6,82%
TOTAL		307	204	307,16	$94.298,12	$62.660,64		1,58%
				BIKELINES				
1995	199574454,1	0	685,78	92,27	$0,00	$63.276,92	$338.333,33	18,70%
1999	199979611	42,26	464,67	92,27	$3.899,33	$42.875,10	$450.000,00	9,53%
1999	1999188348	0	401,78	92,27	$0,00	$37.072,24	$450.000,00	8,24%
1992	199274454,1	0	275,27	92,27	$0,00	$25.399,16	$338.333,33	7,51%
1985	198521658,2	0	232,63	92,27	$0,00	$21.464,77	$500.000,00	4,29%
1995	199529247,8	0	178,82	92,27	$0,00	$16.499,72	$250.000,00	6,60%

1995	199544371,6	0	178,72	92,27	$0,00	$16.490,49	$315.000,00	5,24%
2002	20022799,78	0	177,31	92,27	$0,00	$16.360,39	$135.000,00	12,12%
1921	19215179,33	0	168,58	92,27	$0,00	$15.554,88	$425.000,00	3,66%
1921	19215223,4	0	165,94	92,27	$0,00	$15.311,28	$425.000,00	3,60%
1922	192227174,6	15,17	158,26	92,27	$1.399,74	$14.602,65	$441.250,00	3,31%
1992	199218739	0	143,21	92,27	$0,00	$13.213,99	$400.000,00	3,30%
1921	192123934,9	0	106,87	92,27	$0,00	$9.860,89	$455.000,00	2,17%
2098	20982334,57	0	86,76	92,27	$0,00	$8.005,35	$110.000,00	7,28%
1921	19214375,71	0	81,37	92,27	$0,00	$7.508,01	$412.500,00	1,82%
2002	200218602,4	0	59,45	92,27	$0,00	$5.485,45	$347.500,00	1,58%
1922	19223628,32	0	58,22	92,27	$0,00	$5.371,96	$400.000,00	1,34%
2002	200229247,8	0	56,29	92,27	$0,00	$5.193,88	$225.000,00	2,31%
1985	198510121,2	0	34,29	92,27	$0,00	$3.163,94	$450.000,00	0,70%
1922	19223765,74	0	31,76	92,27	$0,00	$2.930,50	$400.000,00	0,73%
1999	199910121,2	0	25,87	92,27	$0,00	$2.387,02	$450.000,00	0,53%
1921	192127174,6	7,66	24,17	92,27	$706,79	$2.230,17	$441.250,00	0,51%
1919	191910121,2	0	10,21	92,27	$0,00	$942,08	$450.000,00	0,21%
2098	20981913,25	0	4,4	92,27	$0,00	$405,99	$110.000,00	0,37%
	TOTAL	65,09	3810,63	92,27	$6.005,85	$351.606,83		4,40%

PEDESTRIAN LINES								
1922	192227174,6	0	815,05	27,17	$0,00	$22.144,91	$441.250,00	5,02%
1995	199544371,6	299,79	543,99	27,17	$8.145,29	$14.780,21	$315.000,00	4,69%
1995	199574454,1	0	537,74	27,17	$0,00	$14.610,40	$338.333,33	4,32%
1999	199910121,2	509,54	492,42	27,17	$13.844,20	$13.379,05	$450.000,00	2,97%
1995	199529247,8	485,43	441,35	27,17	$13.189,13	$11.991,48	$250.000,00	4,80%
1921	192123934,9	306,34	418,4	27,17	$8.323,26	$11.367,93	$455.000,00	2,50%
1919	191910121,2	950,45	295,93	27,17	$25.823,73	$8.040,42	$450.000,00	1,79%

1992	199274454,1	0	240,96	27,17	$0,00	$6.546,88	$338.333,33	1,94%
1985	198521658,2	0	225,27	27,17	$0,00	$6.120,59	$500.000,00	1,22%
1921	19215223,4	0	137,69	27,17	$0,00	$3.741,04	$425.000,00	0,88%
2002	200229247,8	0	96,23	27,17	$0,00	$2.614,57	$225.000,00	1,16%
1992	199218739	283,85	81,79	27,17	$7.712,20	$2.222,23	$400.000,00	0,56%
1919	191965273,7	86,11	69,47	27,17	$2.339,61	$1.887,50	$371.666,67	0,51%
1921	19214375,71	218,8	69,39	27,17	$5.944,80	$1.885,33	$412.500,00	0,46%
1921	192127174,6	67,86	65,15	27,17	$1.843,76	$1.770,13	$441.250,00	0,40%
1921	19215179,33	0	41,9	27,17	$0,00	$1.138,42	$425.000,00	0,27%
1985	198510121,2	128,99	41,37	27,17	$3.504,66	$1.124,02	$450.000,00	0,25%
1995	19957468,17	38,22	37,54	27,17	$1.038,44	$1.019,96	$315.000,00	0,32%
2002	20022799,78	0	21,69	27,17	$0,00	$589,32	$135.000,00	0,44%
1922	19223628,32	0	19,53	27,17	$0,00	$530,63	$400.000,00	0,13%
1922	19223765,74	947,36	9,74	27,17	$25.739,77	$264,64	$400.000,00	0,07%
TOTAL		4322,74	4702,6	27,17	$117.448,85	$127.769,64		1,65%

VEGETATION COVERAGE

1995	199544371,6	0	106,81	2,67	$0,00	$285,18	$315.000,00	0,09%
1995	199574454,1	0	73,78	2,67	$0,00	$196,99	$338.333,33	0,06%
1919	191965273,7	0	14867,21	2,67	$0,00	$39.695,45	$371.666,67	10,68%
1999	199979611	8381,9066	7448,57	2,67	$22.379,69	$19.887,68	$450.000,00	4,42%
2098	20989365,01	0	11187,85	2,67	$0,00	$29.871,56	$110.000,00	27,16%
1995	199529247,8	52039,04483	1629,55	2,67	$138.944,25	$4.350,90	$250.000,00	1,74%
1922	192227174,6	0	3313,35	2,67	$0,00	$8.846,64	$441.250,00	2,00%
1992	199274454,1	0	29,79	2,67	$0,00	$79,54	$338.333,33	0,02%
1999	199910121,2	0	7948,16	2,67	$0,00	$21.221,59	$450.000,00	4,72%

1921	192123934,9	0	1196,45	2,67	$0,00	$3.194,52	$455.000,00	0,70%
2002	200229247,8	0	7216,82	2,67	$0,00	$19.268,91	$225.000,00	8,56%
2098	209834175,4	0	7268,56	2,67	$0,00	$19.407,06	$145.000,00	13,38%
1919	191910121,2	482,3511498	1825,16	2,67	$1.287,88	$4.873,18	$450.000,00	1,08%
1985	198521658,2	0	4979,66	2,67	$0,00	$13.295,69	$500.000,00	2,66%
2098	20985086,85	37806,15649	4247,69	2,67	$100.942,44	$11.341,33	$110.000,00	10,31%
2098	209874454,1	0	3568,71	2,67	$0,00	$9.528,46	$357.500,00	2,67%
2002	20022799,78	0	3923,8	2,67	$0,00	$10.476,55	$135.000,00	7,76%
2098	209830695,4	0	3706,26	2,67	$0,00	$9.895,71	$110.000,00	9,00%
2098	209844371,6	0	2733,24	2,67	$0,00	$7.297,75	$212.500,00	3,43%
1999	1999188348	0	2554,69	2,67	$0,00	$6.821,02	$450.000,00	1,52%
1995	19957468,17	0	2164,66	2,67	$0,00	$5.779,64	$315.000,00	1,83%
1921	192127174,6	0	52,69	2,67	$0,00	$140,68	$441.250,00	0,03%
2098	20981138,16	0	1428,92	2,67	$0,00	$3.815,22	$110.000,00	3,47%
2098	20982334,57	0	1553,58	2,67	$0,00	$4.148,06	$110.000,00	3,77%
1995	199511064,4	5204,986761	1182,46	2,67	$13.897,31	$3.157,17	$307.500,00	1,03%
1985	198510121,2	0	763,2	2,67	$0,00	$2.037,74	$450.000,00	0,45%
1921	19214375,71	0	901,56	2,67	$0,00	$2.407,17	$412.500,00	0,58%
2098	20981913,25	0	722,99	2,67	$0,00	$1.930,38	$110.000,00	1,75%
2098	20983908,54	0	676,26	2,67	$0,00	$1.805,61	$110.000,00	1,64%
2098	20982700,48	0	494,17	2,67	$0,00	$1.319,43	$145.000,00	0,91%
2098	2098531,88	0	452,57	2,67	$0,00	$1.208,36	$110.000,00	1,10%
2098	20983252,31	0	442,84	2,67	$0,00	$1.182,38	$110.000,00	1,07%
2098	20981878,35	0	280,85	2,67	$0,00	$749,87	$145.000,00	0,52%
1992	199218739	12084,06801	236,81	2,67	$32.264,46	$632,28	$400.000,00	0,16%
2098	209829247,8	0	215,07	2,67	$0,00	$574,24	$135.000,00	0,43%
2002	200218602,4	0	164,32	2,67	$0,00	$438,73	$347.500,00	0,13%
1919	191919434,4	0	129,36	2,67	$0,00	$345,39	$426.666,67	0,08%

2002	20025338,2	0	126,79	2,67	$0,00	$338,53	$215.000,00	0,16%
1995	19959365,01	0	41,29	2,67	$0,00	$110,24	$110.000,00	0,10%
2098	20984035,85	0	67,78	2,67	$0,00	$180,97	$145.000,00	0,12%
2098	20983116,78	0	17,85	2,67	$0,00	$47,66	$145.000,00	0,03%
1921	19215223,4	0	3,78	2,67	$0,00	$10,09	$425.000,00	0,00%
	TOTAL	115998,5138	101945,91	2,67	$309.716,03	$272.195,58		3,13%

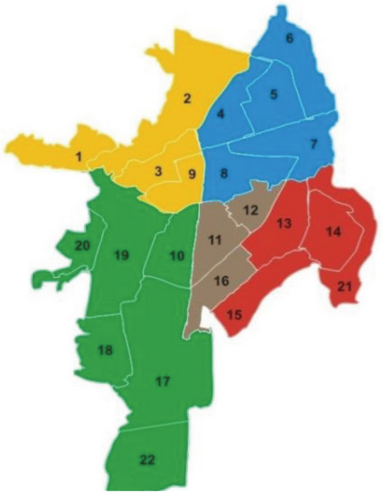
Total ECC increase	**$814.232,69**

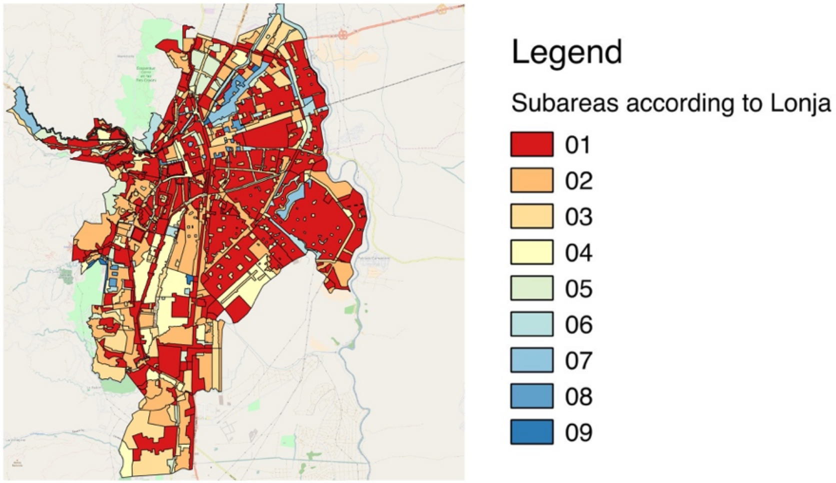
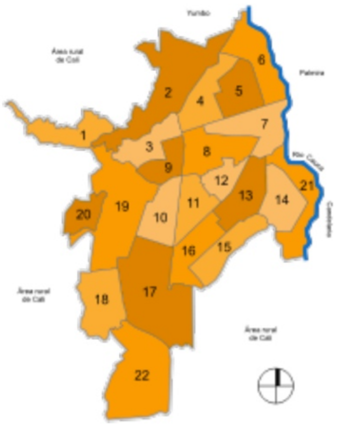
Annex 12: Forecast table per block

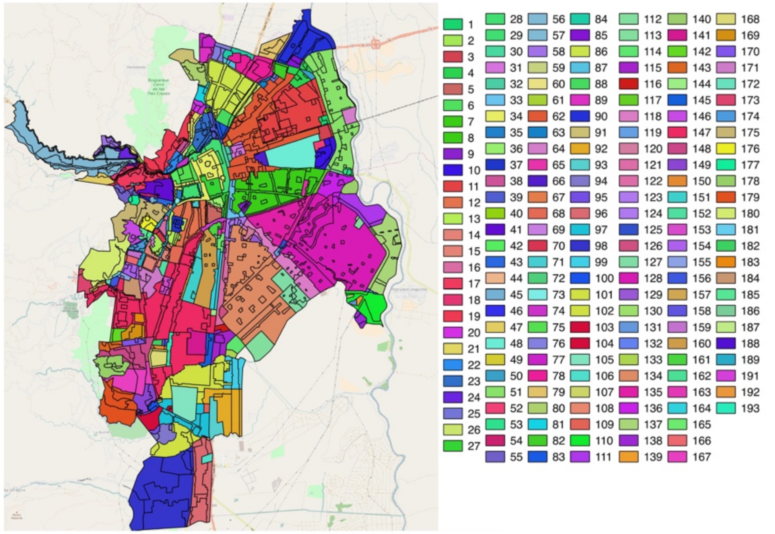
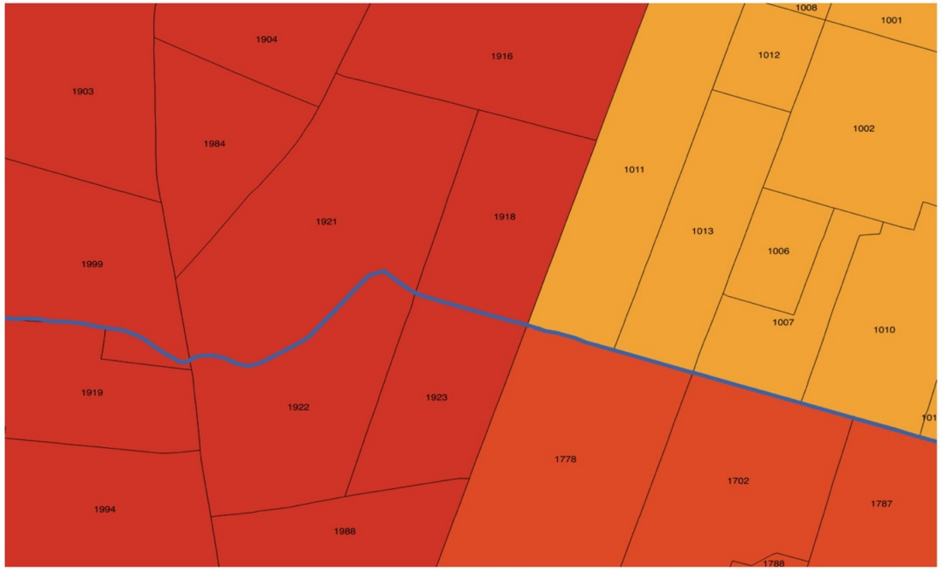
NGBH ID	BLOCK ID	TREES	BIKELINES	PEDESTRIAN LINES	m² VEGETATION COVERAGE	Original AVG LV $COP/m²	ECC increase AVG LV $COP/m²	TOTAL ECC increase % per m²	Original LV per block $COP	Additional value due to ECC $COP
1919	191910121,2	$0,00	$942,08	$8.040,42	$1.825,16	$450.000,00	$10.807,65	2,40%	$4.554.549.000,00	$109.386.651,91
1919	191965273,7	$0,00	$0,00	$1.887,50	$14.867,21	$371.666,67	$16.754,71	4,51%	$8.255.164.374,23	$372.142.289,51
1919	191919434,4	$0,00	$0,00	$0,00	$129,36	$426.666,67	$129,36	0,03%	$4.548.730.787,80	$1.379.118,32
1921	19214375,71	$921,48	$7.508,01	$1.885,33	$901,56	$412.500,00	$11.216,38	2,72%	$578.205.328,16	$15.722.105,41
1921	19215179,33	$4.914,56	$15.554,88	$1.138,42	$0,00	$425.000,00	$21.607,86	5,08%	$1.791.268.205,42	$91.071.698,56
1921	19215223,4	$1.228,64	$15.311,28	$3.741,04	$3,78	$425.000,00	$20.284,74	4,77%	$1.648.596.055,67	$78.685.515,69
1921	19216081,37	$307,16	$0,00	$0,00	$0,00	$425.000,00	$307,16	0,07%	$2.109.321.635,04	$1.524.468,78
1921	192123934,9	$16.586,64	$9.860,89	$11.367,93	$1.196,45	$455.000,00	$39.011,91	8,57%	$541.355.538,05	$46.416.077,14
1921	192127174,6	$7.371,84	$2.230,17	$1.770,13	$52,69	$441.250,00	$11.424,82	2,59%	$242.140.515,06	$6.269.489,27
1922	19224375,71	$614,32	$0,00	$0,00	$0,00	$400.000,00	$614,32	0,15%	$1.750.284.000,00	$2.688.086,17
1922	19225949,52	$614,32	$0,00	$0,00	$0,00	$400.000,00	$614,32	0,15%	$1.515.878.186,30	$2.328.085,72
1922	192227174,6	$30.101,68	$14.602,65	$22.144,91	$3.313,35	$441.250,00	$70.162,59	15,90%	$4.571.377.462,80	$726.888.785,76
1922	19223628,32	$0,00	$5.371,96	$530,63	$0,00	$400.000,00	$5.902,59	1,48%	$571.566.731,37	$8.434.309,47
1922	19223765,74	$0,00	$2.930,50	$264,64	$0,00	$400.000,00	$3.195,13	0,80%	$1.506.296.000,00	$12.032.032,61
1985	198521658,2	$0,00	$21.464,77	$6.120,59	$4.979,66	$500.000,00	$32.565,02	6,51%	$5.274.596.890,97	$343.534.664,30
1985	198510121,2	$0,00	$3.163,94	$1.124,02	$763,20	$450.000,00	$5.051,16	1,12%	$4.554.549.000,00	$51.123.913,76
1992	199274454,1	$0,00	$25.399,16	$6.546,88	$29,79	$338.333,33	$31.975,84	9,45%	$634.053.672,52	$59.924.324,07
1992	199218739	$0,00	$13.213,99	$2.222,23	$236,81	$400.000,00	$15.673,03	3,92%	$2.399.131.832,79	$94.004.168,97
1995	199574454,1	$0,00	$63.276,92	$14.610,40	$73,78	$338.333,33	$77.961,10	23,04%	$7.823.323.306,44	$1.802.704.026,98
1995	199529247,8	$0,00	$16.499,72	$11.991,48	$1.629,55	$250.000,00	$30.120,75	12,05%	$1.181.481.900,62	$142.348.488,09
1995	199544371,6	$0,00	$16.490,49	$14.780,21	$106,81	$315.000,00	$31.377,51	9,96%	$13.977.076.050,00	$1.392.272.638,95
1995	19957468,17	$0,00	$0,00	$1.019,96	$2.164,66	$315.000,00	$3.184,62	1,01%	$1.268.359.170,70	$12.822.997,67
1995	199511064,4	$0,00	$0,00	$0,00	$1.182,46	$307.500,00	$1.182,46	0,38%	$906.804.680,83	$3.487.025,25

1995	19959365,01	$0,00	$0,00	$0,00	$41,29	$110.000,00	$41,29	0,04%	$1.030.151.100,00	$386.681,26
1999	199979611	$0,00	$42.875,10	$0,00	$7.448,57	$450.000,00	$50.323,67	11,18%	$4.552.544.486,16	$509.112.778,84
1999	1999188348	$0,00	$37.072,24	$0,00	$2.554,69	$450.000,00	$39.626,93	8,81%	$11.401.880.420,57	$1.004.047.831,41
1999	199910121,2	$0,00	$2.387,02	$13.379,05	$7.948,16	$450.000,00	$23.714,24	5,27%	$4.554.549.000,00	$240.017.002,72
2002	20022799,78	$0,00	$16.360,39	$589,32	$3.923,80	$135.000,00	$20.873,51	15,46%	$377.970.300,00	$58.441.238,63
2002	200218602,4	$0,00	$5.485,45	$0,00	$164,32	$347.500,00	$5.649,77	1,63%	$4.584.825.405,78	$74.541.628,52
2002	200229247,8	$0,00	$5.193,88	$2.614,57	$7.216,82	$225.000,00	$15.025,27	6,68%	$702.288.902,83	$46.898.126,92
2002	20025338,2	$0,00	$0,00	$0,00	$126,79	$215.000,00	$126,79	0,06%	$1.084.400.178,02	$639.493,48
2098	20982334,57	$0,00	$8.005,35	$0,00	$1.553,58	$110.000,00	$9.558,93	8,69%	$256.802.700,00	$22.315.980,00
2098	20981913,25	$0,00	$405,99	$0,00	$722,99	$110.000,00	$1.128,98	1,03%	$210.457.500,00	$2.160.017,16
2098	20989365,01	$0,00	$0,00	$0,00	$11.187,85	$110.000,00	$11.187,85	10,17%	$1.535.165,01	$156.138,14
2098	209834175,4	$0,00	$0,00	$0,00	$7.268,56	$145.000,00	$7.268,56	5,01%	$456.999.845,43	$22.908.488,25
2098	20985086,85	$0,00	$0,00	$0,00	$4.247,69	$110.000,00	$4.247,69	3,86%	$559.553.500,00	$21.607.361,88
2098	209874454,1	$0,00	$0,00	$0,00	$3.568,71	$357.500,00	$3.568,71	1,00%	$26.617.347.900,00	$265.705.162,59
2098	209830695,4	$0,00	$0,00	$0,00	$3.706,26	$110.000,00	$3.706,26	3,37%	$477.370.057,90	$16.084.159,55
2098	209844371,6	$0,00	$0,00	$0,00	$2.733,24	$212.500,00	$2.733,24	1,29%	$9.428.979.875,00	$121.278.423,31
2098	20981138,16	$0,00	$0,00	$0,00	$1.428,92	$110.000,00	$1.428,92	1,30%	$125.197.600,00	$1.626.339,59
2098	20983908,54	$0,00	$0,00	$0,00	$676,26	$110.000,00	$676,26	0,61%	$223.465.943,48	$1.373.827,99
2098	20982700,48	$0,00	$0,00	$0,00	$494,17	$145.000,00	$494,17	0,34%	$200.680.887,88	$683.934,31
2098	2098531,88	$0,00	$0,00	$0,00	$452,57	$110.000,00	$452,57	0,41%	$58.506.800,00	$240.712,93
2098	20983252,31	$0,00	$0,00	$0,00	$442,84	$110.000,00	$442,84	0,40%	$255.205.926,56	$1.027.412,66
2098	20981878,35	$0,00	$0,00	$0,00	$280,85	$145.000,00	$280,85	0,19%	$138.284.903,43	$267.843,55
2098	209829247,8	$0,00	$0,00	$0,00	$215,07	$135.000,00	$215,07	0,16%	$3.948.462.450,00	$6.290.339,40
2098	20984035,85	$0,00	$0,00	$0,00	$67,78	$145.000,00	$67,78	0,05%	$395.029.386,90	$184.655,81
2098	20983116,78	$0,00	$0,00	$0,00	$17,85	$145.000,00	$17,85	0,01%	$348.436.358,17	$42.893,72
Total		62.660,64	351.606,83	127.769,64	101.945,91	$13.890.000,00	$643.983,02	203,70%	$144.195.036.917,90	$7.795.229.434,96
Total % increased in LV due ECC								**23% Average increase**		**Net increase 5%**

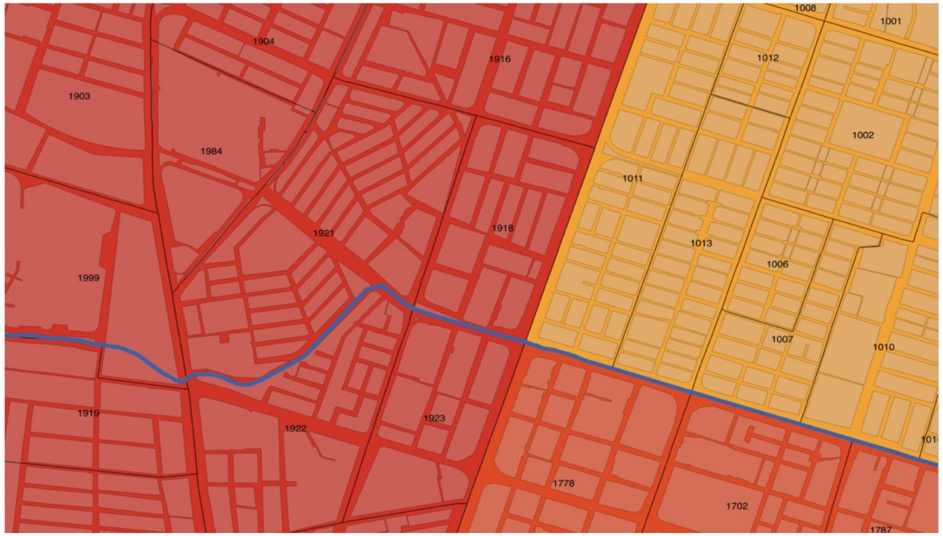
Annex 13: Categories of observation units

CATEGORIES OF OBSERVATION UNITS				
NAME	DESCRIPTION	TYPES	KEY	IMAGE
PIEZAS URBANAS (URBAN PIECES)	A GROUP BETWEEN 1 - 6 COMUNAS DEPENDING ON THEIR GEOGRAPHIC LOCATION	Northwest (NOC) - yellow Northeast (NOR) - blue South (SUR) - green East (ORI) - brown Distrito AguaBlanca (DAB) - red	PUR	

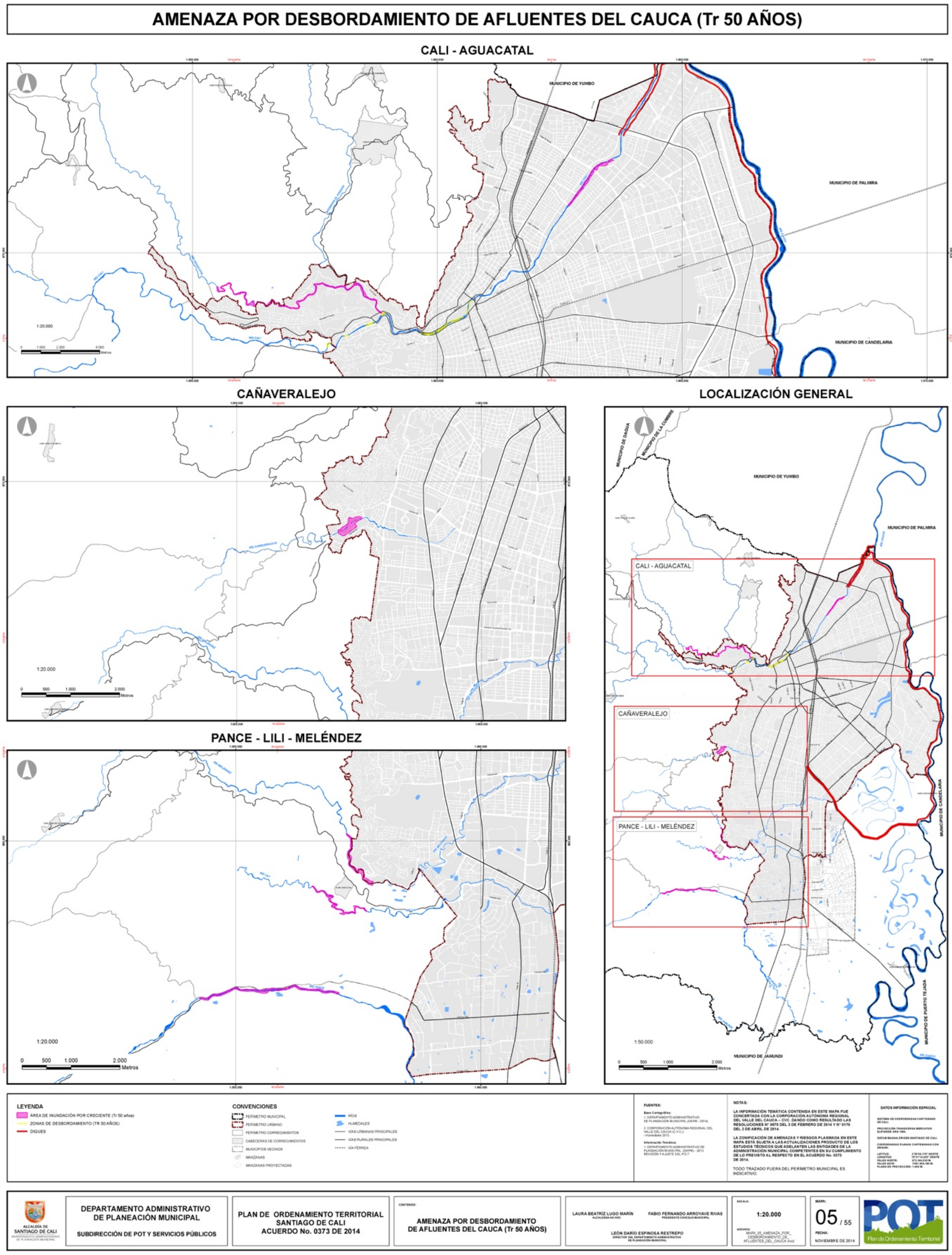
SUBAREAS	Group of regulatory polygon and the different areas relatively homogeneous in terms of typology edificatoria and morphological determined by factors as stroke, volumetrics, insulation, front yards, occupancy rates and construction heights, all which allow to apply to the respective subarea one in treatment regime in line with the objectives of the general rule and set to the uses and mix of uses permitted by it.	9		
COMUNAS	A GROUP OF SEVERAL NEIGHBORHOODS ACROSS THE CITY	FROM 1 -22	COM	

POLIGONO NORMATIVO	PORTION OF URBAN LAND OR URBAN LAND EXPANSION WHICH IS ASSIGNED SIMULTANEOUSLY AN AREA OF ACTIVITY AND TREATMENT. EACH "POLIGONO NORMATIVO" CONTAINS UNIVOCALLY ONE AND ONLY ONE AREA OF ACTIVITY AND ONE AND ONLY ONE TREATMENT.	193		
BARRIO (NGBH)	A GROUP OF SEVERAL MANZANAS	336	BAR	

MANZANAS (BLOCKS)	A GROUP OF SEVERAL LOTES	15875	MAN
PREDIOS	A PROPERTY OR CONSTRUCTION	444774	



Annex 14: Exposure to Fluvial Flooding maps – Merge among different time frames



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