LINCOLN INSTITUTE
OF LAND POLICY

Exploring the Use of Land Value Capture Instruments for Green Resilient Infrastructure Benefits: A Framework Applied in Cali, Colombia

Working Paper WP19SG1

Stelios Grafakos
Global Green Growth Institute

Alexandra Tsatsou
BluAct

Luca D'Acci
Politecnico di Torino

James Kostaras
Institute for International Urban Development

Adriana Lopez
Universidad del Valle

Nohemi Ramirez
RECOMS

Barbara Summers
Collaborative Media Advocacy Platform

July 2019

Abstract

Building resilient infrastructure is one of the major challenges cities face due to urbanization rates and climate change. Financing these investments is an additional challenge particularly for cities in low and middle-income countries. However, land value capture (LVC) can provide alternative and local finance sources. This study identifies and assesses the multiple benefits of a green resilient infrastructure (GRI) project including flood risk reduction and proposes land value capture instruments for green resilient infrastructure benefits, as a framework for financing public benefits and (partly) recovering the project investment.

The framework is applied on a GRI river project in Santiago de Cali, Colombia: the CAU Cañaveralejo. It combines and tests existing methodologies, researching the possibilities of expanding the concept of LVC and applying it on GRI projects that contribute to flood risk reduction. The research is based on primary and secondary data collection (fieldwork, literature, collection of project documents) to conduct a hedonic pricing modelling combined with GIS and stakeholders' workshop consultation. The study aims to assess the impact of GRI attributes to the land values of the project's area. Also, it explores the feasibility of using different LVC instruments in the context of Cali.

Keywords: green infrastructure benefits, land value capture, climate resilience finance, hedonic model, Cali, Colombia.

About the Authors

Stelios Grafakos is a Principal Economist at the Global Green Growth Institute (GGGI), Office of Thought Leadership, headquarters in Seoul, South Korea. In his current role, he is responsible for GGGI's work on economic issues of green growth. Prior to GGGI, Stelios worked as a senior expert on urban Sustainability and climate change at the Institute for Housing and Urban Development Studies (IHS), Erasmus University Rotterdam. His research interests and experience lie towards the fields of environmental economics, environmental decision making and analysis, ecosystems valuation, urban sustainability assessment and urban low carbon and climate resilient development and planning. He has been leading several advisory, research and capacity building projects in different countries around the world for clients such as the European Commission, The World Bank, Asian Development Bank, Inter-American Development Bank, United Nations Development Programme (UNDP), UN-HABITAT, the Lincoln Institute of Land Policy and the Dutch government. Stelios holds a bachelor's degree in Economics from the Athens University of Economics and Business, a master's degree in Environmental Management and Policy from the University of Amsterdam and a PhD in decision analysis and support from the Erasmus University Rotterdam. In addition, he has published several peer-reviewed articles in academic journals, books, and international conferences.

Contact: stelios.grafakos@gggi.org

Alexandra Tsatsou (MSc Urban Management and Development, IHS Erasmus University Rotterdam, The Netherlands; MSc Architectural Engineering, Aristotle University of Thessaloniki, Greece) is a researcher, consultant and trainer on urban planning and climate change exploring the interface of stakeholder engagement, climate action and economic growth as the axis for sustainable urban development. Her professional experience has evolved around topics such as mainstreaming climate change in urban planning, co-creation of urban spaces resilient to natural disasters, valuation of ecosystem services, urban vulnerability assessment, sustainability and resilience benefits, multi-criteria analysis for climate change adaptation, port cities and climate resilience, capacity assessment for climate change interventions. She has worked in projects funded by the European Commission, UN-Habitat, the World Bank, C40, GIZ, the Dutch government and public bodies. Currently she is coordinating a network of European port cities (BluAct) that aim to reconnect with the sea and achieve blue growth through blue economy entrepreneurship.

Contact: alex.d.tsatsou@gmail.com

Luca D'Acci is currently a Senior Research Fellow at the University of Portsmouth, a researcher at Politecnico di Torino and at Erasmus University Rotterdam. He worked in projects for the World Bank, Asian Development Bank, European Commission, Engineering and Physical Sciences Research Council (EPSRC), PRIN (Projects of Relevant National Interest - Italy) and the Lincoln Institute of Land Policy. He has been an academic and/or guest lecturer at Oxford University, Cambridge University, ETH, University College London, Vienna Technology

University, Reading University, TU Delft, Utrecht University, Birmingham University, Trinity College Dublin, University of Surrey, Bournemouth University, Heriot-Watt University, among others. After almost 10 years among Brazil, Uruguay, Scotland, Australia, Spain, England, Ireland and the Netherlands, he decided, in December 2017, to move to his mother Alpine Region in North Italy where he is teaching and researching on valuations, sustainable development and urban forms.

Contact: luca.dacci@polito.it

James Kostaras is a Senior Fellow and urban development expert at the Institute for International Urban Development (I2UD) in Cambridge, Massachusetts. In his role at I2UD, he has helped communities address the challenges of urban poverty, housing, rapid urbanization and the climate adaptation in Belize, Haiti, Mexico, Colombia, Bolivia, Ecuador and Morocco. Climate adaptation and resiliency through urban planning and sustainable community development is a major focus of his work. As an urban planner and executive planning and development director for over 25 years, he led a 65-person economic development agency and launched major urban regeneration strategies that have attracted over $1 billion in public and private investment in the cities of Boston and Somerville, Massachusetts. From 1998 to 2008, Mr. Kostaras was a Lecturer and Design Critic in Urban Planning and Design at the Graduate School of Design at Harvard University. He is a registered architect in the Massachusetts and a former member of the American Institute of Certified Planners (AICP). He received his B.Arch. from RISD and his Master of Architecture in Urban Design from the Harvard Graduate School of Design.

Contact: kostaras@i2ud.org

Adriana Patricia López Valencia is currently teaching and developing academic research as a professor at Universidad del Valle. Ms. López Valencia has carried out research in Germany at United Nations University at the VARMAP section about urban vulnerability to natural and technological hazards, and as part of her doctoral research she worked at the Université du Québec à Montréal in Canada as a winner of the Emerging leaders of the Americas program (ELAP). She worked as a consultant for the cities of Yumbo, Cerrito, Tulua and Mitu in Colombia and for Energy Rating Services, an energy and sustainable design consulting firm in the UK. Ms. López Valencia is currently working on projects related to risk management and vulnerability assessment with GIS techniques and involving social perception, working with children in the tactical urbanism school recently created at Universidad del Valle. Ms. López Valencia is interested in holistic approaches to capturing economic, ecological and societal components of an urban space as a basis for land use planning.

Contact: adriana.lopez@correounivalle.edu.co

Nohemi Ramirez Aranda is an architect graduated with honors from Universidad Iberoamericana Torreon, and holds a Master of Science in Urban Management and Development with a Specialization in Urban Environment, Sustainability and Climate Change from IHS Erasmus Rotterdam. She is currently Ph.D. candidate and a fellow from the RECOMS - Marie Curie programme working with Gent University, ILVO (Instituut voor Landbouw-, Visserij- en Voedingsonderzoek) and Groningen University on public participatory GIS tools for building resourceful and resilient community open space management. For six years, she specialized in architecture and design working as a chief designer of a local firm back in Mexico. Parallel to this work, she collaborated in municipal urban research and design. After her master program, she gained experience developing tools and methods for capacity assessment and participatory planning process with IHS Erasmus Rotterdam and GIZ (Deutsche Gesellschaft für Internationale Zusammenarbeit). Further interests include quantitative and qualitative research, GIS analysis, econometrics, and data visualization.

Contact: nohemi.ramirez@ilvo.vlaanderen.be

Barbara Summers is the Lead Community Planner for Collaborative Media Advocacy Platform (CMAP). She manages and leads capacity building exercises for marginalized waterfront slum dwellers in a participatory mapping and planning program in Port Harcourt, Nigeria. While working at the Institute for International Urban Development (I2UD), she worked on expanding the Institute's work in climate change adaptation, resilience and capacity building initiatives in emerging countries. Her work included managing a team of local officials to pilot the Rockefeller Foundation's City Resilience Index in Tanzania, developing case studies and best practices on increasing community participation in land use planning and climate change adaptation for cities in the Dominican Republic, as well as, mapping and data analysis to update Iraq's National Urban Spatial Plan. Previously, she worked with the non-profit Greensburg GreenTown to facilitate sustainable disaster recovery and environmental sustainability at the community level. She has a Master in Regional Planning form Cornell University and a B.A. in Environmental Studies and Urban Sustainability from Bucknell University.

Contact: barbara.l.summers@gmail.com

Acknowledgments

The authors would like to acknowledge the support from the participants of the Urban Management and Development (UMD) course of IHS Erasmus University Rotterdam, Diego Giron Estrada and Juliana Giraldo Sanabria who conducted their master's theses on parts of this research and contributed to the data collection and analysis. Furthermore, the authors would like to thank Carlos Morales from IHS for his support, feedback and insights provided to the project team on land value capture instruments and Dr. Spiros Stavropoulos from Erasmus School of Economics (ESE) for his valuable comments on the statistical analysis and application of the hedonic pricing model. In addition, the authors would like to thank Melissa Warmenhoven for editing the final report. Moreover, the authors would like to express their gratitude to Robin Rajack from the Inter-American Development Bank (IADB) for the valuable comments he provided to the first draft of the report during the LILP seminar in Mexico City in November of 2016. Furthermore, the authors would like to thank the Lincoln Institute of Land Policy for granting this research and particularly LILP senior experts Enrique Silva and Martim Smolka for their feedback and support through the whole process of the research project.

Contents

Exploring the Use of Land Value Capture Instruments for Green Resilient Infrastructure Benefits: A Framework Applied in Cali, Colombia

1. Introduction

Natural disasters such as floods are becoming more frequent and intense due to climate change, while the process of urbanization, often characterized by unsustainable patterns of development, increases the challenges faced by the population living in flood risk-prone urban areas. In most Latin American cities, where there are high contrasts in development between different urbanized areas, the poorest population is generally the most vulnerable to the effects of natural disasters, given their lack of access to infrastructure and resources. Additionally, the phenomenon of "La Niña" and changes in rainfall patterns due to climate change and climate variability in recent years result in even greater impacts in these vulnerable areas.

The process of urbanization, including urban interventions for flood mitigation, modifies the habitats of different species and cuts ecological connections present in environmental corridors. Urbanization has meant a loss of native vegetation and, subsequently, an increase of impervious surfaces, whereby surface runoff increases significantly, leading to an increased risk of flooding. This disrupts the natural ecosystem cycles of the rivers and compromises landscape quality. The reduction of vegetation cover required for those urban "gray infrastructure" interventions interrupts the hydrological cycle of assimilation, infiltration and evapotranspiration. In the process of building gray infrastructure, part of the vegetation cover is removed and the subsoil is compacted, reducing the amount of water that can infiltrate, thereby greatly increasing the speed with which the water runs off on the urban surfaces.

Climate change is expected to lead to changes in the frequency, intensity, duration, and timing of extreme weather and climate events, leading to unprecedented climate-induced disasters (IPCC 2012). It will potentially magnify the existing patterns of climate-induced disaster risks and exert further pressure on the capacities of governments and different actors to respond. UN-Habitat (2011) stated that unsustainable and unplanned urban development can bring increased vulnerability to climate hazards. Many cities are facing rapid growth due to urbanization, which results in the creation of informal settlements that are often the most vulnerable to natural disasters. One of the biggest challenges for national and local governments globally, particularly for low- and middle-income countries, is financing climate change adaptation and resilience interventions.

Urbanization changes the physical environment, with significant effects resulting in accelerated densification, decrease in the capacity of soil infiltration, increased runoff retention times, and increased impermeability of surfaces. This reduces the hydraulic capacity of drainage sectors, which already face high volumes in rainy periods. This is the case of the south drainage system in the city of Santiago de Cali in Colombia (referred to hereafter as Cali), constituted by the rivers Cañaveralejo, Melendez, and Lili, which end up in the Cauca River, as well as various artificial canals flowing into all the rivers. This area is characterized by high rates of urbanization, and faces problems associated with flooding from rivers and canals, erosion of watersheds, mismanagement of solid waste, and limitations of the gray infrastructure built for mitigation of flood hazards. All these issues are directly related to the capabilities and understanding of the processes of urban planning and management, derived from a poor coordination with technicians and professionals responsible for interventions, who, in turn, do not contemplate visions and particularities of the context in which the projects are carried out.

In the future, climate change induced disasters, including floods, are expected to occur more frequently and with more intensity, as the challenges mentioned above are exacerbated by the impacts of climate change.

1.1 Problem Statement

Green Infrastructure (GI) is becoming a promising strategy to adapt to the impacts of climate change, to enhance urban climate resilience, and more specifically to reduce flood risk, while simultaneously delivering other sustainability benefits. Green corridors for flood management, restoration of natural floodplains, and multifunctional public space for recreation and stormwater management, all combine risk reduction attributes with multiple sustainability benefits (Brugman 2011; CCAP 2011; Grafakos et al. 2016). GI that delivers benefits related to both sustainability and flood reduction enhances urban climate resilience.

Financing urban climate resilience is seen as a critical challenge for both now and the coming years, particularly in low and middle-income countries, due to their constrained municipal budgets, as well as the insufficient amounts mobilized through international funds. The impact of floods on land and real estate values is receiving increased attention (Ingram and Hong 2011; Pryce et al. 2011; Koning et al. 2016). However, the impact of risk reduction on land values due to GI, especially as a ratio of the impact of the green components of the project, needs further research. Combining the field of climate change adaptation and resilience with studies on land policy and finance, in order to explore financing resilience through Land Value Capture (LVC), is a new and promising concept to explore.

In Latin America and the Caribbean, LVC has already been an effective tool for municipal governments to finance infrastructure (Smolka 2013), especially in cases where conventional public funding is often constrained. The same mechanisms could be used to finance resilience projects, including GRI investments. However, research and practical applications remain limited. This argument is supported by an option for identifying the value (costs) of the GRI intervention, in addition to the option of calculating the increment of land value added due to the GRI project.

In order to explore the potential of using LVC for GRI investments, the GRI benefits that impact land values should be identified, quantified and valued. The impact from this range of benefits on surrounding land and property values has been also discussed and confirmed in literature (Madison and Covari 2013). Connecting GI benefits to urban climate resilience could provide sufficient evidence to support the financing of GRI projects through land-based financing methods such as LVC (Grafakos et al. 2016; Piriani and Tolkoff 2014), and therefore provide local governments with additional alternatives for financing urban climate change adaptation and resilience.

This research aims to provide evidence of the impact of GRI on land values in Cali and explores the impact of a GRI project on land values. The findings are context-specific, based on a Hedonic Pricing Model (HPM) study for Cali. Although they can provide indications on how GRI would affect land values in other cities, the results cannot be directly replicated. However, the methods and proposed framework could be utilized in order to conduct a similar analysis in other cities.

Moreover, the study builds on the framework suggested by James Kostaras (2015) for the use of LVC instruments for different types of GI. It extends this framework to explore the LVC instruments in relation to the benefits accrued by GI interventions that involve flood risk reduction, which are in this study defined as GRI interventions. In our study we analyze these benefits, with the addition of flood risk reduction, anticipating that land values will rise and that the increment can be captured to fund/finance further investment on urban resilience.

This study combines prior research and empirical knowledge resulting from the analysis of a planned GRI municipal project in the city of Cali. The project is part of the "Corredores Ambientales Urbanos" (translated as Environmental Urban Corridors, hereafter CAU), in order to construct a framework of "LVC instruments for GRI benefits," which is able to assess the multiple benefits of GRI projects in addition to risk reduction. Additionally, the study explores the feasibility of LVC as an GRI financing mechanism, stemming from these benefits.

The application of the framework in Cali aims to address the following research objectives:

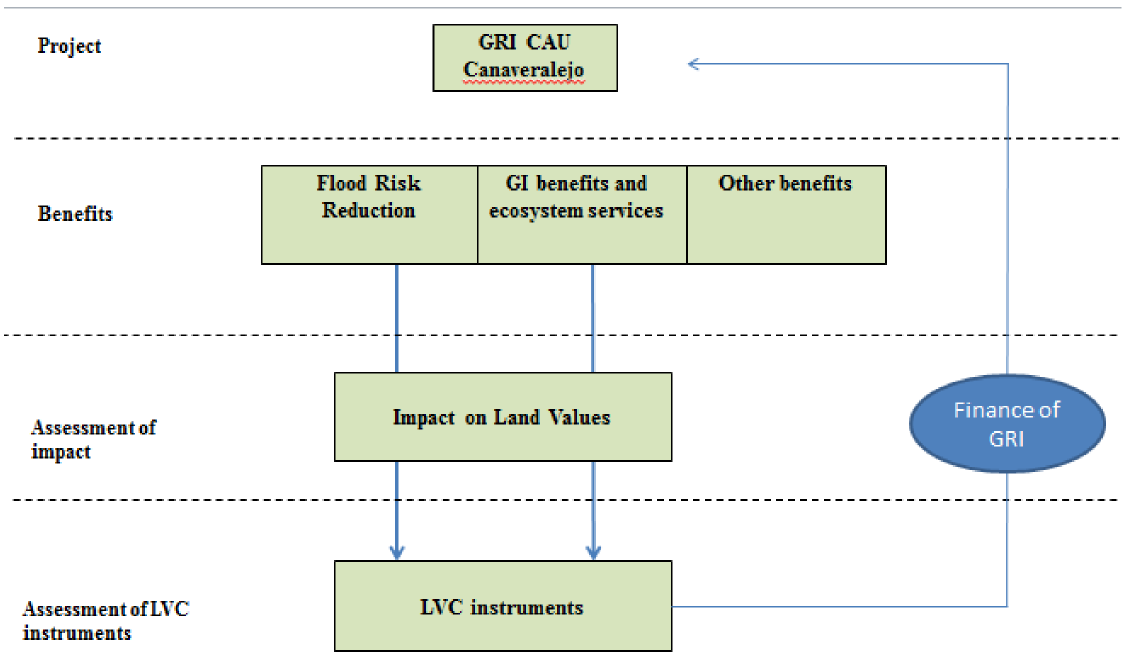
- Identify the multiple benefits of the GRI intervention, including GI/ecosystem services related benefits and flood risk reduction benefits.
- Assess the impact of selected benefits such as flood risk reduction and other additional GI intervention benefits on land values.
- Explore which LVC instruments can be used to capture the added value due to flood risk reduction and the other benefits of GRI project.
- Assess the feasibility of Colombia's LVC instruments as a source of financing GRI projects in the context of Cali.

The current research contributes to the following fields and debates:

- The research bridges different policy fields such as flood risk reduction management, climate change adaptation finance and land policy. Using LVC as a mechanism for financing GI for climate change adaptation and resilience is a relatively new approach, which could trigger further discussion at both research and policy levels.
- Impacts of resilience improvements and GI projects on land value are lesser known and largely undocumented in Cali and other cities in Latin America. It is an open question whether land values in these cities experience these dynamics. In Colombia in particular, there isn't any study applying an HPM to value GI benefits and flood risk reduction.
- The use of LVC as a climate adaptation and resilience finance instrument has hardly been explored in the academic literature and in practice.

Different stakeholders and audiences, including the local government of the city of Cali (and other local governments in Latin America and the Caribbean), can use the outcomes of this research in the context of flood management and GRI financing. Additionally, the research could be useful for the national government dealing with urban climate resilience interventions, while exploring ways to finance them.

Figure 1: Conceptual Framework



2. Background

2.1 Case Study: CAU Cañaveralejo, Cali, Colombia

Cali is situated in the Cauca River valley, 300km southwest of the capital Bogota and approximately 1000m above sea level. It is considered the main urban, economic, industrial and agricultural center of the southwestern part of Colombia. Spanning 560km,[2] Cali is Colombia's second largest city by area, after Bogotá. The population is estimated at 2.3 million residents, making it the most populous city in this region and the third largest metropolitan area by population in Colombia, after Bogotá and Medellín.

Due to the city's location next to the port of Buenaventura, the only Colombian port with access to the Pacific Ocean, Cali is considered Colombia's "gate to the Pacific". This location has contributed to the city's economic development. In Cali's early history, its major economic activities were based on agricultural production, including coffee and sugar production (Vásquez Benítez 1990). This was possible due to the region's hydric richness, which provided some of the most fertile and productive land in the country. In addition to the biggest river Cauca, which runs through the valley, six smaller rivers (Aguacatal, Cali, Cañaveralejo, Melendez, Lili and Pance) flow through Cali, known as "the city of seven rivers". The nearby cluster of hills, the 'Farallones', separate Cali from the Pacific coast and give rise to the six rivers that flow through the city towards the Cauca river, on the city's east edge. Due to this, another common name for the Cali is "the city between the hills and the river".

The growth of the city is closely related to the strong dynamics created by infrastructure like the new railroad line (1944–1958), and its proximity to the port. The new railway line also changed the population dynamics of the city internally, by setting a spatial barrier between the east and the west parts. The "two Calis" have since developed at different paces and is identifiable on maps of the city, such as the stratification map; the eastern part of Cali located next to the Cauca River is overall less developed when compared to the west side of the city, where the city center is located. With the industrial "boom" that occurred in the mid-1900s, a major migration pattern to the city was generated and this urbanization has continued to the present day, accelerating the city's growth rate (Institut de Recherche et débat sur la Gouvernance 2013). In 1938, Cali was a city of about 100,000 inhabitants; in less than 100 years, the city grew to be 24 times bigger. This rapid expansion and urbanization led to the creation of settlements on the flood and landslide prone areas around the rivers Cauca, Cali and Cañaveralejo River (Benítez 2001).

Although several interventions such as dams, dikes, canals and pumping plants were implemented at all seven rivers between 1960 and 1980, they have in fact exacerbated flood hazards, due to the lack of maintenance and the degradation of the natural ecosystems (Velásquez 2011), leading to additional environmental and economic issues.

Climate change in Cali

According to the Global Water Partnership, South America is one of the richest regions in water resources, with 28% of the freshwater resources of the world, and three of the largest river basins; Amazonas, Orinoco and Rio de la Plata. Two of those basins (Amazonas and Orinoco) are partially located in Colombia, a country with around 737.000 bodies of water (Campuzano et al. 2012). In many Colombian cities, like Cali, rivers and streams are affecting urban living conditions. Combined with urban challenges related to poverty and inequality, environment and climate change, urban management and planning, rivers become drivers for flood risk and vulnerability. In the past 40 years, 73% of losses and damages to housing in Colombia have been attributed to flood events.

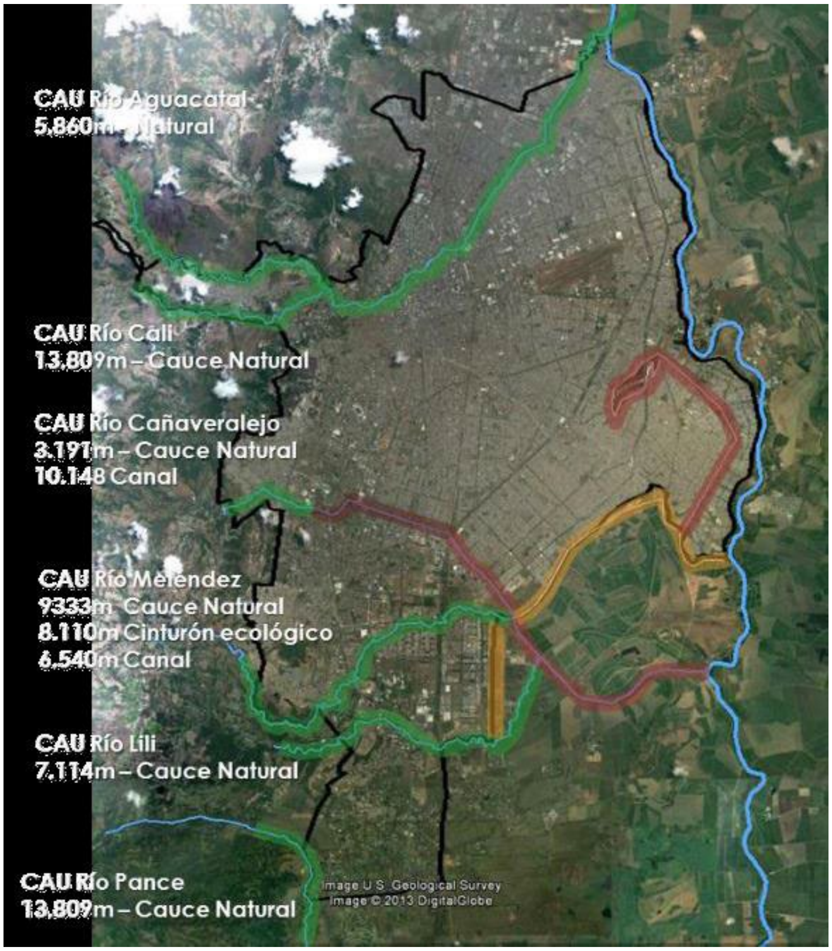
Cali, the "city of the seven rivers" is a great example of a city where the challenges of responding to flood risk and the impacts from existing environmental conditions along the rivers are eminent. According to an OSSO Corporation report (2011), from all disaster events registered between 1970 and 2011, Cali has been most impacted by flooding events, which sum up to 25% of the total events registered. As the city is experiencing an increase in the frequency and strength of its rainy seasons, it faces the challenge of absorbing such shocks while maintaining its ability to function (MacKinnon 2015), especially after events such as torrential rainfalls. Recently, during the 2010–2011 rainy season, Colombia experienced periods of heavy rain caused by the La Niña phenomenon. The Cauca Valley region ranked second in the number of hazard events registered in that period (Comisión Económica para América Latina y el Caribe

[Cepal] 2012).

The spatial distribution of recorded disasters in Cali indicates that the events affect mostly poorer neighborhoods of the city, which are built on dense and risky areas, such as hillsides with steep slopes or low ground exposed to overruns of channels. However, middle income areas are also increasingly affected. The damages have raised awareness of climate issues and, in recent years, the city is aims to increase its resilience and tackling climate change impacts. Various strategies approaches and disciplines of social sciences are attempting to deepen the study of the relationship between society and nature and the impact of deterioration of green open space due to urbanization.

Cali's 2014 land use plan (Plan Ordenamiento Territorial; hereafter POT) put forward goals for restoring the seven rivers, the Farallones and recovering water bodies in the city. According to the POT, the municipality of Cali identifies that the ecosystem base is made up of "the elements of the natural system that interrelate and govern essential ecological processes like: ecosystems, geology, geomorphology, climate, biodiversity and water systems, and they define the strategic determinants that condition land use, location of human settlements and morphology" (Concejo 2014, 56). The plan intends to take measures against further river deterioration, thus improving the green corridors and supplying them with different facilities and high quality green public spaces to improve citizens' well-being. It highlights the specific relevance of upgrading one of the seven rivers, river Cañaveralejo, and its potential for public space along the area.

Image 1: The Seven Rivers of Cali. The biggest river, Cauca, is represented by the blue line.



Source: CVC-CITCE Univalle 2013

Of Cali's seven rivers, the Cañaveralejo river at the south of the city is an example of the deterioration that other rivers have also experienced. One of the most dramatic interventions on the river was its canalization back in the 1950s to prevent flood risk and promote urbanization along its banks in the city center. The riverbed changed and the natural elements on the river's edges were eliminated, causing the loss of environmental identity and replacing the natural elements with a concrete bank. However, as the drainage and the infrastructure supporting the new canal in these areas was not adequate, the areas along the canal soon started experiencing flooding issues. In order to deal with this situation, a dam was constructed in the 1980s between the natural part of the river and the canalized part to retain the water from entering the urban grid through the canal and reduce flooding in the rainy seasons on the lower area of the river. The intervention succeeded in reducing the water flow from the river toward the canal but failed at several other aspects: flooding at the blocked river part where the more vulnerable groups reside, environmental deterioration such as garbage accumulation, managing water runoff from hard urban surfaces, inflow at the intersections with other canals that are part of the south drainage system, and illegal sewage disposal in the river.

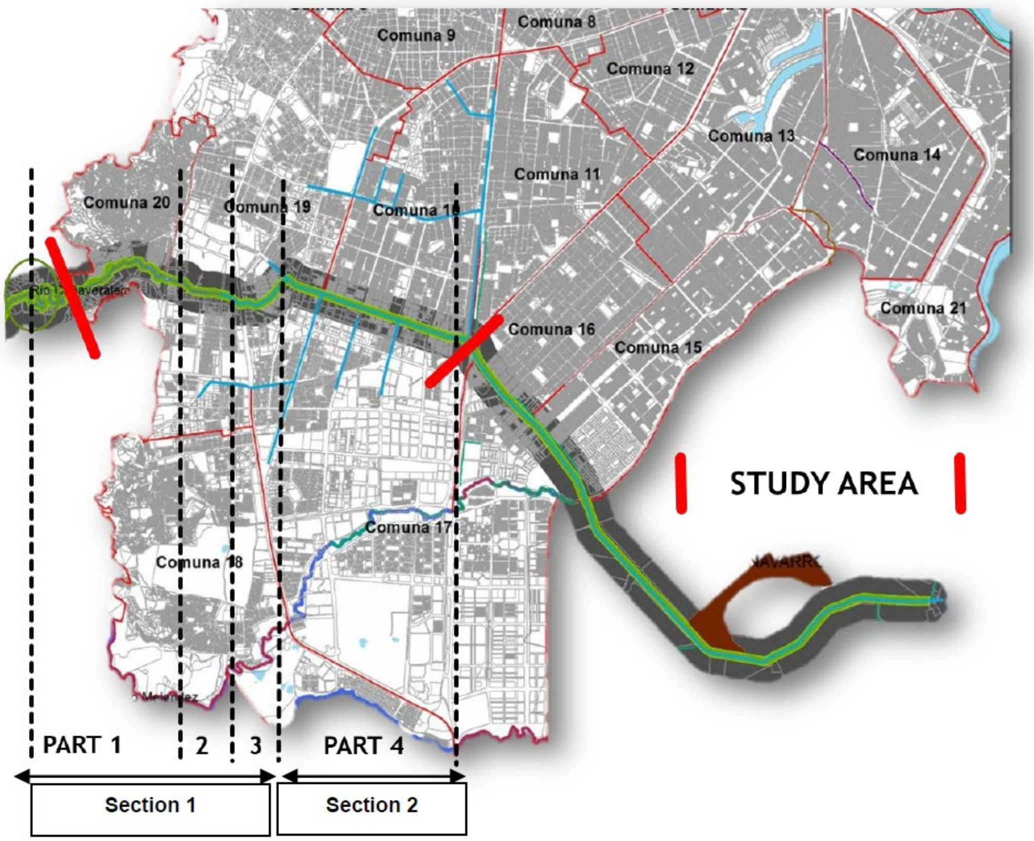
Nowadays, the environmental quality of the Cañaveralejo river corridor is low because of more than 1000 illegal sewage connections discharging into the river (El País 2014), waste disposal, residual mercury from illegal gold mining on the Farallones, discharge from pig farms, coal mining and many other industries (Institut de Recherche et débat sur la Gouvernance 2013), and the deforestation of its basin. These issues, in addition to the risk of flooding, conceal the potential of this natural resource, and its value for the communities that depend on it for their livelihoods and recreation.

2.2 Case Study

This study will focus on a specific part of the Cañaveralejo river and canal, analyzing the CAU Cañaveralejo, a project planned (and in 2017, partly implemented) by the municipality of Cali and local agencies, aiming to restore the Cañaveralejo river area, and part of the canal that replaced the natural bank of the river in the urban grid of Cali (thereby changing its direction).

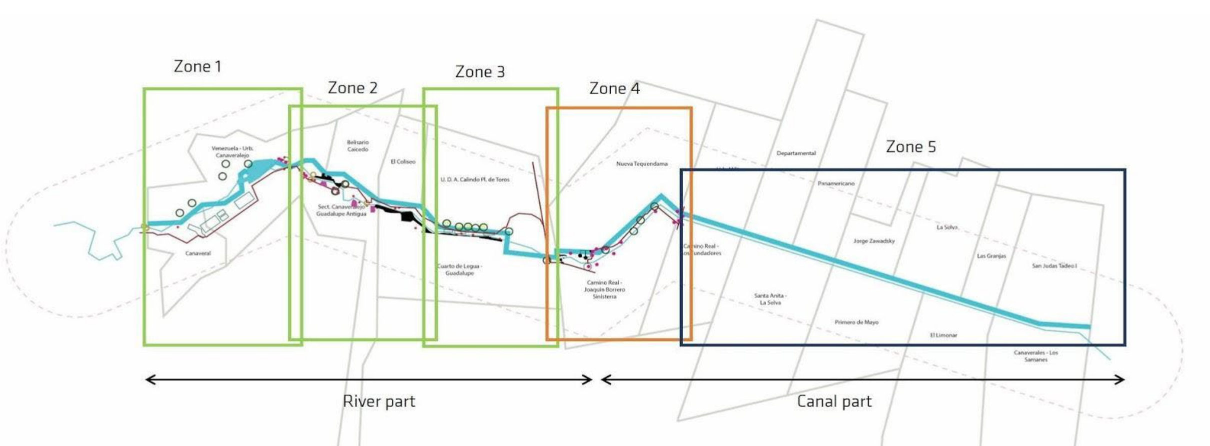
The case study was selected due to the area's characteristics, including its proximity to mixed income neighborhoods, the combination of a green and a gray part of Cañaveralejo "river," a combination of planned and implemented project phases, and its proximity to housing areas with different densities, spatial attributes and social diversity. The multiple benefits (social, environmental, economic) of the project and the added value they bring to the area make the case promising for research on public policies and LVC instruments in relation to environmental improvements and risk reduction. CAU Cañaveralejo is an example of an environmental urban project that can restore ecological connectivity and upgrade environmental quality, while simultaneously presenting opportunities for the partial recovery of the project investment (or capital for other public investments).

Image 2: Overall Study Area.



Source: Authors

Image 3: Case Study Area of CAU Cañaveralejo Intervention and Cañaveralejo Canal.



Source: Authors

Image 4: CAU Cañaveralejo Design (River Part, Zones 1–3 in Image 3 Above).

Source: CVC/CEDING/CUNA 2014

Image 5: CAU Cañaveralejo Design (Case Study Area's River Part, Zone 4 in Image 3 Above).

Source: CVC/CEDING/CUNA 2014

Image 6: Cañaveralejo Canal (Case Study Area's Canal Part, Zone 5 from Image 3 Above).

Source: El País

<u>The CAU Cañaveralejo Project</u>

The CAU Cañaveralejo project concerns the part of the case study area where the river is still in its natural form. It is overseen by Corporación Autónoma Regional del Valle del Cauca (CVC), an entity responsible for managing the natural resources and environment of the Cauca Valley and the main consultancy groups working on the project: CEDING S.A.S and CUNA S.A.S., who mainly focus on architecture and engineering-related services. The project is part of Cali's Corredores Ambientales Urbanos (translated to Environmental Urban Corridors) program, which is included in the aforementioned land use plan (POT) of 2014. In that POT, the Environmental Urban Corridors (CAU) are defined as natural systems that form a network intertwined with the rivers and the canals of the city. The corridors aim to improve the physical space surrounding the rivers in Cali, recompose the municipality's ecosystems and ensure compatibility between hydrological systems and the built environment. However, the important general objective of the CAU program is to encourage the development of urban systems and natural elements through empowering communities and strengthening the dynamics of human activities in urban zones close to Cali's rivers, whilst ensuring the sustainability of protected areas. The components of the Cañaveralejo river environmental corridor project aim to build urban resilience by strengthening the presence of natural systems in the urban grid, thereby minimizing flood risk and increasing the amount and quality of public spaces in the impact area. The overall strategy aims to trigger better social conditions in the neighborhoods around Cañaveralejo, as a result of the aforementioned objectives.

Ecosystems connectivity

- Reconnection and revaluation of the ecological corridor through the landscape, ecological restoration, reforestation and increase in wildlife.
- Smooth transition between the built and the natural environment.
- Promotion of the permanence of protected species that inhabit the areas near the river
- Conservation of different habitats in the urban context.

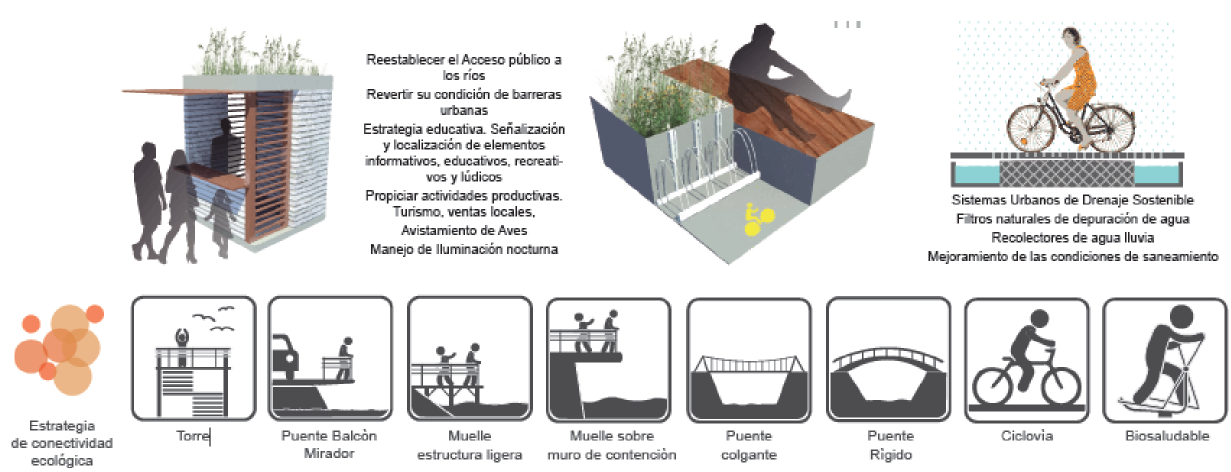
Integrated rainwater management

- Minimum use of hard surfaces, promoting the use of permeable materials that allow infiltration and continuity of the water cycle.
- Introduction of sustainable urban drainage systems to mitigate flood risk.

Citizen interaction and education

- Restoration of public access to the river to reverse the status of "urban barrier" and integrate it with the city, offering opportunities for coexistence and social control.
- Introduction of low impact mobility systems across the urban rivers to increase accessibility.
- Integration of educational, recreational and cultural facilities in order to improve quality of life of inhabitants.
- Promotion of productive activities, urban farming and management of night-lighting to ensure safety.
- Creation of citizens' awareness regarding the status and protection of the rivers and the city's natural resources.

Image 7: Interventions Proposed at the River Part.



Source: CVC/CEDING/CUNA 2014

The Cañaveralejo Canal

The canal section is a rainwater and wastewater canal which directs water to Cauca's river after treatment and is the portion of the corridor that receives the most relevant flooding impacts. The canal is associated with environmental problems related to waste management, as the waste collection plant holds a large amount of waste. In addition to the positive environmental impact (avoiding waste disposal on the canals and preventing floods), this project also has an educational impact, due to its visible components.

The aim of the planned project led by EMCALI in the canal section, is to enhance the hydraulic capacity of the canal to avoid flood risk at the street intersections. This part of the project is directed more toward conventional interventions with gray infrastructure, which include the canal expansion with new concrete retaining walls, making the area look more like a rainwater canal than a river.

Socio-Economic Profile of the Study Area

The city of Cali is organized into 22 communes and 355 neighborhoods. On a property scale, strata (based on socioeconomic input) are assigned to each building, in accordance with Colombian tax law. The main purpose of this differentiation is to be able to charge public services, allocate subsidies and collect taxes per stratum, so that the social groups with higher economic capacity (therefore higher stratum) contribute more to public costs and subsidies than those in lower strata.

The selected study area along Cañaveralejo extends along four communes (10, 17, 19 and 20) and is represented mainly by properties of stratum 3, although all strata are represented (6% stratum 1, 10% stratum 2, 47% stratum 3, 10% stratum 4, 19% stratum 5, 1% stratum 6, 6% municipal land or non-classified land). We can observe social inequality spatially, indicated by stratification, with low strata adjacent to very high strata (POT 2014). The Universidad de Valle and the Institute for Housing and Urban Development Studies (IHS) did fieldwork and conducted demographic surveys in the area in October 2015 and July 2016. According to the results of these surveys, most of the respondents were born in Cali and represent mainly a mestizo ethnic composition, followed by white population. Most of the surveyed population categorize their current employment status as 'independent" or "cuentapropismo" (self-employed), while there are specific neighborhoods with a predominantly retired population. Most of the surveyed population have close family to turn to in an emergency. Sometimes that family lives in the same neighborhood, or in other neighborhoods also located on the Cañaveralejo river or canal, which, in case of disaster, could determine the responsiveness of that population and their capacity to cope. The majority of the surveyed population in the middle and lower-income areas have basic primary and secondary education, while one third of the overall population are tertiary educated.

Regarding income, half of respondents indicated that they earn 1–2 minimum wages per month. The majority of the population live in a house (not an apartment or gated community), while 67% are homeowners.

2.3 Colombia's Legal Framework Enabling Land Value Capture

Land value capture refers to the public sector recovery of the land value increments or unearned income generated by actions other than the landowner's direct investments. The goal is to obtain land value increments generated by actions other than the property owner's, such as public investments in infrastructure or administrative changes in zoning, land use and building regulations, for the benefit of the public interest (Smolka 2013). By definition, land value capture is a municipal finance mechanism through which local governments generate increases in land values by making regulatory decisions, such as changes in land use or maximum allowable density, as well as infrastructure and transit investments, and then use the incremental land value generated by those actions to finance infrastructure or other public benefits. Investments in public transit and transit-oriented development and, by extension, resiliency measures including the expansion of green infrastructure, could be examples of this.

Colombia is recognized in Latin America and around the world as a pioneer in developing a legal framework for the use of land value capture. Since the early 20th century, the country has had some form of levy to finance public investments that have a broader impact on the municipality.

Betterment Contribution: "Contribución de Valorización"

The earliest form, known as contribution of valorization, or betterment contribution, was introduced through legislation in 1921. Contribution of valorization is a type of special assessment or betterment tax that finances the cost of a public works project by creating a proportional levy on all those who benefit from the project. In 1956, contribution levies were expanded in the legal system to include 'contribution for appreciation for general benefit,' which is based on the concept that some public investments have an impact on all of a municipality's inhabitants. Therefore, a contribution can be imposed on all residents, based on the proportion of the estimated benefit to their property.

National legislation established the present framework for contribution levies in 1966 through Decree 1604 and municipal code (Decree 1333) of 1986. Under this framework, municipal governments can apply a valorization levy at the cost of the public works plus 30%, divided among affected properties in proportion to the benefit they receive (de Botero and Smolka 2000). This levy can take effect before, during, or after construction to recover the cost of the project. Over the years, the contribution of valorization has been a major source of local funding in cities throughout Colombia. In 1968, at the height of its use, contribution levies were responsible for 45% of all local public expenditures in Medellín; 30% of Cali's expenditures in the early 1980s; and in 1993, 24% of Bogotá's local revenues (Smolka 2013).

Unearned Increments: "Plusvalías"

Building on the success of contribution levies, in 1997 Colombia introduced Law 388, which lays out the legislative framework to implement land value capture mechanisms. The law is centered on a decree that all municipalities must design and approve a twelve-year master plan (Plan de Ordenamiento Territorial [POT]). To support the POT, the law introduced 17 additional planning instruments, including the establishment of "plusvalías" or land value increments, which is defined as the main financing instrument for the POT. Specifically, the law cites that municipalities are required to capture 30% to 50% of the increased value from changes in density, or land use, in the POT.

Law 388 outlines the ground rules for applying plusvalías to finance public investments. The law established a methodology for calculating the land value capture, using land prices tracked by the Institute of Geography in towns, and using the municipal cadaster in cities. This methodology was later revised by Decree 1788 in 2004. One of the key updates in the legislation was the shift from using the cadaster as the tax base for property values to the consumer price index (CPI).

The primary reasoning for this update is that the CPI more accurately reflects changes in the market and therefore generally produces a higher tax base, while the cadaster may be slower in capturing these changes.,. According to the legislation, the tax base is the estimated difference between the commercial value of property before and after the urban intervention. The tax rate is then calculated as between 30 to 50% of the tax base (de Botero and Smolka 2000).

Furthermore, the legislation stipulates that the tax rate must reflect socio-economic conditions of owners. For example, a neighborhood is scored according to its access to urban infrastructure and services, as well as the stratum or socioeconomic attributes of the occupants. The conditions for applying plusvalías are broadly defined as the conversion of rural to urban land, increase in density, or changes in zoning or the rate of occupation in the POT. In comparison to contribution levies, plusvalías are a true land value capture instrument in that it is an income generating mechanism based on the impact a project has on property values, while contribution of valorization, on the other hand, is a cost recovery mechanism.

Despite the national legislation permitting and establishing land value capture as a legal instrument, few municipalities have implemented plusvalías, the exceptions being Medellín, Bogotá and Barranquilla, which have implemented it with some success. Although national legislation has established land value capture and made it available to municipal governments, each city's municipal council must accept it. In Bogotá, for example, the city council did not approve plusvalías until 2003. This was in part due to scrutiny over the legal and technical components, as well as the fact that the most recent master plan was enacted in 2000; there was uncertainty on whether to retroactive levies should be applied. Despite the delayed application of land value capture, between 2004 and 2007 over $16.5 million USD were levied in Bogotá (Acosta 2008).

As evidenced by Bogotá's experience, municipalities are faced with a significant political hurdle relating to the complexity of land value capture, conceptually and in terms of implementation, which is difficult to explain to voters. In place of land value capture, mayors typically try to implement valorization taxes, which are easier for voters to understand and have a short-term impact, while land value capture tends to have a longer-term impact.

<u>Land-Based Regulatory Instruments Related to Land Value Capture in Colombia</u>

Colombia's national legislation offers local governments a broad range of land-based tools and regulatory instruments. These instruments have been used in several cities in Colombia as mechanisms through which to implement plusvalías, valorization, and other land value capture programs. Although national legislation permits and establishes the legal instrument of land value capture, there has been minimal implementation of land value capture other than valorization in Cali.

Land use plan and maximum building envelope: "Aportes por edificabilidad"

It is useful to consider how the municipal government of Cali employs land policy and regulatory instruments available under national legislation. As in most large cities in Colombia, the land use plan formally regulates construction and new development; although with growth and expansion, much development is informal and, consequently, not in conformance with the adopted land use plan. In Cali, the municipal government utilizes an "index" (similar to a floor area ratio) to determine the maximum allowable squared meters of construction allowable on a given plot; in addition, the maximum building height is a function of the squared meters of a plot. This constitutes a 'base construction index,' a basic allowable envelope of squared meters per plot, further shaped by maximum height limits. Under this zoning system, a provision allows additional density (up to a prescribed limit) above the 'base construction index,' the 'top construction index' to be awarded to builders and developers in exchange for providing amenities, such as public open space. The base construction index plus the density bonus equal the 'maximum allowable building envelope.'

Plan parcial

Law 9 in Colombia's 1989 national legislation provides a land development instrument that has been used in Cali, known as "plan parcial". Included in this plan is a provision for land assembly through direct acquisition or expropriation, and the readjustment of plots after the construction of infrastructure and services (Smolka 2013). Using this provision in the plan parcial, government agencies act as facilitators of private sector social housing construction.

Typically, urban development agencies, such as Metrovivienda, buy and service land through readjustment of plots, and then sell the land to private social housing builders. Law 388 of 1997 later mandated land readjustment for the purpose of achieving a higher quality site design, including better property configurations, more efficient street layouts, and a more equitable redistribution of benefits and costs (Smolka 2013). In many plan parcial projects, a substantial percentage of land is designated for environmental protection, although the study team could not identify examples where high-density residential planes parciales included the explicit investment in green infrastructure or open green space buffers intended for flood risk reduction.

"Planes parciales" are similar to planned unit developments (PUDs) and planned development areas (PDAs) in the US, in that they function as overlay districts to the baseline land use plan and supersede underlying zoning provisions. Within a plan parcial, public agencies and/or private land developers have the flexibility to adjust comprehensive city guidelines to local site conditions (Smolka 2013) and enforce good urban design, land use, and a just redistribution of benefits and costs in land readjustment.

There are three categories of planes parciales:

1. Plan parcial for urban development. Development using planes parciales has characterized Cali's southern expansion. The minimum requirements to create a plan parcial are four city blocks; although, in many cases, planes parciales encompass as much as 800 hectares (in the case of the Operación Urbanística Nuevo Usme [OUNU] project in Bogotá).
2. Plan parcial for the regulation of development in river corridors known as POMCA (Planes de Ordenación y Manejo de Cuencas Hidrográficas). The POMCA is a jurisdictional instrument to manage water resources and prevent the environmental deterioration of the watershed. The Ministry of Environment and Sustainability oversees the implementation of POMCAs, with the stated objective of balancing social and physical development with the protection of the environment.
3. A macro-project ("mega obra"), a type of plan parcial, is a zoning and land use instrument used to allow projects at greater densities than allowed in the city land use plan but controlled through design guidelines and other criteria. A plan parcial functions in a similar way as overlay districts and Planned Unit Developments (PUDs) or Planned Development Areas in US cities. In a macro-project, a provision known as "aportes por edificabilidad" ('contributions for buildability' or 'linkage fees' in the US) is available to developers. Under this provision, a real estate developer is allowed to increase building height (beyond the maximum height limits established in the land use plan) in exchange for payment of "aportes por edificabilidad". In Cali, "aportes por edificabilidad" pay for public green open space in macro-projects.

Transfer of development rights (TDR)

Colombia's national Law 388 establishes the transfer of development rights (TDR) as a legal instrument for development. TDR is a type of land value capture that, in effect, exchanges cash or in-kind exactions and other types of charges, for the use or transfer of building rights to predefined receiving areas. Smolka (2013, 42) defines TDR as "a certificate by which the city administration compensates an owner in-kind for constraints on building rights imposed on the property (e.g. historical preservation or environmental conservation), or when the owner surrenders some of his land for a public interest project such as widening a road, creating a park, or rehabilitating a slum." Additional planning instruments related to value capture introduced in Law 388 include provisions for the public auction of unutilized land to be used for social housing, the right of the public to have the first option to buy the land, the public acquisition of land at prices listed before the announcement of the project, and the enabling of land readjustment in partial plans.

The city of Cali has not implemented TDR, although these could be useful as an incentive-based system in guiding development away from risky areas. Cali could employ TDR to protect green buffer zones, restrict construction in high-risk areas prone to landslides and floods or, as an incentive, to guide growth away from vulnerable areas into more resilient districts. The municipal government, or other designated agencies, might stipulate in-kind or monetary compensation from developers to restore and/or expand floodplains, open space for storm management and multi-functional parks and recreation spaces to manage stormwater drainage on a project site, or in close proximity. TDR, in the case of Cali, could be instrumental in limiting development in high-risk areas or protecting sensitive wetlands near the Cañaveralejo river, the Melendez and Lili rivers' corridors, which constitute the city's southern drainage system. As such, TDR could be an incentive to guide development into non-risk, more resilient areas in lieu of down-zoning and limits to development rights. TDR, used in coordination with POMCA (Planes de Ordenación y Manejo de Cuencas Hidrográficas), could be a useful tool to guide development away from hazard buffer zones in the Cañaveralejo river corridor, toward high-density development in low-risk areas in the southern expansion area of Cali, the zone with the highest levels of urbanization in the city. Cali's land use plan, hypothetically, could allow the transfer of development rights from areas deemed at-risk or optimal for constructed wetlands, open space for storm management, and other resiliency projects.

2.4 Land Value Capture Instruments in Cali

Cali has been a leader in implementing valorization levies in Colombia but has experienced issues of corruption that have reduced the willingness of the population to pay for public investments through taxation and hinders the implementation of LVC strategies.

In the early 1980s, the city received upwards of 30% of revenues from contribution levies; but by the end of the decade, the share of valorization in municipal revenues fell to 8.9% (Peterson 2009). Then in the mid-1990s, during the administration of Mayor Mauricio Guzman Cuevas, a public works department was established to implement valorization. Under Cuevas' leadership, Cali successfully built and financed several bridges and a number of parks. In 1997, Guzman was removed from office due to political scandals involving campaign contributions from narco-cartels. As political "collateral damage," the concept of land value capture was tainted by association (Pretel 2016). In 2008, in response to a declining capital budget and aging infrastructure, Cali turned back to valorization. The then-mayor proposed constructing 21 large-scale projects (mega obras), primarily focused on road and bridge improvements, over a three-year period financed through valorization. Eight years later only nine of the 21 projects have been built, and an insufficient amount of money has been collected to finance subsequent projects.

To date, despite some success in Bogotá and other cities, plusvalías have not been implemented in Cali. There has been some research on the potential to implement land value capture mechanisms on future projects, including the proposed Corridor Verde project, a 22 km green corridor running the length of city with light rail, bicycle paths, as well as market space. The study focuses on the impact of the project on land values of adjacent properties, through several different growth scenarios, including changes in zoning in regard to construction potential.

3. Literature Review

3.1 Urban Green Infrastructure[1] (GI) and Multiple Benefits

Green Infrastructure for Urban Climate Adaptation and Resilience

Many of the multiple GI benefits and ecosystem services that have been identified in recent studies (Byrne et al. 2015; Demuzere et al. 2014; Foster et al. 2011) are being associated with climate change adaptation and resilience. Ecosystem services are key components to building urban resilience and reducing vulnerability in the form of ecosystem-based adaptation. The contribution of ecosystem services in generating more flexible (with regard to shocks) cities is known as 'insurance value' (Gómez-Baggethun and Barton 2013). Insurance value reflects "the maintenance of ecosystem service benefits despite variability, disturbance and management uncertainty" (McPhearson et al. 2014). Ecosystem services promote resilience by responding to a particular disruption, such as urban vegetation that reduces surface runoff and binds soil, thus reducing the probability of damages by flooding and landslides, as well as buffering health impacts. Insurance values produce an intrinsic economic value to ecosystem services, as the changes caused by shocks are costly to reverse, if possible at all (Walker et al. 2010).

Moreover, GI preservation and protection can also be considered an urban strategy to limit populations returning to risky areas (Byrne et al. 2015) after relocation processes. The strategic planning and implementation of GI is presented as an efficient and effective strategy to reduce the need for gray infrastructure, therefore freeing up public funds for other community needs (Benedict and McMahon 2001).

The Nature Conservation (2014) summarizes the reasons why GI is emerging as a very promising strategy for climate change adaptation and building urban resilience:

- Significantly lower construction costs in comparison to gray infrastructure.
- Ability to reduce climate risks when designed and managed accordingly.
- Multiple environmental, social, and economic benefits that can support the city in building resilience.
- Diversity of options that result from the local geographical and topographical context (and therefore fit to every different circumstance).
- The value they have for the community, which leads to strong political support and can be the entry point to significant opportunities for financing GI with resilience attributes.

However, the application of GI solutions for urban climate adaptation and resilience purposes is not established yet as a widespread idea. Common reasons for that are the doubts about its efficacy in comparison to gray infrastructure, the uncertainty regarding its implementation and maintenance, and even the identification and embrace of the concept of GI per se.

[1] In this research GI is used as a concept that is focused in those elements included in the GI project CAU Cañaveralejo, and not in all that could be described under the definition of GI.

Typologies of Green Infrastructure

In literature, there are many definitions of what "green infrastructure" consists of. Starting from gardens, parks, forests, canals and wetlands as merely natural assets or recreational amenities, green infrastructure has developed to a complex and promising tool in environmental, sustainability and climate mitigation/adaptation strategies (Foster et al. 2011; Demuzere et al. 2014). A decisive step in this conceptual transition was the reevaluation of the public park as an indispensable asset of the urban infrastructure network, instead of simply a recreational amenity (Rosenberg 1996). The rationale behind this reconsideration was based on the reevaluation of the services and benefits of public parks, which were comparable to those provided by infrastructural investments. However, the term "green infrastructure" has expanded to include different kinds of green, blue, permeable, natural and engineered elements. Although there are many definitions of GI, each of them with its own perspective, for this research we use a definition from Matthews et al. (2015); according to whom GI can be defined as "the biological resources in urban areas that are human-modified and primarily serve an overt ecological function" and which are "intentionally designed and deployed primarily for widespread public use and benefit." Our working definition of urban green resilient infrastructure is as follows: *The human-modified biological resources in urban areas that provide ecosystem services and enhance resilience by reducing the risk of flooding.*

Moreover, Naumann et al. (2011) mention the value of substitutability with gray infrastructure, and Davies et al. (2015) point to the importance of GI being strategic, inter/trans disciplinary and socially inclusive. Green infrastructure projects such as CAC allow local governments to make the most of the limited public budgets and achieve multiple goals with a single investment (EPA et al. 2014).

Urban GI and Ecosystem Services

The common denominator of all GI typologies is the multiple benefits they provide for urban development and sustainability, in many scales and levels, through ecosystem services. GI offers opportunities like integrating nature in the urban context, protecting the biodiversity and landscape diversity, promoting public health and providing physical and psychological benefits to the citizens. This is achieved by enhancing the provision of ecosystem services through increased vegetation coverage; maintenance or creation of habitats; structuring ecological networks to support the alleviation of ecological impacts and habitat disintegration; and introducing sustainable landscapes and ecological resilience (Opdam et al. 2006; Tzoulas et al. 2007). Over the past decades, an overwhelming amount of research has been conducted on this topic, especially in light of accelerated land use transformations and urbanization, which pressures urban ecosystems and often leads to their degradation with all the consequences this has as a result on human well-being and urban resilience (Demuzere et al. 2014; Gómez-Baggethun et al. 2010a; Gómez-Baggethun et al. 2010b). Ecosystem services (many times referred to as 'natural capital') are the benefits provided by components of nature (e.g., soil, water, species) that contribute to our health and well-being, making human life both possible and worth living. In recent years, the ecosystem services theory has been further developed as a way to understand and manage natural resources (Millennium Ecosystem Assessment 2004).

Although many categorizations of ecosystem services can be found in the literature, a well-established typology has been presented by The Economics of Ecosystems and Biodiversity (TEEB 2010), dividing ecosystem services into the following four basic categories:

- Habitat or supporting services: basic processes and functions that are necessary to produce all other ecosystem services like soil formation, nutrient cycling, photosynthesis, water cycling, required for the upcoming services.
- Provisioning services: the products obtained from ecosystems, including food, fiber, fuel, genetic resources, natural medicines, ornamental resources, fresh water; products that ecosystems provide, and humans consume or use.
- Regulating services: the benefits obtained from ecosystem processes such as flood reduction and water purification, air quality regulation, climate regulation, erosion regulation, pollination; benefits that healthy natural systems can provide.
- Cultural services: intangible benefits people obtain from ecosystems through spiritual enrichment, aesthetic enjoyment, reflection, recreation and religious inspiration provided by natural landscapes.

These four categories can be divided into various subcategories, depending on the conceptual frameworks being used in different studies. There are multiple benefits that have been identified, both in academic literature and practices of GI and ecosystem services; table 1 below presents the GI benefits identified in recent literature, with an emphasis on the benefits related to flood risk and land/property values.

Table 1: Examples of GI Benefits Identified in Recent Literature with an Emphasis on Benefits Related to Flood Risk and Land Values.

Byrne et al. 2015	Broad public appeal, less politically contentious strategy, improved aesthetics, increased property values, modulated ambient temperatures, reduced stormwater runoff, cooling heat islands, reducing electricity consumption, lowering mortality and morbidity associated with heat waves.
Demuzere et al. 2014	CO2 reduction, thermal comfort and reduced energy use, reduced problems with flooding/peak flows/droughts, improved water quality, improved air quality.
M'Ikiugu et al. 2012	Biodiversity promotion, cultural and historical identity, disaster prevention and mitigation, energy saving, economic activities support, environmental education, food/resource production, good aesthetics, improvement of local climate, nature conservation, noise reduction, part of larger green network, planning structure, pollutants filtration, promotion of communal activities, public health promotion, rain water harvesting, recreation opportunity, reduction of greenhouse gases, reduction of public infrastructure cost, stormwater management.
Foster et al. 2011	Land-value, quality of life, public health, hazard mitigation, regulatory compliance, aesthetic value.
CNT & American Rivers 2010	Reduced stormwater runoff, reduced energy use, reduced pollutants, reduced atmospheric CO2, urban heat island, aesthetics, recreation, reduced noise pollution, community cohesion, habitat improvement, public education.
Forest Research 2010	Economic growth and investment, land and property values, aesthetics, improving levels of physical activity and health, promoting psychological health and mental well-being, facilitation of social interaction, inclusion and community cohesion, improving air quality, sustainable drainage, urban heat island, aesthetic quality, regeneration of previously developed land, quality of place, a sense of place, regional and local economic regeneration.
ECOTEC 2008	Economic growth and investment, land and property values, labor productivity, tourism, products from the land, health and well-being, recreation and leisure, quality of place, land and biodiversity, flood alleviation and management, climate change adaptation and mitigation.

Valuation of Ecosystem Services and GI Benefits

The valuation of ecosystem services can serve different purposes, including raising awareness; highlighting the consequences of alternative courses of action; assessing the impacts of ecosystems on human well-being; supporting decision-making regarding the management of urban ecosystems; and overall, establishing an indicative monetary value to natural capital.

When assessing ecosystem values, a combination of methods can be applied; depending on the service being analyzed and, in an urban context, the different scales from regional to building perspective (Gómez-Baggethun and Barton 2013). Moreover, there is a diverse and increasing range of valuation methods and criteria for the ecological and socioeconomic values of functions and services that are provided by natural and semi-natural ecosystems. Even though the valuation of ecosystem services is difficult and sometimes controversial, the potential importance that such values can have for the economic system and policymaking is compelling. Although the innate value of ecosystems services is obvious, failure to qualify and quantify ecosystem services can result in an implied, perceived value of zero. In this case, ecosystems, "rather than being 'priceless,'" can be considered "worthless" (TEEB 2010) and lead to the continuation of the 'business as usual' scheme, an over-exploitation and degradation of ecosystems that is both inefficient and detrimental to the human existence (Loomis 2000).

In business-as-usual practices, ecosystem services are considered easily replaceable by grey infrastructure and engineered services. These more-conventional strategies are often thought of as the best option in local government planning and do not consider the price of replacing the ecosystem services once they are gone, as the damage to urban ecosystem services involves an economic cost in different scales. As examples, health problems can result from a lack of air purification; carbon sequestration by urban trees; buffering of climate extremes by vegetation barriers; and noise reduction by vegetation walls (Gómez-Baggethun and Barton 2013).

A careful selection of valuation methods is vital, as each method is relevant only to specific services, benefits and circumstances. Regarding ecosystem services resulting from GI, authors like Barthel et al. (2010), Ernstson et al. (2010), Schäffler and Swilling (2013) and Davies et al. (2015) suggest that, due to the diversity of GI benefits, the assessment can be undertaken in many different ways and at multiple, different levels, in order to fully understand the impact of each action.

The main valuation methods for GI benefits and ecosystem services as have been discussed by various scholars are: i) direct market value, ii) market alternatives or indirect markets, including replacement costs method, damage costs avoided method and production function, iii) surrogate markets including hedonic price method and travel cost method, iv) stated preference including contingent valuation method (CVM) and choice modelling, v) participatory valuation and vi) benefits transfer (TEEB 2010).

Figure 2: Economic Valuation of Ecosystem Services in Urban Planning at Different Scales.

Scale	Urban planning issue	Role of economic valuation	HP	TC	PF/DF	RC	SP	Selected methodological challenges
			Economic valuation methods					
Region	Prioritizing urban growth alternatives between different areas	Valuing benefits and costs of (i) urban revitalization (ii) urban infill (iii) urban extension (iv) suburban retrofit (v) suburban extension (vi) new neighborhoods, with (vii) existing infrastructure (ix) new infrastructure (x) in environmentally sensitive areas	○ 0	○ 0	○ 0	○ 0	◑ 1	Comprehensive benefit-cost analysis at multiple scales and resolutions at multiple locations is expensive. Spatial multi-criteria analysis as alternative.
Region	Fair and rational location of undesirable land uses (LULUs)	Value of the disamenities of e.g. power plants and landfills	◑ 1	○ 0	● 2	○ 0	● 2	Using benefit-cost analysis to allocate infrastructure with local costs versus regional benefits may not achieve fair outcomes
Region	Preservation of productive peri-urban farm belt	Willingness to pay for preservation of open space and 'short distance' food	◑ 1	○ 0	○ 0	○ 0	● 2	Large import substitution possibilities for locally produced food
Region	Preservation of peri-urban forest, water bodies	Willingness to pay for preservation of recreational areas/sites	◑ 1	● 2	○ 0	○ 0	● 2	Large substitution possibilities for alternative recreation alternatives
Region	Water availability to support urban growth	Valuation to support full cost pricing of water supply. Incentive effects of removing water subsidies.	○ 0	○ 0	○ 0	● 2	● 2	Can require inter-regional geographical scope of valuation
Region	Using transferable development rights (TDR) to concentrate growth and achieve zoning	Determine farmer opportunity costs and benefits of foregoing urban development as a basis for predicting the size of a TDR market	◑ 1	○ 0	○ 0	○ 0	◑ 1	Using real estate prices versus opportunity costs of foregone farm production versus landowner perceptions of opportunities
Neighborhood	**Preserving views, open spaces, parks and trees in public places**	Willingness to pay of households for quality and proximity of recreational spaces	● 2	○ 0	○ 0	○ 0	● 2	Accounting for substitute sites and recreational activities Spatial autocorrelation of neighbourhood amenities
Neighborhood	Conserving soil drainage conditions and wetlands	Valuation of replacement costs of man-made drainage and storage infrastructure; flood and landslide damage	○ 0	○ 0	● 2	● 2	◑ 1	Hydrological and hydraulic modeling required
Neighborhood	Conserving water and urban wetlands	Costs of household water harvesting, recycling and xeriscapes, constructed wetlands	● 2	○ 0	○ 0	● 2	◑ 1	Cost-benefit evaluation requires comparison with full costs of water supply (see regional analysis)
Neighborhood	**Natural corridors**	Benefits of habitat conservation; opportunity costs to urbanization	◑ 1	○ 0	○ 0	◑ 1	◑ 1	Difficulty in specifying habitat connectivity requirements of corridors
Neighborhood	Local farm produce Edible gardens	WTP for local, fresh produce. Recreational value of home gardens	○ 0	○ 0	◑ 1	◑ 1	◑ 1	Large import substitution possibilities for locally produced food
Street-scape	**Street trees**	Value pedestrian safety through slowing traffic; disamenities of heat islands; absorption of storm water, and airborne pollutants, WTP for health amenities	○ 0	○ 0	● 2	● 2	◑ 1	Associating ecosystem service values at neighborhood level to individual trees.
Street-scape	**Green pavements for storm water management**	Willingness to pay of households for green streetscape; additional costs of larger dimension storm water	○ 0	○ 0	◑ 1	◑ 1	◑ 1	Associating ecosystem service values at neighborhood level to individual pavements
Building	Green roof tops Yard trees Lawns vs. xeriscapes	Additional costs of traditional storm water management; mitigation of heat island	○ 0	○ 0	◑ 1	◑ 1	◑ 1	Associating ecosystem service values at neighborhood and street level to individual roofs, trees and lawns

●2 currently used
◑1 potential
○0 probably not relevant

HP: Hedonic Pricing; TC: Travel Cost; PF/DF: Production Funtion / Damage; RC: Replacement Cost; SP: Stated preference

Source: Gómez-Baggethun and Barton 2013.

Damage Costs Avoided Concept

Regarding the valuation of flood protection benefits of GI, the 'damage costs avoided' and has been applied extensively. The method measures the cost of damages incurred if the protection of ecosystem services was absent (for example, property damages avoided) or the cost of providing a protection at a similar level, with the same benefits.

The damage costs avoided method can be applied by using two different approaches:

1) The first approach uses information regarding the potential damages that properties could incur if there were no restoration of the natural barrier.
2) The second approach uses the information of the economic value that people spend in flood protection, for example insurance premiums for natural disasters (i.e. flooding). Therefore, this approach is using insurance costs as a proxy for the value of risk reduction projects (King and Mazzotta 2000). According to MacDonald, et al. (2016), in some urban areas exposed to flooding, people have two options: "pay higher insurance premiums in areas with a greater likelihood of flooding or pay higher housing costs in areas with lower probabilities of flooding".

In the river Charles, Massachusetts, a wetland under protection not only provides a range of water quality, recreational and economic benefits, but also protection to communities of Boston and Cambridge—with an estimated 19 million USD in flood damages avoided. Additionally, adjacent properties have shown an increase in value (Weiskel 2007). Economic flood damage assessments are often conducted, regardless their high level of complexity, to provide valuable information to decision makers about damage costs avoided by implementing climate resilience measures (Mertz et al. 2010; Blanco-Vogt and Schanze 2014) and GRI interventions (Barbier et al. 2013).

An applied avoided cost analysis could compare the incremental cost of resilience infrastructure with the projected costs of rebuilding and recovery after destructive climate events, such as flooding, if no investment had been made in the present. In this formulation, the cost of GRI and other resilience measures might be significantly less than the rebuilding and repair costs to impacted properties and, therefore, constitute saved or avoided costs (Beecher 2011). Theoretically, this will be reflected in land values. Some increment of future land values is preserved by virtue of current investments in resilience measures, and that increment is robust enough to be captured for the purposes of financing green resilient infrastructure. The "preserved" value is "added" in the sense that it represents an increment that would otherwise be diminished by the impacts of flooding value and other severe weather events and costs of restoring those same properties to initial value (Beecher 2011).

Alternatively, according to the second approach of the avoided cost method, in theory, under the existence of a flood/disaster risk insurance market in the housing sector, the risk premiums would reflect the level of flood risk in an area, and therefore could be considered as proxy measurement of the benefit of GRI infrastructure measures that aim to reduce flood risk. In practice there is some evidence showing that people's perceived risk, and therefore demand for flood insurances, is increasing after flood events and, as time passes, eventually decreases (Bin and Landry 2013; Pommeranz and Steininger 2016).

In the study by MacDonald et al. (2016), people were asked to choose between higher land values with no risk of events, or lower land values with high risk of events. By reducing the risk and capturing this extra revenue in higher risk areas, land values go up; providing an increase on tax revenue, produced by multifunctional green and resilient infrastructure. Flood insurance and willingness to pay for flood insurance could therefore indicate the willingness to invest in climate resilient infrastructure.

The city of Chicago became a pioneer of green alleys and streets, implementing 30 green alleys with permeable pavement and over 200 catch-basins throughout the city. The objective of these measures was to slow the rate of stormwater runoff, allowing urban surfaces to have natural absorption, thus preventing flooding and therefore increasing the urban infrastructure capacity to handle extreme precipitation events. It also showed that with avoiding the flooding of just three homes, the investment was justified. Additionally, the trees planted are also estimated to have returned approximately $1.50 to $3.00 USD per tree for every dollar invested (City of Chicago 2010).

<u>Hedonic Pricing Model (HPM) for Valuing GI and Flood Risk Reduction</u>

HPM incursion in the environmental assessment is relatively new and is gaining popularity among economists and urban planners because of the benefits that it provides for monetizing non-market values such as environmental amenities.

The provision of leisure opportunities 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 land value is required to approach relevant stakeholders to encourage GI initiatives. HPM, combined with technologies like GIS, has become a powerful tool to fill this lack of data and translate it into the language that planners and decision makers are familiar with (Kronenberg 2015).

The following table shows research examples of assessments of GI impacts on land value through HPM, which can provide valuable ecosystem services.

A report by the Trust for Public Land states that proximity to urban parks and open space positively affects residential land value and suggests that commercial properties are likely to share a similar response. According to the report, the impact of park space on property values is primarily affected by the distance from the park and the quality of the park. Furthermore, the study investigates the impacts of urban parks on reducing the costs of managing urban stormwater using the amount of runoff diverted from traditional "hard infrastructure to estimate cost reduction" (Harnic and Welle 2009). However, the impact of flood risk reduction on land values due to GI, especially as a ratio of the impact of the green components of the project, hasn't been researched thoroughly and systematically.

HPM has also been widely applied for the assessment of the impact of flood events on land and property values (Table 2). It is worth noting that Daniel et al. (2009) conducted a meta-analysis of hedonic modelling case studies in the US and found that there is often an obfuscation of amenity effects of proximity to water and risk exposure that causes a systematic bias in the implicit price of flood risk. They clearly suggest to carefully distinguish between the positive (pleasant view) and the negative (flood risk) water related amenities.

As shown in tables 2 and 3, literature offers cases in the US, Europe and Asia where green corridors for flood management, restoration of natural floodplains, multifunctional public space for recreation and stormwater management all combine risk reduction with multiple sustainability benefits and increase surrounding property values (Madison and Covari 2013), chiefly through the HPM approach. However, as mentioned, the impacts of resilience improvements and green infrastructure projects on land value are less known, and largely undocumented, in Latin American cities, including Cali. It is an open question whether land values in these cities experience similar dynamics. Particularly in Colombia there is not any study applying an HPM to value GI attributes and flood risk reduction.

HPM has become a useful tool to understand 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 tradeoffs between sprawl, leap frogging and urban quality of life. HPM offers an opportunity to position GI as a priority in governance, urban and climate change issues through its capitalization in marketable goods, making it an adequate strategy for a capitalized neoliberal world (de Groot et al. 2012).

Table 2: Studies of GI Impacts on Real Estate and Land Values Using HPM.

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 to 12% in house prices based on GI size and their proximity to the property.
Malaysia	2015	Noriah Othman, Abdul Hadi Nawawi	GI positive contribution toward house and property price. Concluding that GI provides benefits toward the community in term of economic, social and environment.
Poland	2015	Robert Zygmunt, Michal Gluszak	Strong evidence of positive impact of GI proximity on undeveloped property prices, 100 m 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 real estate 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 real estate 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.

Source: Authors.

Table 3: Studies on the Impact of Flooding on the Value of Real Estate and Land Values.

Author	Year	Location	Method	Results
Eves	2002	Sydney, Australia	Comparison of mean prices of objects influenced by flood and objects flood free (t-test)	Short term discount
Zhai and Fukuzono	2003	Japan	Cross-sectional, Panel analyses & Hedonic Model	The flood effect amounts to -1.27% in 2001 and -4.7% yen/m^2 in 2002.
Bin and Polasky	2004	North Carolina, USA	Hedonic Model	Floodplain location lowers real estate values by 5.7 %
Troy and Romm	2004	California, USA	Hedonic Model	Floodplain location lowers real estate values by 4.2 %
Hallstrom and Smith	2005	Florida, USA	Repeat sales	Decline of 19 % of housing prices in flood zones
Bin and Kruse	2006	North Carolina, USA	Hedonic Model	Floodplain location lowers real estate values by 5–10 %
Bin et al.	2008	North Carolina, USA	Hedonic Model and Spatial Data	Price discount depends on flood rate, lies between 6.2–7.8 %
Pope	2008	North Carolina, USA	Hedonic Model	Floodplain location lowers real estate values by 3.8–4.5%
Lamond et al.	2009	UK	Repeat sales	Temporary impact of flooding on property values, normal market value after 3 years
Daniel et al.,	2009	USA	Hedonic Pricing Methods (meta-analysis)	The increase probability of flood risk by 0.01 is associated with a real estate price reduction of 0.6%
Pryce et al.	2011	Different areas	Analyzing housing prices in combination with findings of behavioral economics and sociology risks	Uneven pattern of inertia followed by rapid tipping-point declines

Source: Authors

3.2 Green Resilient Infrastructure and LVC

Financing Green Infrastructure

Numerous studies have been quantifying the benefits of green infrastructure in monetary terms, as was discussed in the previous section, to provide arguments for financing investments on ecosystem services and GI. Pesquera and Ruiz (1996), in their study on green financing for urban (water sector) infrastructure projects in Colombia, underline the need for involvement of new actors to mobilize financial resources and the importance of adding environmental attributes to projects (green infrastructure elements providing ecosystem services), as they are crucial for the funding opportunities these green infrastructure projects can have. Similarly, Foster et al. (2011) explain how cities in the U. S. have managed to incentivize (and therefore finance) green infrastructure projects:

1. By showing evidence of upfront or life-cycle cost savings when compared to alternatives for both public and private projects.
2. By providing direct financial incentives to property owners for green infrastructure installations.
3. By instituting laws, regulations, and local ordinances requiring implementation of green infrastructure on private property.
4. By mandating that public projects incorporate green infrastructure to demonstrate viability and value (e.g., street tree planting, green modifications to roads, green roofs on public buildings).

The aforementioned studies, among others, have shown how private, municipal, or regional funds can be successfully mobilized for the implementation of GI projects by highlighting their multiple benefits. However, the GI projects studied do not necessarily include resilience attributes such as flood risk reduction but are focused on the existence of green attributes that provide various types of ecosystem services.

LVC as a Finance Mechanism of Urban Climate Adaptation and Resilience

The implementation of LVC instruments is a widespread strategy to finance (grey) infrastructure improvements, especially in Latin America and Colombia (Smolka 2013). Kostaras et al. (2015) argue that the same instruments can be used to finance GI interventions and present an “LVC instruments for GI interventions” framework that describes which LVC instruments are most suitable for each GI intervention.

Despite the research on how GI impacts land values (Asmawi and Abdulah 2015; Jim and Chen 2010; Madison and Covari 2013; Mazzotta et al. 2014), the financing of climate adaptation and resilience measures through LVC remains untested. Literature on climate finance refers to LVC as a potential mechanism to fund investments in urban resilience, particularly as a component of strategies to mobilize private capital in adaptation through market mechanisms (Brugmann 2011). However, the direct use of LVC to finance climate adaptation has yet to be implemented in practice in any significant way in Latin America and the Caribbean, with the exception of the Curitiba Flood Protection TDR Program.

The Curitiba (Brazil) Flood Protection TDR Program is an exceptional example of the use of land value capture to implement resilience solutions that might have relevance to Cali. Curitiba, a city surrounded by rivers, experiences serious recurrent flooding. Curitiba has used TDR to preserve the green recreational areas for flood protection and relocate slum dwellers from informal settlements that, in large measure, occupy flood prone areas. Curitiba has created a natural drainage system using TDR for environmental protection, instead of building hard-engineered flood protection structures. The city has transferred development from areas designated for conversion into parks to absorb overflow and lakes constructed to contain floodwaters and prevent flooding downstream (termed as "TDR sending areas"). Through the TDR mechanism, developers and owners of property in high risk or environmentally sensitive zones obtain the right to build in designated city "receiving areas." Research shows that the costs of building and maintaining Curitiba's extensive park system is estimated to be five times less expensive than the construction of flood protection canals (referred to as "hard engineered" or "gray" resilience solutions) (Dharmavaram 2013).

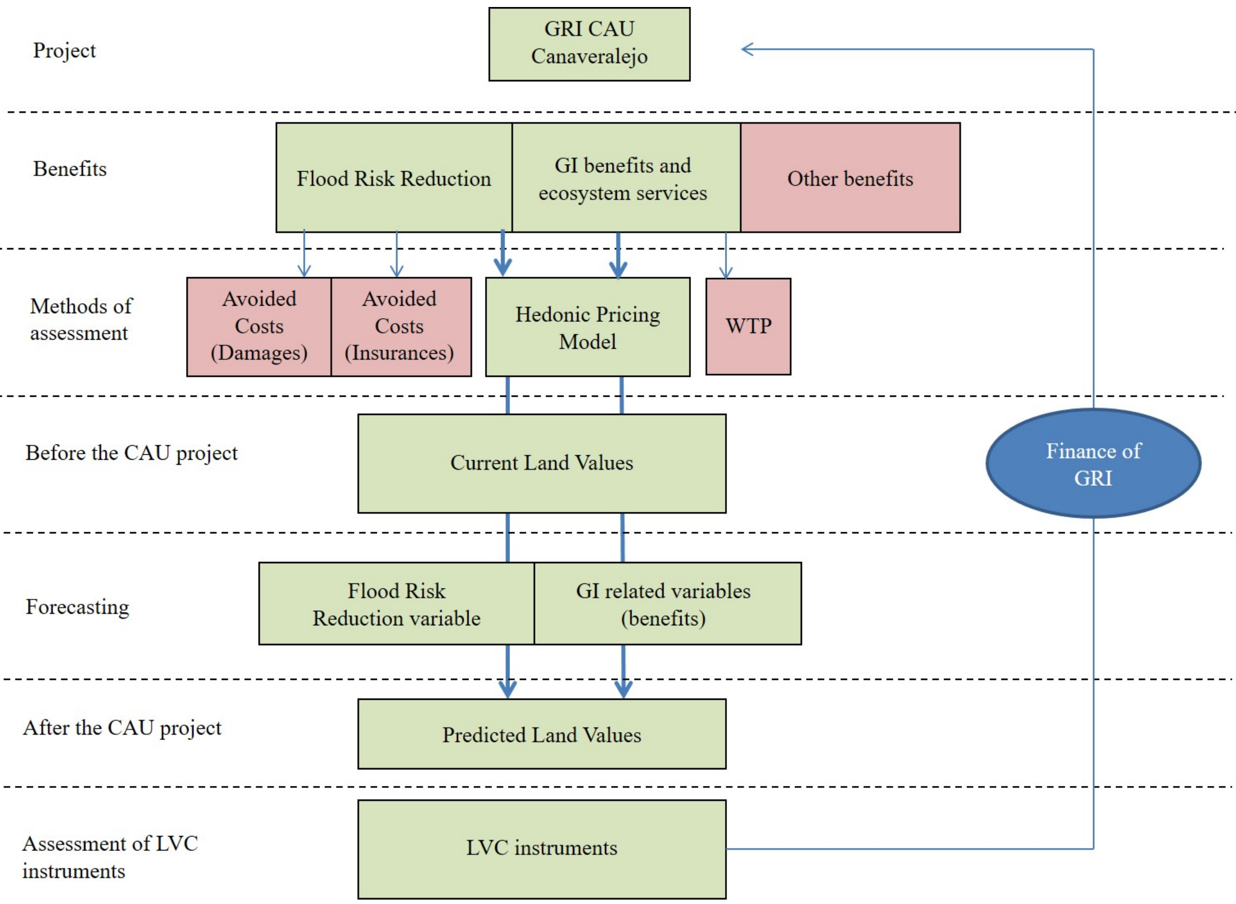
The lack of application of LVC mechanisms toward urban climate change investments presents a challenge for this type of land policy in Cali and other cities (Kostaras et al 2015). The application of LVC becomes more difficult when the impact of the (green or resilience) infrastructure project on the land and real estate values is not direct and immediate. Thus, property and land markets are very slow in reflecting risk reduction benefits (Pryce et al. 2011), especially if they result from GI intervention (such as parks, green areas; possibly also including recreation elements) and not from gray, visibly robust and effective infrastructure.

By assessing the environmental benefits and the flood risk reduction of GRI, land value capture has the potential to finance urban climate adaptation and resilience.

The GI presented in this framework include risk reduction components, and therefore the increase of land value is expected due to both the "green" elements and the flood risk reduction that the GI intervention achieves. Still, there is a gap in the literature looking at the ratio of the impact of GI-related benefits in land values in relation to the flood risk reduction impacts to land values.

Figure 3 illustrates the main steps of the elaborated conceptual framework, including the main methods applied in the study.

Figure 3: Elaborated Conceptual Framework and Main Steps of the Study.



Note: The red highlighted boxes indicate concepts and methods that could be applied in theory but were not applied in this study.

Source: Authors

4. Methods and Data

4.1 Data Collection

<u>POT GIS Database</u>

The main data source was the "revised and adjusted land use plan" (RAPOT) GIS Geographic Data Base (GDB) of 2013, from the municipality of Cali and other municipal organizations such as the Administrative Department of Environmental Management (DAGMA) and the organization responsible for preparing publicly accessible spatial data for the city (Infraestructura de Datos Espaciales de Santiago de Cali, IDESC). The databases are available online on the website of the municipality of Cali. By comparing the timeframes of all sources, year 2013 was selected for the analysis, as most data is available for this year. When information was not available for 2013, GIS layers for 2014 (POT 2014) were used. In the case of missing data or mismatches on timeframe, after having exhausted other sources, estimations were made based on files from past years. Since 2011, which is the year of our earliest data used (except for the land value, which dates from 2010) there have not been any major shock events in Cali.

In cases of data missing from the GIS databases, additional sources are: official documents; reports and results from the national surveys carried by Ipsos Public Affairs and the program "Cali Cómo Vámos;" the official project design documents from "Corredor Ambiental Cañaveralejo" made by Corporación Regional Autónoma del Valle del Cauca (CVC), Ceding SAS and Cuna Group for sustainable engineering and architecture; urban analysis done by CVC and The Territory Construction and Space Research Center from Universidad del Valle (CITCE); the annual reports of "Cali en cifras" (Alcaldía de Santiago de Cali 2014); water and air quality reports from the Administrative Department of Environmental Management (DAGMA) and homicides and robbery events from the Social Observatory.

Table 4: Variables for HPMs and Sources of Data.

Category	Variable	Unit	Source
Land value	Land values from Lonja	COP / square meter	GIS_#164_LonjaPropiedadRaiz_Precio_del_suelo_x_Subareas_2010
Green infrastructure	Number of trees	Number of trees	GIS_#280_RAPOT_2013 ARBOLES_CENSO_CALI
	Open green spaces	Square meters	GIS_#268_GIS LAYER_Espacio Publico
	Vegetation coverage	Square meters	LILP_HEDONIC_RISK/ URBAN VEGETATIONCOVER (.shp file UniVallle)
	Pedestrian streets	Meters	GIS_#16_Ejes Peatonales
	Bike lanes	Meters	http://idesc.cali.gov.co/download/pot_2014/mapa_31_red_basica_de_ciclo_rutas_priorizadas.pdf
	Exposure to fluvial flooding	Yes/no	GIS_FR_CAÑAVERALEJO GIS_FR_CALI GIS_FR_CAUCA GIS_#421_BARIOS GIS_#634_MANZANAS CATASTRO

	Contact with water bodies in an 80 m radius	Yes/no	GIS_#88_RIOS_dg07 GIS_#421_BARIOS GIS_#634_MANZANAS CATASTRO
Mobility and accessibility	Public transport efficiency	Number (from index)	Encuesta Cali como vamos 2013 (Affairs 2014)
	Public transport stops	Number of stops	GIS_#21_Estaciones de parada GIS_#631_Estaciones MIO GIS_#421_BARIOS GIS_#634_MANZANAS CATASTRO
	Public roads quality	Number (from index)	Encuesta Cali cómo vamos 2013 (Affairs 2014)
	Distance to CBD	Meters	Computation done in QGIS
	Distance from secondary central locations (less than 1 km)	Meters	Computation done in QGIS
Socio-economic	Life satisfaction index	Number (from index)	(Giraldo and Zapata Toro 2014)
	Health amenities	Number of locations	GIS_#158_Equip Salud GIS_#585_Equip Salud GIS_#421_BARIOS GIS_#634_MANZANAS CATASTRO
	Cultural amenities	Number of locations	GIS_#127_Equip Cultura GIS_#152_Equip Cultura GIS_#421_BARIOS GIS_#634_MANZANAS CATASTRO
	Commercial activities	Number of locations	GIS_RAPOT_2013 Actividades_Economicas_Camara_Comercio_2012 any
	Restaurants and hotels	Number of locations	
	Floor Space Index	Number (from index)	GIS_#164_LonjaPropiedadRaiz_Precio_del_suelo_x_Subareas_2010

			GIS_#421_BARIOS GIS_#634_MANZANAS CATASTRO
Safety	Homicides	Number of homicides	(Cali 2010)
	Robberies	Number of robberies	(Cali 2011)
Environment	Noise average levels	Decibel	GIS_#622_Ruido GIS_#421_BARIOS GIS_#634_MANZANAS CATASTRO

Source: Authors

Data on Land Values

There are two main sources of information for land values in Cali: the Lonja and the cadaster, each of them with advantages and disadvantages to be used in the hedonic model.

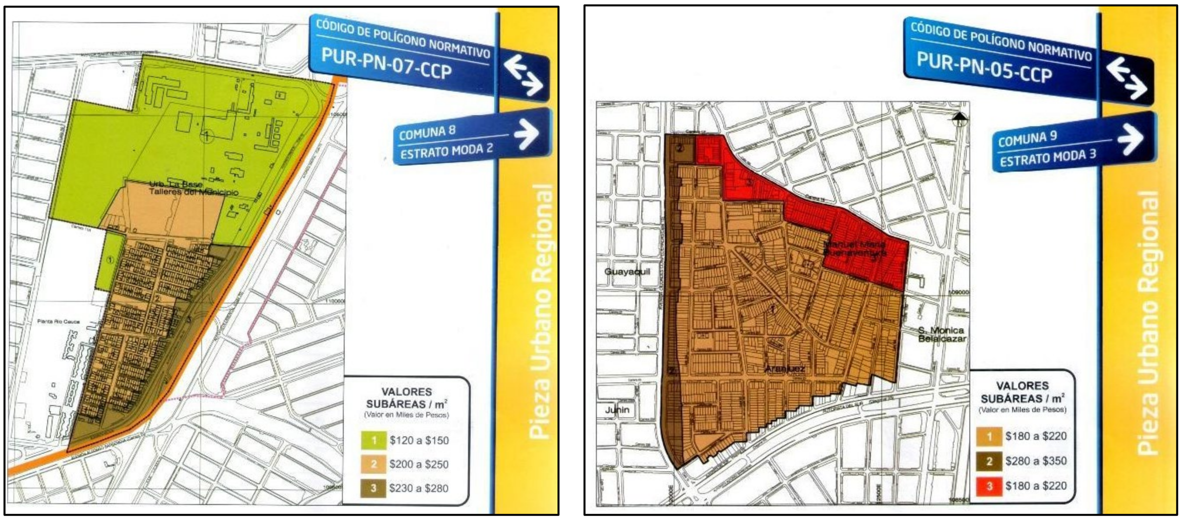
Table 5: Comparison Between the Two Possible Sources for Land Value in Cali.

Variable	Cadaster	Lonja
Level	Land parcel	Land parcel
Value	Exact value	Price range levels (minimum-maximum)
Components included	Land and building	Land
Unit	Colombian pesos / m^2	Colombian pesos / m^2
Availability	Urban perimeter of Cali	Urban perimeter of Cali

The land value information source selected for this study is the digital GIS layer of the Lonja of 2010, as more recent versions are not available digitally. In the Lonja, the land values are provided as a range between a minimum and a maximum value per "value-defined" area ("polygon"). These polygons form value zones that may extend beyond the block borders. Going through the Lonja, in many cases the reader can observe that land values at the frontline of a main street or a park, with a good view, are much higher. Therefore, the Lonja is able to sense and indicate these differences in the "value zones," which are independent of the spatial organizational divisions of the city (for example, city block). In our model, the land values per block are calculated as the average land parcel value in the respective area.

The cadaster could be an alternative data source for the land value in this study, as it provides the exact, official value of each plot. However, it does not differentiate between the value of the land and the buildings on it, but it presents their total, combined value. Unfortunately, these two elements cannot be separated within the same GIS layer of RAPOT. Under some assumptions and using information from other layers in the RAPOT database (such as the built area per plot, and the maximum area allowed to be built on the plot, in square meters), a manual separation of land and building values could be attempted. However, the result would not be very precise, as the index of occupation (IO, “índice de ocupación”: the mapping of the current built space situation) information is not available in the RAPOT database. For this reason, and as the Lonja represents the market land values reflecting actual “on the ground” transactions (not official estimated ones), the Lonja was preferred over the cadaster as the land value source to be used in the HPM.

Figure 4: Extracts from the Lonja of Cali.



Source: Lonja de Propiedad Raíz de Cali y Valle del Cauca 2008.

Data on Exposure to Flooding

Despite the high exposure of Cali to flooding due to the river Cauca and the six other rivers of the city, which are the main sources and locations of flooding, there is no concise flood exposure analysis for the same return period at city level. This limitation could be substituted by separate analyses of consistent flood scenarios for the seven rivers.

However, several studies have been conducted on smaller segments of the urban area and for different return periods; not on a river base but on a drainage system base. There is an overlap between these studies for 1 in 100 events. Studies conducted by engineer Gustavo Barrientos of DAGMA in 2011 for the rivers Cali, Cañaveralejo, Aguacatal, Lili, and Melendez have calculated the exposure to flooding at 1/100 years level. The study conducted in 2013 by OSSO Corporation and Royal Haskoning DHV for the dike of the river Cauca calculates the exposure to flooding for a longer time horizon: up to 500 years. However, the scenario for 1/100 has also been calculated.

Some of these studies, in various combinations with additional information and with different focus, have been visualized on several maps that are available on the website of the municipality of Cali, and recently published in the “Plan de Adaptación en Mitigación to CC” (Alcaldía de Santiago de Cali 2016). However, the maps are not included in the GIS databases available online at the website of the municipality of Cali.

Table 6: State of Knowledge for Threat of Flooding, Vulnerability and Flood Risk in Cali in 2016.

Phenomenon	Threat knowledge	Vulnerability knowledge	Risk assessment
Flooding of Cauca river	Modeling for the floodplain between the Interceptor Canal Sur and Cali river. The model assumes the overflow of Cauca river over the dam in 6 sections of 150 meters each (sections with reduction of the original height of the dike).	Vulnerability analysis based on population, housing, education and health infrastructure, and main elements of water supply, sewerage and electricity systems. Area of analysis: between South Interceptor Canal and Cali river.	Estimation of losses in housing (structure and content), education and health infrastructure, and main elements of water supply, sewerage and electricity systems. Area of analysis: between the Canal South River Interceptor and Cali river.
	Return period (years): 100, 250, 500	Return period (years): 100, 250, 500	Return period (years): 100, 250, 500
Pluvial flooding	Modeling for pluvial flooding of the east drainage zone of Cali for return periods of 10, 20, 50 and 100 years.	Modeling vulnerability homes in the area Oriental City sewer for rains TR = 10, 20, 50 and 100 years	Calculating losses housing (content) for flooding in the area Oriental City sewer for rains TR = 10, 20, 50 and 100 years
	Return period (years): 10, 20, 50, 100	Return period (years): 10, 20, 50, 100	Return period (years): 10, 20, 50, 100
Flooding of the tributaries of Cauca river	Modeling for the South Interceptor Channel and sections of rivers Pance, Cañaveralejo, Lili, Meléndez, Cali and Aguacatal. For the last 4 rivers hydraulic capacity analysis has also been conducted.	Not available	Not available
	Return period (years): 50, 100	Not available	Not available

Source: Adjusted and translated by the authors from Documento Técnico de Soporte POT 2014, Alcaldía de Santiago de Cali.

Due to data limitations, the current analysis has been conducted with separate flood exposure maps for each of the city's rivers. Only the three biggest fluvial threats of the city are included: rivers Cauca, Cali, Cañaveralejo, for return periods that vary from 50 to 500 years, according to the available data.

The research team contacted all possible sources in order to receive or construct digital flood exposure maps for the same return period, for all rivers; however, it has not been possible to achieve this within the timeframe of this study. An interview with the hydraulic engineer and flood risk expert Gustavo Barrientos, who has conducted flood risk studies on behalf of the municipality for several rivers (among them the Cañaveralejo river), confirmed the lack of a consistent flood risk study and map that covers all rivers and the total area of the urban perimeter. The interview provided deeper understanding of flood risk in Cali. Rivers Cauca, Cañaveralejo and Cali are the only natural rivers, while the others are currently in the state of artificial collector canals. There is an important difference between natural and artificial rivers, as the natural ones carry residuals, rocks, trees, natural elements from the mountains. The artificial are easier to manage, within the urban area. Regarding protection against flood risk, the guidelines provided by the POT explain that dikes and canals in the city should be designed for a return period of 100 years, plus one meter. However, currently not all the natural rivers are protected by dikes, while the canals are designed for a return period of 25 years. Specifically, rivers Cañaveralejo and Cali don't have any protection of dikes. There are two flood risk scenarios for the city: for flood events with functioning dikes and also for failure of the dikes. Maps that present "pluvial flooding" could be considered more realistic because they do not include failure of dikes. However, the maps that illustrate "fluvial flooding" present more hazardous situations. The flood risk maps of Cauca river that are included in the POT represent one of the most extreme scenarios, with failure of dikes for a 500-years return period.

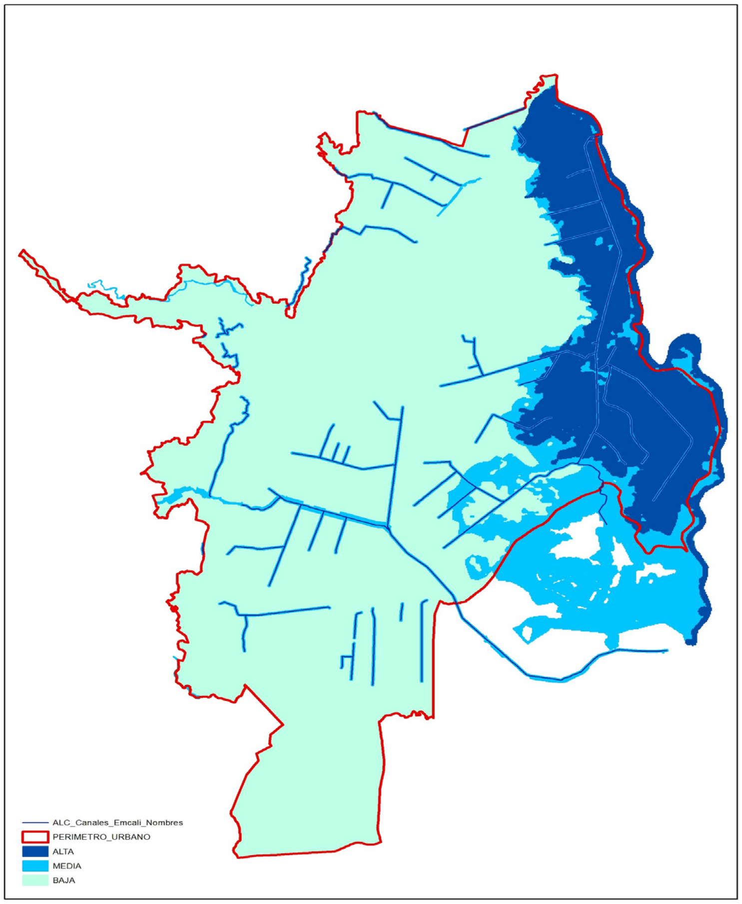
The result of the interview was the development of a city-wide flood risk map, based on empirical expert knowledge and official studies published by the city (image 8). In this map there are no areas without risk of flooding. This is due to empirical evidence from past events, which proves that, in several locations, floods are observed even in areas without rivers, due to rain (pluvial flooding) and the conditions of drainage infrastructure. Table 7 below provides an overview of the attributes of each of the three flood risk levels (low, medium, high) that summarize the flood risk knowledge we currently have for Cali and are illustrated in image 8. However, although this map provides an overview of flood risk in the city, it is not and official map but a synthesis product of primary and secondary data, and therefore was not included in the hedonic model analysis.

Table 7: Compilation of Available Knowledge of Flood Risk in Cali, in Three Flood Risk Levels.

Risk levels	Risk types	Rivers	Return years (available studies)	Impacts
High risk level	Fluvial flood risk and failure of dikes (immitigable risk)	Cauca	500 (and maybe 100)	Long time to recover, lives lost, high economic damages
Medium risk level	Fluvial (no failure of dikes) and pluvial for channels	Cañaveralejo study of G.B. 2011, Rio Cali, Aguacatal, most of the channels in the city	100 for rivers, 25 for channels	2-3 days recovery time, less economic damage, small amount of water to manage (for example 50cm)
Low risk level	Mitigable risk	Melendez, Lili, Pance	100	(not detailed flood risk information) flood risk protection exists

Source: Adjusted and translated by the authors from Documento Técnico de Soporte POT 2014, Alcaldía de Santiago de Cali.

Image 8: Risk Map for the Whole City.



Source: Authors, based on expert interview and secondary data.

Limitation and challenges

Challenges faced while analyzing the GIS data were changes in coding, no metadata, inadequate information on the attributes measurement units and meanings, contradictions and data holes[2] which can constrain the analysis significantly, and potentially affect the results. In such cases, gaps are filled with data from other organizations, or approximate estimations based on data from other years. Moreover, validation of the information used is achieved through triangulation with other sources, researchers, experts.

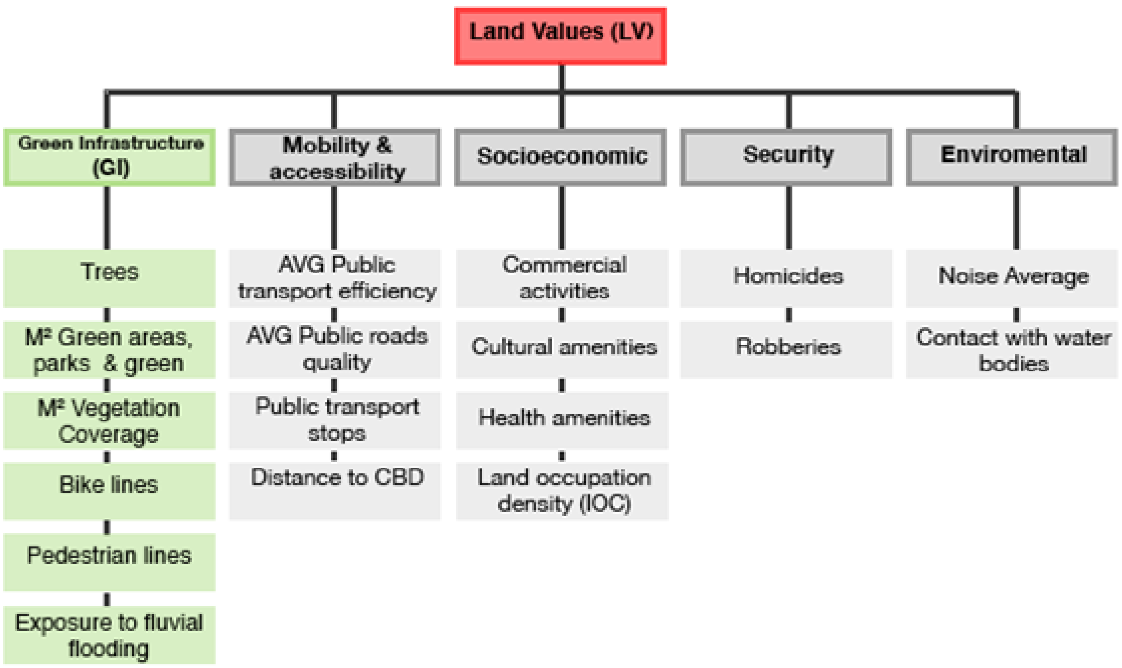
4.2 Data Analysis: Hedonic Pricing Models

Multiple regression analysis in Hedonic Pricing Models (HPM) was used to estimate the influence of variables representing green infrastructure elements, socioeconomic aspects,

[2] For example, a partial tree census where some districts have not been mapped and are presented on the map as having zero trees.

mobility/accessibility and environmental attributes on land values in the city of Cali. In the respective HPMs that were structured, land value is the dependent variable, and all other indicators are the independent variables. Multiple regression allows a *ceteris paribus* analysis that controls for other variables (crime, amenities, accessibility, among others) that simultaneously affect the dependent variable (land value). As the dependent variable in this case is the land value, variables related with the intrinsic characteristic of the flats or houses, such as furniture, balconies, air conditioning, etc., are not included in the model. The variables chosen for the model are the ones connected with extrinsic factors that affect land values based on the position of the land unit in the city, such as: presence of green infrastructure, crime, distance from the city center, proximity to public transport, etc.

Image 9: Dependent and Independent Variables of HPMs.



Source: Authors

The HPM method was used to conduct analysis at three levels, in order to explore the relations between the variables in more detail:

1. HPM1: at the scale of the neighborhood, for the total of the urban perimeter.
2. HPM2: at the scale of the urban block, for the total of the urban perimeter.
3. HPM3: all urban blocks within the urban perimeter that are in contact with water bodies in a radius of 80 m, which is an average depth for a standard block.

The equation used in all models is the following (Wooldridge 2003):

$$y = \beta_0 + \beta_1\chi_1 + \beta_2\chi_2 + \beta_n\chi_n + \cdots \varepsilon$$

The main purpose of the analysis at the block level is to approach in detail those critical indicators that did not show significance at neighborhood scale and check if the ones that did indicate significant impact changed their sign of significance. Similarly, the purpose of structuring a more focused model at the block level, for blocks that are in contact with water bodies, is to isolate the variable of exposure to the risk of flooding and explore it in detail.

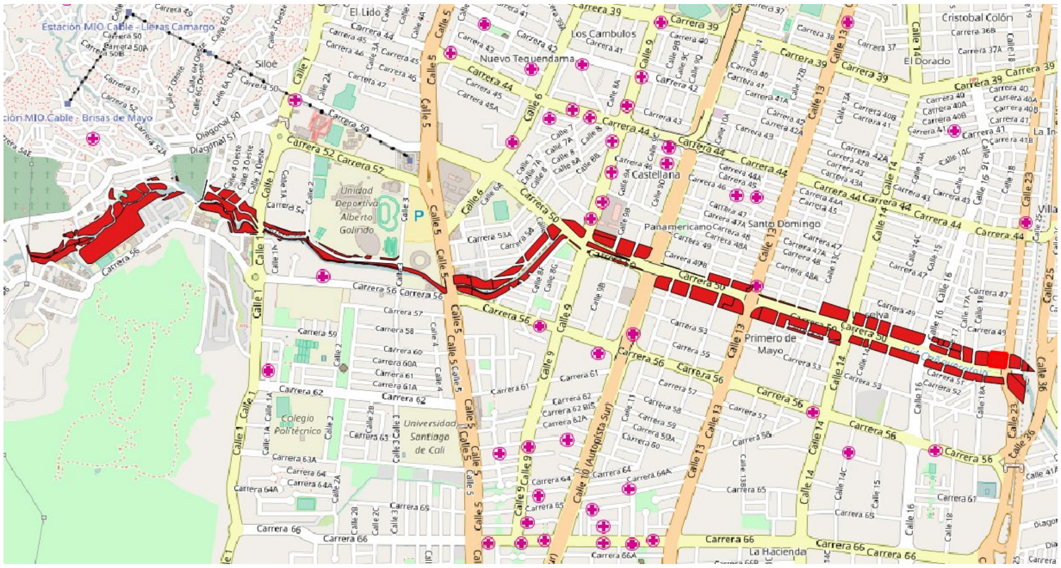
Before concluding to the three models that are presented below, more versions were explored using the stepwise method. For the final model selection, we avoided to add independent variables which intuitively do not have a partial effect on y in order to reduce the problem of multicollinearity: being led to a higher variance of the estimator, but a less efficient model.

However, the primary aim of our models is not the prediction of y, which is the land value, but the estimation of the beta coefficients of specific independent variables: the ones that will be altered from the CAU Cañaveralejo project. Therefore, our attention can be shifted to the statistical significance (p-values) of those variables, rather than the adjusted r^2 of the full model. For this reason, we explored models in two spatial levels (neighborhood and block) and worked with a general sample that covers the whole urban perimeter, and an additional selective sample consisting of blocks that are in contact with water bodies, where the risk of flooding is higher. The three selected models presented below have differences in the selection of independent variables, the coefficient and significance of each variable, and the adjusted r^2 of the model; but these three models are the best ones, as they were constructed with a selection of indicators in order to answer the different research questions, and partially at the level of R squared (see summary of all models in table 8).

As mentioned, our focus for this analysis is on the variables that will be altered from the CAU Cañaveralejo project, which is considered a GI intervention. In our models, we have grouped those variables under the category "green infrastructure," in order to isolate the impact of GI on land value. The other variables are used as control variables, as no changes are expected to them from the CAU Cañaveralejo project. The selection of variables is based on the literature review (Balchin et al. 2000; Duarte and Tamez 2009; Glaeser et al. 2001; Tita et al. 2006; Yang et al. 2016). In models HPM1 and HPM2 the green infrastructure variables "open green spaces" and "vegetation coverage" are used interchangeably, as the variable "open green spaces" describes square meter of public green areas, parks and green squares accessible to people as mapped in the POT database, and the variable "vegetation coverage" describes square meters of vegetation coverage as they were mapped in GIS by Universidad de Valle using satellite images. "Vegetation coverage" includes all green spaces visible in the satellite image and is, therefore, more detailed than the variable "open green spaces," reflecting the current situation on the ground. The differences between the coefficients of the two variables are presented in the "results" section. Other differences in the variables of the two models are the exclusion of the mobility and accessibility variable "public transport stops" and the socio-economic variables "life satisfaction index" and "health amenities."

We developed HPM3 to analyze the proximity to water bodies in more detail and understand whether the positive effect is due to the existence of water in a range of eye contact, which would correlate with the view of bodies of water. Model HPM3 explores mainly the issue of the blocks' exposure to flood risk and focuses only on this green infrastructure variable. In addition, this model focuses spatially only on the blocks that are in contact with water bodies, meaning within 80 meters from a river, canal or "quebrada" in the whole city of Cali. The value of 80 meters reflects the average length of a city block in Cali, and the selection of the block in HPM3 ensures that properties on them have visual contact with the bodies of water.

Image 10: HPM3 Sample, Zoom at the Case Study Area.



Source: Authors

In model HPM1, the variables are expressed as the total or average value (depending on the variable) within the area of each neighborhood. For example, the variable "number of trees" describes the number of trees within the limits of each neighborhood. In general, a neighborhood in Cali is an area with an average radius of 265.7 meters. We have 328 observations of neighborhoods in model HPM1, which is the number of neighborhoods in Cali excluding neighborhoods with missing data and the "corregimientos,". Similarly, in models HPM2 and HPM3, variables are expressed as the total or average value at the block level. A block in Cali has in average radius of 43 m. In HPM2 we have 10543 block observations, which cover the whole urban perimeter of Cali, excluding 3339 blocks that are located in the "corregimientos" outside the defined urban perimeter. HPM3, which focuses only on the blocks that are in direct contact with water bodies within a radius of 80 m, has less observations (2282). A critical aspect when using this method for the input of values per spatial unit (neighborhood or block) in the models, is that the radius may be considered, and we do not include the influence of items that are outside the limits of this specified area (such as trees or areas of green space,) but may in fact be directly adjacent to its outline.

Land value, the dependent variable in all models, is expressed as the average price of the land on the neighborhood or the block in Colombian Pesos (COP) per square meter of land (COP/m^2).

4.3 Feasibility Assessment of Land Value Capture Instruments

On November 8, 2016 the research team carried out the second workshop to work closely with institutional representatives who are linked to the CAU Cañaveralejo. Based on focus groups discussions, the experts' representatives of institutions (DAGMA, CVC, Alcaldía de Cali) and community leaders assessed the feasibility of LVC instruments available in Cali and their possible application in the study area to capture the added value resulting from the CAU Cañaveralejo project. Furthermore, they explored the possibility of financing the GRI using LVC instruments.

Another objective of this workshop was to present the preliminary results from the hedonic pricing model to validate the data and outputs of the study.

5. Results

5.1 HPM Models Results

The following section presents the results of the three selected models, analyzing differences per variable. Land value is the dependent variable in all models. The GI variables that are included in the models are: number of trees, vegetation coverage, bike lanes, pedestrian streets and exposure to fluvial flooding.

The neighborhood model HPM1 showed, in general, which factors correlate significantly with the land value across Cali. The control variables groups aligned with the expected results predicted by the literature. Variables such as mobility, socioeconomic factors, as well as safety, scored high on significance and are shown to have notable impacts on the land value at the neighborhood level. This was also observed in the GI group, where trees, open green space and pedestrian streets have high significant and positive impacts on land values. Indicators like bike lanes, exposure to fluvial flooding and noise did not figure in the significant results. However, they could be further addressed and discussed at the block level analysis in models such as HPM2 and HPM3. Indeed, the results from the block analyses helped to verify indicators that at a neighborhood scale had already shown significance, and to clarify the behavior of other variables, such as bike lanes, average noise and, more importantly, exposure to fluvial flooding risk.

Overall, bike lanes, average noise and exposure to flooding were the three indicators that did not show significant impacts in land value at neighborhood level, but did so at the block level, where their coefficients were both positive and highly significant. Consistent with the neighborhood results, in the block model all the control variables, as well as the rest of GI variables (trees, vegetation coverage, pedestrian streets), showed high significance and positive impact on land values.

Table 8: Comparative Table: HPM1, HPM2, HPM3.

		HPM1	HPM2	HPM3
	Level of analysis	Neighborhood	Block	Block
	Spatial focus	Urban perimeter	Urban perimeter	In contact with water bodies
Green infrastructure	Number of trees	38.39***	307.16***	-
	Open green spaces	0.00*	-	-
	Vegetation coverage	-	2.67***	-
	Pedestrian streets	10.84*	27.17*	-
	Bike lines	18.21	92.27***	-
	Exposure to fluvial flooding	14777.03	19338.91***	-31778.29***
Mobility and accessibility	Public transport efficiency	422710.14***	656394.36***	-
	Public transport stops	-997.06	-	-
	Public roads quality	1113707.16***	308599.65***	-
	Distance to CBD	-7.97**	-20.21***	-4.07**
	Distance from secondary central locations (less than 1 km)	-	-	26816.08***
Socio-economic	Life satisfaction index	39363.67**	-	-
	Health amenities	1952.89**	-	-
	Cultural amenities	10043.52***	31566.90***	39092.23***
	Commercial activities	141.25***	1836.49***	2052.91***
	Restaurants and hotels	-	-	13526.23***

	Floor Space Index	91.91**	26.52***	-
Safety	Homicides	-3149.62***	-1896.59***	-2422.28***
	Robberies	-1208.13***	723.87***	1035.63***
Environment	Noise average levels	-2097.18	-1169.80***	-1911.97***
	Observations	328	10543	2282
	Adjusted r2 Constant and significance VIF	0.53 - 4228079.23*** 1.41	0.30 -2662994.85*** 1.15	0.19 406213.35*** 1.34

Level of significance: *p<0.1; **p<0.05; ***p<0.01

Number of Trees

Results both at the neighborhood and block levels (HPM1 and HPM2) indicate that the "number of threes" variable has a positive and significant impact. However, the impact of each tree on land value appears to be eight times higher when we explore this variable at the block level. This result confirms the findings of The University of Texas (2008), Wolf (2007), Hastie (2003) and also 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 a 30 m radius. In the latter study, the average combined value is 12,828 USD to the properties lying within that radius. In the case of Cali, and according to the results of HPM1, each tree has an impact of 38.39 COP per m² of neighborhood land in contact with it. This impact is eight times higher (307.16 COP) when we examine the variable at the block level in HPM2. Taking, as an example, the neighborhood El Ingenio and this calculation, the value of trees in the neighborhood as it is projected on land is almost 27 million COP (8 million USD). However, as Benotto (2002) discusses, "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 land values across Cali might be larger than the models' results show.

Open Green Spaces and Vegetation Coverage

The variable "open green spaces" is used to describe square meters of public green areas, parks and green squares accessible to people and was included only in HPM1, at the neighborhood level. Similarly, "vegetation coverage" is a variable that was used to measure the presence of greenery at the block level. The indicator considers public and private green spaces, as well as small vegetation areas between streets. Although at the neighborhood scale the beta coefficient "for open green spaces" is 0.00, this variable was found to be significant at the block level. The HPM2 regression coefficient showed that 1 m² of vegetation coverage could increase the land value per square meter of land by $2.67 COP. Compared to the variable "number of trees", the vegetation coverage coefficient seems low. However, the presence of vegetation across the city is much bigger than trees. This explains the big impacts observed in neighborhoods like Parcelaciones Pance in commune 22, where 25% of the neighborhood surface is covered by vegetation, representing a high percentage of the neighborhood's land. These results are consistent with authors like Morancho (2003), Poudyal et al. (2009), Damigos and Anyfantis (2011), Melichar and Kaprov (2013), who showed the relevance of green areas on property values depending on their surface and proximity to the plot.

Bike Lanes

Bike lanes showed a positive significant impact on land value at the block level (HPM2;) and a smaller, not significant impact at the neighborhood level (HPM1.) The research of Racca and Dhanju (2006) indicated that, on a neighborhood scale, bike lanes caused a slightly significant negative impact on property values. In similar studies carried out in Toronto and New York City (NYC) the conclusion was that at neighborhood scale the impact was almost negligible (NYC Department of Transportation 2013; Sztabinski 2009). However, when the analysis was carried out at a street/block scale, residential and commercial properties registered an increase on land value and sale prices, respectively, due to the addition of new bike lanes. Moreover, in the case of NYC, at first the inclusion of a bike lane was opposed by small businesses and homeowners in nearby areas. However, after the construction of the bike lane and the resulting "enhancement of the streetscape" (NYC Department of Transportation 2014, 39) the traffic flow, economic vitality and property values were improved. This supports the results in HPM2, where bike lanes reached high significance and a positive impact of $92.27 COP in the average price per m² of land for each meter of bike lane created.

Cali has a small number of bike lanes across the city (less than 25 km in total,) which are distributed in 58 neighborhoods and 536 blocks. Among these blocks, the average contact between a block and a bike lane is 50m. This led us to think that, as a result of the HPM, bike lanes would not affect land values significantly in the city of Cali. However, when analyzed at a block scale through HPM2, the impact that bike lanes have on their adjacent blocks became clear. The radius of impact of bike lanes (150 m on average) is large enough to affect the blocks in direct contact with it. As mentioned, based on the results of HPM2, each meter of bike lane has an impact of $92.27 COP per m² on values for properties in the same block, which is consistent with the results showed by the NYC Department of Transportation (2014). In the case of Cali, an additional reason that possibly reduces the impact of bike lanes on land values, apart from the small number of bike lanes in the city, is that they are mainly introduced as recreational and not as transport infrastructure. Therefore, bike lanes appear isolated and segmented, roughly connected to a bigger network. To maximize their benefits, it would be necessary to introduce them in combination with the aforementioned "enhancement of the streetscape" (NYC Department of Transportation 2014, 39) which is greenery and tree planting, elements that can increase land values even as stand-alone variables. A similar strategy in New York City resulted in rents increasing along pedestrian and bicycle paths by 71% (APTA 2010), and local businesses registered a 49% increase in retail sales (NYCDOT 2013).

Pedestrian Streets

This variable scored a significant and positive impact in both HPM1 and HPM2 models. The coefficient at the block level is higher, indicating that each additional meter of pedestrian street correlates with an increase of $27.17 COP on the value of a square meter of land on the same block. This positive impact on land value is consistent with the results from CEOs 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 USD and $3,000 USD increase in property values. The importance that pedestrian streets 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.

In our models the impact of pedestrian streets seems low compared to the tree coefficient and less significant statistically. However, it is important to consider that Cali is car-oriented and relies on motorized transportation vehicles, neglecting pedestrian infrastructure. Nevertheless, the results from the HPM show the market's tendency to prefer 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 results in more people walking, a signal that the area is safe and interesting (Jacobs 1961). It can be concluded from the effect of pedestrian streets on land value and their presence in Cali that, as most cities around the globe, there is a "high demand and low supply for human-friendly streets" (APTA 2010).

<u>Exposure to Risk of Fluvial Flooding</u>

Exposure to fluvial flooding was included in all models as a dummy variable indicating that a block is either covered by a flood risk polygon on the risk map (yes) or not (no). The results in HPM1 indicated it as a variable with a positive coefficient, but not significant. The more detailed HPM2 at the block level returned a positive but significant result for the same variable. This means that, contrary to what would be expected, a property located in an area exposed to fluvial flooding is worth $19,338.9 COP/m² more than one located in an area without risk of flooding, in the condition that all the other indicators are equal. However, this finding could indicate that there is a confounding effect between the positive and negative aspects of water features, and therefore these water-related amenities should be distinguished (Daniel et al. 2009).

The more focused HPM3 model, where the indicator "contact to water bodies" was introduced, the results of the effect of risk of flooding on land values became negative and still highly significant (-31778.29***). Such model, examining contact to water bodies, could help differentiate between the benefits of a property that is close to a river and provides a pleasant view without being exposed to flooding, and one with exposure to flooding but no benefit of a pleasant view (Eves 2002; Daniel et al. 2009). This finding confirms several studies (Bin et al. 2008, Posey and Rogers 2010, Pryce et al. 2017; Koning et al. 2016) who found a decrease of 11% and 8,6% respectively in the land value of properties located in a floodplain or a flood prone area, based only on the exposure of the property to this risk and not additional factors.

Table 9: Regression Output HPM1 at Neighborhood Level. Variables are ordered in descending order according to coefficients.

HPM1	Variable	Indicator	β Coefficient	Unit
Variables that correlate with increase of land values	Mobility and accessibility	Public roads quality	1113707.16 (105878.49)	scale 1–5
	Mobility and accessibility	Public transport efficiency	422710.14 (58129.69)	scale 1–5
	Socioeconomic	Life Satisfaction Index	39363.67 (17306.24)	number
	Green Infrastructure	Exposure to fluvial flooding	14777.03 (15885.17)	yes/no
	Socioeconomic	Cultural amenities	10043.52 (2259.49)	number of locations
	Socioeconomic	Health amenities	1952.89 (822.78)	number of locations
	Socioeconomic	Commercial activities	141.25 (31.65)	number of locations
	Socioeconomic	Floor space index (FSI)	91.91 (44.62)	m²
	Green Infrastructure	Number of trees	38.39 (12.93)	number of trees
	Green Infrastructure	Bike lines	18.21 (26.18)	meters
	Green Infrastructure	Pedestrian lines	10.84 (5.76)	meters
	Green Infrastructure	Open green spaces	0.00 (0.00)	m² green public and private spaces
Variables that correlate with decrease of land values	Mobility and accessibility	Distance to CBD	-7.97 (3.51)	meters
	Mobility and accessibility	Public transportation stops	-997.06 (952.66)	number of stops
	Security	Robberies	-1208.13 (423.75)	number of robberies
	Environment	Noise pollution	-2097.18 (1385.28)	decibels
	Security	Homicides	-3149.68 (833.95)	number of homicides

Note: Std. Error in parentheses

Table 10: Regression Output HPM2 at Block Level. Variables are ordered in descending order according to coefficients.

HPM2	Variable	Indicator	β Coefficient	Unit
Variables that correlate with increase of land values	Mobility and accessibility	Public transport efficiency	656394.36 (21511.32)	scale 1–5
	Mobility and accessibility	Public roads quality	308599.65 (12580.51)	scale 1–5
	Green Infrastructure	Exposure to fluvial flooding (EFF)	19338.91 (4528.32)	yes/no
	Socioeconomic	Cultural amenities	31566.9 (4086.27)	number of locations
	Socioeconomic	Commercial activities	1836.49 (120.73)	number of locations
	Security	Robberies	723.87 (70.24)	number of robberies
	Green Infrastructure	Number of trees	307.16 (88.38)	number of trees
	Green Infrastructure	Bike lines	92.27 (33.79)	meters
	Green Infrastructure	Pedestrian lines	27.17 (14.18)	meters
	Socioeconomic	Floor space index	26.52 (4.01)	m²
	Green Infrastructure	Vegetation coverage	2.67 (0.35)	m² green public and private spaces
Variables that correlate with decrease of land values	Mobility and accessibility	Distance to CBD	-20.21 (0.66)	meters
	Environment	Noise pollution	-1169.8 (202.22)	decibels
	Security	Homicides	-1896.59 (136.07)	number of homicides

Note: Std. Error in parentheses

Table 11: Regression Output HPM3 at Block Level. Variables are ordered in descending order according to coefficients.

HPM3	Variable	Indicator	β Coefficient	Unit
Variables that correlate with increase of land values	Socioeconomic	Cultural amenities	39092.23 (8258.13)	number of locations
	Mobility and accessibility	Distance from secondary central locations (less than	26816.08 (3429.98)	meters

		1 km)		
	Socioeconomic	Restaurants and hotels	13526.23 (3005.48)	number of locations
	Socioeconomic	Commercial activities	2052.91 (685.55)	number of locations
	Safety	Robberies	1035.63 (156.52)	number of robberies
Variables that correlate with decrease of land values	Mobility and accessibility	Distance to CBD	-4.07 (1.84)	meters
	Environment	Noise	-1911.97 (412.01)	decibels
	Safety	Homicides	-2422.28 (279.67)	number of homicides
	Green Infrastructure	Exposure to fluvial flooding	-31778.29 (7257.79)	yes/no

Note: Std. Error in parentheses

5.2 Predicting the Potential Impact of the CAU Cañaveralejo on Land Value

This section will discuss the potential impact of the CAU Cañaveralejo project on land values in adjacent properties. In the previous sections, this study explored the impact of variables such as mobility, socio-economic factors, safety, environmental aspects and GI features on land values across Cali. After the HPM results, it was possible to calculate the correlation (regression coefficients) of specific GI elements on land value. Using these coefficients and the quantifications of the planned changes to these GI elements, suggested by the CAU Cañaveralejo design, we can predict the monetary impact of the project on the areas adjacent to the Cañaveralejo interventions. Three predictions are made based on each HPM and the significant variables found.

<u>Prediction Based on HPM1</u>

This prediction is performed at the neighborhood level, for the two significant variables of HPM1: number of trees and pedestrian streets. Table 12 shows that the potential impact that CAU can have varies depending on the neighborhood that is being observed, based on how each neighborhood is benefitted by the project. Not all neighborhoods are affected in the same way. Depending on their location, some neighborhoods will benefit by two or four features included in the CAU Cañaveralejo project, which would reflect a higher impact in the average price per m² of land in that neighborhood.

Looking at the forecast results, not per neighborhood but per variable, we also observe differences on how they can affect land values. For example, "number of trees" is the variable that scored the highest regression coefficient among the GI variables in the HPM1 model, indicating its significance at the city level. However, the number of new trees that are proposed by the CAU Cañaveralejo project is small, and they would be concentrated in one area. Thus, the impact of this variable is finally very low, providing just $62,660.64 COP of added value. The impact of the new pedestrian streets was overall the highest, providing an added value of $127,769.64 COP.

The percentage shown in the last column of the prediction table is the proportional increase in comparison with the actual average price per m² of land. For example, if the CAU Cañaveralejo project is implemented, the intervened area in the neighborhood Cuarto de Legua - Guadalupe would have an increase in its land value of 1.0%, and so on. This number is based on the original price of land in each neighborhood. Therefore, if the absolute impact of the CAU project is large in comparison to the impact in other neighborhoods, but its original average land price per m² is high, the percentage of increase could be low.

Table 12: Prediction of Land Value Increase Based on HPM1. Total increase of value 2.5%.

HPM1 Summary	Added value due to new GI		Land value increment		
Neighborhood	**Trees**	**Pedestrian Lines**	**Current land value per neighborhood (COP)**	**Added value per neighborhood (COP)**	**Land value increase (%)**
Cuarto de Legua - Guadalupe	$ -	$ 3,961	$ 1,190,452,275	$ 11,331,842	1.0%
Nueva Tequendama	$ 3,916	$ 7,941	$ 1,270,257,625	$ 34,974,024	2.8%
Camino Real - Joaquín Borrero Sinistera	$ 3,916	$ 9,152	$ 982,412,800	$ 31,447,338	3.2%
El Coliseo	$ -	$ 2,890	$ 648,042,500	$ 3,943,342	0.6%
Canaveral	$ -	$ 3,499	$ 714,116,006	$ 6,767,711	0.9%
Sect. Cañaveralejo Guadalupe Antigua	$ -	$ 16,917	$ 1,786,766,230	$ 110,868,043	6.2%
U.D.A. Calindo Plaza de Toros	$ -	$ 5,338	$ 1,114,470,000	$ 13,219,677	1.2%
Belisario Caicedo	$ -	$ 1,278	$ 394,138,125	$ 2,184,534	0.6%
Venezuela - Urb Cañaveralejo	$ -	$ -	$ 446,333,408	$ -	0.0%
TOTAL	**$ 7,832**	**$ 50,976**	**$ 8,546,988,969**	**$ 214,736,511**	

Source: Authors

Prediction Based on HPM2

This prediction is performed at the block level for the significant variables of HPM2 (number of trees, vegetation coverage, pedestrian streets, bike lanes) and for blocks having changes on GI variables due to the implementation of the CAU Cañaveralejo project. The impact of the exposure to fluvial flooding on land values, although significant, is not calculated. According to its coefficient in HPM2, increased exposure to fluvial flooding correlates with higher land values. However, in HPM3 this variable was analyzed further, and when detached from the feature “eye contact with water,” its coefficient was negative. For this reason, the prediction of its monetary impact on land values is not be calculated for HPM2, but only for HPM3.

Table 13: Summary of the Prediction of Land Value Increase in Million COP Based on HPM2. (Predictions per block in Annex 6).

HPM2 Summary	Added value due to new GI (in COP)				Land value increment		
Neighborhood	**Trees**	**Bike lanes**	**Pedestrian streets**	**Vegetation coverage**	**Land value increase (COP/m²)**	**Land value increase (%)**	**Added value per block (million COP)**
Cuarto de Legua - Guadalupe	$ -	$ 942	$ 9,928	$ 16,822	$ 9,231	2.2%	$ 483.0
Nueva Tequendama	$ 31,330	$ 50,465	$ 19,903	$ 2,155	$ 17,309	4.0%	$ 239.5
Camino Real - Joaquín Borrero Sinistera	$ 31,330	$ 22,905	$ 22,940	$ 3,313	$ 16,098	3.9%	$ 752.3
El Coliseo	$ -	$ 24,629	$ 7,245	$ 5,743	$ 18,808	4.0%	$ 394.4
Canaveral	$ -	$ 38,613	$ 8,769	$ 267	$ 23,824	6.5%	$ 154.0
Sect. Canaveralejo Guadalupe Antigua	$ -	$ 96,267	$ 42,402	$ 5,199	$ 23,978	8.8%	$ 3,353.7
U.D.A. Calindo Plaza de Toros	$ -	$ 82,334	$ 13,379	$ 17,951	$ 113,665	8.4%	$ 1,753.5
Belisario Caicedo	$ -	$ 27,040	$ 127,770	$ 11,432	$ 10,419	4.5%	$ 180.7
Venezuela - Urb Canaveralejo	$ -	$ 8,411	$ -	$ 39,065	$ 2,793	2.0%	$ 484.8
TOTAL	**$ 62,661**	**$351,607**	**$252,335**	**$ 101,946**	**$ 236,124**		**$ 7,795.8**

Source: Authors

Prediction Based on HPM3

Table 14: Summary of the Prediction of Land Value Increase in Million COP, Based on HPM3. (Predictions per block in Annex 7).

HPM 3 summary	Flood Risk reduction		Land value increment	
Neighborhood	**Project part**	**Area of flood risk reduction (m2)**	**Land value increase (%/m²)**	**Land value increment (million COP)**
Jorge Zawadsky	Canal part	1,404	1.0%	$ 44.6
La Selva	Canal part	17,277	5.0%	$ 549.0
Departamental	Canal part	201	0.1%	$ 6.4
Panamericano	Canal part	7,446	4.0%	$ 236.6
Las Granjas	Canal part	9,511	12.0%	$ 302.3
San Judas Tadeo I	Canal part	27,021	2.0%	$ 858.7
Primero de Mayo	Canal part	22,625	3.0%	$ 719.0
Santa Anita - La Selva	Canal part	25,288	2.0%	$ 803.6
Canaverales - Los Samanes	Canal part	19,382	4.0%	$ 615.9
El Limonar	Canal part	12,431	2.0%	$ 395.1
Urb. Militar	River part	18,857	2.0%	$ 599.2
Cuarto de Legua - Guadalupe	River part	3,505	2.0%	$ 111.4
Nueva Tequendama	River part	28,642	1.0%	$ 910.2
Camino Real - Joaquín Borrero Sinistera	River part	15,374	1.0%	$ 488.6
Camino Real - Los Fundadores	River part	1,865	0.3%	$ 59.3
El Coliseo	River part	3,734	1.0%	$ 118.7
Canaveral	River part	6,632	1.0%	$ 210.8
Sect. Canaveralejo Guadalupe Antigua	River part	53,183	2.0%	$ 1,690.1
U.D.A. Calindo Plaza de Toros	River part	13,492	0.3%	$ 428.8
Belisario Caicedo	River part	17,004	2.0%	$ 540.4
Venezuela - Urb Canaveralejo	River part	30,488	1.0%	$ 968.9
TOTAL				$ 10,657.3

Source: Authors

Table 15: Prediction Overview of Land Value Increase Due to Flood Risk Reduction Based on HPM3.

	Current land value (million COP)	Value increase (million COP)	Increase (%)
Canal Part	**$201,814**	**$4,763**	2.4%
River Part	**$2,088,619**	**$26,589**	1.3%
Case study area (total)	**$2,290,433**	**$31,353**	1.4%

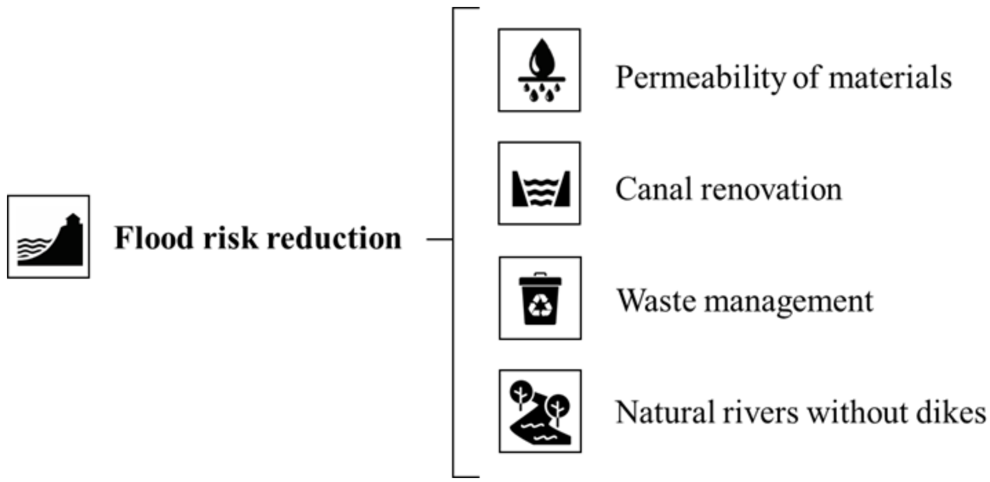
Source: Authors

Total Land Value Increase per GRI Variable

The three HPM models were run with aggregated data of the official data of the POT database, and with the limitations that were discussed in the data collection section (different return years, different levels of detail, missing risk data for some of the rivers). Exposure to flooding was introduced in the models as a dummy "yes/no" variable: yes, where there is risk of any level, and no, where there is not any risk of flooding indicated in the POT flood risk maps. In addition, based on the interview with the hydraulic engineer / flood risk expert, we compiled an integrated flood risk map for the city of Cali, that summarizes the flood risk in three overall levels: low, medium and high (see image 7). Nevertheless, while reviewing this map, the expert confirmed that the areas that we have indicated with "yes" in our models are areas with "medium" level of risk in the aggregated map, while the areas indicated as "no" are areas with "low" level of risk, and therefore the difference between the two variables reflects a level of flood risk. Regarding risk reduction, the expert concluded that we can state confidently that the interventions of the project will reduce the flood risk at the case study area (around the CAU Cañaveralejo intervention and along the canal) from medium to low level due to:

1. The CAU Cañaveralejo project characteristics: increase of permeable surfaces, new trees, water storage in bike lanes, floodplain.
2. The improvement of the canal (gray infrastructure) which is renovated to have better water carrying capacity.
3. Other municipal actions aimed at improved as waste management.
4. Moreover, the rivers that have been included in our HPMs are the ones with the highest risk of flooding as they are natural rivers without dikes.

Image 11: Main Factors Responsible for the Reduction of Flood Risk (from Medium to Low) Around CAU Cañaveralejo.



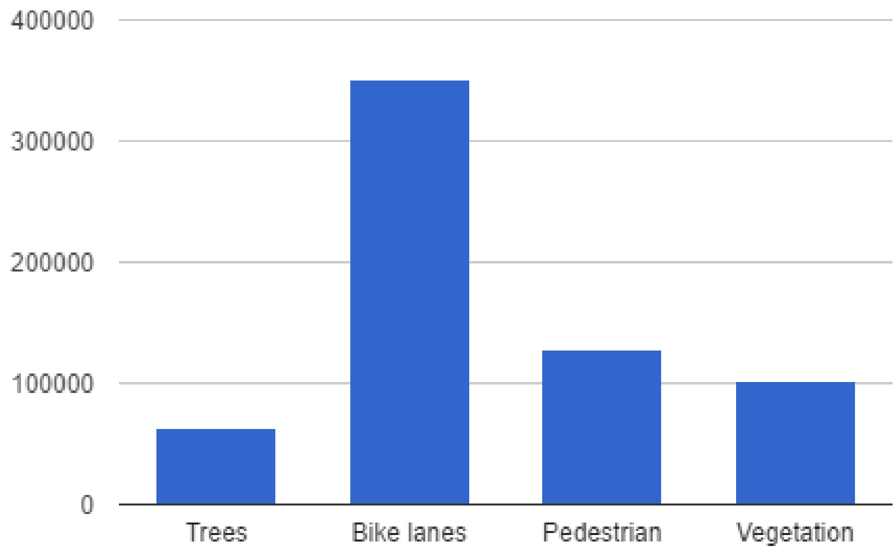
As a result, we conclude that we can use the outcomes from HPM3 to calculate how the land values along the river and canal will be increased by flood risk reduction due to the project and additional flood risk reduction interventions at the area.

Overall, we observe that the number of trees and the flood risk are the only GI variables that are highly significant in two out of the three HPM models, while exposure to flood risk is also found as significant twice, but as its coefficients indicate, is highly controversial ranging from very positive to very negative.

The effect of GI is more visible at the block level, and of flood risk in a more detailed analysis within the block level, where the positive impact of being in eye contact with water can be separated from the risk of flooding.

The next illustrations show the total land value that is expected to be increased due to the GRI attributes of the CAU project, namely bike lanes, pedestrian streets, trees, vegetation coverage and flood risk reduction. As shown in figure 5, out of the GI attributes, bike lanes would have the largest impact to the land values of the overall project area.

Figure 5: Expected Land Value Increase, in COP, Due to the GI Attributes of the CAU Cañaveralejo Project Based on HPM2.

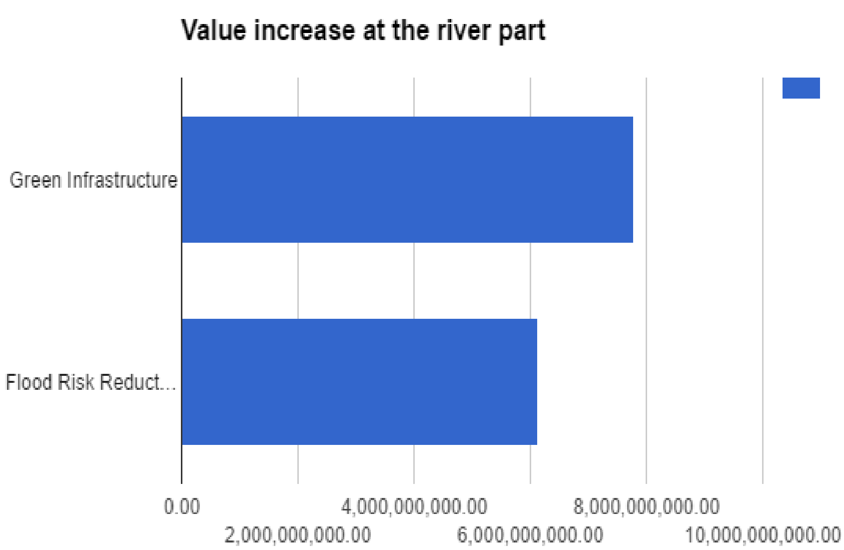


Source: Authors

Image 12: Overall Increase of Land Value Due to the GI and Flood Risk Attributes of CAU Project.

Source: Authors

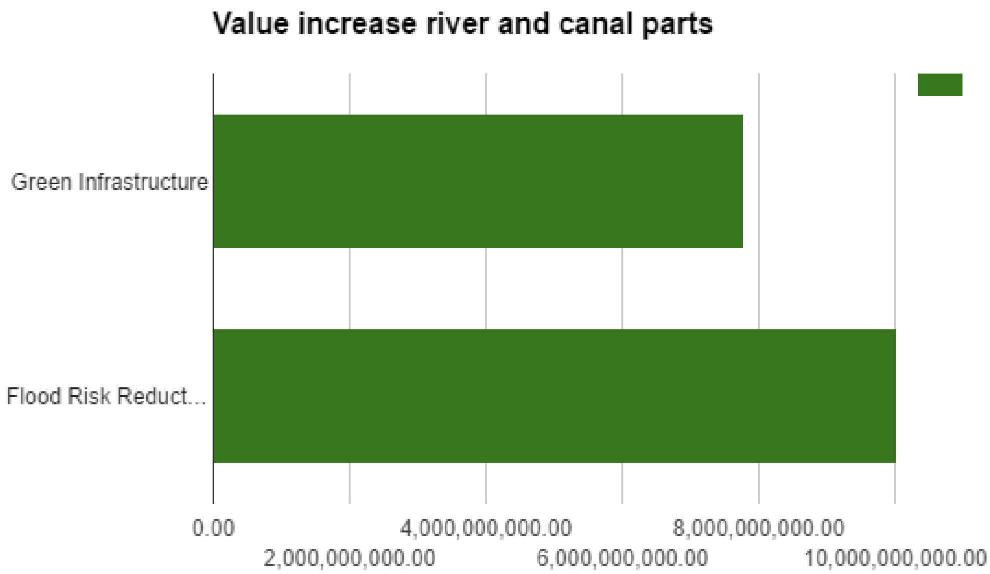
Figure 6: Land Value Increase, in COP, at the River Part of the CAU Project Due to GI and Flood Risk Reduction Interventions Based on HPM2.



Source: Authors

Regarding expected land value increases at the river portion of the project, we estimate that the GI interventions will have larger impact than reduction of risk. The ratio of impact to land values between GI attributes and flood risk reduction along the river is about 4/3.

Figure 7: Land Value Increase, in COP, in the Case Study Area Due to GI Attributes and Flood Risk Reduction Interventions Based on HPM2 and HPM3.



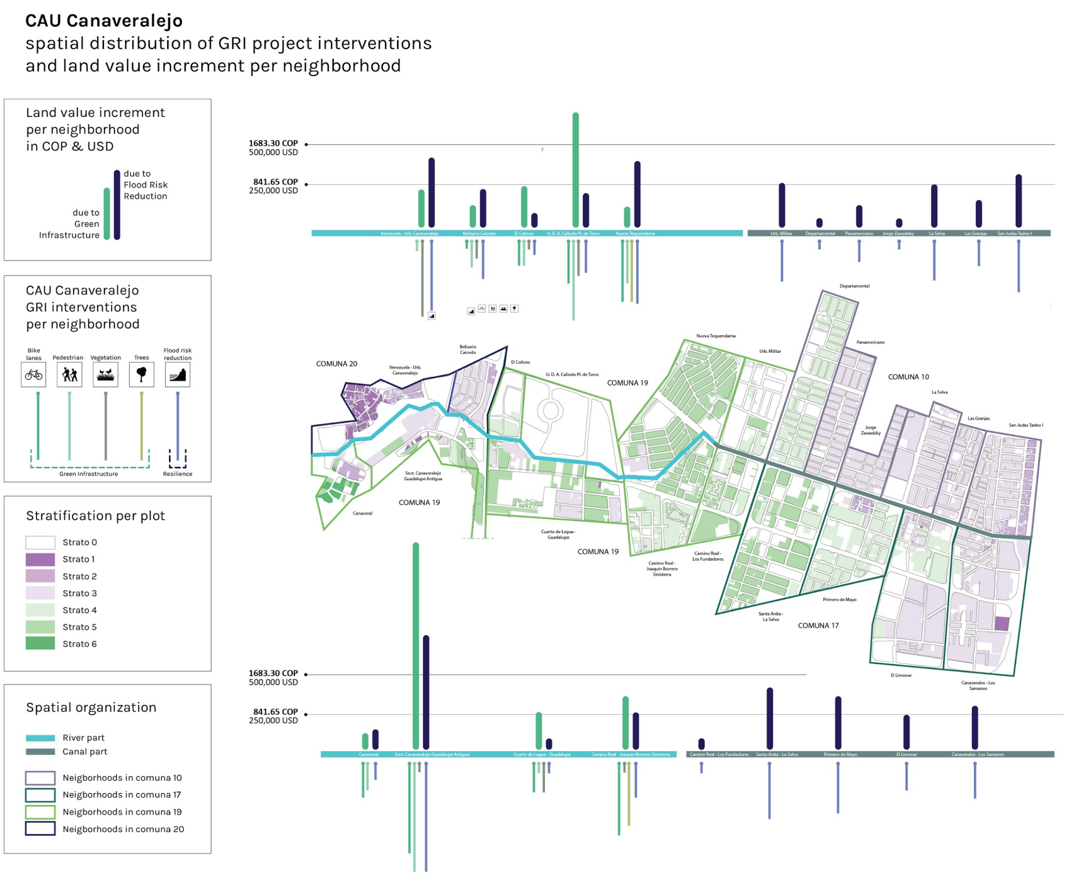
Source: Authors

Regarding the expected land value increase in the overall project area, flood risk reduction results to a higher Regarding the expected land value increase in the overall project area, flood risk reduction results in a higher impact than the GI elements of the project. The ratio of land value impact between GI attributes and flood risk reduction in the whole project area is about 4/5.

It is important to note that the values resulted in these prediction calculations reflect part of the overall value of all the sustainability and resilience benefits that open spaces and ecosystem services provide to the neighborhood and the city. The SRBA applied during the first stakeholders' workshop indicated many of these benefits (Annex 1). Due to quantification and monetization challenges of some of the other sustainability benefits, we can conclude that the values would be higher than predicted if all these benefits were included in the assessment and valuation.

The results of this forecast analysis show the potential effect of the CAU on the land value of the areas to be intervened. It also provides relevant information about which GI attributes affect the most, which can be used to reconsider and increase their presence in the project. The use of these results can be beneficial for private stakeholders and public actors since they quantify the potential increase in land value that could be directly related to a potential increase in property taxes, future municipal revenues, and the time it would take to recover the initial investment.

Figure 8: Spatial Distribution of the CAU Cañaveralejo GRI Project Interventions and Land Value Increment Per Neighborhood



Source: Authors (link to high resolution image: https://issuu.com/alex.ts./docs/benefits_canaveralejo)

5.3 Possible Application of Land Value Capture Instruments

<u>Feasibility Assessment of LVC Instruments</u>

In November 8, 2016, participants of the workshop concluded that the “aportes por edificabilidad” (charges on development rights) would be the most effective, suitable LVC mechanism to finance green resilient infrastructure and conventional hard engineered investments in risk reduction in the Cañaveralejo river. This was a consensus and reflected the political concerns about past corruption.

In addition to “aportes por edificabilidad”, participants considered other types of LVC instruments, including valorization contributions (betterment levies); the model of “plusvalías” implemented in Bogotá and other cities; “valorización predial” (property tax reassessments), land value taxation, which could work in Zone 5, the hard engineered Cañaveralejo canal that channels rainwater and wastewater to Cauca river after being treated; and the “fondo de adaptación” (climate adaptation fund), currently used as financing mechanism in plan Jarillon, could be used to support Cali’s hydraulic capacity and flood risk mitigation strategies.

Participants recommended the “aportes por edificabilidad” because, as an incentive-based rather than tax-based system, it could attract private investment. Public-financed investment in effective green resilient infrastructure could be a catalyst that inspires confidence from private investors in the areas along the Cañaveralejo. The “aportes por edificabilidad”, established in the POT 2014, could be an incentive to invest in the area and develop related projects, which would, in theory, increase land values.

In contrast, participants, including local stakeholders, considered tax-based approaches as less effective. This was in reaction to the negative experience of the municipality of Cali’s 2009 tax for “21 Mega-obras,” the anticipated 5-year construction of 21 mega-projects.

Workshop participants expressed an interest in involving the private sector in flood risk reduction in support of initial investments by the public sector on a “voluntary” basis by offering incentives rather than “punitive’ measures such as taxation and plusvalías, which risk having the effect of discouraging investment in the Cañaveralejo corridor. “Aportes por edificabilidad” is a discretionary zoning mechanism that allows the public sector to negotiate with private developers to build or fund the construction of public space and infrastructure, including green resilient infrastructure, in exchange for the rights to build at a higher density. The examples of MioCable and Spain library in San Domingo Medellín demonstrates the effectiveness of “aportes por edificabilidad” (with proper public sector management—a critical component of the success of these projects). In effect, “aportes por edificabilidad” theoretically (and empirically based on the examples in Medellín and Cali’s MioCable) triggers a “virtuous circle” of beneficial investment in urban development and in resiliency.

Valorization (betterment contribution)

Valorization is a type of tax that finances the cost of a public project by creating a proportional levy on all those who benefit from the project.

Strengths	**Weaknesses**
• The contribution imposed on residents is divided among affected properties and is calculated in proportion to the benefit they receive. • This levy can be applied before, during or after construction to recover the cost of a project.	• It is a cost recovery mechanism, not an income generating instrument. • Cali voters are skeptical of valorization taxes based on past experiences of corruption in municipal government, where the planned projects were not fully implemented.

Plusvalías (unearned increments)

Plusvalías are taxes defined by law as the main financing instrument for urban interventions in Colombia. They reflect the estimated difference between the commercial value of property before and after the intervention.

Strengths	Weaknesses
• The tax rate is informed by the socioeconomic conditions of property owners. • It is a strong income generating mechanism for local governments.	• Plusvalías are challenging for voters to understand as their impacts are visible over a longer period. • Property owners pay plusvalías when they apply for building permits, so informal settlements are excluded. • To date, Cali has never implemented plusvalías. • Cañaveralejo is not indicated as an area where plusvalías can be implemented in the land use plan.

"Aportes por edificabilidad" (Density bonus, or charges on additional building rights)

In the land use plan, a provision allows additional density above the 'base construction index' to be awarded to developers in exchange for providing amenities, such as public open space.

"Aportes por edificabilidad" is a mechanism that allows the public sector to negotiate with private developers to build or fund the construction of public space and infrastructure, including green resilient infrastructure, in exchange for the rights to build at a higher density.

Strengths	Weaknesses
• "Aportes por edificabilidad" theoretically and empirically (based on the examples in Medellín and Cali) triggers a "virtuous circle" of beneficial investment in resilient urban development. • This instrument is perceived by stakeholders as an incentive rather than a punitive measure.	• General challenges as all LVC instruments in Cali

Challenges for the Implementation of LVC in the CAU Project

According to the workshop participants the following challenges were identified for the LVC implementation in the CAU project area:

Lack of Trust / Willingness to Pay Taxes

To implement LVC, which can have benefits in terms of financing resiliency, the municipal government needs to generate public confidence. The prior experiences with corruption make the public skeptical about the capacity of government to administer plusvalías programs or valorization taxes. Government will need to make an upfront investment in pilot projects and other initial interventions to inspire public confidence.

Coordination of Many Stakeholders

Due to the large number of stakeholders, resiliency projects in Cali will require the establishment of a public agency or institution to coordinate the large number of institutional stakeholders and manage projects in an integrated way to respond to both flood risk reduction as well as land management and urban development. This capacity or function does not currently exist in Cali. One alternative could be a collaboration in which stakeholders (including public agencies and other institutions) collectively finance initial projects without using LVC or asking citizens to pay through valorization. This could be a first step in a much broader program of "aportes por edificabilidad."

Low Investment Costs

The relative low cost of the CAU Cañaveralejo project does not need additional or alternative financing because, at present, CVC and DAGMA have the public funding to support this project. For this reason, LVC instruments for project financing are not being considered. Future stages of construction, however, might require additional financing to supplement the current funding allocation. The project benefits from a program in which private companies and institutions with properties along the CAU Cañaveralejo adopt and maintain public spaces (largely green spaces), in some cases, in exchange for tax reductions by the city (DAGMA).

6. Discussion and Concluding Remarks

Our analysis identifies the urban factors that affect land values across Cali. The block level analysis confirmed the positive and high significant impact of GI on land values 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 (Bin et al. 2008; Pope 2008; Pryce et al. 2011) scored a highly significant and positive impact on land value. The cause of these results was directly connected with an interference between the exposure to flood risk and contact with a water body indicator, also discussed by Daniel et al. (2009). To understand the relation among these two variables, we carried out a third model (HPM3) where contact to bodies of water was controlled. This analysis demonstrated that a block directly in contact with a river with no risk of flooding accounts for a positive impact on the land value due to the pleasant view that the river provides (Luttik 2000; Daniel et al. 2009). However, if a block has direct contact with a river with flood exposure, the positive impacts related with the pleasant view are not large enough to compensate the negative impact of being in risk of flooding, which leaves a negative impact on the land value.

The hedonic results provided the regression coefficients for each one of the GI variables used to predict CAU's potential impact on land value if implemented as projected. The results showed an overall increase of 7.8 billion COP distributed across 48 blocks in 9 neighborhoods, meaning an average increase of 5.4% (table 13) on the land value in the intervened area due to the GI attributes and 1.4 % due to the flood risk reduction.

Currently, the presented estimations are being updated to cover the complete extent of the study area and quantify all the benefits that will affect land values. In addition, the total amount of the added land value at the neighborhoods surrounding the Cañaveralejo river is being calculated, based on the area (square meters) that are affected by each significant factor identified through the regressions.

The obtained results in the forecast analysis show the potential effect that the CAU project can have on the land value of the areas to intervene (both in absolute values and in percentage). It also provides relevant information on which GRI attributes affect land value the most, which can be used to reconsider and increase their presence in the project. Furthermore, the results of the forecasting provide information about the level of land value increase due to the GI attributes of the project and due to the flood risk reduction (figure 7). The ratio of land value increase due to the GI attributes and flood risk reduction is approximately 4/5. Since the canal part of the project would probably require higher investment, (part of) this investment could be covered from capturing the land value increase due to the GRI attributes of the project. The use of these results can be relevant and beneficial to private stakeholders and public agencies since they show the potential land value increases in land value that could be captured by potential increases in property taxes, future municipal revenues and the time it would take to recover the investment cost of the project.

6.1 Policy Recommendations

This section discusses how the research results can support and be turned into public policy. The positive correlation between GI and land value across Cali found in this study can work as valuable hints for real estate developers and government stakeholders on land investments.

Moreover, the application of these findings in public policy can help prevent the tradeoffs between densification and green urban spaces commonly seen in cities without awareness of GI benefits. The results presented in Chapter 5 conclude that GI has a significant positive impact on land value across Cali in addition to the impacts from control variables such as mobility or safety. This finding can be the basis of policy framework 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 the potential impact of increasing GI to a higher level in areas with a GI deficit. According to the preliminary results from the tree census carried out by DAGMA and CVC, 17 out of the 22 communes 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. Communes 20, 21, 1, 14 15 and 18 are the ones with the highest tree deficit as a consequence of the uncontrolled urban expansion and population growth. Therefore, these communes would be the best option to start a GI intervention with potentially better outcomes in comparison with the ones that could be obtained in communes 17 and 19 that have no tree deficit.

After controlling for contact to bodies of water, as suggested by Daniel et al. (2009) the variable "exposure to flood risk" showed to have a negative impact on land value, which needs to be approached besides the local interventions suggested by CAU. According to Konrad (2003), Sampson (2008) and Pineo (2009) permeable surfaces can reduce runoffs and increase the absorption capacity, reducing fluvial and pluvial flood risk. This means that a program to promote changes in the existing impermeable surfaces plus a reform in the construction regulations for new developments to include permeable surfaces instead of traditional non-permeable pavements would be beneficial for reducing flood risk.

Among the multiple benefits that GI has (Bottalico et al. 2016; EPA et al. 2014; Van Den Berg et al. 2015), its potential to minimize crime is something to take into consideration for Cali's policy, especially in neighborhoods like Siloé, Mojica y Potrero Grande, which have the highest crime rates (Cali 2010). In the case of trees, Donovan and Prestemon (2012) pointed out 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 have the highest impacts on land value, representing an opportunity to explore them in a more integrated way. An option could be to combine the river network with green corridors and a sustainable public transport system parallel to the GI network. This GI-transport network could guarantee access to the CBD even from the farthest points in the city, but more importantly, it could work as a catalyzer for job creation, urban development and accessibility to amenities and social housing.

Sustainable transport, in combination with a green/blue network of infrastructure across the seven rivers of Cali, can become a green transport-oriented development (GTOD) by generating economic corridors and boosting urban growth in the city. Their impact as a whole network would be "more than the sum of its parts." Therefore, all this growth would generate revenues that could be collected through land value capture instruments and betterment taxations. However, upgrading land without taking proper precautions with current owners could create a problem as much as a solution.

Gentrification is a common externality when these types of policies are "successfully" implemented. Using GI as a tool for land improvement without appropriate policy precautions can enable 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, according to Harvey (2012). It is imperative to take all the stakeholders into consideration when planning an integrated policy. If important parties are not aware of the decisions taken, GI projects can turn into a green disguise for gentrification, that far 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.

Institutional Challenges Regarding the Implementation of Land Value Capture

The challenges of implementing land value capture for conventional purposes in Cali have been discussed previously in this report; implementation for the purposes of financing green infrastructure and other resilience measures would almost certainly present additional complexities. The same institutional challenges encountered in land value capture schemes would potentially present impediments to a resilience-based land value capture system. This study's hedonic model may point to a dynamic private sector-driven land market in Cali with a robust real estate market and rapid appreciation of land prices. Although such land appreciation, in principle, generates new land value that can be captured, the Cali municipal government might not have the capacity to leverage this. Research suggests that dismal fiscal performance in Cali and other cities in Latin America constrain the capacity of local governments to manage and use land as a financing mechanism and resilience building resource (Kostaras et al. 2015).

As noted earlier in the report, municipal governments in Colombia have been slow to adopt land value capture despite national legislation.is a big political hurdle, in part, because of its complexity, in concept and in terms of implementation, is hard to explain to voters. In place of land value capture instruments, mayors in Cali have typically tried to implement a valorization tax, which is easier for voters to understand and has a short-term impact while the benefits of land value capture are longer term. As noted earlier, in 2008, Cali re-considered valorization but was constrained in its capacity to collect enough valorization taxes in the initial phases of the mayor's ambitious initiative to build 21 macro-projects ("mega-obras") to finance projects in the subsequent phases.

Consequently, valorization invited criticism in many quarters. In terms of valorization tax, the city only collected 12000 USD through valorization over a year and a half period (Pretel 2016). Many landowners have not paid owed valorization taxes and the lowest stratum has been unable to pay the levy. The number of paying residents, including those who initially paid the levy, has waned in ensuing years, largely due to dissatisfaction in the progress of the large-scale projects. The perceived evidence of an ineffective program is a disincentive for taxpayers to comply and pay owed taxes.

To encourage upfront payment of the contribution levy, Cali has a policy in which the landowner receives a 50% discount on the tax, the entirety of it paid in one lump sum. Despite the evident benefit of this policy, it has not been well publicized to residents and has been minimally utilized. Additionally, all revenues from valorization are applied to a designated fund that can solely be used for public open space and parks. People in the expansion areas, particularly in the south of the city, living in the new macro-projects largely subsidize, in effect, public open space and green areas city-wide. This has presented potential political resistance to valorization. Another obstacle to implementing the city's land use plan through the aggressive use of land value capture is the absence of a department in the city government that administers land value capture, including the enforcement and collection of valorization taxes. The housing department, which is currently charged with this task, with only two staff does not have the capacity for this purpose.

Recommendations to improve the capacity of municipal government in Cali to administer and implement land value capture initiatives in general, and in the construction of resiliency infrastructure, include the following (Pretel 2016):

- Create an agency within government; delegate the power to implement and manage land value capture programs to this agency. It should be responsible for distributing the proceeds from land value capture to several city departments (transit, public works—not just parks) for the purpose of financing their operations and executing projects.
- "Empresa Municipal de Renovación Urbana" (EMRU) is a mixed public-private urban redevelopment agency established in Cali. EMRU receives no money from the municipal government and is entirely lacking in resources. Municipal government could give EMRU the budget and institutional capacity to undertake land value capture-funded urban redevelopment projects, which could include green resilient infrastructure and risk reduction projects (such as the Río Cañaveralejo project). The Municipal Infrastructure Department in Cali's government is responsible for land value capture, but it is understaffed to administer the valorization tax program. In response, a separate team within the municipal government could be organized with the explicit responsibility to establish land value capture rates—a complex exercise subject to challenge and, therefore, staff expertise in this area would be needed to respond.
- Empower a separate tax collect team. In Bogotá, Mayor Peñalosa, acting on the belief that people will not pay taxes without some incentive or punitive measures, established a blacklist of taxpayers in arrears and submitted it to banks, which denied credit to those individuals.

A more complex analysis of land value capture as a means to directly finance green resilient infrastructure might require a reconceptualization of the concept of land value in the context of climate risk (Kostaras et al. 2015). In the case of Cali, specifically the Rio Cañaveralejo project, the following factors should be considered:

<u>The Concept of 'Avoided Costs' as an Analog for LVC in the Case of Urban Climate Resilience</u>

As noted in the paper *Financing Urban Climate Adaptation through Land Value Capture in Latin America and the Caribbean* (Kostaras et al. 2015):

> Financing urban climate adaptation through land value capture, in some respects, requires an inversion of the fundamental premise of the concept: rather than creating value, investments in adaptation serve to preserve value that would otherwise be diminished or paid. Some increment of the land value that is being preserved and protected by climate adaptation interventions is mobilized as a source of funding to mitigate impact of flooding and other climate-driven events.

In this formulation, the cost of GRI might be significantly less than the rebuilding and repair costs to impacted properties and, therefore, constitute saved or avoided costs (Beecher 2011). Using this paradigm, avoided costs might be reframed as 'added value.' Theoretically, this will be reflected in land values. This has been tested in CAU Cañaveralejo GRI project and proved that the project, due to its green and resilience attributes, could increase future land values by 5,4 and 1,4 % respectively. Therefore, in principle some increase of future land values can be preserved by virtue of current investments in GRI measures and that increment is robust enough to be captured for the purposes of financing GRI projects (Beecher 2011).

Property Insurance as a Proxy for Land Value

In theory, insurance is a useful proxy for determining the climate-impact on land values and, by extension, the added or preserved increment of value that could be captured.

A critical determination is whether insurance is a timely proxy for risk assessment or, in fact, lags in terms of signaling levels of risk and hazard information to local land markets. As noted in *Financing Urban Climate Adaptation through Land Value Capture in Latin America and the Caribbean* (Kostaras et al. 2015), efficient property markets, in theory, consider a broad range of market risk factors that are reflected in the pricing of debt and equity investment and insurance rates for residential and commercial real estate. An impediment to this analysis proved to be the fact that insurance markets in Cali are not yet well developed as only a small percentage of the Cali population (about 7–10%) has housing-related insurance (Annex 4). In theory, increasing climate-related risks to property will be priced into the flood risk premiums and reflected in current and future land values, forcing the reconsideration of land uses and insurance policies (ULI 2013).

6.2 Concluding Remarks

This study has attempted to answer the following research questions through the application of an integrated method of analysis combining HPM and GIS:

- *Can GRI, particularly at-risk areas, increase real estate values in the Rio Cañaveralejo corridor?*
- *What types of benefits can derive from GRI projects, apart from risk reduction, in the case of the Rio Cañaveralejo project? Which benefits of GRI projects can impact land or real estate values in Cali?*
- *How can resilience (risk reduction) and other benefits of GRI projects be captured using Land Value Capture instruments? Can Colombia's land value capture mechanisms for general purposes be used effectively to finance GRI projects in the institutional context of Cali?*

Can GRI, particularly in at-risk areas, increase real estate values in the Rio Cañaveralejo corridor?

The application of land value capture instruments to finance GRI and risk reduction has been highlighted as a promising idea. For policymakers, however, the practicality of this concept depends on a quantitative analysis that demonstrates that investments in green resilient infrastructure and flood reduction will, in fact, increase land values and that the increment can be captured to finance further investment on urban resilience. To date, there have been few examples of the use of land value capture to explicitly fund investment in climate adaptation measures in Latin America and the Caribbean, specifically GRI (Kostaras et al. 2015).

This study quantitatively demonstrates a useful increase in land values attributable to capital investments in resilience and risk reduction in the CAU Cañaveralejo project in Cali, Colombia — a necessary basis for any land value capture strategy. Land value increases are attributable to investments in resilience measures such as the implementation of sustainable urban drainage systems (SUDS), green corridors for flood management, restoration of natural floodplains, and multifunctional public space for recreation and storm water management. As a policy consideration, this dynamic has allowed for an exploration of mechanisms that capture the additional increment of land value attributable to flood risk reduction and other measures proposed in the CAU Cañaveralejo project from the perspective of Cali's land and fiscal policies and institutional context.

What types of benefits can derive from GRI projects, apart from risk reduction, in the case of the Rio Cañaveralejo project? Which benefits of GRI projects can impact land or real estate values in Cali?

In zones 1–3, the non-channelized "river" segment of Cañaveralejo, GRI including bike lanes, pedestrian paths, trees and vegetation significantly increased land values in the communes (neighborhoods) along these zones. Flood risk reduction in these zones further increased land values. (See Figure 8: Spatial distribution of the CAU Cañaveralejo GRI project interventions and land value increment per neighborhood). Risk reduction interventions also increased in the communes (neighborhoods) in Zone 5, the Cañaveralejo canal corridor, the area where investments have been made in hard engineered concrete channels without the benefit of added green resilient infrastructure. This analysis suggests that added investments in green resilient infrastructure in Zone 5, in the form of a hybrid a grey/green project, would increase land values in these neighborhoods. In summary, investments in risk reduction through green resilient infrastructure, hard engineered "grey" infrastructure, or a hybrid of both, will increase land values in the Cañaveralejo neighborhoods and, consequently, a land value capture approach could be used, in principle, to finance risk reduction.

How can resilience (risk reduction) and other benefits of green infrastructure resilience projects be captured using land value capture instruments? Can Colombia's land value capture mechanisms for general purposes be used effectively to finance green infrastructure resilience projects in the institutional context of Cali?

As a practical matter, the feasible land value capture mechanisms are limited by technical, administrative and political challenges previously discussed in section 5.3. In fact, stakeholders and other respondents conclude that LVC mechanisms that are incentive-based, such as "aportes por edificabilidad", will be more effective than LVC that uses taxes and betterment levies, such as valorization, in generating resources to finance urban resilience.

Cali's experience with land value capture, valorization in particular, echoes that of other Latin American cities. In Cali, the framework of "institutional infrastructure" suggests that land policy instruments could augment the capacity of local government to implement resilience strategies and problems of limited institutional and technical capacity could be resolved. The challenges to land value capture for conventional purposes become more complicated in the case of resilience financing in Cali and other cities impacted by recurrent flooding and other climate-driven events.

References

Alcaldía de Santiago de Cali. 2014. "Documento técnico de soporte." *Revisión ordinaria del Plan de Ordenamiento Territorial de Santiago de Cali*. Alcaldia de Santiago de Cali, Cali

Alcaldía de Santiago de Cali. 2014. *Cali En Cifras* 2014, Santiago de Cali, Cali, pp.1–175.

Andersson, E. et al. 2014. "Reconnecting Cities to the Biosphere: Stewardship of Green Infrastructure and Urban Ecosystem Services." *Ambio*, 43(4), pp.445–453.

Southwick Associates. 2013. *Potential Impacts to Property Values from Long-Term Changes in Water Levels on the Colorado River and its Tributaries: A Delphi Approach*. Fernandina Beach: Southwick Associates. Available at: http://www.verderiverinstitute.org/CO-River-Property-Values-Report-07-09-13.pdf

Baptiste, A.K., C. Foley and R. Smardon. 2015. "Understanding Urban Neighborhood Differences in Willingness to Implement Green Infrastructure Measures: A Case Study of Syracuse, NY." *Landscape and Urban Planning*, 136, pp.1–12. Available at: http://dx.doi.org/10.1016/j.landurbplan.2014.11.012.

Barthel, S., C. Folke and J. Colding. 2010. "Social-ecological Memory in Urban Gardens-Retaining the Capacity for Management of Ecosystem Services." *Global Environmental Change,* 20(2), pp.255–265.

Benedict, M. and E. T. McMahon. 2006. "Green Infrastructure: Linking Landscapes and Communities." *Urban Land*, June, p.299.

———. 2001. "Green Infrastructure: Smart Conservation for the 21st Century." *Sprawl Watch* Clearinghouse Monograph Series. Washington: Island Press, pp.12–18. Available at: http://www.sprawlwatch.org/greeninfrastructure.pdf.

Benítez, V. and Edgar. 2001. *Historia de Cali en el siglo 20: sociedad, economía, cultura y espacio.* Santiago de Cali: Available at: https://books.google.nl/books?id=9F8I1tOsA38C&pg=PA237&lpg=PA237&dq=periodos+de+inundacion+rio+ca%C3%B1averalejo+cali&source=bl&ots=KuPPRnfc49&sig=iqj_2GAZp2XxMvLsnqkHllzeBG0&hl=en&sa=X&ved=0ahUKEwism8Dy_6vLAhWiC5oKHUbOCFgQ6AEIJDAB#v=onepage&q=periodos%20de%20inundacion%20rio%20ca%C3%B1averalejo%20cali&f=false

Blignaut, J. et al. 2016. "The Amenity Value of Abu Dhabi's Coastal and Marine Resources to its Beach Visitors." *Ecosystem Services*, 19, pp.32–41. [online]. Available at: http://linkinghub.elsevier.com/retrieve/pii/S2212041616300808 [Accessed May 10, 2016].

Box, G.E.P. 1976. "Statistics." *Journal of the American Statistical Association*, 71(356), pp.791–799.

Box, G.E.P. and R. Cox. 1964. "An Analysis of Transformations," *Royal Statistical Society Stable* 26(2), pp.211–252 Available at: http://www.jstor.org/stable/2984418.

Brueckner, J.K., J. F. Thisse, and Y. Zenou. 1999. "Why is Central Paris Rich and Downtown Detroit Poor? An Amenity-Based Theory." *European Economic Review*, 43(1), pp.91–107.

Brugmann, J. 2011. *Financing the Resilient City: A Demand Driven Approach to Development, Disaster Risk Reduction and Climate Adaptation*. Bonn: ICLEI.

Bubeck, P., W. J. Botzen, and J. C. Aerts. 2012b. "A Review of Risk Perceptions and Other Factors that Influence Flood Mitigation Behavior." *Risk Analysis*, 32 (9), pp. 1481-1495.

Bubeck, P., W. J. W. Botzen, J. C. J. H. Aerts, and H. Kreibich. 2013a. "Detailed Insights into the Influence of Flood-Coping Appraisals on Mitigation Behaviour," *Global Environmental Change* 23(5) pp.1327-1338.

Byrne, J.A., A. Y. Lo, and Y. Jianjun. 2015. "Landscape and Urban Planning Residents Understanding of the Role of Green Infrastructure for Climate Change Adaptation in Hangzhou, China." *Landscape and Urban Planning*, 138, pp.132–143. Available at: http://dx.doi.org/10.1016/j.landurbplan.2015.02.013.

Cali, C.D.S. De. 2014. *Por Medio Del Cual Se Adopta Plan De Ordenamiento.*

Campos Garcia, A. et al. 2011. *Analysis of Disaster Risk Management in Colombia: A Contribution to the Creation of Public Policies*. Washington: World Bank. Available at: http://documents.worldbank.org/curated/en/658361468018050201/Main-report

Carlet, F., 2015. "Understanding Attitudes Toward Adoption of Green Infrastructure: A Case Study of US Municipal Officials." *Environmental Science and Policy*, 51, pp.65–76. Available at: http://dx.doi.org/10.1016/j.envsci.2015.03.007.

Carrillo, B. 2012. Por: Luis Armando Galvis Colombia: Una aplicación con métodos de emparejamiento.

Castaño, J., M. Laverde, M. A. Morales, and A.M. Yarum. 2013. "Índice de los Precios de la vivienda nueva para Bogotá: Metodología de precios hedónicos. *Temas de Estabilidad Financiera*, 78, p.28. Available at: http://www.banrep.gov.co/es/estabilidad-tema-78

Cervero, R., and K. Kockelman. 1997. "Travel Demand and The 3Ds: Density, Design and Diversity." *Transportation Research Part D: Transport and Environment*, 2(3), pp.199–219.

Chan, K.A. et al. 2010. *Objective and subjective Measures of Willingness to Pay for Green Electricity: Do They Measure the Same? Evidence from a South African Case.*

Chang, Q. et al. 2012. "A GIS-based Green Infrastructure Planning for Sustainable Procedia." *Environmental Sciences*, 12(41001112), pp.491–498. Available at: http://dx.doi.org/10.1016/j.proenv.2012.01.308.

Cho, S., J. M. Bowker, and W. M. Park. 2006. "Of Water and Measuring the Contribution to Housing Green Space Amenities Values: An Application and Comparison Hedonic Models of Spatially Weighted." *Journal of agricultural and resource economics 31*(3), pp.485–507.

CNT and American Rivers. 2010. *The Value of Green Infrastructure: A Guide to Recognizing Its Economic, Environmental and Social Benefits*, Available at: http://www.ingentaconnect.com/content/wef/wefproc/2011/00002011/00000017/art00031\nwww.cnt.org

Comisión Económica para América Latina y el Caribe (Cepal). 2012. *Valoración de daños y pérdidas Ola invernal en Colombia 2010-2011*. Bogotá: Misión BID – Cepal.

Connop, S. et al. 2016. "Environmental Science and Policy Renaturing cities using a regionally-focused biodiversity-led multifunctional benefits approach to urban green infrastructure." *Environmental Science and Policy*, 62, pp.99–111. Available at: http://dx.doi.org/10.1016/j.envsci.2016.01.013.

Corporación Autónoma Regional Del Valle Del Cauca (CVC). 2015. *Diseño arquitectónico, paisajístico y de conectividad ecológica de corredores ambientales urbanos para los ríos Meléndez y Cañaveralejo en Santiago de Cali.* Cali. Colombia.

Court, Dubrul and Horner. 1939. *The Dynamics of Automobile Demand.*

Cullen, J.B. and S. D. Levitt. 1999. "Crime, Urban Flight, and the Consequences for Cities." *Review of Economics and Statistics*, 81(2), pp.159–169.
D'Acci, L. 2014. "Monetary, Subjective and Quantitative Approaches to Assess Urban Quality of Life and Pleasantness in Cities (Hedonic Price, Willingness-To-Pay, Positional Value, Life Satisfaction, Isobenefit Lines)." *Social Indicators Research*, 115(2), pp.531–559.
Damigos, D. and F. Anyfantis. 2011. "The Value of View Through the Eyes of Real Estate Experts: A Fuzzy Delphi Approach." *Landscape and Urban Planning*, 101, pp.171–178.
Defra 2011. *The natural choice: securing the value of nature*, Department for Environment, Food & Rural Affairs, UK (June), https://www.gov.uk/government/publications/the-natural-choice-securing-the-value-of-nature
de Groot, R.S., M. A. Wilson, and R. M. J. Boumans. 2002 "A Typology for the Classification, Description and Valuation of Ecosystem Functions, Goods and Services." *Ecological Economics*, 41(3), pp.393–408.
de Groot, R. et al. 2012. "Global Estimates of the Value of Ecosystems and Their Services in Monetary Units." *Ecosystem Services*, 1(1), pp.50–61.
Demuzere, M. et al. 2014. "Mitigating and Adapting to Climate Change: Multi-Functional and Multi-Scale Assessment of Green Urban Infrastructure." *Journal of Environmental Management 146*, pp.107–115.
Department DNP (DPAD) and UNDP. 2008. *Plan de acciones regionales prioritarias para el desarrollo sustentable de La Mojana*. Bogotá, Colombia.
Dharmavaram, S. 2013. "Land Value Capture in Urban DRM Programs." EAP DRM Knowledge Notes: Disaster Rick Management in East Asia and the Pacific.
DNP – DDTS. 2007. *Fortalecer la descentralización y adecuar el ordenamiento territorial*. Bogotá, Colombia.
G. Tamez. 2009. "Does Noise Have a Stationary Impact on Residential Values?" *Journal of European Real Estate Research*, 2(3), pp.259–279.
Dubgaard, A. et al. 2003. "Cost-benefit Analysis of the Skjern River Restoration in Denmark." *Cost-Benefit Analysis and Water Resources Management*, (July).
Dugan, L. 1999. "The Effect of Criminal Victimization on a Household's Moving Decision." *Criminology*, 37(4), pp.903–930.
Ecocities, 2013. "A Climate Strategy: An Opportunity to Reduce Social Inequalities?" [Online]. Available at: http://www.afd.fr/webdav/site/afd/shared/ELEMENTS_COMMUNS/pdf/climatVA.pdf
ECOTEC, 2008. *The economic Value of Green Infrastructure.*
EPA, 2015. "Tools, Strategies and Lessons Learned from EPA Green Infrastructure Technical Assistance Projects." Available at: http://www.epa.gov/green-infrastructure/tools-strategies-and-lessons-learned-epa-green-infrastructure-technical
———, 2014. "Enhancing Sustainable Communities with Green Infrastructure a Guide to Help Communities Better Manage Stormwater While Achieving Other Environmental, Public Health."
Ernstson, H. et al. 2010. "Urban Transitions: On Urban Resilience and Human-Dominated Ecosystems." *Ambio*, 39(8), pp.531–545.
European Commission, 2013. *Building a Green Infrastructure for Europe*. p.24.
Faehnle, M. et al. 2014. "Landscape and Urban Planning How Can Residents' Experiences Inform Planning of Urban Green Infrastructure? Case Finland." *Landscape and Urban*

Planning, 130, pp.171–183. Available at: http://dx.doi.org/10.1016/j.landurbplan.2014.07.012

Fausold, C. J., and R. J. Lilieholm. 1996. "The Economic Value of Open Space." *Land Lines*, Cambridge, MA: Lincoln Institute of Land Policy.

Filippidis, E.I. 2005. "A Willingness to Pay Survey for Improved Water Supply Conditions in Taxiarchis Municipal District of Halkidiki Prefecture, Greece. *New Medit* No. 2, pp.43–47.

Fischel, W. 2004. "An Economic History of Zoning and a Cure for its Exclusionary Effects." *Urban Studies*, 41(2), pp.317–340.

Forest Research, 2010. "Benefits of Green Infrastructure." Report to Defra and CLG. *Forest Research*, pp.1–196.

Foster, J., A. Lowe, and S. Winkelman. 2011. "The Value of Green Infrastructure for Urban Climate Adaptation." *The Centre For Clean Air Policy*, (February), p.52.

Giraldo, N.C. and M. A. Zapata Toro. 2014. *Santiago De Cali*. Manuel Alejandro Zapata Toro Directora del Proyecto: Lina María Martínez Quintero.

Glaeser, E.L., J. Kolko, and A. Saiz. 2001. "Consumer City." *Journal of Economic Geography*, 1(1), pp.27–50.

Gómez-Baggethun, E. et al. 2010. "The History of Ecosystem Services in Economic Theory and Practice: From Early Notions to Markets and Payment Schemes." *Ecological Economics*, 69(6), pp.1209–1218. [online]. Available from: http://dx.doi.org/10.1016/j.ecolecon.2009.11.007.

Gómez-Baggethun, E. D. N. Barton. 2013. "Classifying and Valuing Ecosystem Services for Urban Planning." *Ecological Economics*, 86, pp.235–245.

Grafakos, S., A. Gianoli, and A. Tsatsou. 2016. "Towards the Development of an Integrated Sustainability and Resilience Benefits Assessment Framework of Urban Green Growth Interventions," *Sustainability, 8*(5), 461; doi:10.3390/su8050461

Gobierno de Colombia, 2015. *2010 GHG Emissions* (UNFCC) [Online Translation]. Available at: http://www4.unfccc.int/submissions/INDC/Published%20Documents/Colombia/1/Colombia%20iNDC%20Unofficial%20translation%20Eng.pdf

Haer, T., Botzen, W. W. and J. C. Aerts. 2016. "The Effectiveness of Flood Risk Communication Strategies and the Influence of Social Networks. Insights from an Agent-Based Model." *Environmental Science and Policy*, 60 pp. 44-52. [Accessed 4/14/2016; 4/14/2016].

Hansen, J.L. and E. D. Benson. 2013. "The Value of a Water View: Variability over 25 Years in a Coastal Housing Market," Washington: Western Washington University, 12(1), pp.76–99.

Harvey, D. 2012. *Rebel Cities. From the Right to the City to the Right to the Urban Revolution.* London: Verso.

Hendriks, R., 2002. "Distance Limits for Traffic Noise Prediction Models." *TAN*-02-02.

Hung, H.C. et al. 2016. "Building Resilience. Mainstreaming Community Participation into Integrated Assessment of Resilience to Climatic Hazards in Metropolitan Land Use Management." *Land Use Policy*, 50, pp.48–58.

IPCC, 2007. *Climate Change 2007: Impacts, Adaptation, and Vulnerability.*

ISDR, 2009. *Global Assessment Report on Disaster Risk Reduction*. United Nations, Geneva.

Jim, C.Y. and w. Y. Chen. 2009. “Value of Scenic Views: Hedonic Assessment of Private Housing in Hong Kong.” *Landscape and Urban Planning*, 91(4), pp.226–234.

Kambites, C. and S. Owen. 2006. “Renewed Prospects for Green Infrastructure Planning in the UK.” *Planning Practice and Research*, 21(4), pp.483–496.

Kasperson, R.E., O. Renn, P. Slovic, H. S. Brown. 1988b. *The Social Amplification of Risk a Conceptual Framework.*

Kaushal, S.S. et al. 2010. “Rising Stream and River Temperatures in the United States.” *Frontiers in Ecology and the Environment*, 8(9), pp.461–466. [online]. Available at: http://doi.wiley.com/10.1890/090037 [Accessed June 2, 2016].

Kopperoinen, L., P. Itkonen, and J. Niemel. 2014. “Using Expert Knowledge in Combining Green Infrastructure and Ecosystem Services in Land Use Planning: An Insight into a New Place-Based Methodology.” *Landscape Ecology*, 29(8), pp.1361–1375.

Kostaras, J. et al. 2015. *Assessing Alternative Resiliency Strategies in Under-Resourced Coastal Communities in Belize Impacted by Climate Change and Vulnerable to Environmental Risk*.

Laurice, L. and R. Bhattacharya. 2005. “Prediction Performance of a Hedonic Pricing Model for Housing.” *The Appraisal Journal*, 73(2), p.198.

van der Linden, S. 2015. The Social-Psychological Determinants of Climate Change Risk Perceptions: Towards a Comprehensive Model. *Journal of Environmental Psychology*, 41, pp.112-124.

Liu, W., W. Chen, and C. Peng. 2014. “Assessing the Effectiveness of Green Infrastructures on Urban Flooding Reduction: A Community Scale Study.” *Ecological Modelling*, 291.

Loomis, J. B. 2000. “Measuring the Total Economic Value of Restoring Ecosystem Services in an Impaired River Basin: Results from a Contingent Valuation Survey.” *Ecological Economics*, 33(1), pp.103–117. [online]. Available at: http://catalog2.nmsu.edu:2048/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=ecn&AN=0528147&site=ehost-live&scope=site

López-Marrero, T. and B. Yarnal. 2010. “Putting Adaptive Capacity into the Context of People’s Lives: A Case Study of Two Flood-Prone Communities in Puerto Rico.” *Natural Hazards*, 52 (2), pp. 277-297. [Accessed 4/15/2016].

Luttik, J. 2000. “The Value of Trees, Water and Open Space as Reflected by House Prices in the Netherlands.” *Landscape and Urban Planning*, 48(3-4), pp.161–167.

M’Ikiugu, M.M., W. QuanNa, and I. Kinoshita. 2012. “Green Infrastructure Gauge: A Tool for Evaluating Green Infrastructure Inclusion in Existing and Future Urban Areas.” *Procedia - Social and Behavioral Sciences*, 68(November), pp.815–825. Available at: http://dx.doi.org/10.1016/j.sbspro.2012.12.269

Madison, C. and J. Kovari. 2013. “Impact of Green Infrastructure on Property Values Within the Milwaukee Metropolitan Sewerage District Planning Area: Case Studies.”, Available at: http://www4.uwm.edu/ced/publications/MMSD_GreenInfrastructure_Final.pdf

Makinde, O. I. and O. O. Tokunboh. 2013. “Impact of Water View on Residential Properties House Pricing.” *American Real Estate Society Conference*, (October), pp.1–6.

Mansor, M., N. Z. Harun, and K. Zakariya. 2015. “Residents’ Self-Perceived Health and its Relationships with Urban Neighborhood Green Infrastructure.” *Procedia Environmental Sciences*, 28 (SustaiN 2014), pp.433–442. Available at: http://dx.doi.org/10.1016/j.proenv.2015.07.053

Matthews, T., A. Y. Lo, and J. A. Byrne. 2015. “Landscape and Urban Planning Reconceptualizing Green Infrastructure for Climate Change Adaptation: Barriers to Adoption and Drivers for Uptake by Spatial Planners.” *Landscape and Urban Planning*, 138, pp.155–163. Available at: http://dx.doi.org/10.1016/j.landurbplan.2015.02.010

McDonald, J. F. and D. P. McMillen. 2011. *Urban Economics and Real Estate: Theory and Policy.*

McPhearson, T. et al. 2014. “Resilience of and Through Urban Ecosystem Services.” *Ecosystem Services*, 12, pp.152–156.

Millennium Ecosystem Assessment. 2003. *Ecosystems and Human Well-Being: A Framework for Assessment*. pp.1–25.

———. 2004. *Living Beyond Our Means: Natural Assets and Human Well-Being*. Annual Report, p.24. [online]. Available at: http://ideas.repec.org/a/fip/fedbar/y2004p6-25.html

Morales Zurita, L., and F.A. Arias Arbeláez. 2005. La calidad de la vivienda en Bogotá: Enfoque de precios hedónicos de hogares y de agregados espaciales. *Revista sociedad y economía*, (9), pp.47-80.

Naumann, S. et al. 2011. *Design, Implementation and Cost Elements of Green Infrastructure Projects. Final Report*. (070307), p.142.

Nazir, N. N. M., N. Othman, and A. H. Nawawi. 2014. “Green infrastructure and its Roles in Enhancing Quality of Life.” *Procedia - Social and Behavioral Sciences*, 153, pp.384–394. Available at: http://dx.doi.org/10.1016/j.sbspro.2014.10.071

Neuman, W.L., 2006. “Qualitative and Quantitative Measurement” (Chapter 7). In W. Laurence Neuman, *Social Research Methods*. Boston: Pearson, pp. 188–210.

New York City Department of Transportation. 2014. *The Economic Benefits of Sustainable Streets. p*.43.

Olivotto, V. 2016. *Relocation and Vulnerability in Cali, Colombia.*

Opdam, P., E. Steingröver and S. Van Rooij. 2006. “Ecological Networks: A Spatial Concept for Multi-Actor Planning of Sustainable Landscapes.” *Landscape and Urban Planning*, 75, pp.322–332.

Pesquera, M. and J. Ruiz. 1996. “Sustainable Development Strategies for Cities and Ports.: In UNCTAD Monographs on Port Management. New York and Geneva. Available at: http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Sustainable+development+strategies+for+cities+and+ports#1 [Accessed April 29, 2014].

Platt, R.H., 1991. *Land Use Control: Geography, Law, and Public Policy*, Presidence, NJ: Englewood Cliffs.

Pretel, A. J. 2016. “Land Value Capture in Cali, Colombia.” (B. Summers, and J. Kostaras, Interviewers, May 15, 2016)

Racca, D. P. and A. Dhanju. 2006. “Project Report for Property Value / Desirability Effects of Bike Paths Adjacent to Residential Areas.” Delaware Center for Transportation and The State of Delaware Department of Transportation (November).

Restrepo, P.A. 2010. “Instrumentos de financiación del desarrollo urbano en Colombia: la contribución por valorización y la participación en plusvalías. Lecciones y reflexiones.” *Desafíos*, 22(1), pp.13–54.

Rosenberg, E. 1996. “Public Works and Public Space: Rethinking the Urban Park.” *Journal of Architectural Education* (1984), 50, 89–103.

Schäffler, A. and M. Swilling. 2013. “Valuing Green Infrastructure in an Urban Environment Under Pressure - The Johannesburg Case.” *Ecological Economics*, 86, pp. 246–257.

Spence, P. R., K. A. Lachlan, and D. R. Griffin. 2007. “Crisis Communication, Race, and Natural Disasters.” *Journal of Black Studies*, 37(4), 539-554.
Slovic, P. 1987. *Perception of Risk*. pp. 280-285.
Smolka, M. 2013. “Implementing Value Capture in Latin America: Policies and Tools for Urban Development.” Policy Focus Report. Cambridge, MA: Lincoln Institute for Land Policy.
Super Servicios-SSPD. 2012. *Cartilla de servicios públicos para entidades territoriales.*
Sussams, L.W., W. F. Sheate, and R. P. Eales. 2015. “Green Infrastructure as a Climate Change Adaptation Policy Intervention: Muddying the Waters or Clearing a Path to a More Secure Future?” *Journal of Environmental Management*, 147, pp.184–193. Available at: http://dx.doi.org/10.1016/j.jenvman.2014.09.003
TEEB. 2010. “The Economics of Ecosystem and Biodiversity for Local and Regional Policymakers.” Report, p.207. [online]. Available at: http://doc.teebweb.org/wp-content/uploads/Study%20and%20Reports/Reports/Local%20and%20Regional%20Policy%20Makers/D2%20Report/TEEB_Local_Policy-Makers_Report.pdf
The Nature Conservancy, 2014. “Reducing climate risks with natural infrastructure.” Available at: http://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/california/ca-green-vs-gray-report-2.pdf
Tita, G. E., T. L. Petras, and R. T. Greenbaum. 2006. “Crime and Residential Choice: A Neighborhood Level Analysis of The Impact of Crime on Housing Prices.” *Journal of Quantitative Criminology*, 22(4), pp.299–317.
Tyrväinen, L. and A. Miettinen. 2000. “Property Prices and Urban Forest Amenities.” *Journal of Environmental Economics and Management*, 39(2), pp.205–223. [Tyrväinen (1997), in report]
Tzoulas, K., K., Korpela, S. Venn, V. Yli-Pelkonen, A. Kaźmierczak, J. Niemela, and P. James. 2007. Promoting Ecosystem and Human Health in Urban Areas Using Green Infrastructure: A Literature Review. *Landscape and Urban Planning*, 81(3), pp.167–178.
Velásquez, R., and A. Andrés. 2011. “Conceptos y estrategias para el manejo y la reducción de riesgos por fenómenos socionaturales: una visión desde Colombia, el Valle del Cauca y Cali”. (Comité Intergremial del Valle del Cauca; OSSO Corporation.
Wallace, K.J. 2007. *Classification of Ecosystem Services: Problems and Solutions.*
Wachinger, G., O. Renn, C. Begg, and C. Kuhlicke. 2013. “The Risk Perception Paradox - Implications for Governance and Communication Of Natural Hazards.” *Risk Analysis*, 33
Wamsler, C. and E. Brink. 2014a. “Interfacing Citizens’ and Institutions’ Practice and Responsibilities for Climate Change Adaptation.” *Urban Climate*, 7 pp. 64-91. [Accessed 5/9/2016].
Wedgwood, A. and K. Sansom. 2003. “Willingness-to-Pay Surveys - A Streamlined Approach: Guidance Notes for Small Town Water Services.” [Online]. Available at: http://www.wsp.org/Hygiene-Sanitation-Water-Toolkit/Resources/Readings/Willingness to Pay.pdf
Whitehead, P., D. Butterfield, and A. Wade. 2008. “Potential Impacts of Climate Change on River Water Quality.” [Online]. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/291500/scho0508bocw-e-e.pdf
WHO, 2005. *Ecosystems and Human Well-Being*. Geneva: World Health Organization. Available at: http://apps.who.int/iris/bitstream/10665/43354/1/9241563095.pdf

Wilson, J.Q. and G. L. Kelling. 1982. “The Police and Neighborhood Safety: Broken Windows.” *The Atlantic*, 127(March), pp.29–38.
Winegarden, W. and D. Rieck. 2012. “The Robin Hood Tax System: Taking from The Rich to Give to The Poor.” *Forbes*. October 9.
World Bank, 2014. “Poverty Headcount Ratio at National Poverty Lines (% of Population)” [Online] Available at: http://data.worldbank.org/indicator/SI.POV.NAHC?locations=CO-BO-EC-BR&start=2009
World Health Organization and UN-Habitat. 2016. *Global Report on Urban Health: Equitable, Healthier Cities for Sustainable Development.*
Yang, H., J. Song, and M. Choi. 2016. “Measuring the Externality Effects of Commercial Land Use on Residential Land Value: A Case Study of Seoul.” *Sustainability*, 8(5), p.432.
Young, R. et al. 2014. “A Comprehensive Typology for Mainstreaming Urban Green Infrastructure.” *Journal of Hydrology*, 519, pp.2571–2583. Available at: http://dx.doi.org/10.1016/j.jhydrol.2014.05.048
Zhang, Y., S. N. Hwang, and M. K. Lindell. 2010. “Hazard Proximity or Risk Perception? Evaluating Effects of Natural and Technological Hazards on Housing Values.” *Environment and Behavior*, 42 (5), pp. 597-624. [Accessed 4/19/2016].
Źróbek, S. et al. 2015. “The Influence of Environmental Factors on Property Buyers’ Choice of Residential Location in Poland.” *Journal of International Studies*, 8(3), pp.164–174.
Zygmunt, R. and M. Gluszak. 2015. “Forest Proximity Impact on Undeveloped Land Values: A Spatial Hedonic Study.” *Forest Policy and Economics*, 50, pp.82–89.

Appendix A: Stakeholders' Workshop

At the initial stages of the research, a workshop was organized at Universidad del Valle in Cali with stakeholders of the Cañaveralejo area to discuss environmental and socio-economic issues, scrutinize the planned intervention and its impacts (benefits or tradeoffs) it would bring. Participants of the workshop were community leaders, citizens, representatives of the municipal environmental agency (DAGMA), representatives of the municipal water company (EMCALI), the architects of the CAU Cañaveralejo project (CUNA) and university students.

Green collaborative mapping

During the workshop, the architect of the CAU Cañaveralejo presented the project and its design elements, the network of bike lanes with underground rainwater storage, the controlled flood plain, improved lighting features, as well as potential impacts on the environmental and social conditions of the area, also in eventual flooding situations. The workshop's participants went through the project drawings in detail over big scale prints, where they could pinpoint risky, problematic or good locations, explaining the reasons for this classification. This green collaborative mapping exercise was part of a process to get to know the project before discussing the potential sustainability and resilience impacts. The map was digitized and the outcomes, presenting a participatory current situation analysis of the Cañaveralejo river, can be accessed at the green maps website database[3]. Overall, three locations in the study area were prioritized from the participants' input as the most vulnerable to flood risk.

Identification of sustainability and resilience benefits

Following the collaborative mapping, participants engaged in a discussion on the CAU Cañaveralejo project and its impacts, inspired by case studies on green infrastructure approaches for flood risk reduction in Latin America. The outcomes of this discussion were captured using the SRBA checklist—a list of possible environmental, social, economic and institutional benefits as identifiers of expected impacts of urban green interventions. The workshop participants filled in the checklist in three smaller focus group discussions and identified a short list of expected positive impacts, which are mainly social, but also environmental, economic and institutional.

Regarding the impact on land and real estate values, participants anticipated the land values to increase because of the area upgrading, the new facilities and better quality of life due to the expected benefits. Although they considered this a positive outcome because their property would gain additional value, it entailed a threat: the assignment of higher strata to the properties in the area, leading to higher taxation. The residents agreed that they would like the value of real estate to increase without impacting the land values, leading to gentrification; and without impacting the amount of taxes they would have to pay.

[3] http://www.opengreenmap.org/greenmap/rio-Cañaveralejo

Table A1: Benefits That Scored More Than 2.7/3 at the Workshop.

Environmental benefits	Water	Conservation of water resources
		Stormwater retention
	Resource conservation	Conservation of natural resources
	Biodiversity	Protection of biodiversity
	Climate change	Improved microclimate regulation
Social benefits	Health, safety and risk reduction	Reduction in heat island effect
	Welfare	Support to community development
		Improved quality of life
		Improved recreational facilities
		Promotion of environmental equity
		Aesthetic improvements
		Reduced foul smell
		Improved quality of open public spaces
		Increased quantity of open public spaces
	Education & capacity building	Enhanced educational services
Economic benefits	Growth	Increased investment opportunities
		Reduced impact on land values
Institutional benefits	Knowledge	Creation of awareness
	Networks	Cooperation between multiple stakeholders

Appendix B: Description of Lonja Creation

Description of the content and process of creating the “estudio del valor del suelo”, translated to English as “study for the value of land”

Content of the Lonja document

Unlike previous studies, the Study of land value (Estudio del valor del suelo) in Cali 2008 takes as a starting point for the land value analysis “regulatory polygons” established in the five urban parts in which the city was divided in the land use plan (POT) of the municipality of Santiago de Cali, approved by agreement 069 of October 26, 2000, since in the previous studies only those sectors or areas that had higher real estate dynamics and also some commercial corridors were analyzed; i.e. it did not cover the area of the whole city, as it happens in this study.

The basis for the allocation of market values for the areas defined in the regulatory polygons are the land use characteristics (heights, occupancy rates, indices of construction, insulation of land infrastructure, etc.) of each normative polygon, as they are established in normative records. […]

The process of creating the Lonja

The study of the value of urban land in Cali 2008 was made by the committee of appraisals of the market of real estate of Cali and Valle del Cauca (La Lonja de Propiedad Raiz de Cali y Valle del Cauca), an interdisciplinary group of professionals composed of twenty-seven appraisers with extensive experience in this activity and belonging to the National Register of RNA appraisers. For this purpose, groups of 2 or 3 appraisal committee members were formed, and the regulatory polygons of each urban piece were distributed to the groups. For the determination of the units’ market values, databases of transactions or the residual method for lots of undeveloped land, were taken into consideration.

On the other hand, it is important to note that this study does not provide specific values, but value ranges (minimum and maximum) of the normative polygons, in order to cover different ranges of value presented in the different sub-areas. This study delivers values for different sectors by taking into consideration extrinsic factors (location, regulations, stratification, basic public services, complementary services, etc.) but is not considered a property appraisal since these values may vary depending on the intrinsic characteristics (superficial extension, form, front, depth, front-depth ratio, specific location, etc.) of each plot of land. The value of urban land occupied by buildings of institutional type such as churches, schools, governmental buildings, green areas, rivers, clubs and parks, are not included in this stud as they are not considered tradable and therefore *not are not assigned commercial value.*

It is also important to mention that this study focuses on one point in time, no analysis of comparative values in time (no inflation is calculated on the values) with previous years are included, although it is expected that future studies may reflect also on this type of analysis. Finally, we should mention that this study is based on the official regulations provided by the administrative department of city planning, some of which have been subjected to revisions or amendment processes by the same department.

Source: Translated by the authors from the Lonja de Propiedad Raíz de Cali y de Valle del Cauca. 2008

Appendix C: Damages Due to Past Flood Events in the Project Area

The study sought information on the frequency of extreme events in the area and the damages incurred (in monetary terms) in the event, as well as the insurance company responsible for payment.

Figure C1: Damage Costs from Past Flood Events (According to Insurance Companies)

Damages Past Events					
	Isurance Companies Responsible				
Year	Sura	La Occidental	Mapfre	Other	Total
2007				$9,800.00	$9,800.00
2010	$297,500.00				$297,500.00
2013		N/A	$8,750.00		$8,750.00
Total	$297,500.00	$0.00	$8,750.00	$9,800.00	$316,050.00

Combining with secondary data acquired from DesInventar, a Disaster Information Management System that holds a database of past disaster events, a total of 15 flood events were found from 2000 to 2013. According to DesInventar, the total damage losses from 2000 to 2013 in the study area were approximately $253,510 USD (DesInventar 2017). It is important to note that there are no cost damage figures for all the events. Therefore, this information is providing us the minimum damage costs that have occurred due to past flood events. Furthermore, this damage costs indication is provided by official sources (e.g. government, insurance companies). Considering that in Cali there is not an elaborated flood risk insurance market, in conjunction with the fact that the costs for rebuilding and recovering from flood disasters are bear by the citizens, these figures underestimate significantly the real damage losses due to past flood events.

Appendix D: Insurance Survey

A survey was conducted targeting the insurance companies of Santiago de Cali, especially the ones that provide services to households along Cañaveralejo river. According to the Colombian Federation of Insurers; Fasecolda (Federación de aseguradores colombianos), Colombian Association of Insurance Brokers; Acoas (Asociación Colombiana de Corredores de Seguros) and the Insurance Information Institute, there are around twenty prestigious home insurance companies that provide service in Santiago de Cali. The top ten for the past years were among the targeted companies:

1. Suramericana de Seguros
2. Seguros del Estado
3. Mapfre
4. Seguros Bolívar
5. Allianz Seguros SA
6. Liberty Seguros
7. Previsora
8. AXA Colpatria Seguros S.A.
9. QBE Seguros
10. La Occidental

Multi-risk home insurance is a fairly complex tool because of the large amount of coverage offered, which can complicate acquiring a policy. A home insurance policy may be different from another, depending on the company that issues it or the needs of the insured. In any case, the insured may find a suitable policy for their needs and financial capacity. Additionally, citizens are able to create a custom-built package that includes individual preferences.

According to the survey conducted, although individual home insurance is becoming more popular in Santiago de Cali, the percentage of the population with home insurance is very low, barely reaching a range between 7 to 15 percent.

This can be corroborated with the statistics gathered from a study conducted by Fasecolda, which shows that the percentage of households with home insurance in Colombia (including flood risk) is less than 5%. Although this study was conducted in 2007. Using the statistical study led by Statista[4] an increment of up to 25% of households would be insured in Colombia by 2020. The survey from Universidad del Valle also contributed to these findings as their study only found 7% of the sample to have insurance.

[4] http://www.statista.com/

Appendix E: List of Participants of Second Stakeholders' Workshop in Cali

Noviembre 8 de 2016

Proyecto "Exploring the use of land value capture instruments for green resilient infrastructure benefits: a framework applied in Cali, Colombia"

Taller Instrumentos de Gestión Urbana para la financiación de Proyectos de Infraestructura Verde

	NOMBRE	INSTITUCION	CARGO
1	Diego Carvajal	DAGMA	Coordinador planeación
2	Laura M Chave Medina	DAGMA	Contratista
3	[illegible]	CVC	[illegible]
4	Marlon Chagüendo G.	DAPM · SDI	Arquitecto [illegible]
5	Hector Fabio Ospina Hurtado	Comite ambiental	Gestor ambiental
6	[illegible]	[illegible] Nueva/12	[illegible] comunitario
7	Adriana López Valencia	EIDENAR/Univalle	Docente
8	Héctor F. Maipiga	UNIVALLE	Est. Maestría
9	Carolina Villegas	Dagma	Arquitecta
10			
11			
12			
13			
14			
15			
16			
17			

Appendix F: Prediction of Land Value Increase Based on HPM2

HPM2		Added value due to new GI (in COP)				Land value increment				
Neighborhood	Block ID	Trees	Bike lanes	Pedestrian streets	Vegetation coverage	Current land value (COP/m²)	Land value increase (COP/m²)	Land value increase (%/m²)	Current land value per block (COP)	Added value per block (COP)
Cuarto de Legua - Guadalupe	191910121.2	0.0	942.0767	8040.4	1825.2	450000.0	10807.7	2.40%	4554549000.0	109309176.0
Cuarto de Legua - Guadalupe	191965273.7	0.0	0.0	1887.5	14867.2	371666.7	16754.7	4.51%	8255164374.2	372307913.3
Cuarto de Legua - Guadalupe	191919434.4	0.0	0.0	0.0	129.4	426666.7	129.4	0.03%	4548730787.8	1364619.2
Nueva Tequendama	19214375.71	921.5	7508.0	1885.3	901.6	412500.0	11216.4	2.72%	578205328.2	15727184.9
Nueva Tequendama	19215179.33	4914.6	15554.9	1138.4	0.0	425000.0	21607.9	5.08%	1791268205.4	90996424.8
Nueva Tequendama	19215223.4	1228.6	15311.3	3741.0	3.8	425000.0	20284.7	4.77%	1648596055.7	78638031.9
Nueva Tequendama	19216081.37	307.2	0.0	0.0	0.0	425000.0	307.2	0.07%	2109321635.0	1476525.1
Nueva Tequendama	192123934.9	16586.6	9860.9	11367.9	1196.5	455000.0	39011.9	8.57%	541355538.1	46394169.6
Nueva Tequendama	192127174.6	7371.8	2230.2	1770.1	52.7	441250.0	11424.8	2.59%	242140515.1	6271439.3
Camino Real - Joaquin Borrero Sinistera	19224375.71	614.3	0.0	0.0	0.0	400000.0	614.3	0.15%	1750284000.0	2625426.0
Camino Real - Joaquin Borrero Sinistera	19225949.52	614.3	0.0	0.0	0.0	400000.0	614.3	0.15%	1515878186.3	2273817.3

Camino Real - Joaquin Borrero Sinistera	192227174.6	30101.7	14602.7	22144.9	3313.4	441250.0	70162.6	15.90%	4571377462.8	726849016.6
Camino Real - Joaquin Borrero Sinistera	19223628.32	0.0	5372.0	530.6	0.0	400000.0	5902.6	1.48%	571566731.4	8459187.6
Camino Real - Joaquin Borrero Sinistera	19223765.74	0.0	2930.5	264.6	0.0	400000.0	3195.1	0.80%	1506296000.0	12050368.0
El Coliseo	198521658.2	0.0	21464.8	6120.6	4979.7	500000.0	32565.0	6.51%	5274596891.0	343376257.6
El Coliseo	198510121.2	0.0	3163.9	1124.0	763.2	450000.0	5051.2	1.12%	4554549000.0	51010948.8
Canaveral	199274454.1	0.0	25399.2	6546.9	29.8	338333.3	31975.8	9.45%	634053672.5	59918072.1
Canaveral	199218739	0.0	13214.0	2222.2	236.8	400000.0	15673.0	3.92%	2399131832.8	94045967.8
Sect. Cañaveralejo Guadalupe Antigua	199574454.1	0.0	63276.9	14610.4	73.8	338333.3	77961.1	23.04%	7823323306.4	1802493689.8
Sect. Cañaveralejo Guadalupe Antigua	199529247.8	0.0	16499.7	11991.5	1629.6	250000.0	30120.8	12.05%	1181481900.6	142368569.0
Sect. Cañaveralejo Guadalupe Antigua	199544371.6	0.0	16490.5	14780.2	106.8	315000.0	31377.5	9.96%	13977076050.0	1392116774.6
Sect. Cañaveralejo Guadalupe Antigua	19957468.17	0.0	0.0	1020.0	2164.7	315000.0	3184.6	1.01%	1268359170.7	12810427.6
Sect. Cañaveralejo Guadalupe Antigua	199511064.4	0.0	0.0	0.0	1182.5	307500.0	1182.5	0.38%	906804680.8	3445857.8

Sect. Cañaveralejo Guadalupe Antigua	19959365.01	0.0	0.0	0.0	41.3	110000.0	41.3	0.04%	1030151100.0	412060.4
U.D.A. Calindo Plaza de Toros	199979611	0.0	42875.1	0.0	7448.6	450000.0	50323.7	11.18%	4552544486.2	508974473.6
U.D.A. Calindo Plaza de Toros	1999188348	0.0	37072.2	0.0	2554.7	450000.0	39626.9	8.81%	11401880420.6	1004505665.1
U.D.A. Calindo Plaza de Toros	199910121.2	0.0	2387.0	13379.1	7948.2	450000.0	23714.2	5.27%	4554549000.0	240024732.3
Belisario Caicedo	20022799.78	0.0	16360.4	589.3	3923.8	135000.0	20873.5	15.46%	377970300.0	58434208.4
Belisario Caicedo	200218602.4	0.0	5485.5	0.0	164.3	347500.0	5649.8	1.63%	4584825405.8	74732654.1
Belisario Caicedo	200229247.8	0.0	5193.9	2614.6	7216.8	225000.0	15025.3	6.68%	702288902.8	46912898.7
Belisario Caicedo	20025338.2	0.0	0.0	0.0	126.8	215000.0	126.8	0.06%	1084400178.0	650640.1
Venezuela - Urb Cañaveralejo	20982334.57	0.0	8005.3	0.0	1553.6	110000.0	9558.9	8.69%	256802700.0	22316154.6
Venezuela - Urb Cañaveralejo	20981913.25	0.0	406.0	0.0	723.0	110000.0	1129.0	1.03%	210457500.0	2167712.3
Venezuela - Urb Cañaveralejo	20989365.01	0.0	0.0	0.0	11187.9	110000.0	11187.9	10.17%	1535165.0	156126.3
Venezuela - Urb Cañaveralejo	209834175.4	0.0	0.0	0.0	7268.6	145000.0	7268.6	5.01%	456999845.4	22895692.3
Venezuela - Urb Cañaveralejo	20985086.85	0.0	0.0	0.0	4247.7	110000.0	4247.7	3.86%	559553500.0	21598765.1
Venezuela - Urb Cañaveralejo	209874454.1	0.0	0.0	0.0	3568.7	357500.0	3568.7	1.00%	26617347900.0	266173479.0
Venezuela - Urb Cañaveralejo	209830695.4	0.0	0.0	0.0	3706.3	110000.0	3706.3	3.37%	477370057.9	16087371.0
Venezuela - Urb Cañaveralejo	209844371.6	0.0	0.0	0.0	2733.2	212500.0	2733.2	1.29%	9428979875.0	121633840.4
Venezuela - Urb	20981138.16	0.0	0.0	0.0	1428.9	110000.0	1428.9	1.30%	125197600.0	1627568.8

Cañaveralejo										
Venezuela - Urb Cañaveralejo	20983908.54	0.0	0.0	0.0	676.3	110000.0	676.3	0.61%	223465943.5	1363142.3
Venezuela - Urb Cañaveralejo	20982700.48	0.0	0.0	0.0	494.2	145000.0	494.2	0.34%	200680887.9	682315.0
Venezuela - Urb Cañaveralejo	2098531.88	0.0	0.0	0.0	452.6	110000.0	452.6	0.41%	58506800.0	239877.9
Venezuela - Urb Cañaveralejo	20983252.31	0.0	0.0	0.0	442.8	110000.0	442.8	0.40%	255205926.6	1020823.7
Venezuela - Urb Cañaveralejo	20981878.35	0.0	0.0	0.0	280.9	145000.0	280.9	0.19%	138284903.4	262741.3
Venezuela - Urb Cañaveralejo	209829247.8	0.0	0.0	0.0	215.1	135000.0	215.1	0.16%	3948462450.0	6317539.9
Venezuela - Urb Cañaveralejo	20984035.85	0.0	0.0	0.0	67.8	145000.0	67.8	0.05%	395029386.9	197514.7
Venezuela - Urb Cañaveralejo	20983116.78	0.0	0.0	0.0	17.9	145000.0	17.9	0.01%	348436358.2	34843.6
TOTAL									144,195,036,917.89	7,795,752,705.57

Appendix G: Prediction of Land Value Decrease Based on HPM3

Neighborhood	Case study area part	Block ID	Current land value (COP/m²)	Current land value per block (COP)	Area exposed to flood risk (m^2)	Increased value per block (COP)
Jorge Zawadsky	Canal part	10074337.22	1000000.0	4337220000.0	76.7	2436759.3
Jorge Zawadsky	Canal part	10074337.22	300000.0	1301166000.0	453.3	14405098.9
Jorge Zawadsky	Canal part	10073730.24	300000.0	1119072000.0	469.2	14910055.9
Jorge Zawadsky	Canal part	10073707.31	300000.0	1112193000.0	405.1	12874020.8
La Selva	Canal part	10106807.78	275000.0	1872139500.0	2869.3	91181447.5
La Selva	Canal part	10106782.76	275000.0	1865259000.0	2886.3	91722631.8
La Selva	Canal part	101019247.9	300000.0	5774391000.0	8202.5	260661423.7
La Selva	Canal part	10107217.31	275000.0	1984760250.0	3318.8	105466742.2
Departamental	Canal part	10115245.43	400000.0	2098172000.0	83.2	2644907.1
Departamental	Canal part	10115195.02	500000.0	2597510000.0	37.3	1183741.3
Departamental	Canal part	10115195.02	400000.0	2078008000.0	80.2	2549254.4
Panamericano	Canal part	10133579.08	1000000.0	3579080000.0	606.1	19261774.9
Panamericano	Canal part	10133579.08	400000.0	1431632000.0	2973.0	94475267.3
Panamericano	Canal part	10133866.52	400000.0	1546608000.0	3866.5	122871393.9
Las Granjas	Canal part	10169511.89	275000.0	2615769750.0	9511.9	302271598.9
San Judas Tadeo I	Canal part	101751422.6	225000.0	11570089500.0	150.3	4775005.9
San Judas Tadeo I	Canal part	101751422.6	210000.0	10798750200.0	1223.0	38864530.9
San Judas Tadeo I	Canal part	101711716.8	275000.0	3222125500.0	1934.7	61480822.1
San Judas Tadeo I	Canal part	10171710.01	275000.0	470252750.0	640.6	20357808.1
San Judas Tadeo I	Canal part	10172473.36	275000.0	680174000.0	2473.4	78599151.4
San Judas Tadeo I	Canal part	10171828.76	275000.0	502909000.0	786.7	24999345.2
San Judas Tadeo I	Canal part	10171700.01	275000.0	467502750.0	752.9	23926510.1
San Judas Tadeo I	Canal part	10174577.06	260000.0	1190035600.0	4149.3	131858294.3
San Judas Tadeo I	Canal part	10177832.01	260000.0	2036322600.0	5136.1	163215204.1
San Judas Tadeo I	Canal part	10178486.2	210000.0	1782102000.0	3382.1	107476719
San Judas Tadeo I	Canal part	10177587.67	275000.0	2086609250.0	3129.2	99441260.6
San Judas Tadeo I	Canal part	10171916.44	275000.0	527021000.0	1916.4	60901186.1
San Judas Tadeo I	Canal part	10171389.23	275000.0	382038250.0	1346.1	42775802.8
Primero de Mayo	Canal part	17022646.66	400000.0	1058664000.0	2646.7	84106329
Primero de Mayo	Canal part	17023329.56	400000.0	1331824000.0	837.5	26613682.3
Primero de Mayo	Canal part	17023420.34	400000.0	1368136000.0	3420.3	108692556.4

Primero de Mayo	Canal part	170211710.7	400000.0	4684296000.0	7507.7	238582821.2
Primero de Mayo	Canal part	170210989.6	400000.0	4395872000.0	5354.2	170147002.5
Primero de Mayo	Canal part	170210989.6	750000.0	8242260000.0	2082.4	66173840
Primero de Mayo	Canal part	17029404.52	400000.0	3761808000.0	776.4	24671075.4
Santa Anita - La Selva	Canal part	177824278.2	400000.0	9711292000.0	3427.7	108926126.9
Santa Anita - La Selva	Canal part	177824278.2	750000.0	18208672500.0	4430.8	140802294
Santa Anita - La Selva	Canal part	177824140.2	400000.0	9656108000.0	8326.0	264587313.7
Santa Anita - La Selva	Canal part	17786654.59	400000.0	2661836000.0	4891.0	155427934.2
Santa Anita - La Selva	Canal part	17786560.92	500000.0	3280460000.0	4212.9	133878440.2
Canaverales - Los Samanes	Canal part	17863940.82	275000.0	1083725500.0	3053.7	97039775.3
Canaverales - Los Samanes	Canal part	178622544.5	275000.0	6199759500.0	2960.3	94073589.7
Canaverales - Los Samanes	Canal part	178611716.8	275000.0	3222125500.0	6906.5	219477395.5
Canaverales - Los Samanes	Canal part	17869008.1	275000.0	2477227500.0	3233.7	102762409.7
Canaverales - Los Samanes	Canal part	17863911.71	275000.0	1075720250.0	3227.7	102569833.3
El Limonar	Canal part	178716423	400000.0	6569216000.0	3078.9	97842177.1
El Limonar	Canal part	17877044.94	400000.0	2817976000.0	3549.7	112803713.8
El Limonar	Canal part	178729563.1	400000.0	11825256000.0	5802.8	184403696.8
Urb. Militar	River part	191813136.9	425000.0	5583182500.0	5772.4	183438272.3
Urb. Militar	River part	191811064.7	450000.0	4979155500.0	4208.8	133747513.6
Urb. Militar	River part	19183177.59	400000.0	1271036000.0	8.2	261535.3
Urb. Militar	River part	19183177.59	425000.0	1350475750.0	2817.5	89535967.6
Urb. Militar	River part	191811278.6	425000.0	4793434750.0	3880.5	123316289.9
Urb. Militar	River part	191811278.6	1500000.0	16918005000.0	2169.2	68934737.8
Cuarto de Legua - Guadalupe	River part	191965273.7	0.0	0.0	121.7	3866146.8
Cuarto de Legua - Guadalupe	River part	191910121.2	450000.0	4554549000.0	101.6	3227085.4
Cuarto de Legua - Guadalupe	River part	191910121.2	0.0	0.0	3282.0	104296030
Nueva Tequendama	River part	19215179.33	425000.0	2201215250.0	3065.1	97404907.8

Nueva Tequendama	River part	19216081.37	425000.0	2584582250.0	672.9	21384246.9
Nueva Tequendama	River part	192127174.6	465000.0	12636202950.0	687.8	21856154.5
Nueva Tequendama	River part	192127174.6	400000.0	10869852000.0	6.7	214185.7
Nueva Tequendama	River part	192127174.6	475000.0	12907949250.0	498.2	15830990.7
Nueva Tequendama	River part	192127174.6	425000.0	11549217750.0	12.5	397864.2
Nueva Tequendama	River part	192123934.9	465000.0	11129765700.0	3661.1	116344768.7
Nueva Tequendama	River part	192123934.9	475000.0	11369115500.0	4937.0	156889735.5
Nueva Tequendama	River part	192123934.9	425000.0	10172366500.0	2276.2	72332154.8
Nueva Tequendama	River part	19215223.4	425000.0	2219945000.0	5223.4	165990720
Nueva Tequendama	River part	19214375.71	400000.0	1750284000.0	54.6	1735412.4
Nueva Tequendama	River part	19214375.71	425000.0	1859676750.0	3050.7	96944440.4
Nueva Tequendama	River part	192115121.1	400000.0	6048464000.0	4496.2	142880276.4
Camino Real - Joaquin Borrero Sinistera	River part	192227174.6	465000.0	12636202950.0	1857.1	59016415.7
Camino Real - Joaquin Borrero Sinistera	River part	192227174.6	400000.0	10869852000.0	12938.7	411168489.7
Camino Real - Joaquin Borrero Sinistera	River part	192227174.6	475000.0	12907949250.0	18.0	572962.6
Camino Real - Joaquin Borrero Sinistera	River part	192227174.6	425000.0	11549217750.0	13.5	427735.8
Camino Real - Joaquin Borrero Sinistera	River part	19224375.71	400000.0	1750284000.0	4.8	150946.9
Camino Real - Joaquin Borrero Sinistera	River part	19223765.74	400000.0	1506296000.0	56.9	1809455.8
Camino Real - Joaquin Borrero Sinistera	River part	19223628.32	400000.0	1451328000.0	358.9	11405546.1
Camino Real - Joaquin Borrero Sinistera	River part	19222976.35	400000.0	1190540000.0	125.8	3997073.3
Camino Real - Los Fundadores	River part	192313398.9	500000.0	6699455000.0	337.4	10722630.6
Camino Real - Los Fundadores	River part	192319439.3	400000.0	7775744000.0	248.3	7889913.8
Camino Real - Los Fundadores	River part	19233177.59	400000.0	1271036000.0	104.8	3330364.8

Camino Real - Los Fundadores	River part	19233177.59	425000.0	1350475750.0	247.1	7850826.5
Camino Real - Los Fundadores	River part	192314848	400000.0	5939212000.0	827.0	26279056.9
Camino Real - Los Fundadores	River part	1923120.2	400000.0	48080000.0	100.5	3194989.3
El Coliseo	River part	198521658.2	500000.0	10829110000.0	292.2	9285934.1
El Coliseo	River part	198521658.2	0.0	0.0	3060.2	97248240.8
El Coliseo	River part	198510121.2	450000.0	4554549000.0	0.0	953.4
El Coliseo	River part	198510121.2	0.0	0.0	381.4	12119604.2
Canaveral	River part	199274454.1	0.0	0.0	1.3	42265.1
Canaveral	River part	199274454.1	400000.0	29781648000.0	6630.8	210714532
Sect. Cañaveralejo Guadalupe Antigua	River part	199511064.4	300000.0	3319326000.0	90.2	2866719.5
Sect. Cañaveralejo Guadalupe Antigua	River part	19957468.17	315000.0	2352473550.0	435.8	13848661
Sect. Cañaveralejo Guadalupe Antigua	River part	199529247.8	300000.0	8774361000.0	124.9	3969426.2
Sect. Cañaveralejo Guadalupe Antigua	River part	199529247.8	135000.0	3948462450.0	41.3	1313714.5
Sect. Cañaveralejo Guadalupe Antigua	River part	199529247.8	315000.0	9213079050.0	9259.5	294249805.1
Sect. Cañaveralejo Guadalupe Antigua	River part	199574454.1	400000.0	29781648000.0	190.2	6044230.8
Sect. Cañaveralejo Guadalupe Antigua	River part	199574454.1	315000.0	23453047800.0	2612.0	83006164.6
Sect. Cañaveralejo Guadalupe Antigua	River part	199544371.6	315000.0	13977076050.0	40419.3	1284455601
Sect. Cañaveralejo Guadalupe Antigua	River part	19959365.01	110000.0	1030151100.0	10.1	319371.8
U.D.A. Calindo Plaza de Toros	River part	199979611	450000.0	35824990500.0	4507.5	143240642.2
U.D.A. Calindo Plaza de Toros	River part	199910121.2	450000.0	4554549000.0	5795.0	184155508.3
U.D.A. Calindo Plaza de Toros	River part	199910121.2	0.0	0.0	523.3	16628625.8
U.D.A. Calindo Plaza de Toros	River part	1999188348	450000.0	84756627000.0	2666.4	84732043.5
Belisario Caicedo	River part	20024606.99	295000.0	1359062050.0	718.5	22833972.5
Belisario Caicedo	River part	20025338.2	295000.0	1574769000.0	2276.3	72337557.1
Belisario Caicedo	River part	20025338.2	135000.0	720657000.0	2.3	72772.3

Belisario Caicedo	River part	20023881.04	295000.0	1144906800.0	1680.1	53391022.8
Belisario Caicedo	River part	200218602.4	400000.0	7440992000.0	3024.1	96101362.4
Belisario Caicedo	River part	20022799.78	135000.0	377970300.0	2799.8	88972220.8
Belisario Caicedo	River part	200229247.8	135000.0	3948462450.0	4825.0	153329931.5
Belisario Caicedo	River part	200229247.8	315000.0	9213079050.0	1678.0	53323017.3
Venezuela - Urb Cañaveralejo	River part	209829247.8	0.0	0.0	0.0	0
Venezuela - Urb Cañaveralejo	River part	209829247.8	135000.0	3948462450.0	12.1	384517.3
Venezuela - Urb Cañaveralejo	River part	209830695.4	0.0	0.0	211.5	6722061.7
Venezuela - Urb Cañaveralejo	River part	209830695.4	0.0	0.0	6.0	190352
Venezuela - Urb Cañaveralejo	River part	209830695.4	110000.0	3376499500.0	11.7	372759.3
Venezuela - Urb Cañaveralejo	River part	20983252.31	110000.0	357754100.0	510.0	16206292.3
Venezuela - Urb Cañaveralejo	River part	20981138.16	110000.0	125197600.0	1026.0	32604843.3
Venezuela - Urb Cañaveralejo	River part	20981913.25	110000.0	210457500.0	1909.2	60669522.4
Venezuela - Urb Cañaveralejo	River part	20982334.57	110000.0	256802700.0	2334.6	74188642.5
Venezuela - Urb Cañaveralejo	River part	20983908.54	110000.0	429939400.0	0.3	9533.5
Venezuela - Urb Cañaveralejo	River part	209844371.6	315000.0	13977076050.0	2817.0	89519125.2
Venezuela - Urb Cañaveralejo	River part	209844371.6	110000.0	4880883700.0	0.2	4766.7
Venezuela - Urb Cañaveralejo	River part	20985086.85	110000.0	559553500.0	5086.9	161651394.5
Venezuela - Urb Cañaveralejo	River part	20989365.01	110000.0	1030151100.0	9254.6	294095680.4
Venezuela - Urb Cañaveralejo	River part	20984035.85	110000.0	443943500.0	108.3	3439999.9
Venezuela - Urb Cañaveralejo	River part	209874454.1	0.0	0.0	16.1	510994.9
Venezuela - Urb Cañaveralejo	River part	209874454.1	400000.0	29781648000.0	1765.7	56110291.1
Venezuela - Urb Cañaveralejo	River part	209874454.1	315000.0	23453047800.0	842.4	26770984.8
Venezuela - Urb	River part	209834175.4	0.0	0.0	2283.1	72552378.3

Cañaveralejo						
Venezuela - Urb Cañaveralejo	River part	209834175.4	180000.0	6151584600.0	1140.3	36237419.7
Venezuela - Urb Cañaveralejo	River part	209834175.4	110000.0	3759301700.0	14.8	471272
Venezuela - Urb Cañaveralejo	River part	20982700.48	110000.0	297052800.0	890.4	28295071.6
Venezuela - Urb Cañaveralejo	River part	2098531.88	110000.0	58506800.0	247.0	7850508.8
TOTAL				773384155700.0		10657277923