



GLOBAL PROGRAM  
RESILIENT HOUSING

# Striking a Balance: Toward a Comprehensive Housing Policy for a Post-COVID Colombia **Annexes**

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SEPTEMBER 2021



La vivienda y el agua  
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Minvivienda



**FEDESARROLLO**

Centro de Investigación Económica y Social



**THE WORLD BANK**

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# Annex A: Poverty in Colombia

## A.1 The Multidimensional Poverty Index (MPI) and Housing

The Ministry of Planning (DNP) designed its Multidimensional Poverty Index<sup>1</sup> according to international standards, the information available (e.g., current national surveys), and experts' advice on how standards should be adjusted for the Colombian context. Thresholds and components were aligned with the Sustainable Development Goals (SDGs).

The index comprises five dimensions: education, childhood, employment, healthcare, and housing and utilities. All of them are related to the original OPHI (Oxford Poverty and Human Development Initiative) dimensions, but they are organized in a different way. Each of the dimensions has a 20-percent weight; the weight of the subdimensions is distributed uniformly within each dimension. In the housing and utilities dimension, the measured components are water source, sanitation, floor materials, wall materials, and critical overcrowding, as table A1 shows.

TABLE A1 | Multidimensional poverty index component definitions

DIMENSIONS	WEIGHT	COMPONENT	DEFINITION	WEIGHT
Education	20%	Low educational achievement	A member of the household older than 15 years with less than 9 years in school	10%
		Illiteracy	An illiterate member of the household older than age 15	10%
Childhood	20%	School absenteeism	A member of the household between 6 and 16 years old who is not going to school	5%
		Education lag	A member of the household between 7 and 17 years old with education lag (according to the law, fewer years of schooling than the national norm)	5%
		Childhood care	Children of the household between 0 and 5 years old without access to health, nutrition, or initial education services	5%
		Child work	Children aged 12 to 17 years that are currently working	5%
Employment	20%	Long-term unemployment	An economically active member of the household that has been unemployed for at least 12 months	10%
		Formal job	An active working member of the household without formal affiliation with the pension system	10%
Healthcare	20%	Insurance	A member of the household who is not insured in the health system	10%
		Access	A member of the household who in the past 30 days was sick or injured and was not able to receive formal health care	10%
Housing and utilities	20%	Water source	A member of the household living in a residence without access to the water supply (in urban areas) or who gets water from a well without a pump, rainwater, river, spring, tank car, water tank, or other source (in rural areas)	4%
		Sanitation	A member of the household living in a house without public sewer service; or, in rural areas, in a house which has a toilet without a sewerage connection or which has no sanitary facilities	4%
		Floor	A person living in a house with mud or dirt floors	4%
		Walls	A person living in a house with unstable wall materials or without walls	4%
		Critical overcrowding	A person living in a house where there are three or more persons per sleeping room (or strictly more than three in rural areas)	4%

SOURCE: DANE 2020a. Authors' translations.

<sup>1</sup> The responsibility for measuring the index was later transferred to Colombia's National Administrative Department of Statistics (DANE).

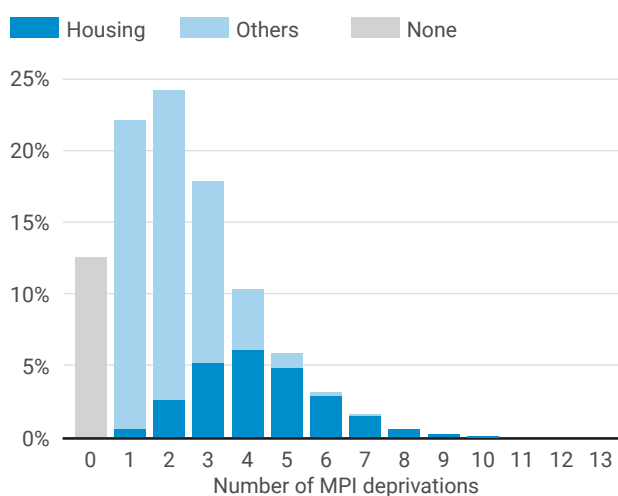
Housing deprivation is prevalent in most households with a high overall number of poverty deprivations; figure A1 shows that as deprivations per household increases for poorer families, the proportion of households with housing deprivations increases as well. Since the severity of the MPI depends on the *number* of deprivations a household has, not what or how severe those deprivations are, intervening on the housing components may not radically change the MPI.<sup>2</sup> However, it will mean a leap forward in living conditions for the poorest households.

## A.2 The MPI and the Evolution of Monetary Poverty in Colombia

There are two main measures of poverty: monetary and non-monetary. Monetary poverty is defined by an income-level threshold under which a household is considered poor because it cannot satisfy its basic necessities; the extreme poverty line (indigence) is defined by the household income necessary to cover only dietary necessities. Non-monetary poverty measures include the MPI.

Colombia's poverty indexes show a long-term (2002–2019) sharp reduction in poverty, but with stagnation or even deterioration of results in recent years. For the first six years that Colombia measured non-monetary poverty, the country showed a positive reduction trend. Between 2010 and 2016, the country was successful, reducing the MPI year by year in both rural and urban areas. In fact, the percentage of the population classified as poor by the MPI index diminished from 30.4 percent to 17.8 percent during this period.

FIGURE A1 | Proportion of households by number and type of MPI deprivation

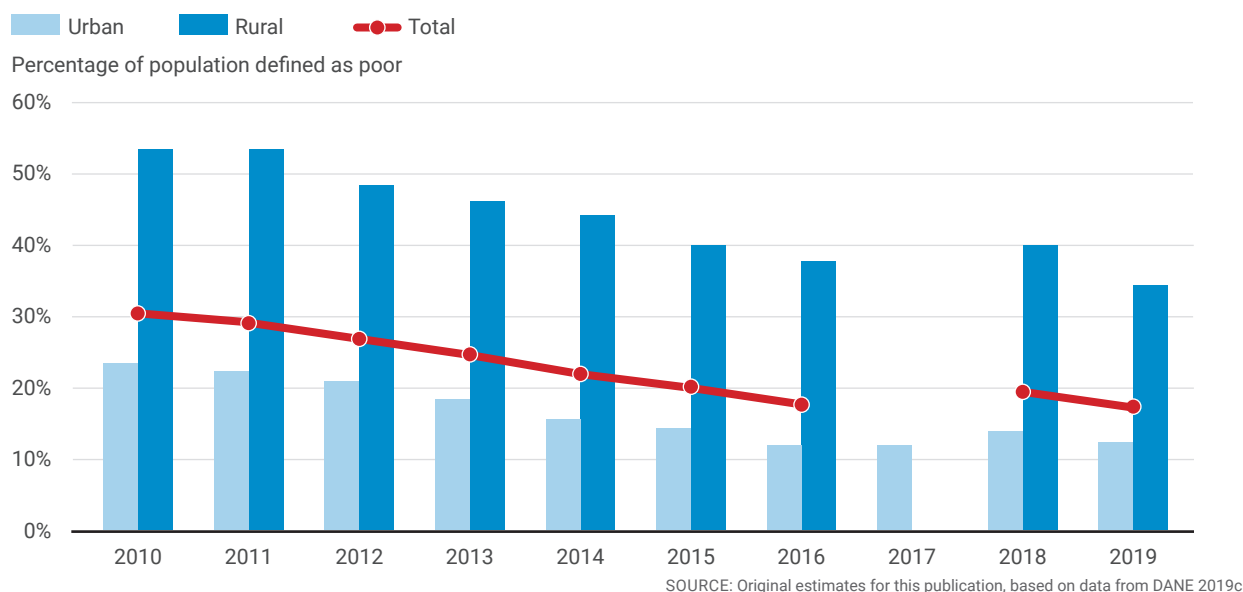


SOURCE: DANE 2019c. Original estimates for this publication.

<sup>2</sup> Of the total households in poverty, 5.1% could be lifted out of poverty with a single intervention. This is because, according to the MPI methodology, if a household has an MPI index higher than 33.3%, it is considered poor. So, households with an MPI index between 33.3 and 37.3% could leave poverty via the elimination of only one deprivation. Conversely, 4 percentage points (p.p.) below the 33.3% threshold is the population defined as potentially poor or vulnerable; these households bear the risk that, if they are deprived by a single additional component, they would be pushed down to the MPI-defined poverty level.

FIGURE A2 | **Poor Colombians as defined by the multidimensional poverty index**

The 2017 estimates are only representative for urban areas due to technical problems with the information available.



However, this reduction in monetary poverty was heavily dependent on economic growth rather than on social or tax policy. Although there are important differences between monetary and non-monetary measurements, they are highly correlated, and the DNP and CEPAL (2019) show that the programs that aimed to improve poverty through redistributive measures have not been as successful as economic growth in reducing poverty levels.

In 2018, the multidimensional poverty reduction trend reversed, with poverty increasing by almost 2 percentage over the 2016 rate. The increase in the MPI occurred both in rural and urban areas. Between 2016 and 2018, 1.1 million people were pushed into multidimensional poverty. Although data in 2017 is not representative at a national level, the results for urban areas show that the increase could have started in 2017. The latest data, for 2019, shows that the MPI returned to its 2016 levels. During this period, there was a similar trend in monetary poverty, although less severe.

### A.3 Comparison with Other Latin American Countries

Most countries in Latin America, using different approaches and results, have committed to the first Sustainable Development Goal of reducing extreme poverty by 2030, although not all of them are on track to achieve this goal.<sup>3</sup> Comparing the poverty-policy results of Colombia with its Latin American peers shows that Colombia has not been among the top performers in the region in terms of either monetary or non-monetary variables.

On the whole, poverty reduction results over the past two decades have been positive in most Latin American countries. However, one group of countries has been the most successful at reducing poverty, with Uruguay and Chile leading the pack. A second group has had moderate results; this includes Colombia and Costa Rica. Finally, Brazil, Venezuela, and, to a lesser extent, Ecuador have backslid.

<sup>3</sup> Comparing multidimensional poverty between countries is complex because each country has different dimensions and definitions, and the availability of information varies as well. There is also more abundant, comparable, and reliable international information for monetary poverty variables than for non-monetary variables; some countries do not even measure the latter yearly as Colombia does.

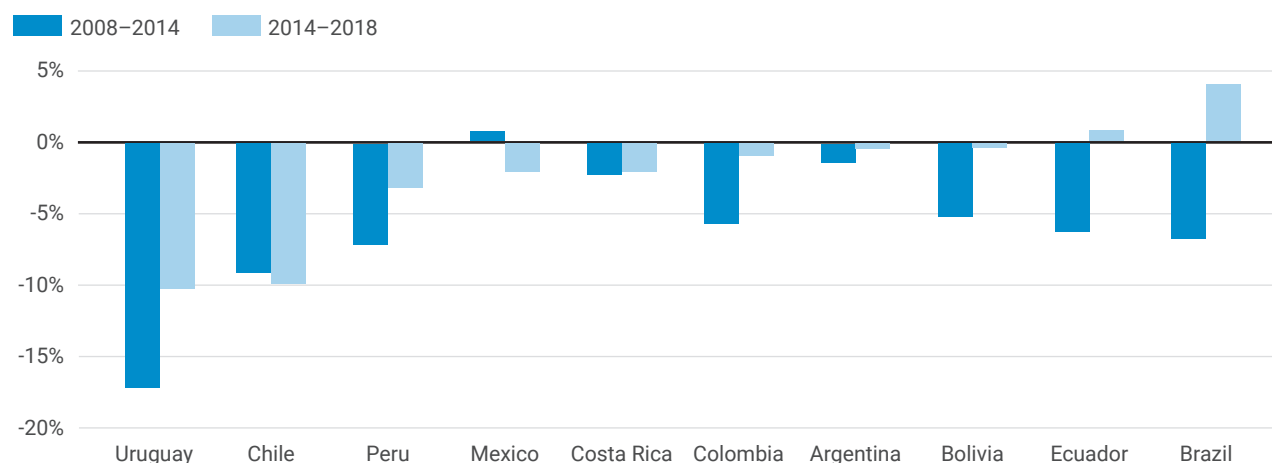


Total poverty in Latin America diminished progressively from 2002 to 2014. During this period, poverty and extreme poverty were reduced by 17.6 and 4.4 percentage points, respectively, from the 2002 levels of 45.4 percent and 12.2 percent of the population (CEPAL 2019). Both Oxford Poverty and Human Development Initiative (OPHI) reports and self-reported data from each country evidence important outcomes in multidimensional poverty levels. The OPHI graph shows that Colombia, Peru, Bolivia, and Mexico were reducing multidimensional poverty until 2015–2016. The MPI data reported by each country show a similar trend. Although there is not sufficient information for all the years, we can conclude there was a steady reduction in poverty in the region until 2015. As in Colombia, this poverty reduction was, overall, driven more by the income growth effect than by a distributional effect (CEPAL 2019).

In 2015, the trend shifted. Monetary poverty started to increase again across the region, led by a sharp increase in Brazil, Venezuela, and, to a lesser extent, Ecuador (i.e., oil-dependent economies). In the rest of the continent, the rate of poverty reduction started to slow. The slowdown effect occurred throughout the Latin American region, with limited exceptions, and was more noticeable by the end of the decade. Between 2014 and 2018, these factors caused a total increase in Latin American poverty levels for the first time in the millennium.

Analyzing the results across the region, the Economic Commission for Latin America (CEPAL) classified Colombia's poverty reduction performance between 2008 and 2018 as moderate (CEPAL 2019). While Chile, the Dominican Republic, El Salvador, Panama, and Uruguay were able to sustain annualized reductions in poverty of more than 5 percent between 2014 and 2018, Colombia was not able to sustain even a 3 percent reduction rate in this period. Although between 2008 and 2014 Colombia's annualized reduction rate was close to 10 percent, its slowdown in the second part of the decade contrasts with the performance of more successful countries. The countries most successful in poverty reduction were able to increase income through various monetary transfers and labor income growth; in the other countries, transfers were not a successful strategy (CEPAL 2019). Therefore, it is crucial to enhance the reach and effectiveness of poverty policy in countries like Colombia.

FIGURE A3 | **Change in monetary poverty rate in Latin America (compound annual growth rate)**



SOURCE: Original estimates for this publication, based on data from CEPAL 2020.

## Annex B: Colombia's Housing Deficit

### B.1 Comparison of the 2009 and 2020 Housing Deficit Methodologies

Before Colombia's 2018 census, the available data showed that the housing deficit had diminished, a trend driven mainly by the quantitative component. Although the number of households increased sharply from 2005 to 2018, Colombia was able to provide quantitative housing solutions to match and surpass that growth. This resulted in a 4-percentage-point reduction in the quantitative deficit. Colombia was not as effective at reducing the qualitative deficit; nevertheless, the qualitative solutions provided did exceed population growth (although to a lesser extent than for the quantitative deficit). Table A2 depicts the housing deficit before the new census data was collected and the new methodology was implemented.

TABLE A2 | 2005 census and 2018 GEIH deficit results (pre-2018 census)

	CENSUS 2005	PERCENT OF HOUSEHOLDS	GEIH 2018	PERCENT OF HOUSEHOLDS	PERCENT VARIANCE
Total households	10,570,899	100%	14,618,231	100%	38%
Total deficit	3,828,055	36%	4,563,812	31%	19%
Quantitative	1,307,757	12%	1,208,928	8%	-8%
Qualitative	2,520,298	24%	3,354,884	23%	33%

SOURCE: Original calculations for this publication, based on data from DANE 2016, 2018.

Alongside the collection of new census data in 2018, a new housing deficit methodology was designed to provide a better picture of the needs of Colombian households. Some of the deficit components needed to be adjusted to consider changes in urban and rural contexts and to comply with the latest international standards. In 2020, the government adjusted the definitions in an effort led by the Ministry of Housing, with involvement from the Ministry of Planning (DNP) and the National Department of Statistics (DANE), and with the participation of UN-Habitat. The changes in the methodology aimed to offer a more precise picture of different types of rural households. The new methodology better reflects the needs of rural areas by dividing the definition of some components between populated centers and dispersed rural areas, which are intrinsically different in behavior and needs.

In order to develop an effective housing strategy, it is important to understand the nuances of each component of the deficit and its incidence. When the methodology for measuring the housing deficit was updated, the definitions of some of these components changed. The following table details these changes.

As detailed in Chapter 1 (section 1.3), the new 2018 census data, when interpreted with the revised methodology, indicated that the housing deficit was more severe than had been assumed based on the previous data from the National Households Survey (GEIH) and the old methodology. The new data from the national census shifted the paradigm away from GEIH.

TABLE A3 | Methodology adjustments in deficit measurement

DEFICIT TYPE	COMPONENT	AREA	2009 METHODOLOGY	2020 METHODOLOGY
Quantitative	House type	Urban	Households that live in “other type of houses,” which include containers, tents, boats, wagons, and caves or natural refuges	No change
		Rural		
	Wall materials	Urban	Households living in houses without walls, or with walls made of: rough wood, board, or plank; cane, mat, or other vegetables; or waste materials	Households living in houses without walls or with walls made of unstable materials (cane, mat, or other vegetables or waste materials)
		Rural		
	Cohabitation	Urban	Housing units with three or more households	Housing units with 2 or more households
			Secondary households living in a house with more than 6 persons only for municipal heads and populated centers	Primary households are excluded
		Rural	Primary and unipersonal households are excluded	No change
Qualitative	Non-mitigable overcrowding	Urban	Households with more than 4 persons per sleeping room only for municipal heads and populated centers	Households with more than 5 persons per sleeping room only for municipal heads
		Rural		Excluded from the definition
	Floor materials	Urban	Houses with dirt, sand, or mud floors	No change
		Rural		
	Mitigable overcrowding	Urban	Households with 2–4 persons per sleeping room for municipal heads and populated centers	Households with 3–5 persons per sleeping room for municipal heads and populated centers
		Rural	Households with more than 2 persons per sleeping room only for dispersed rural areas	Households with more than 3 persons per sleeping room only for dispersed rural areas
	Kitchen	Urban	Households living in houses where the cooking is done in a room also used for sleeping, in a dining room without a dishwasher, or in a patio, corridor, arbor, or outdoors	No change
		Rural		
	Water supply	Urban	Households living in houses without connection to the water supply	No change
		Rural		
	Sewerage	Urban	Households living in houses without connection to sewerage, or with sewerage but with sanitary facilities connected to a septic tank or without connection; with a latrine; with direct discharge to water sources; or without a toilet	No change
		Rural		
	Electricity	Urban	Households living in houses without electricity service	No change
		Rural		
	Garbage collection	Urban	Households living in houses without a garbage collection service	No change
		Rural		

SOURCE: Based on Deficit Methodology 2020 and 2009 (DANE 2020b).

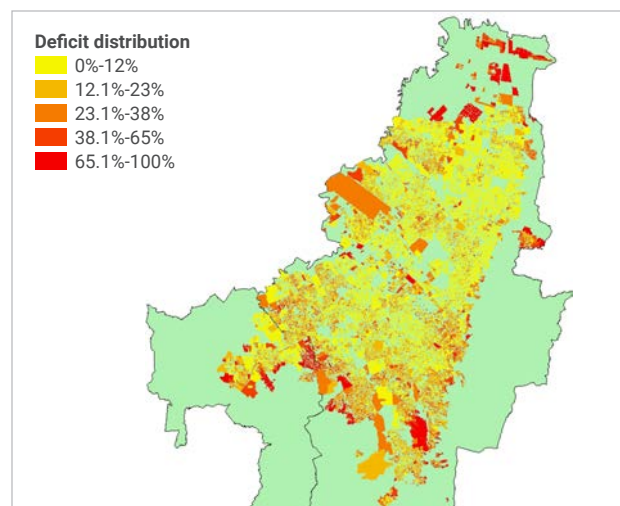
## B.2 Spatial Distribution of the Housing Deficit in Selected Areas

TABLE A4 | Distribution of deficit in Bogota

Total Deficit	14.58%	
Quantitative Deficit	3.83%	
Qualitative Deficit	10.75%	
Inadequate Walls	0.38%	
Inadequate Floors	0.32%	
Inadequate Kitchen	0.70%	
Water Source	0.96%	
Bathroom/Sewer	2.76%	

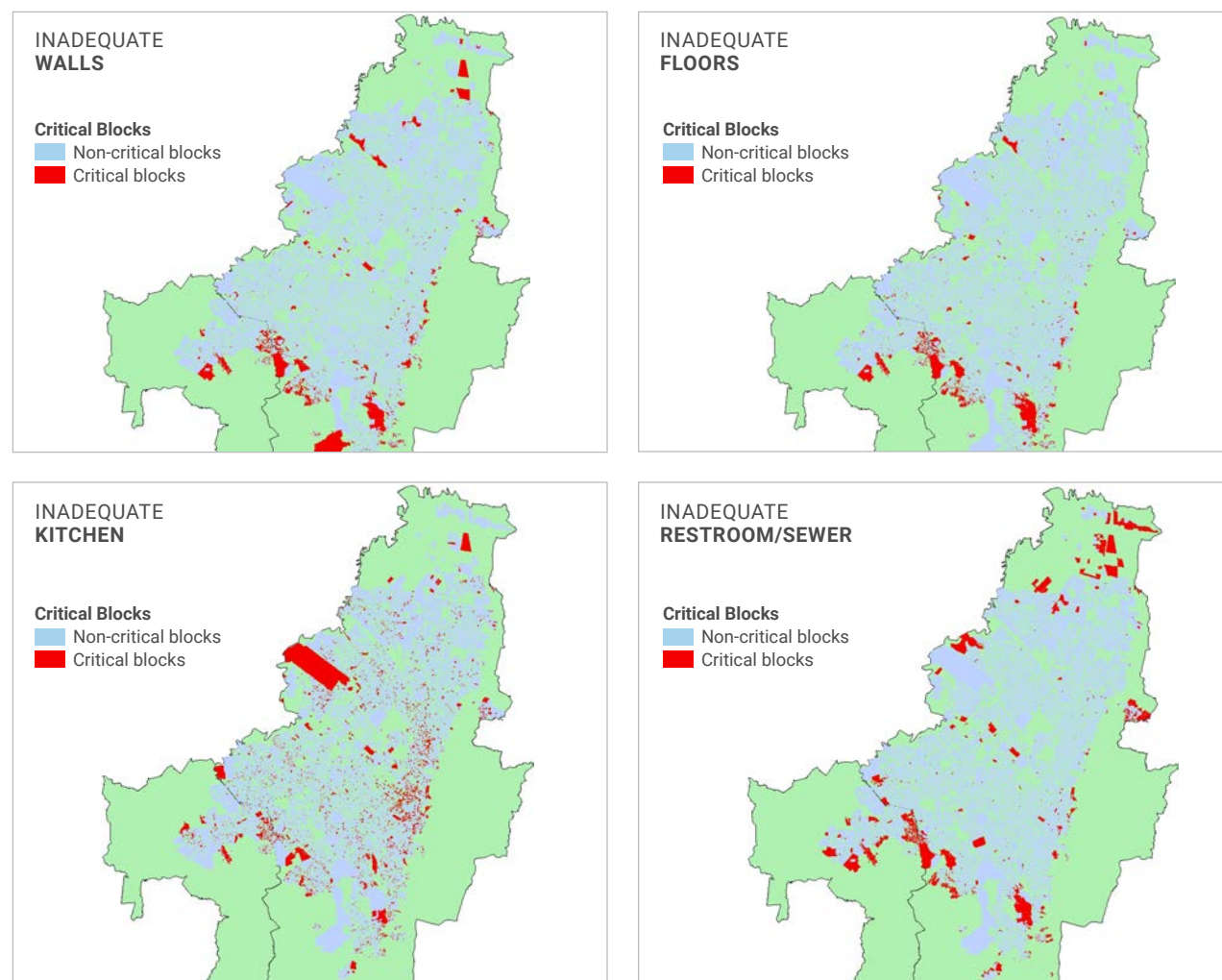
SOURCE: Original figures for this publication based on information from the Ministry of Housing.

FIGURE A4 | Total qualitative deficit in Bogota



SOURCE: Original figures for this publication based on information from the Ministry of Housing.

FIGURE A5 | Inadequate housing conditions in Bogota



SOURCE: Original figures for this publication based on information from the Ministry of Housing.

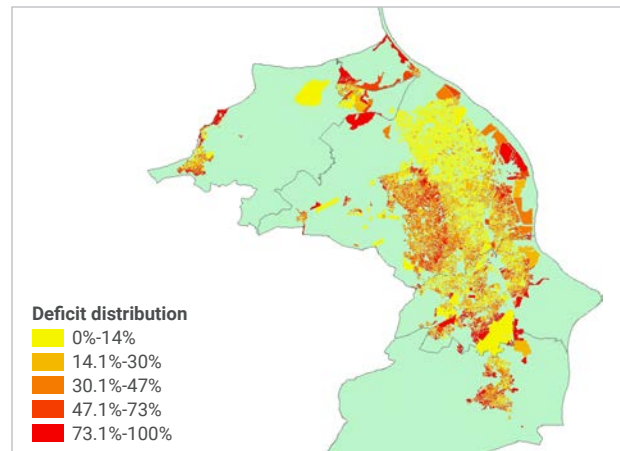


TABLE A5 | **Distribution of deficit in Barranquilla**

Total Deficit	29.28%	<div style="width: 29.28%;"></div>
Quantitative Deficit	5.27%	<div style="width: 5.27%;"></div>
Qualitative Deficit	24.01%	<div style="width: 24.01%;"></div>
Inadequate Walls	1.29%	<div style="width: 1.29%;"></div>
Inadequate Floors	1.42%	<div style="width: 1.42%;"></div>
Inadequate Kitchen	3.18%	<div style="width: 3.18%;"></div>
Water Source	1.55%	<div style="width: 1.55%;"></div>
Restroom/Sewer	6.27%	<div style="width: 6.27%;"></div>

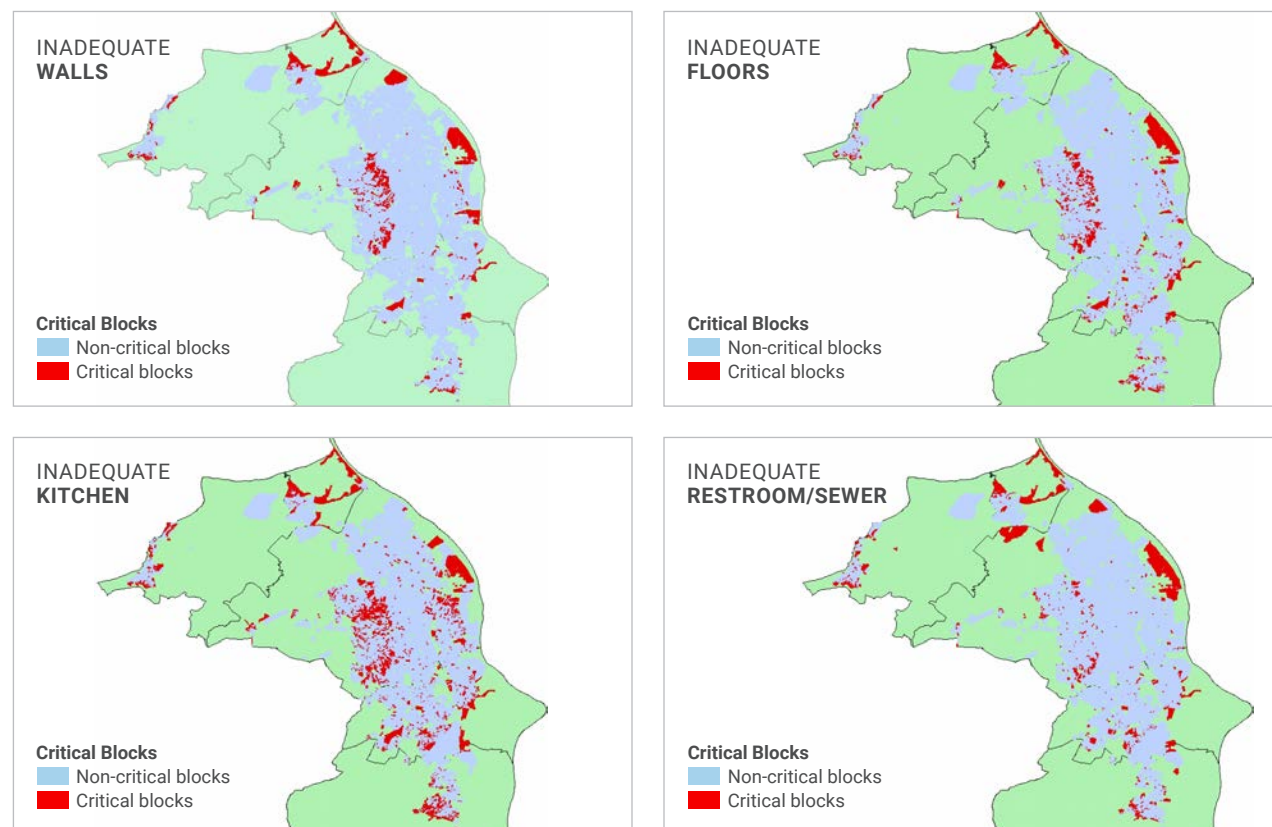
SOURCE: Original figures for this publication based on information from the Ministry of Housing.

FIGURE A6 | **Total qualitative deficit in Barranquilla, Puerto Colombia, Soledad, and Malambo**



SOURCE: Original figures for this publication based on information from the Ministry of Housing.

FIGURE A7 | **Inadequate housing conditions in Barranquilla**



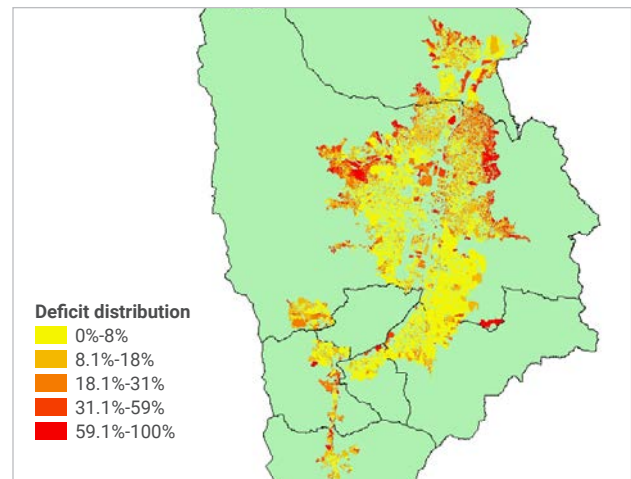
SOURCE: Original figures for this publication based on information from the Ministry of Housing.

TABLE A6 | **Distribution of deficit in Medellin**

Total Deficit	14.59%	<div style="width: 14.59%;"></div>
Quantitative Deficit	2.24%	<div style="width: 2.24%;"></div>
Qualitative Deficit	12.35%	<div style="width: 12.35%;"></div>
Inadequate Walls	0.92%	<div style="width: 0.92%;"></div>
Inadequate Floors	0.29%	<div style="width: 0.29%;"></div>
Inadequate Kitchen	2.34%	<div style="width: 2.34%;"></div>
Water Source	2.11%	<div style="width: 2.11%;"></div>
Restroom/Sewer	3.72%	<div style="width: 3.72%;"></div>

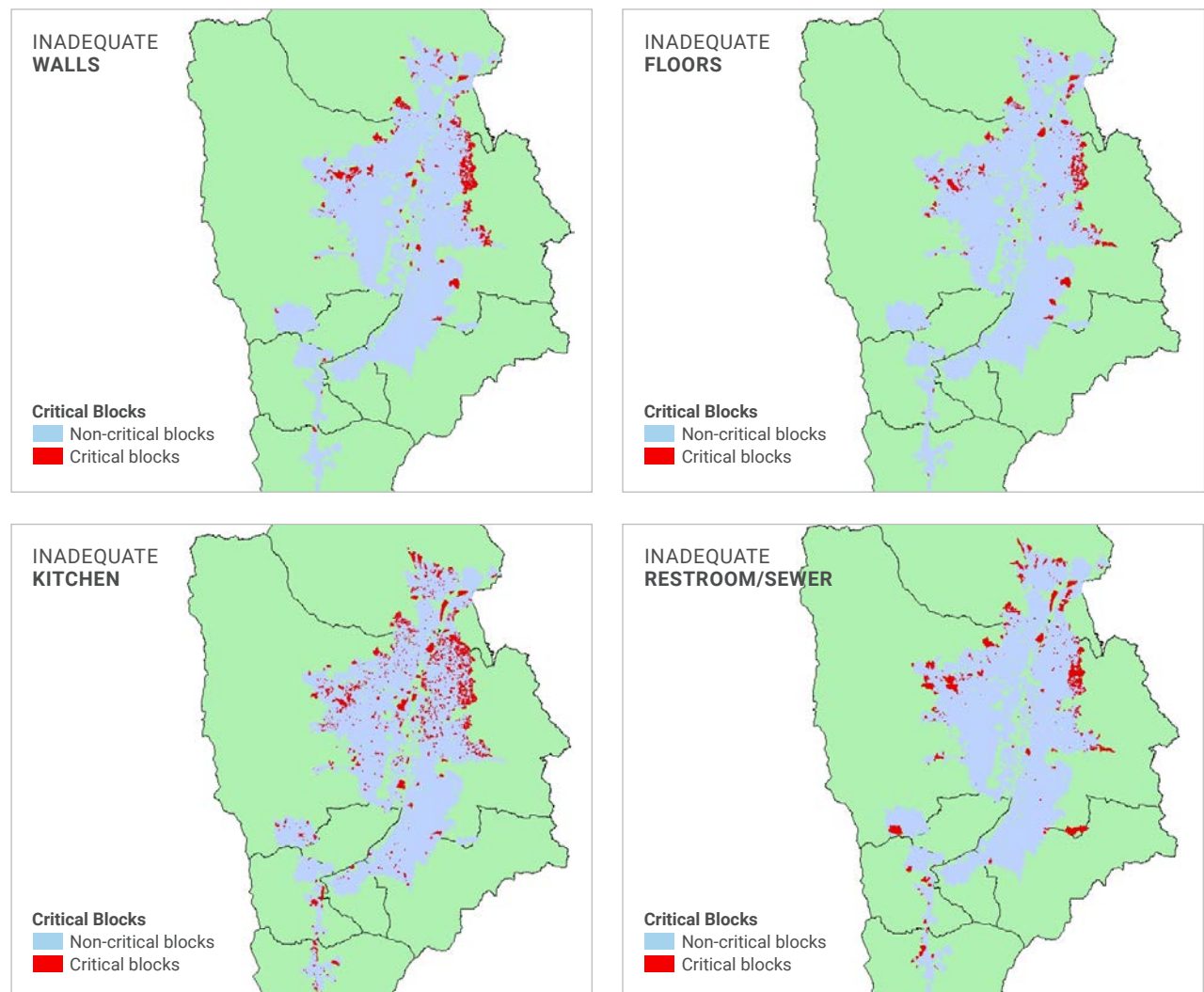
SOURCE: Original figures for this publication based on information from the Ministry of Housing.

FIGURE A8 | **Total deficit in Medellin metropolitan area**



SOURCE: Original figures for this publication based on information from the Ministry of Housing.

FIGURE A9 | **Inadequate housing conditions in Medellin**



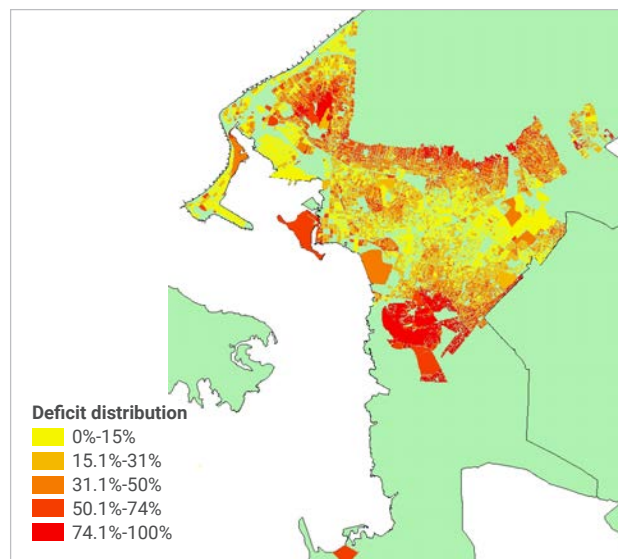
SOURCE: Original figures for this publication based on information from the Ministry of Housing.

TABLE A7 | Distribution of deficit in Cartagena

Total Deficit	35.36%	<div style="width: 35.36%;"></div>
Quantitative Deficit	10.08%	<div style="width: 10.08%;"></div>
Qualitative Deficit	25.29%	<div style="width: 25.29%;"></div>
Inadequate Walls	6.26%	<div style="width: 6.26%;"></div>
Inadequate Floors	4.97%	<div style="width: 4.97%;"></div>
Inadequate Kitchen	6.43%	<div style="width: 6.43%;"></div>
Water Source	5.68%	<div style="width: 5.68%;"></div>
Restroom/Sewer	8.72%	<div style="width: 8.72%;"></div>

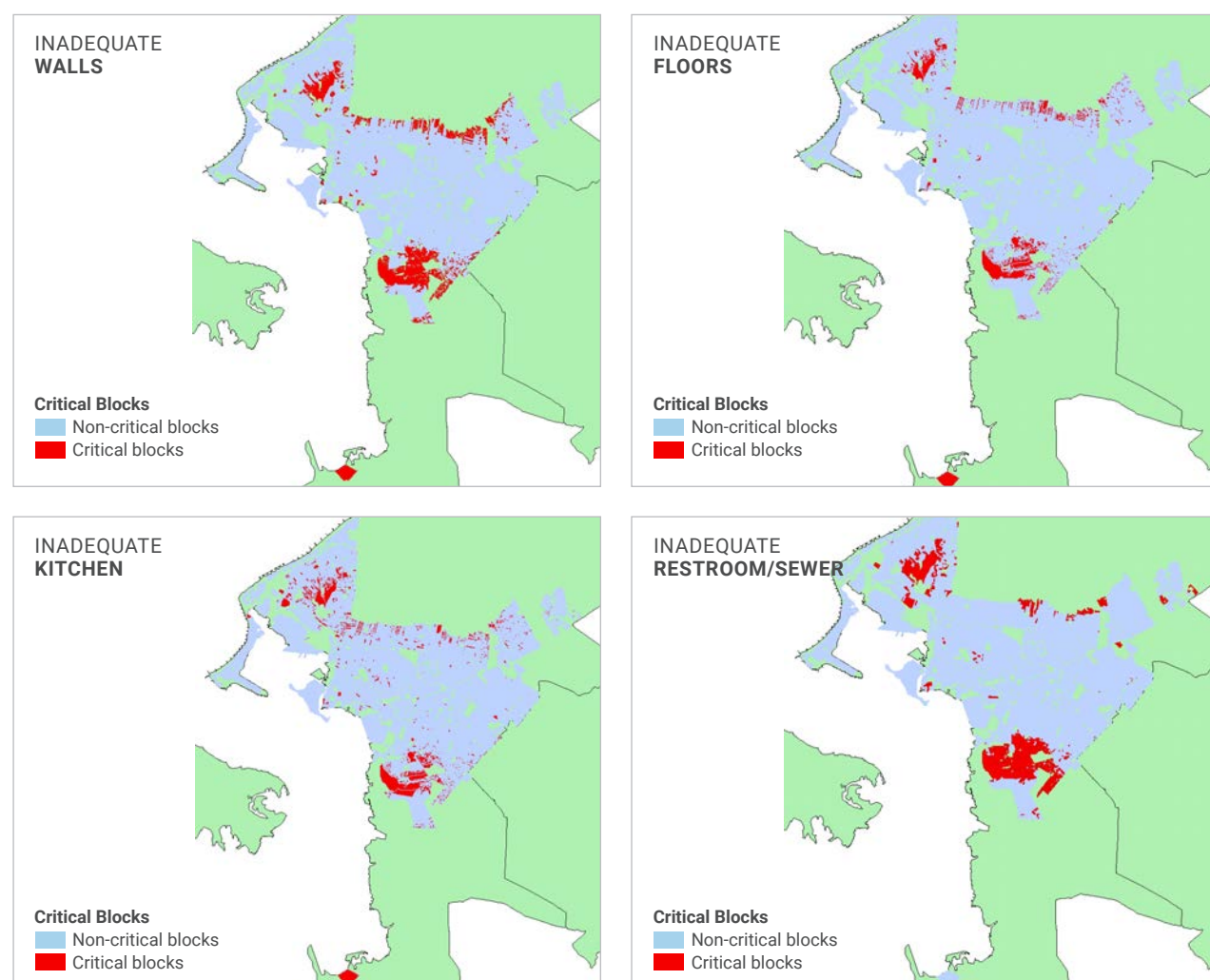
SOURCE: Original figures for this publication based on information from the Ministry of Housing.

FIGURE A10 | Total deficit in Cartagena



SOURCE: Original figures for this publication based on information from the Ministry of Housing.

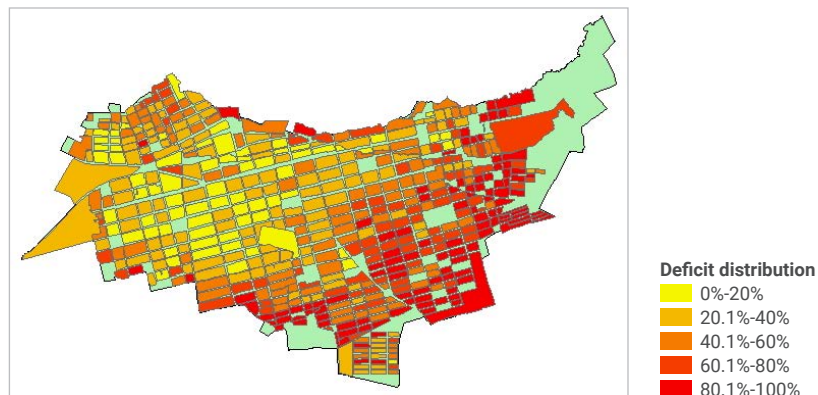
FIGURE A11 | Inadequate housing conditions in Cartagena



SOURCE: Original figures for this publication based on information from the Ministry of Housing.

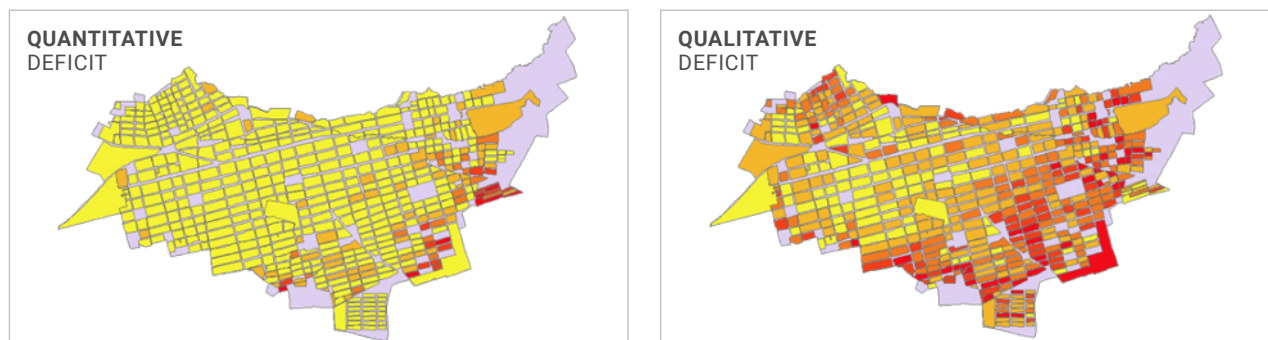


FIGURE A12 | **Total deficit in Fonseca**



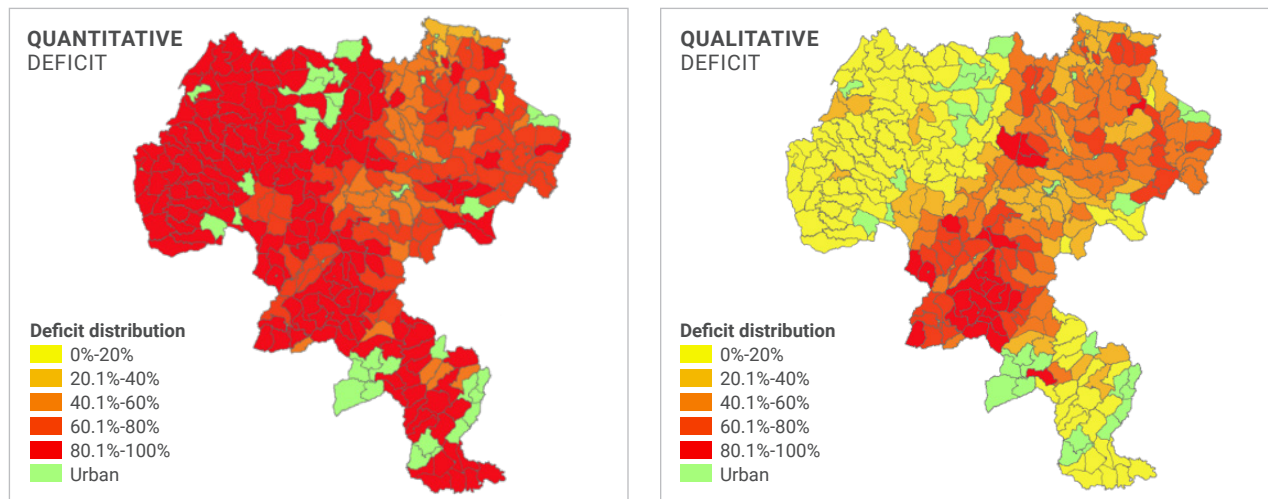
SOURCE: Original figures for this publication based on information from the Ministry of Housing.

FIGURE A13 | **Housing deficit in Fonseca**



SOURCE: Original figures for this publication based on information from the Ministry of Housing.

FIGURE A14 | **Housing deficit in Cauca department**



SOURCE: Original figures for this publication based on information from the Ministry of Housing.



# Annex C: COVID-19 Spread and Housing Deprivations in Colombia

## C.1 National-Level Analysis: Methodology and Results

To explore the relationship between COVID-19 and housing deprivations, we evaluated three different specifications; in all of them, we found that water-supply deprivations and inadequate temporary housing variables are correlated with the presence of COVID-19. The first specification is a Probit model in which a dummy variable indicating the presence of COVID-19 in a given municipality was regressed against housing deprivations and a vector of controls. After evaluating the presence of the disease, we evaluated the effect of housing conditions on the speed of COVID-19 spread by performing an ordinary least squares (OLS) regression with the number of COVID-19 cases per 1,000 inhabitants as the dependent variable. Finally, we estimated the effect of housing conditions only on the 828 municipalities that presented at least one case of COVID-19. Results are presented in table A8.

TABLE A8 | COVID-19 and housing conditions across municipalities

Using 2018 census data on housing deprivations, the authors could determine the proportion of the urban population lacking each housing component. Control covariates included municipal GDP and population. As omitted variables may cause biased estimators, given that cultural and political institutions may change the perception of and response to this disease, the authors included state fixed effects, as municipalities tend to be homogenous within each state.

CONTROL	PRESENCE OF COVID-19 (PROBIT)	COVID-19 CASES PER 1,000 PEOPLE (OLS)	COVID-19 CASES PER 1,000 INFECTED MUNICIPALITIES (OLS)
<b>Inadequate Housing Condition</b>	<b>21.98</b>	<b>259.37***</b>	<b>266.74***</b>
Wall deprivation	-1.34	-2.43	3.91
Cohabitation	-2.27	-4.19	-0.647
Overcrowding	-0.79	-0.78	0.29
Kitchen	1.08	-2.79	4.14
Water supply	1.71***	7.26***	5.79***
Sewer/Restroom	-0.35	-0.08	-0.37
Electricity	1.30	-11.15	-8.35
Garbage	1.10	-1.97	-2.71
Population	0.000297***	0.000064**	0.000059***
Income per capita	3.18	26.39	32.29***
Fixed effects	YES	YES	YES
Robust errors	YES	YES	YES
Observations	1,100	1,100	906
R-squared	0.32	0.18	0.17

SOURCE: Original calculations for this publication. Number of cases for each municipality (cases confirmed through August 10, 2020) were sourced from the Colombian Ministry of Health's open database. Housing deprivations were sourced from 2018 census data (DANE 2019c).

## C.2 Geospatial Analysis: Bogota

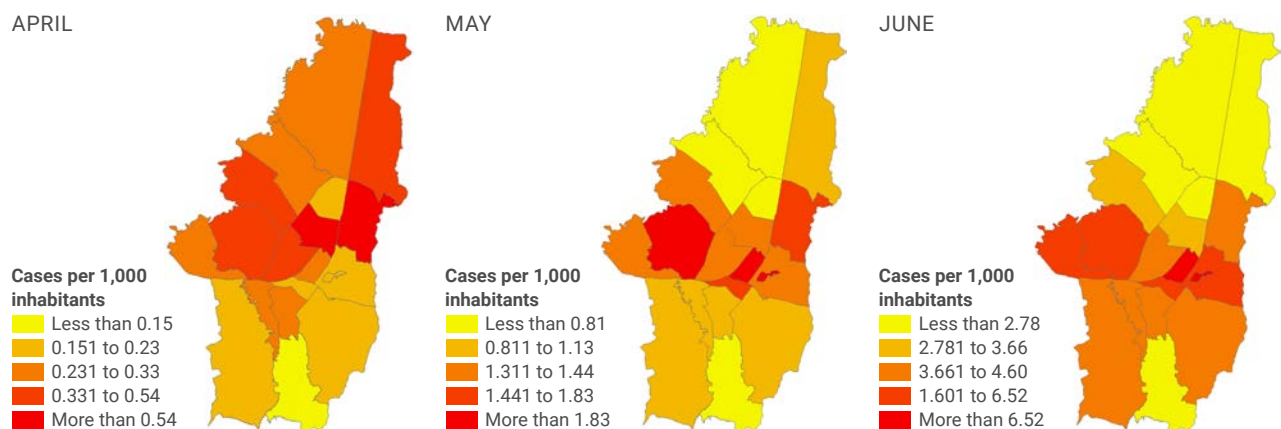
Since omitted unobservable variables may bias our results, we conducted a more extensive geospatial analysis exercise to assess the effects of housing conditions on the COVID-19 infection rate, using local information on the block level for the city of Bogota. The relevance of a geospatial analysis comes from a deep geographic relationship between our variables of interest: COVID-19 infection rates and housing deprivations. These two variables do not have a homogenous distribution across space; rather, they are spatially concentrated. Health conditions and housing deprivations will be related even after COVID-19 has been mitigated. The spread of current infectious diseases and future pandemic outbreaks could be reduced by investing in adequate housing conditions, especially for the most vulnerable families.

Our analysis takes advantage of two important geospatial datasets available for assessing the housing deprivations of urban Colombian families: geo-processed data from the 2018 national census, and the geospatial location of confirmed COVID-19 cases for the city of Bogota. The 2018 census information contains the housing conditions for every unit in urban areas of Colombia, which allows us to identify housing deprivations at the city-block scale. This geographic measure defines our level of observation. Each explanatory variable  $X_{k,i}$  is defined by the proportion of households that presents a specific deprivation in each block.

$X_{k,i}$  : Proportion of households with deprivation (k) in block (i)

The 19 boroughs of Bogota were the first geographical units for which COVID-19 infection data were available. Although the extent and heterogeneity of each borough prevented us from drawing a definitive conclusion, a trend can be perceived in the data. A first wave of infections appeared in the affluent northeast neighborhoods of the city, which can be related to imported cases from international travelers returning to the city. As time passes, the focal point of the disease moves to the much poorer southwest, which also happens to have the worst housing conditions.

FIGURE A15 | Evolution of COVID-19 infections by borough, Bogota



SOURCE: Original calculations for this publication, based on data from Observatorio de Salud de Bogota 2020.

By the end of July, Bogota had more than 150,000 COVID-19 cases across the 19 boroughs. This four-month maturation period may allow us to identify a statistical correlation between housing deprivations and the COVID-19 infection rate at the borough level. Given the data restrictions, we used an OLS model in which the total count of confirmed COVID-19 cases per borough was evenly distributed across all the blocks that compose each borough. The low dispersion of the dependent variables is compensated for by the great heterogeneity within each, which increases the statistical power. At the

end of the merging process, we had 38.362 blocks located in the 19 boroughs. The model is presented in the equation below; control variables include income approximation, local density, and population.

$$y_{ib} = X_{i,b} \beta + Z_b \delta + u_{ib} \text{ if } i \in b \text{ where } X_{i,b} : \text{Housing variables in block } i, \text{ Borough } b$$

Results are consistent with the national-level exercise we performed, with cohabitation exhibiting the most significant impact on COVID-19 cases for the city of Bogota. This may be the result of families that take an array of prevention measures nevertheless becoming infected by sharing the same housing unit. Inadequate meal preparation facilities and lack of access to a source of water are also positively correlated with a higher rate of COVID-19 transmission. These results were expected, as good hygiene is a key factor for slowing the spread of the disease. Control variables present the expected signs: income has a negative correlation, as lower-income households tend to go out more frequently (since their income proceeds from informal activities and essential activities that cannot be performed from home), and population density is positively correlated, since the probability of infection increases as people from different households get closer.

As illustrated, housing deprivations contribute to the spread of infectious diseases like COVID-19. Containment measures like strict lockdowns are harder to implement when families inhabit inadequate units that constrain their ability to stay inside.

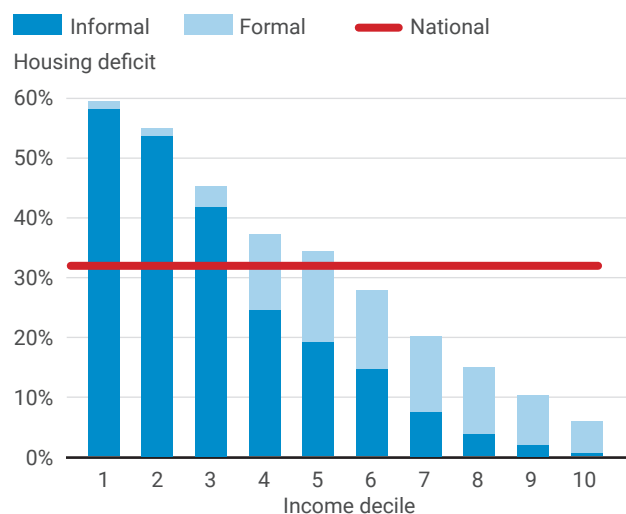
TABLE A9 | **COVID-19 and housing conditions: local estimations**

CONTROLS	CONFIRMED COVID-19 CASES
Income	-121.2***
*Temporary Housing	-81.47
*Walls	175.1*
*Cohabitation	575.6***
*High Overcrowding	-104.4
Medium Overcrowding	381.7*
*Adequate Kitchen	498.5***
*Water Connection	335.6***
*Sewer	327.8***
*Electricity	405.6***
Residual Disposal	-84.28
Population	0.00348***
Density	5.37e-06***
Constant	-557.7***
Observations	38,362
R-squared	0.714

SOURCE: Original calculations for this publication, based on data from DANE, Observatorio de Salud de Bogota 2020.

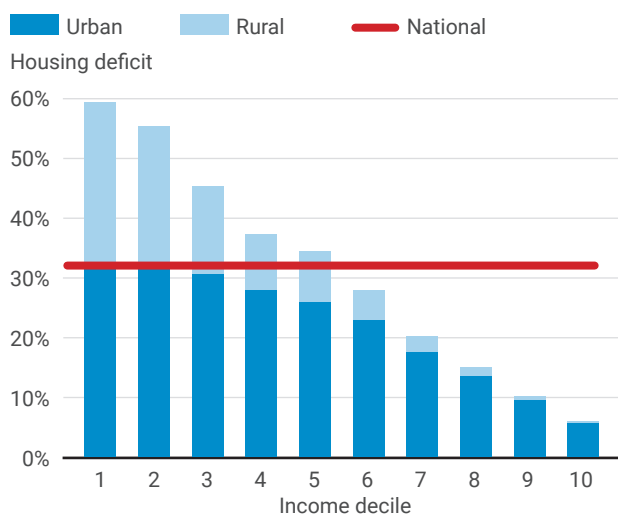
## Annex D: Affordability and Access through the Acquisition Approach

FIGURE A16 | Total housing deficit by income decile and labor characterization



SOURCE: DANE 2018.

FIGURE A17 | Total housing deficit by income decile and rurality



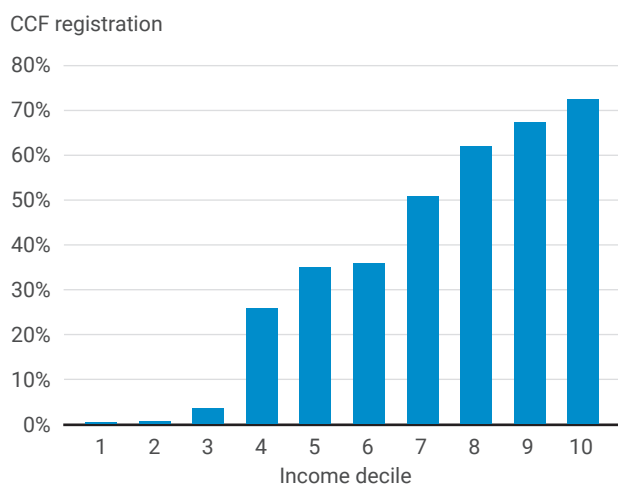
SOURCE: DANE 2018.

Low income, rurality, and informality – the main barriers Colombian families face in trying to access housing finance in general and acquisition-approach housing policies in particular – are correlated both among each other and with the housing deficit, as can be seen in the graphs below.

There is significant overlap, therefore, between households with low income and households whose income comes from informal employment. It is therefore unsurprising that the proportion of low-income families registered in a CCF (Family Compensation Fund) – a benefit available only to formal workers – is extremely low. The graph below demonstrates the stark difference between the lowest and highest income groups: while a mere 0.6 percent of the lowest income decile is registered in a CCF, that proportion rises in the highest income decile to over 70 percent.

This is particularly unfortunate because CCFs offer additional housing subsidies to registered households making less than four minimum wages; these CCF subsidies can be combined with the government (*Mi Casa Ya*) subsidies as shown in the table below.

FIGURE A18 | Proportion of households registered in a CCF by income decile



SOURCE: DANE 2018.



TABLE A10 | **Social housing subsidies by family income**

MONTHLY HOUSEHOLD INCOME	CCF STATUS	GOVERNMENT SUBSIDY (MMW)	CCF SUBSIDY (MMW)	TOTAL SUBSIDY (MMW)
<b>0–2 monthly minimum wages (MMW)</b>	Registered	20	30	50
	Not registered	30	0	30
<b>2–4 MMW</b>	Does not apply	20	20	20

SOURCE: Original table for this publication, based on information from the Ministry of Housing.

## Annex E: Effects of Risk Regulations and Upgrading Restrictions on the Housing Deficit

### E.1 Case Studies of Cartagena, Cali, and Neiva

Construction in risk areas and zoning restrictions limit the potential of home upgrading as a strategy to reduce Colombia's housing deficit. However, these restrictions are particularly concentrated in areas with the highest housing deficit, as can be seen in case studies of Cartagena, Cali, and Neiva.

The three cities, which were all targeted by the Ministry of Housing for interventions in 2019, were selected for data availability and population. They are provincial capitals and are among the top 20 largest cities in Colombia: Cali, with 2.3 million inhabitants in 2020, is ranked third; Cartagena, with 1.02 million, is ranked fifth; and Neiva, with 364,000, is ranked 19th. Each city faces a different major natural risk and maintains zoning restrictions for retrofitting processes. We carried out a quantification process to identify the number of units with deficits that were located in retrofitting-restricted zones. Table A11 shows the number of deprived units located in mitigable and non-mitigable risk zones. We found that 35,129 households are located in these areas with unmet basic conditions in Cali, 41,928 in Cartagena, and 5,172 in Neiva.

The identification of the number of families located in restriction zones proceeded as follows:

1. All threat types were identified for each location. The lack of a unified framework of risk and threats makes the identification process unique to each location and not directly comparable.
2. A retrofitting restriction zone was selected for each threat. These zones constitute areas where the local government may deter retrofitting, but mitigation actions are plausible and might reduce the risk levels.
3. Other zoning restrictions that deter housing improvements were identified. Paradoxically, zones classified as renovation areas are not meant for individual retrofitting, as the intention of local government is the total upgrade of the area, replacing old housing stock with new housing units.
4. A unique layer was created that identified a restriction zone for each city. By merging this information with the geolocations of housing units (from the 2018 census data), the number of total housing units and deprived units located in the restriction zone were quantified.

TABLE A11 | Households restricted from home retrofitting in Neiva, Cartagena, and Cali

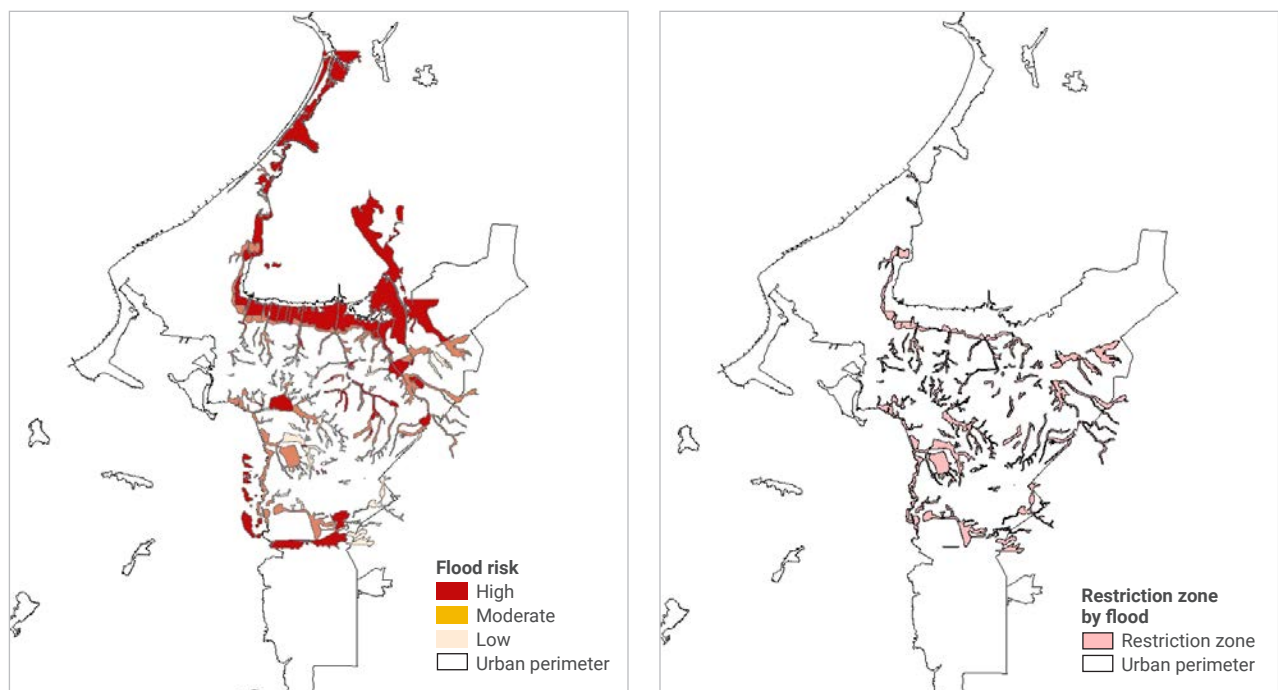
CITY	HOUSEHOLDS LIVING IN DEPRIVED UNITS	DEPRIVED HOUSEHOLDS LIVING OUTSIDE RISK ZONES	DEPRIVED HOUSEHOLDS LIVING IN RISK ZONES	DEPRIVED HOUSEHOLDS LIVING IN NON-MITIGABLE RISK ZONES	DEPRIVED HOUSEHOLDS LIVING IN MITIGABLE RISK ZONES
Cali	78,673	43,332	35,341	3,702	31,639
Cartagena	92,072	43,274	48,798	6,870	41,928
Neiva	20,185	12,981	7,204	2,032	5,172

SOURCE: Original calculations for this publication.

### E.1.1 Cartagena

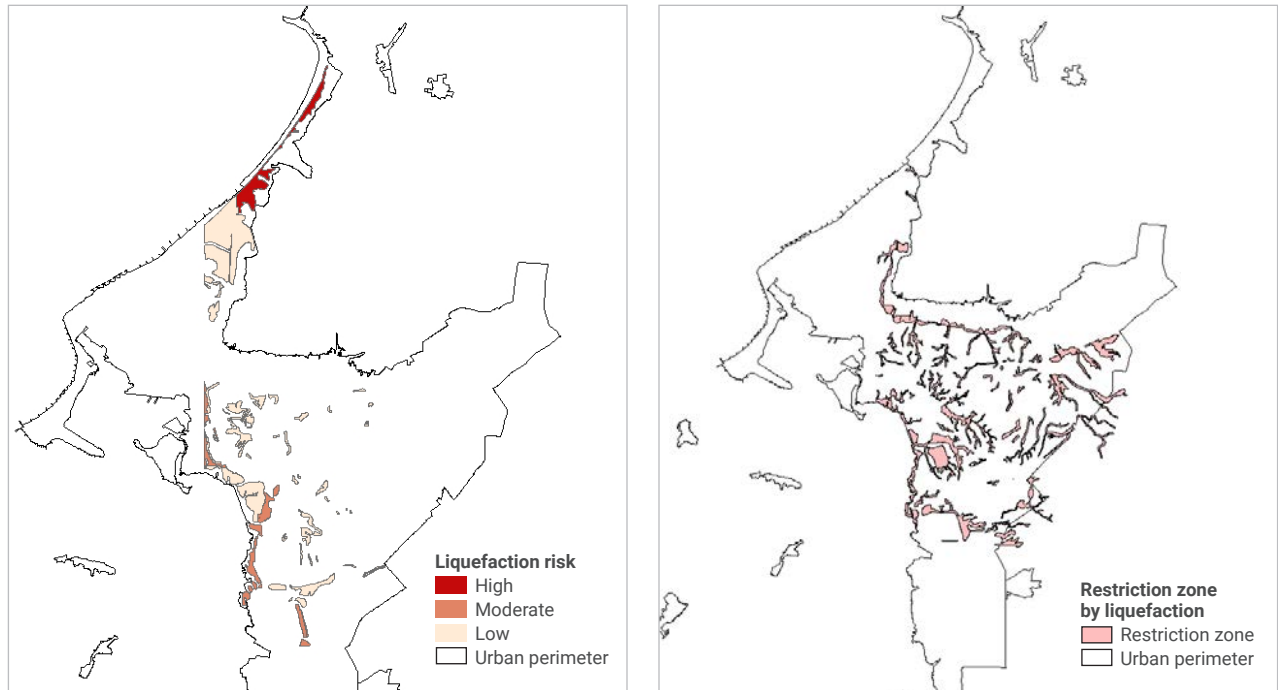
With a total population of 1 million as of 2020 and a total area of 610 square kilometers, Cartagena, the capital of Bolivar department of Colombia, presents a great variety of ecosystems configured around the coastal-marine ecology and geography of its adjacent bay. The **District Risk Management Plan for Cartagena de Indias** (*Plan Distrital de gestión del riesgo para Cartagena de Indias*) identifies several natural disaster risks as potential threats for the region based on a quantitative score derived from threat intensity, frequency, and area affected by particular risks. Floods are identified as the most critical hydrometeorological risk; coastal erosion is the main concern in terms of geological hazards. Other hazards classified as medium-risk include hurricanes, storm gales, and “choppy sea.” The complete methodological results show a persistent higher risk for rural and marginal areas of the city, which are the main concern for our present investigation.

FIGURE A19 | Flood risk, Cartagena



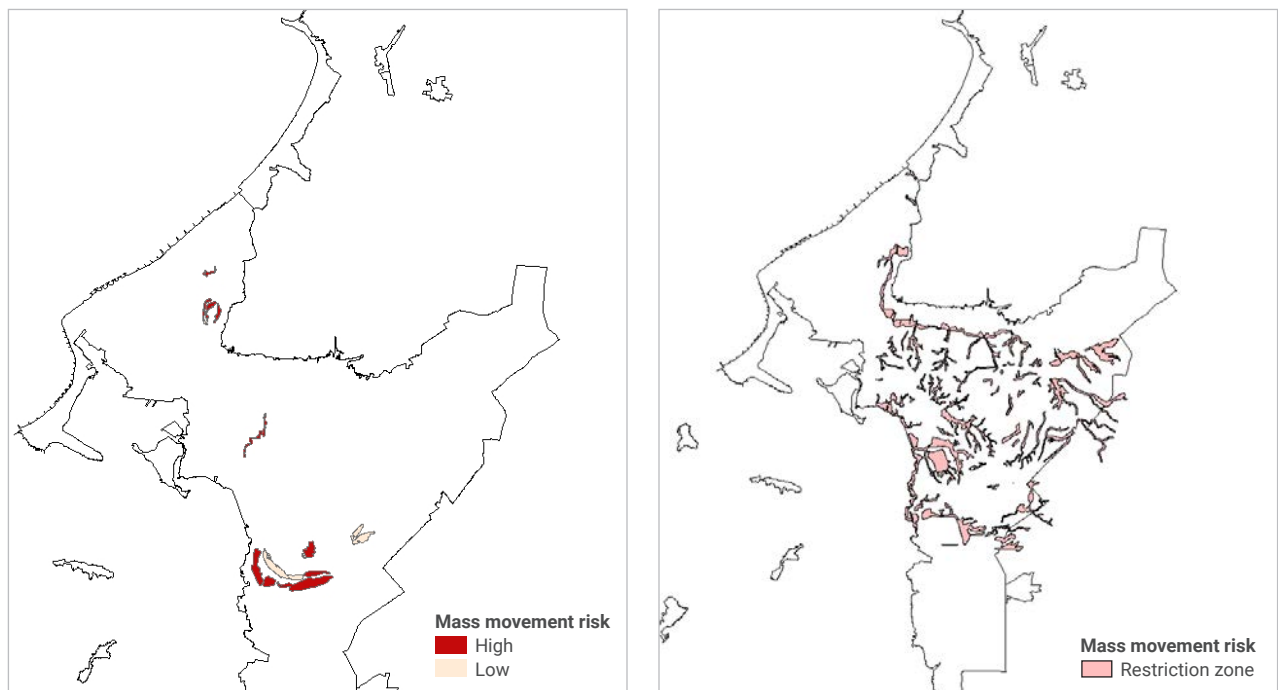
SOURCE: Original figures for this publication based on information from the Ministry of Housing.

FIGURE A20 | Liquefaction risk, Cartagena



SOURCE: Original figures for this publication based on information from the Ministry of Housing.

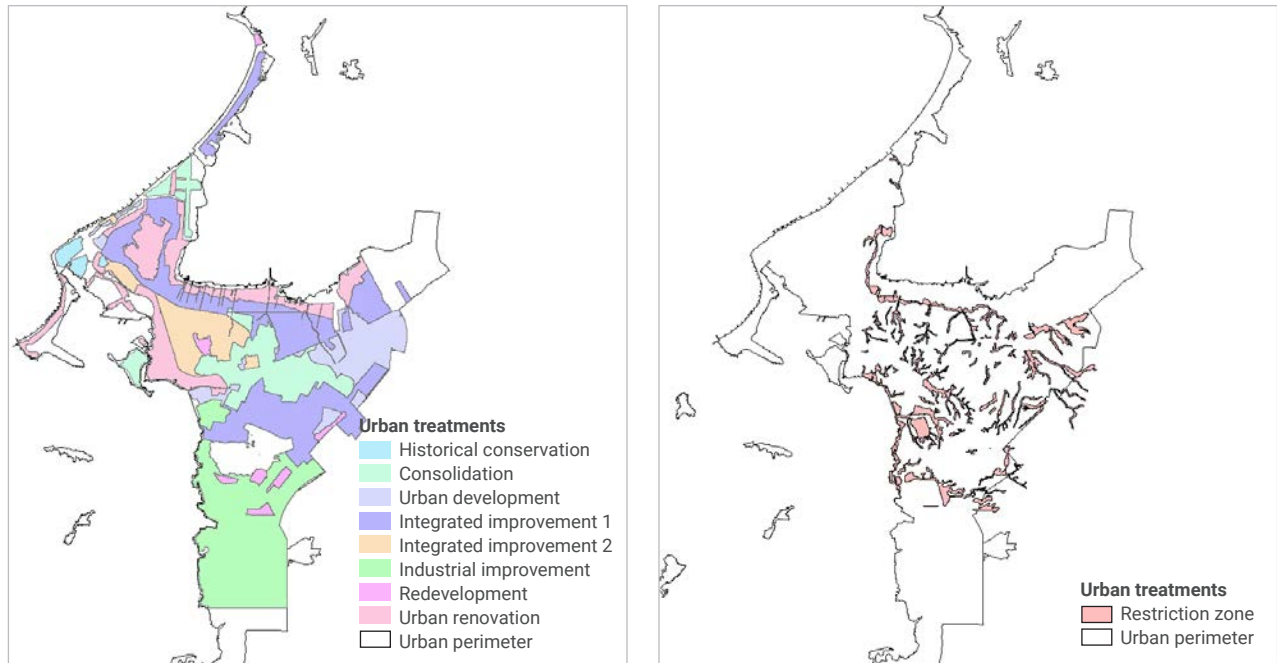
FIGURE A21 | Mass movement risk, Cartagena



SOURCE: Original figures for this publication based on information from the Ministry of Housing.

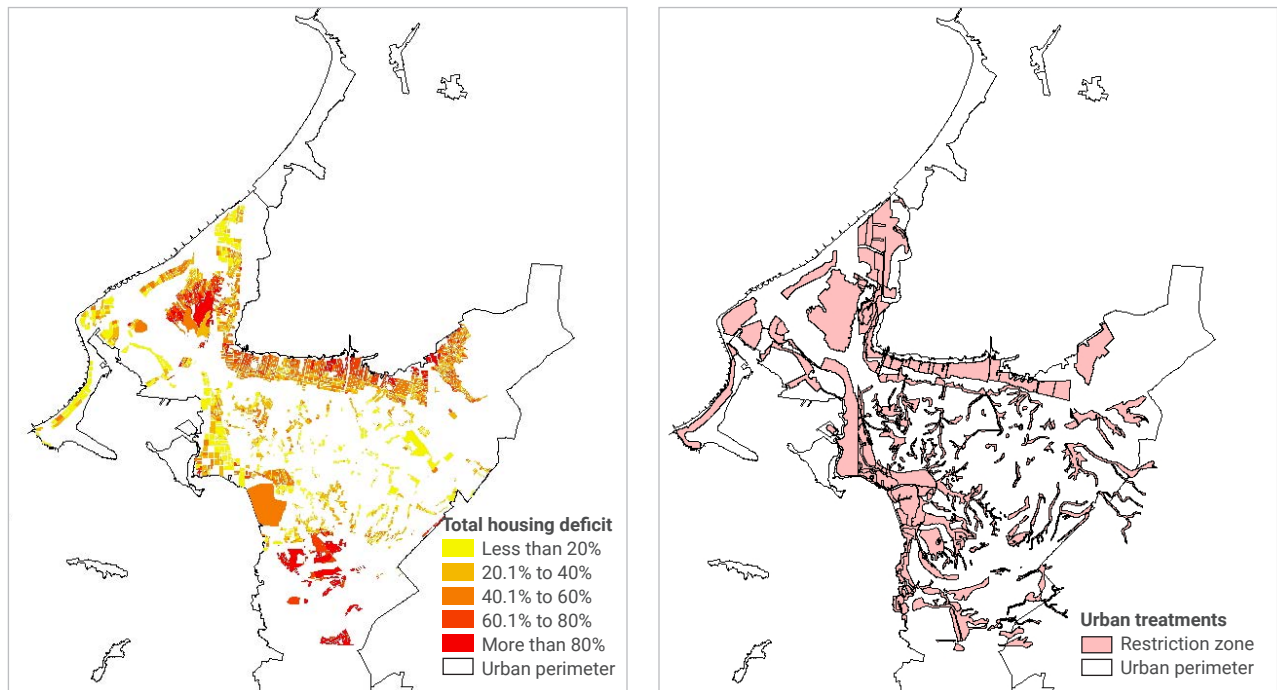


FIGURE A22 | **Urban treatments, Cartagena**



SOURCE: Original figures for this publication based on information from the Ministry of Housing.

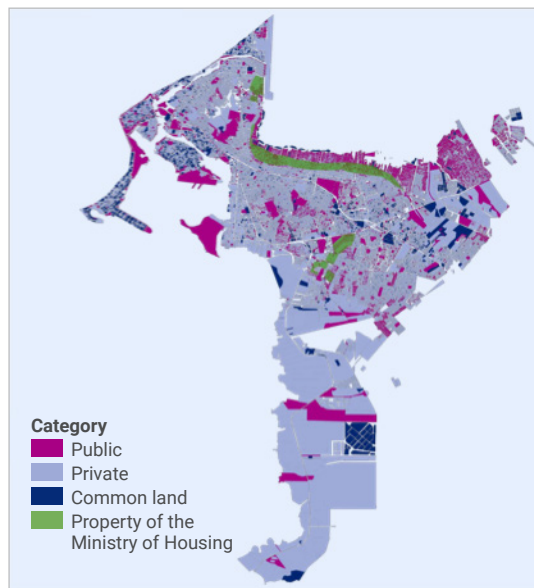
FIGURE A23 | **Unified restriction zone and housing deficit**



SOURCE: Original figures for this publication based on information from the Ministry of Housing.

Besides the restrictions on home retrofitting in risk zones, the incentives for any investment are low if there is no property-title security. Of the property titles in Cartagena, 18.2 percent are public titles for developments in areas that were previously public land, 78.8 percent are private titles, and 3 percent are common land that has not been regularized. The city has a total of 15,726 public properties occupied by housing developments, and each one of these titled properties can have more than one house on it. Only 845 titles had been legalized as of December 2019.

FIGURE A24 | Informal property titles in Cartagena



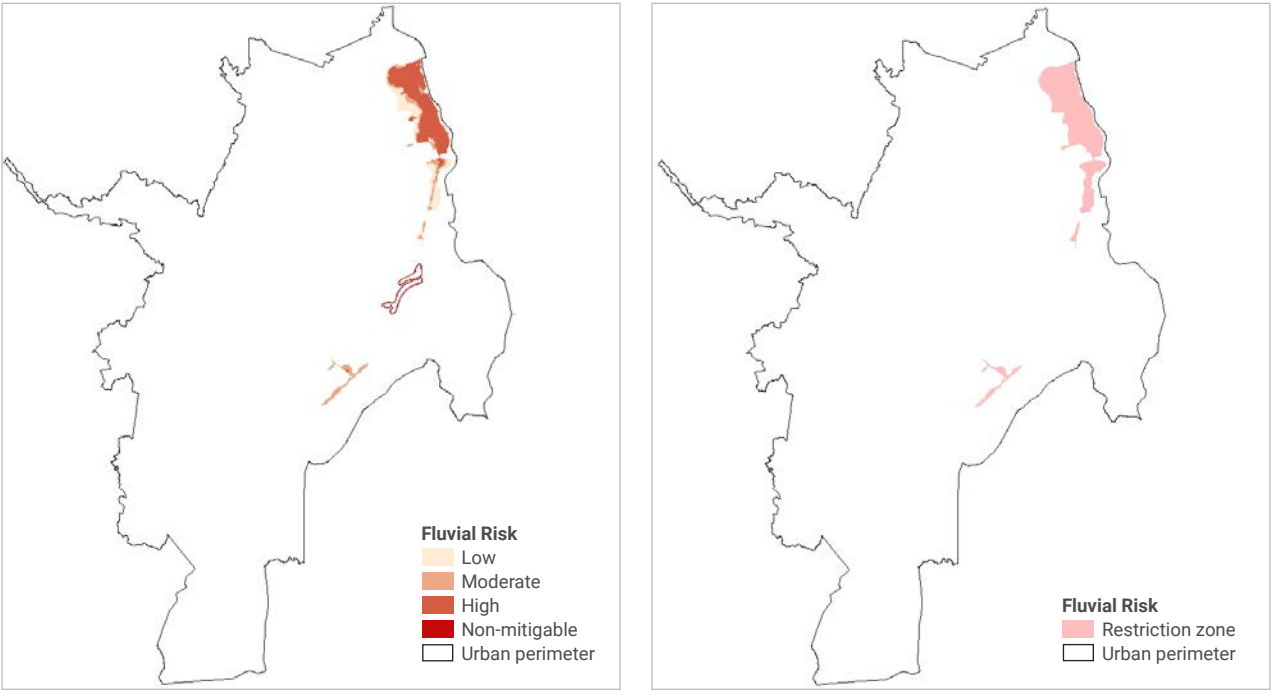
SOURCE: Ministry of Housing.

### E.1.2 Cali

Cali, with its 2.5 million inhabitants and 620 square kilometers, is the capital city of the department of Valle del Cauca, Colombia. Cali is located in the valley of the Cauca River, among the western and central mountain ranges of Colombia. Climatologically speaking, Cali is characterized by a high precipitation rate during the winter, with approximately 600 millimeters per year. The city is divided into seven basins composed of six hydric sources surrounding the urban area. Cali's geographical position and its geomorphological characteristics make the city a high-risk area exposed to several natural hazards. These characteristics, combined with the urban development of the region and the socioeconomic situation of the locals, have led to a complex risk profile.

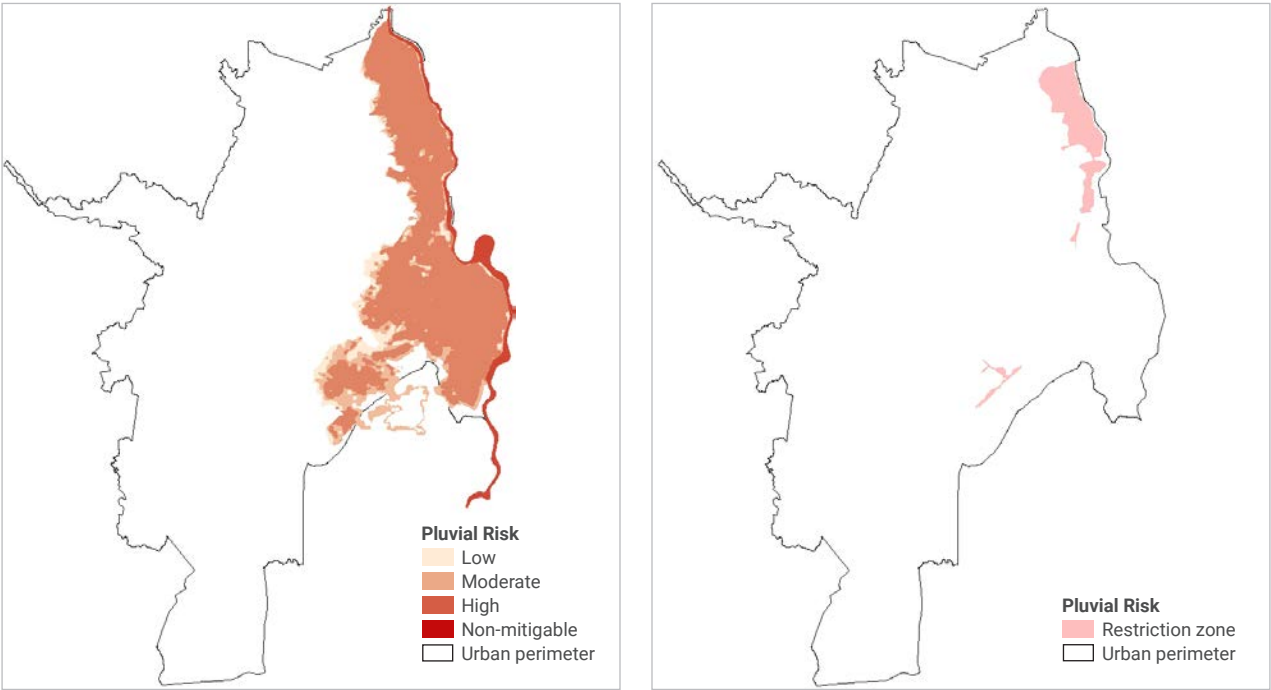
Considering Cali's geomorphology, the local government has identified three main natural disaster threats based on the frequency, probability of occurrence, and likely human and capital losses of various hazards. Local findings are consistent with broader analysis of natural hazards in Colombia. Cali has a particular risk of human and material losses due to the seismic activity that is characteristic of the region, as well as its high risk for flood and landslides, issues that are common in major cities of Colombia due to the country's geography. The **Natural Disaster Risk Management Plan for Santiago de Cali**, developed by Cali's risk management center in 2018, establishes these hazards – seismic activity, followed by floods and landslides – as major risks.

FIGURE A25 | **Fluvial risk, Cali**



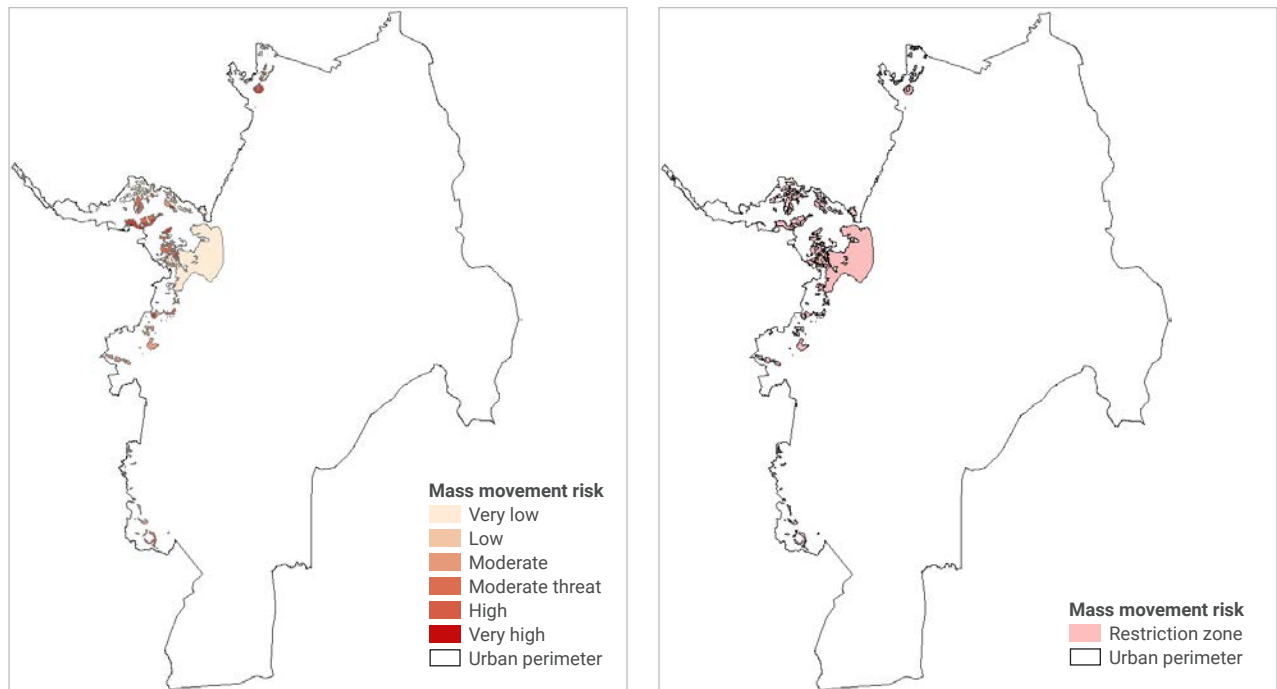
SOURCE: Original figures for this publication based on information from the Ministry of Housing.

FIGURE A26 | **Pluvial risk, Cali**



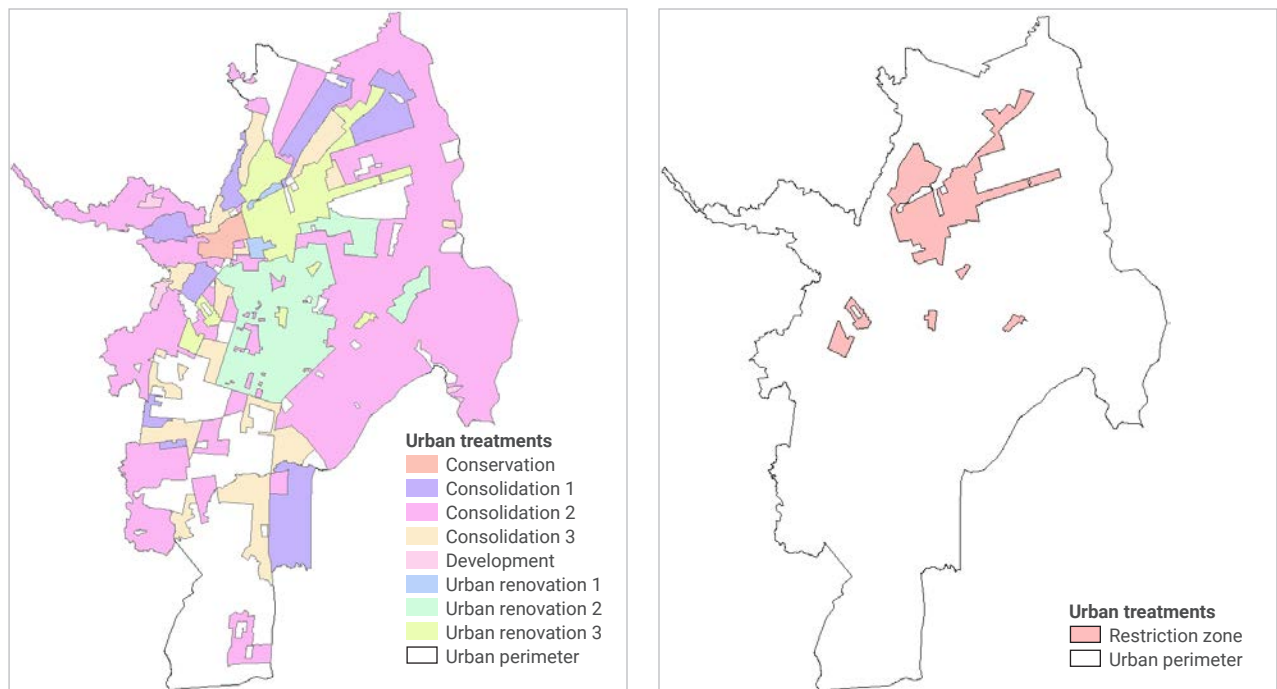
SOURCE: Original figures for this publication based on information from the Ministry of Housing.

FIGURE A27 | **Mass movement risk, Cali**



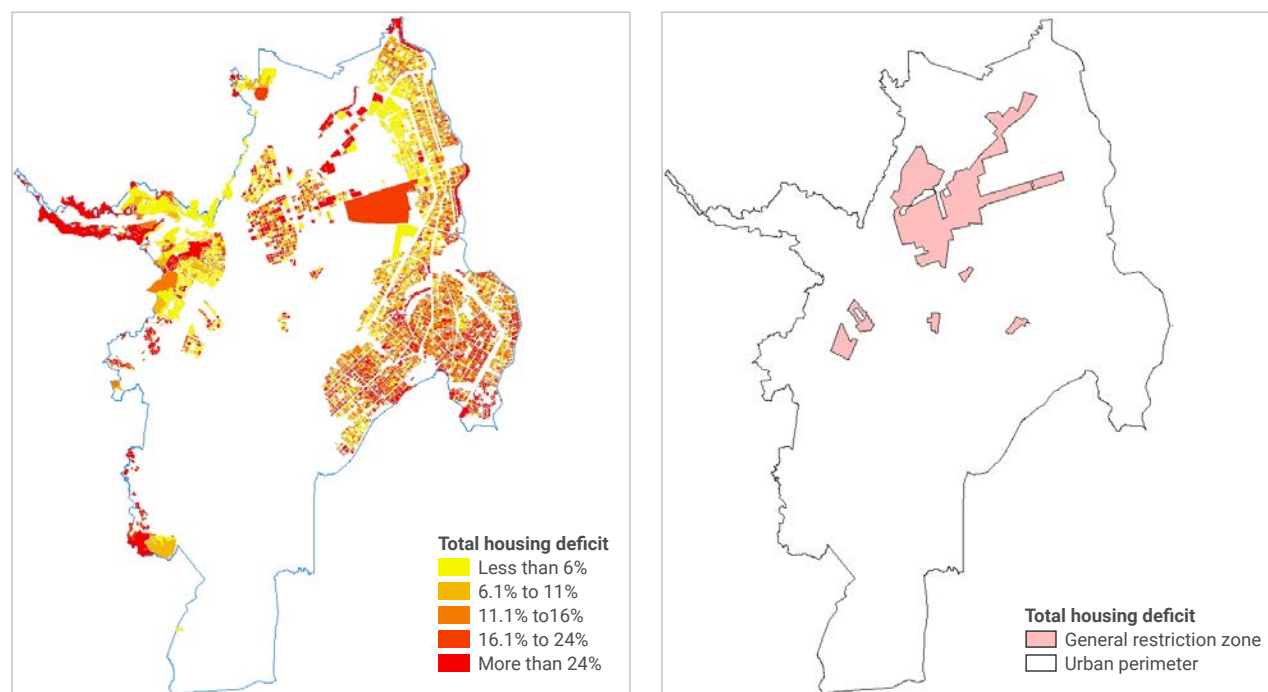
SOURCE: Original figures for this publication based on information from the Ministry of Housing.

FIGURE A28 | **Urban treatments, Cali**



SOURCE: Original figures for this publication based on information from the Ministry of Housing.

FIGURE A29 | Unified restriction zone and housing deficit, Cali



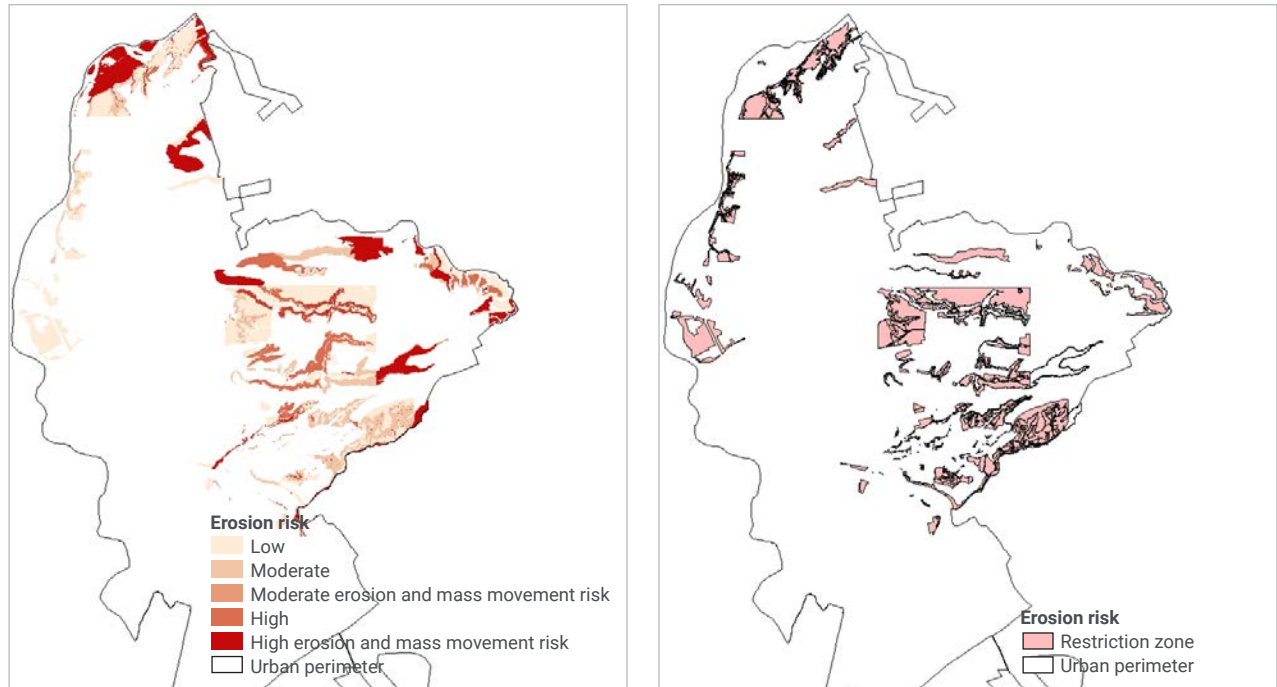
SOURCE: Original figures for this publication based on information from the Ministry of Housing.

### E.1.3 Neiva

With a total population of approximately 350,000 as of 2020 and a total area of 1,550 square kilometers, Neiva is the capital of the department of Huila. It is situated in a valley between the east and central section of the Andes mountain range, 442 meters above sea level. The city is encircled by the Ceibas and Magdalena rivers, with the latter creating a natural barrier to urban expansion in the west of the city. Neiva presents an irregular soil composition: in many areas, the ground is soft, uneven, and uncompacted. Given the biophysical characteristics of the city, particularly its location in the lower valley of the Ceibas River where it meets the Magdalena River, Neiva faces several natural hazards that have been categorized as high-vulnerability risks by the local government. In a study on climate-change mitigation, the government, supported by the Inter-American Development Bank, conducted a risk analysis that assessed the probability of occurrence of disasters and their economic and social impact based on historical data. The analysis concluded that the most significant threats are, in order of impact and relevance, floods, landslides, fires, and storm gales. This is consistent with results obtained in the Action Plans for Sustainable Neiva 2040, which emphasizes floods and landslides as the natural disasters most likely to occur in the area.

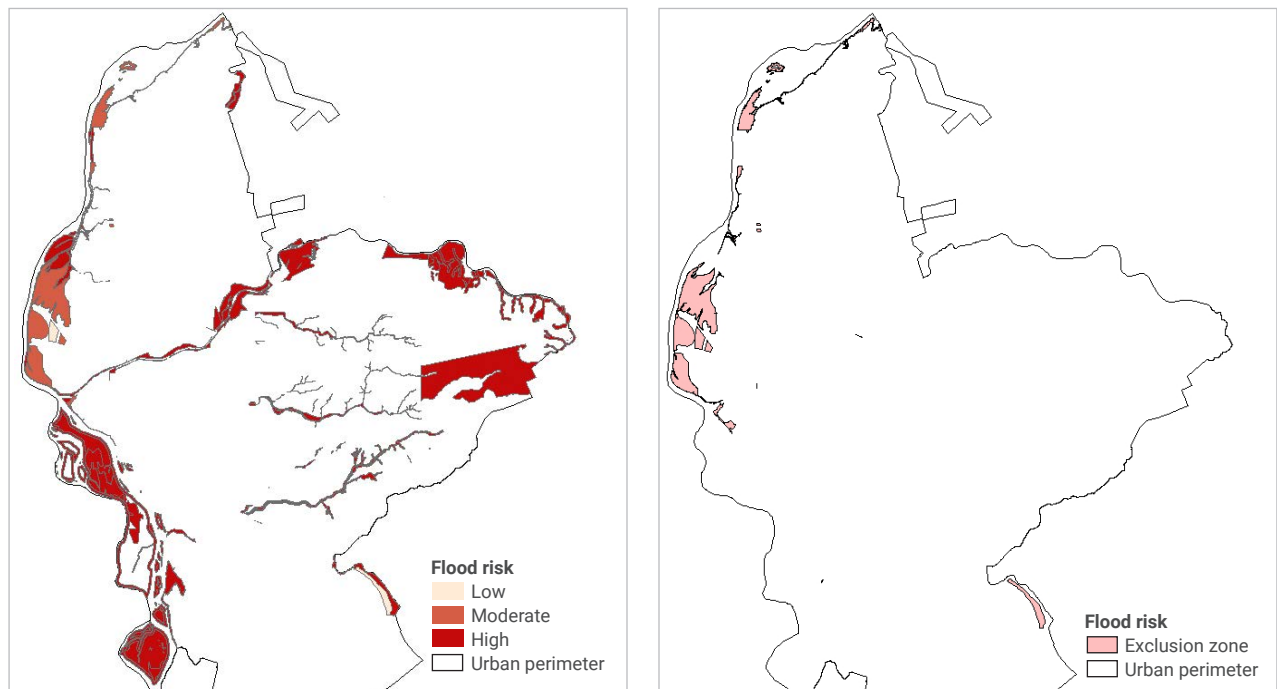


FIGURE A30 | Erosion risk areas, Neiva



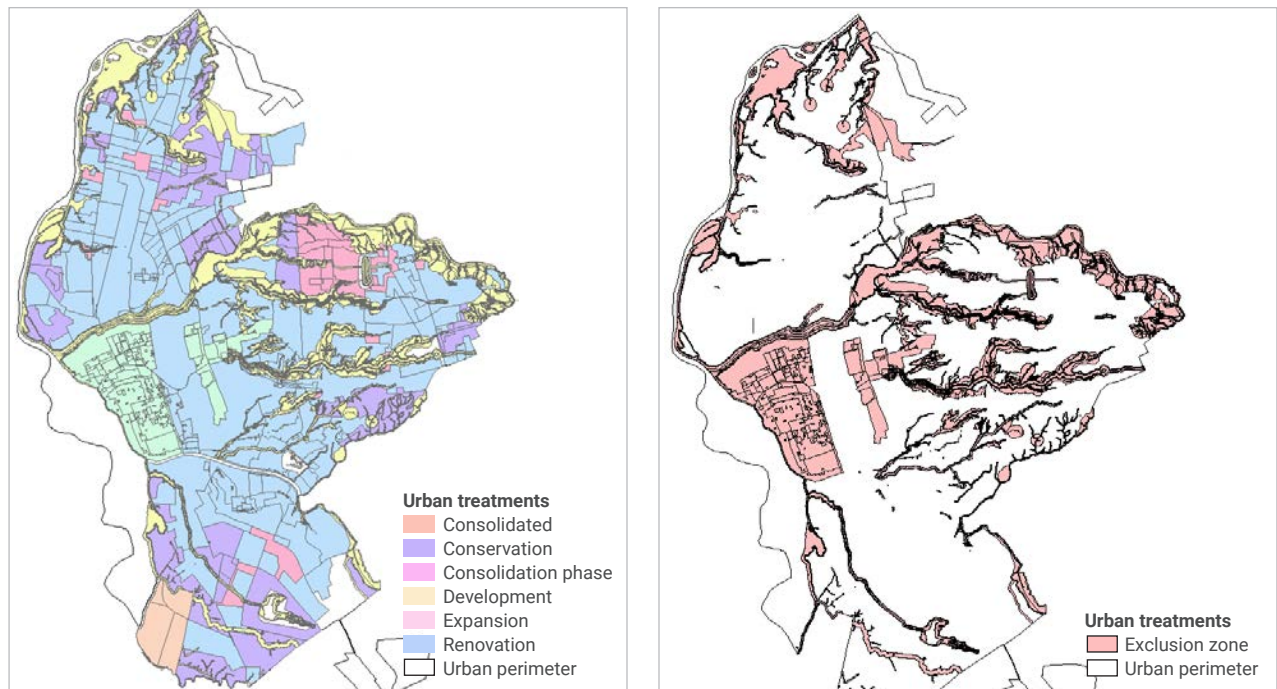
SOURCE: Original figures for this publication based on information from the Ministry of Housing.

FIGURE A31 | Flood risk, Neiva



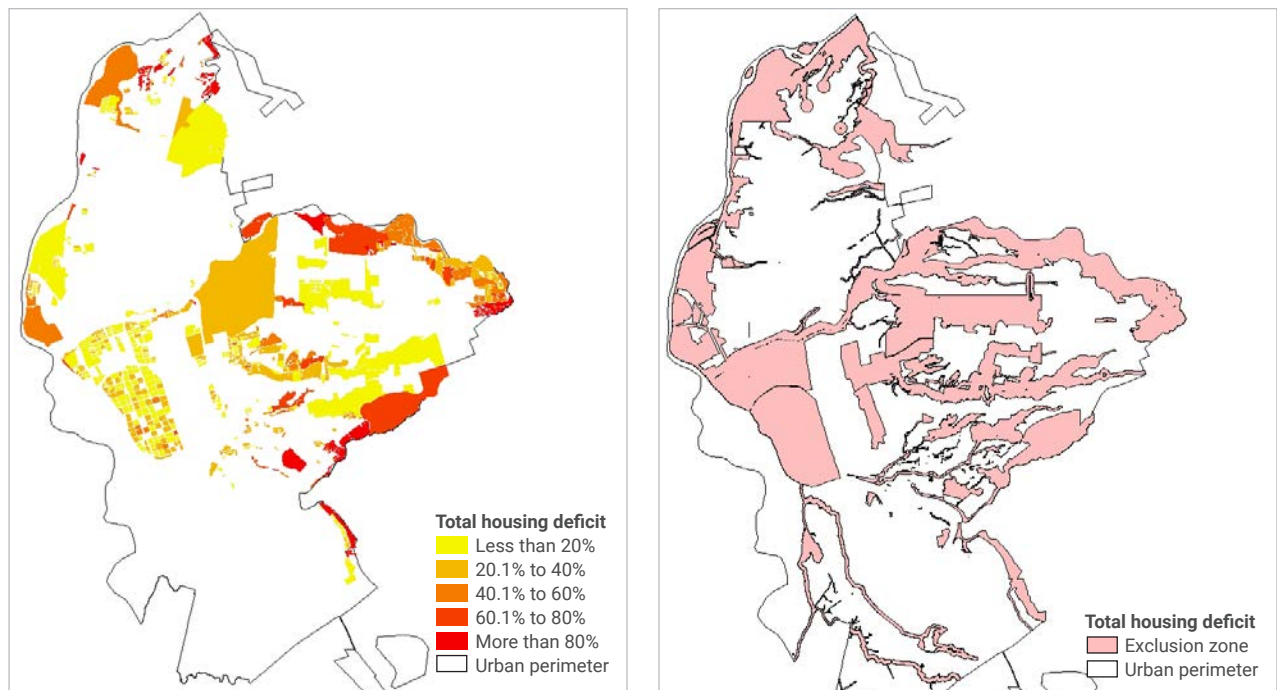
SOURCE: Original figures for this publication based on information from the Ministry of Housing.

FIGURE A32 | Zoning restrictions according to the POT, Neiva



SOURCE: Original figures for this publication based on information from the Ministry of Housing.

FIGURE A33 | Unified restriction zone and housing deficit, Neiva



SOURCE: Original figures for this publication based on information from the Ministry of Housing.

## Annex F: Venezuelan Migration

### F.1 The Venezuelan Migration since 2015

The recent socioeconomic and political changes in Venezuela have led to the largest migration in the recent history of Latin America and the Caribbean. For most of the countries in the region, the Venezuelan migration over the last four years represents a much faster and larger population inflow than previously experienced, and constitutes a significant shock to these countries.

In 2020, according to the United Nations High Commissioner for Refugees (UNHCR 2020), there were approximately 5.1 million refugees and migrants from Venezuela around the globe. Of those, 4.3 million were in Latin America and the Caribbean, with 1.9 million in Colombia specifically.

The rate of migration has been increasing. It is estimated that in 2015 there were only approximately 700,000 Venezuelans living outside their country. By June 2018, Venezuelan emigrants totaled 3 million, a figure 4.2 times bigger than it was in 2015. And in 2019 alone, more than 2 million Venezuelans left their country. Though estimates of this population differ, all the figures agree that between 4.5 and 5.3 million Venezuelans are currently living outside their country, with around 1.9 million of them in Colombia.

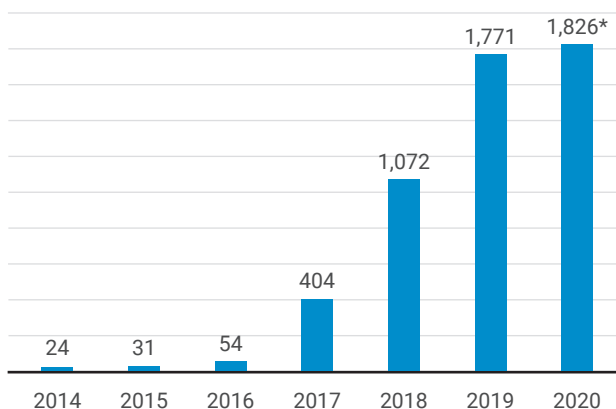
Colombia has experienced the greatest impact from the Venezuelan migration. Mainly because of its cultural similarity, geography, commercial relations, and historical background, Colombia has had the largest proportion of Venezuelans entering its economy. Since the migration began 2015, its rate has increased exponentially. Three critical periods stand out. First, in June 2015, some 20,000 people made their way from Venezuela into Colombian territory. Then, in 2016 and 2017, more than 550,000 Venezuelans crossed the border. Finally, from 2018 until today, more than 2 million Venezuelans have arrived in Colombia, some to stay and others to continue on their way, mostly to another Latin American country. The number of Venezuelans living in Colombia has also been steadily growing (see figure A34).

So far, the highest Venezuelan immigration in a single year occurred in 2019. According to *Migración Colombia*, approximately 60,000 Venezuelans settled in Colombia each month in 2019, while the remainder of those that crossed the border were in transit to another Latin American country.

In the current context of the COVID-19 pandemic, these populations are extremely vulnerable, given the persistence of overcrowding and the shortage of affordable housing units for rent. The experience of other countries managing massive migrations might be instructive in the development of policies Colombia could implement with the objective of improving quality of life not just for the Venezuelan migrant population but also for its own, even in a scenario of shared health risks such as the COVID-19 pandemic.

FIGURE A34 | Venezuelan immigrants living in Colombia

Thousands of people



\*Data for 2020 was collected in February 2020.

SOURCE: Original figure for this report, based on data from Migración Colombia 2020..

## F.2 The Venezuelan Population in Colombia

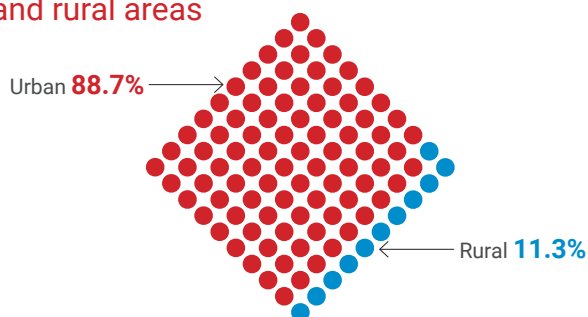
In order to characterize the Venezuelan population in Colombia, we use the General Integrated Households Survey (GEIH),<sup>4</sup> which contains information about the individual characteristics, labor situation, and living conditions of migrants in Colombia. According to the GEIH, Venezuelan migrants in Colombia numbered 1.9 million in 2019, with an average household size of 3.3 people (3.2 on average in urban areas and 4.2 in rural areas).

### F.2.1 Geographic Distribution

As figure A35 shows, the Venezuelan population lives mostly in urban areas (88.7%). The urban concentration accelerated in 2017 and 2018. This is expected, as migrants are primarily seeking economic opportunity, which is more often found in urban areas.

The exact cities where Venezuelan migrants are living are presented in figure A36. Bogota D.C. stands out as the city with the highest concentration of Venezuelan immigrants, with almost one out of four (23.2%); it is followed by Medellin and Barranquilla, each with around 8 percent of total Venezuelan migrants. The cities closest to the border, Cucuta and Bucaramanga, host 7.1 percent and 3.2 percent, respectively. This distribution reinforces the idea that Venezuelan migrants are trying to establish themselves in bigger cities in order to seek better economic opportunities, while leaving border cities that have lower migrant populations.

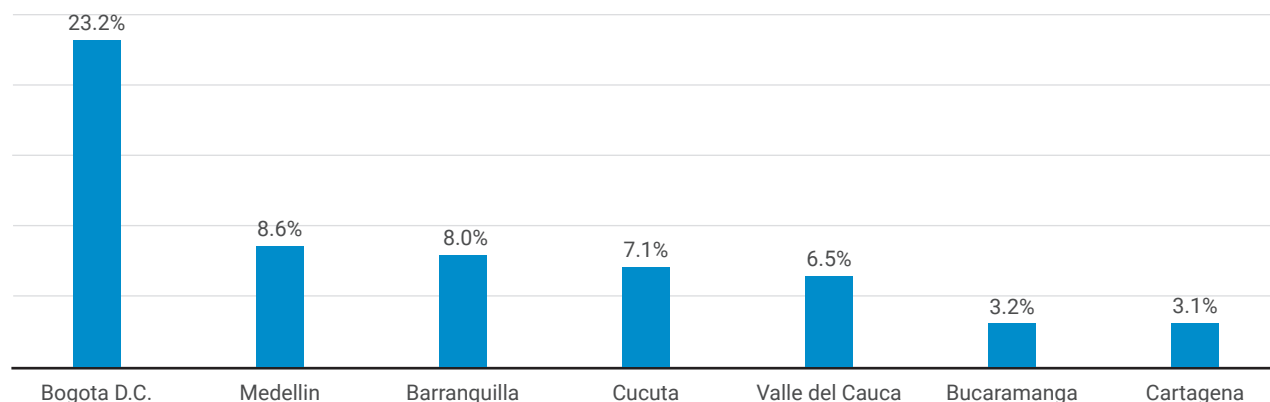
FIGURE A35 | Venezuelan population in urban and rural areas



SOURCE: Original calculations for this publication, based on data from DANE – GEIH.

FIGURE A36 | Main recipient cities of Venezuelan migrants in Colombia

% of total Venezuelan migrants



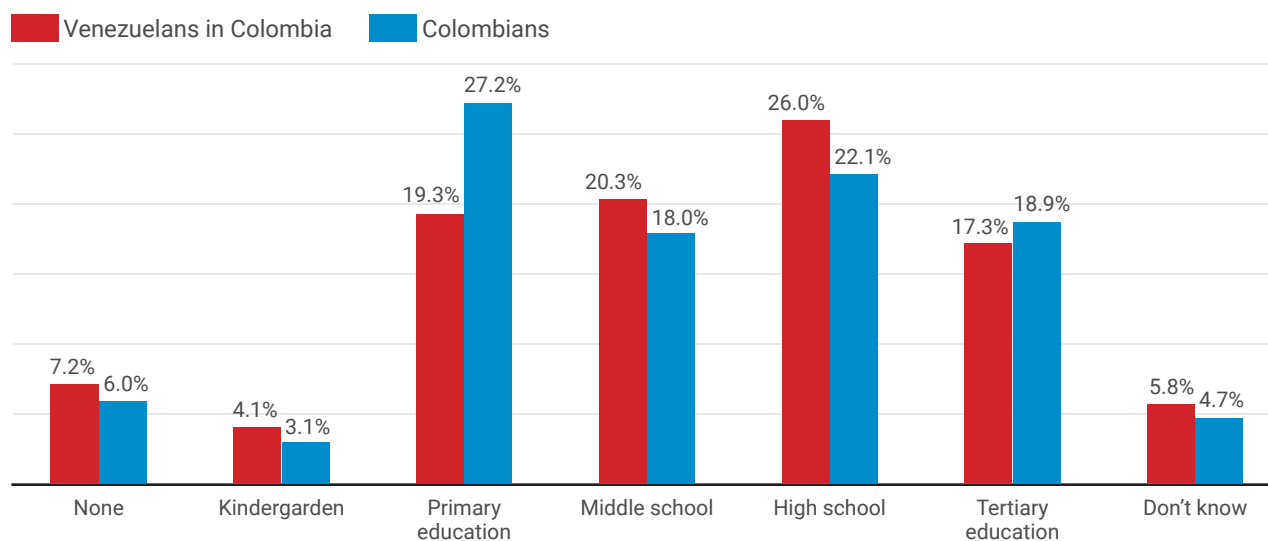
SOURCE: Original calculations for this publication, based on data from DANE – GEIH.

<sup>4</sup> The GEIH has been carried out by the National Administrative Statistics Department (DANE) since 2007. This survey is implemented in the state capital cities in order to obtain information at the national and regional level, with urban–rural comparisons.

## F.2.2 Demographic and Income Distribution

While 50.7 percent of the total Colombian population is female and 49.3 percent is male, Venezuelan migrants are almost the opposite: 49.7 percent female and 50.3 percent male. On the other hand, the educational level of Venezuelan migrants does not differ from that of the general Colombian population (figure A37). However, Venezuelans present a more uniform distribution across educational levels, with the highest proportion having a high school degree, while Colombians are more concentrated at the levels of primary education (27.2% versus 19.3% of Venezuelans) and tertiary education (18.9% versus 17.3%).

FIGURE A37 | **Distribution of the population by education level**



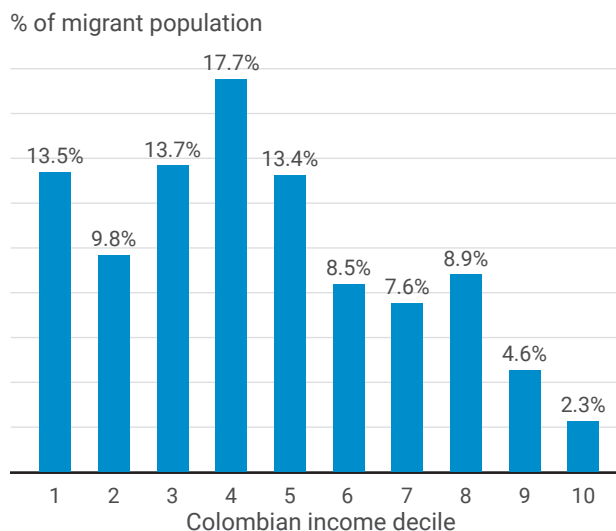
SOURCE: Original calculations for this publication, based on data from DANE – GEIH.

Figure A38 shows the distribution of Venezuelan migrants in Colombia according to their income, using the income distribution deciles of the Colombian population as a reference. Migrants have a lower income than Colombians, with 68.1 percent of the migrant population concentrated in the lower half of the Colombian income distribution. This indicator demonstrates that Venezuelan migrants have higher vulnerability to economic and social shocks than the general Colombian population, and face difficulties when seeking affordable and appropriate housing.

## F.2.3 Housing Deficit Incidence

In a mass migration, housing conditions for migrants tend to be worse than they were in their home country, although this varies across countries and migration processes. According to Displacement Tracking Matrix data (2020), 32 percent of migrants worldwide do not have access to housing. Often, vulnerable migrant populations start by settling in public spaces in urban areas, such

FIGURE A38 | **Income distribution of Venezuelan migrants in Colombia across income deciles of the Colombian population**



SOURCE: Original calculations for this publication, based on data from DANE – GEIH.

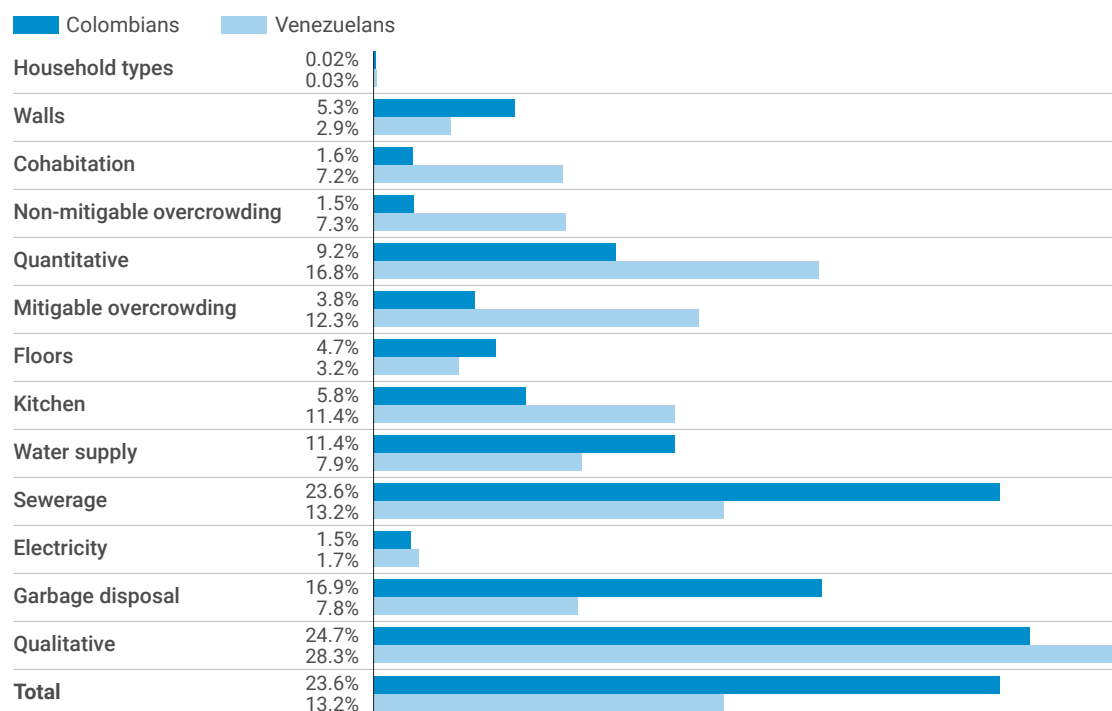


as streets or parks, where they suffer a lack of access to public services such as drinkable water, electricity, and sewerage. Later, a proportion of them establish themselves in informal settlements or rent a place to live. Despite the lack of comparable data about housing conditions for those migrants who can access housing, the UN International Organization for Migration (IOM 2019a) found that overcrowding and multiple families sharing the same living area are the most common issues for migrant populations.

With the information provided by the GEIH, it is possible to estimate the qualitative and quantitative housing deficit experienced by Venezuelan migrants in Colombia and compare it to the average situation of a Colombian household. Venezuelans suffer from lower-quality housing conditions and higher housing deficit, both quantitative and qualitative. We find that there is no difference between Colombians and Venezuelans in terms of housing deficit by gender or level of education, even though migrants tend to be concentrated in the lower part of the income distribution, which drives their aggregate indicators downwards. Finally, a high proportion of Venezuelan households are leaseholders – double the percentage of Colombian leaseholders.

Figure A39 shows that 45.1 percent of Venezuelan migrants have a housing deficit of some kind, as opposed to only 33.9 percent of Colombians. Qualitative housing deficits affect 28.3 percent of Venezuelan migrant households, compared with 24.7 percent of Colombians. While the principal causes of qualitative deficit for Colombian households are sewerage and garbage disposal, Venezuelan migrants actually register lower incidences of water-access, sewerage, and garbage-disposal deprivations. This may be the result of the high concentration of migrants in the suburbs and exurbs of major cities, where public services such as these are often guaranteed. On the other hand, Venezuelan migrants suffer from significantly higher deficits in dimensions such as mitigable and non-mitigable overcrowding and cohabitation. These factors push the quantitative deficit of Venezuelan households up to 16.8 percent, whereas the figure for Colombian households is only 9.2 percent.

FIGURE A39 | **Percentage of households with housing deficit**



SOURCE: Original figure for this publication, based on data from DANE – GEIH.

When evaluating how the housing deficit breaks down for different education levels of heads of households, a consistent pattern can be seen for both quantitative and qualitative deficits: Venezuelan households suffer from higher deficit at each educational level. The only exception is among households headed by people without any education, where Colombians have a higher qualitative housing deficit than their Venezuelan peers.

The differences across income deciles are similar. Compared with similar Colombian households, Venezuelan migrants experience poorer housing conditions independent of their income. As figure A40 shows, Venezuelan in all income deciles register a higher housing deficit, with the difference being greater for the lowest deciles. While for the lowest decile the difference between housing deficits of Colombians and Venezuelans is 5.4 percentage points, this difference is reduced to 3.4 percentage points for the highest decile, although this reduction is not uniform.

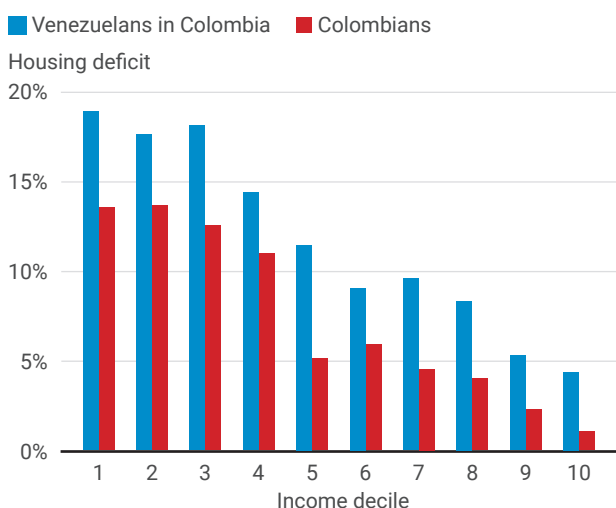
This comparison can be further disaggregated into qualitative and quantitative housing deficits. Figure A41 shows the percentage of households with housing deficits according to income, disaggregating the latter as multiples of the minimum wage (MW). Several trends are apparent:

1. Lower-income people have a higher housing deficit, as would be expected.
2. The qualitative deficit is worse than the quantitative deficit for both populations.
3. All across the income distribution, a higher proportion of Venezuelan migrants than Colombians suffer from housing deficit.
4. An income of 4 MW serves as a threshold for Venezuelan households. Below that level, the qualitative deficit seems to be higher than the quantitative deficit; above that income level, the quantitative deficit is higher. By contrast, for Colombian households, the qualitative deficit is always higher than the quantitative, for all income ranges.

## F.2.4 Tenure Conditions

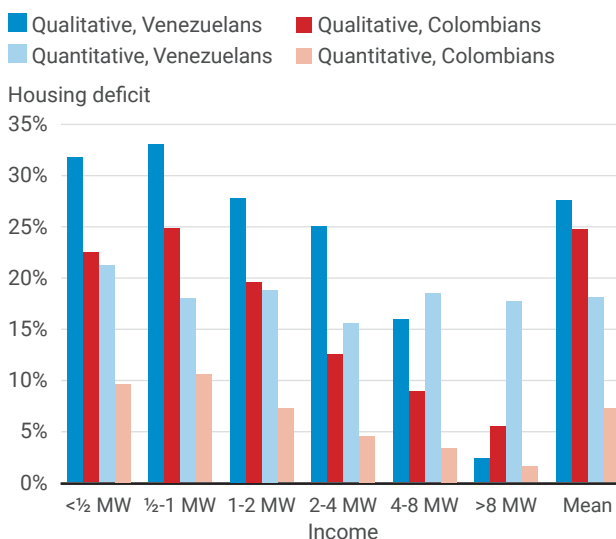
Arguably, the most important differences between Venezuelan and Colombian households are tenure conditions. While 38.6 percent of Colombians own their homes, only 1.1 percent of Venezuelan migrants do. Instead, 88.4 percent of Venezuelans are leaseholders, compared with 39.5 percent of Colombians.

FIGURE A40 | Percentage of households with housing deficit by Colombian income decile



SOURCE: Original calculations for this publication, based on data from DANE – GEIH.

FIGURE A41 | Percentage of housing deficit by income and type of deficit



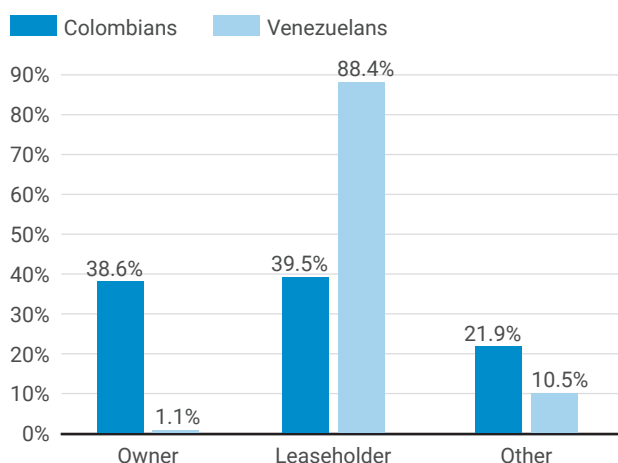
SOURCE: Original calculations for this publication, based on data from DANE – GEIH.

We can also determine the housing deficit for different tenancy types in urban areas. Figure A43 shows that owners have a higher qualitative deficit compared to leaseholders, while leaseholders register a higher quantitative deficit. For each type of tenancy, Venezuelan households present both a higher qualitative and quantitative deficit than their Colombian peers, with a difference of 12 percentage points and 10 percentage points, respectively.

Venezuelan migrants, however, seem to spend a lower proportion of their income on rental payments than Colombian leaseholders do. Figure A44 shows that, whatever their income, Venezuelan migrant leaseholders spend on average 5 percent less than Colombian leaseholders on housing. This difference could be explained by the modest conditions of migrant housing. It also seems that rental expenditure is an adjustable variable for Venezuelan households, allowing them to save or spend in other sectors.

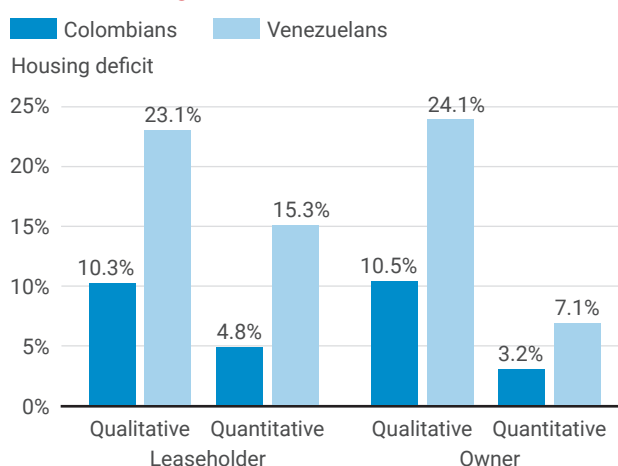
The last graph compares the qualitative and quantitative conditions in the principal cities where Venezuelan migrants are established. Cucuta, Barranquilla, and Cartagena have the highest proportion of qualitative housing deficits among Venezuelan migrants, with 37.1 percent, 31.2 percent, and 24.7 percent, respectively. The highest proportion of Venezuelans with quantitative housing deficits are found in Cali (23.5 percent) and Cucuta (22 percent). By contrast, Bucaramanga offers better quantitative and qualitative living conditions for its migrant population.

FIGURE A42 | Household distribution by housing tenure



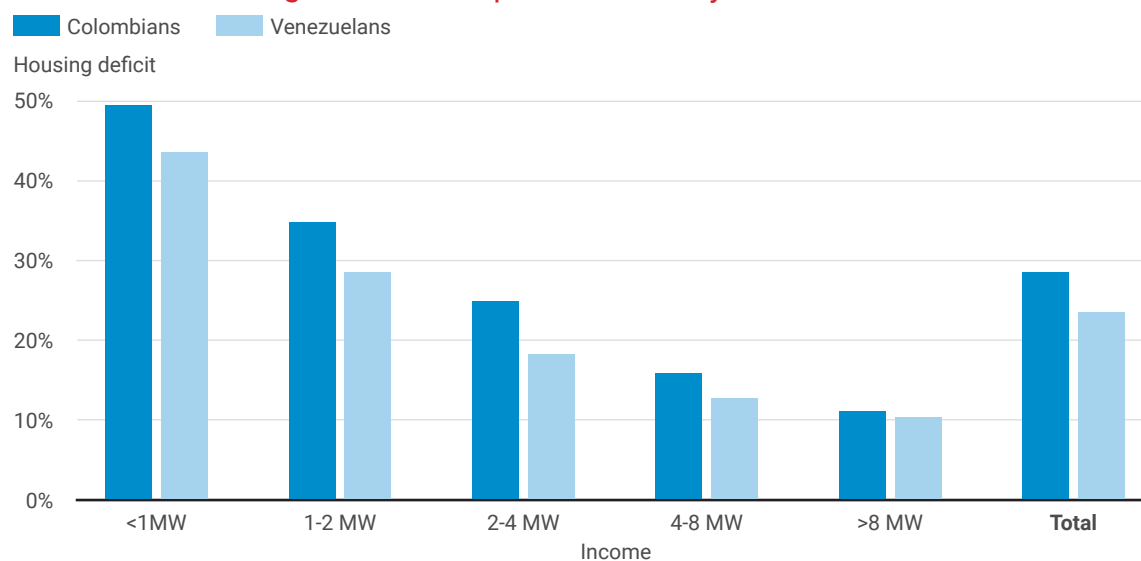
SOURCE: Original figure for this publication, based on data from DANE – GEIH.

FIGURE A43 | Percentage of urban households with housing deficit



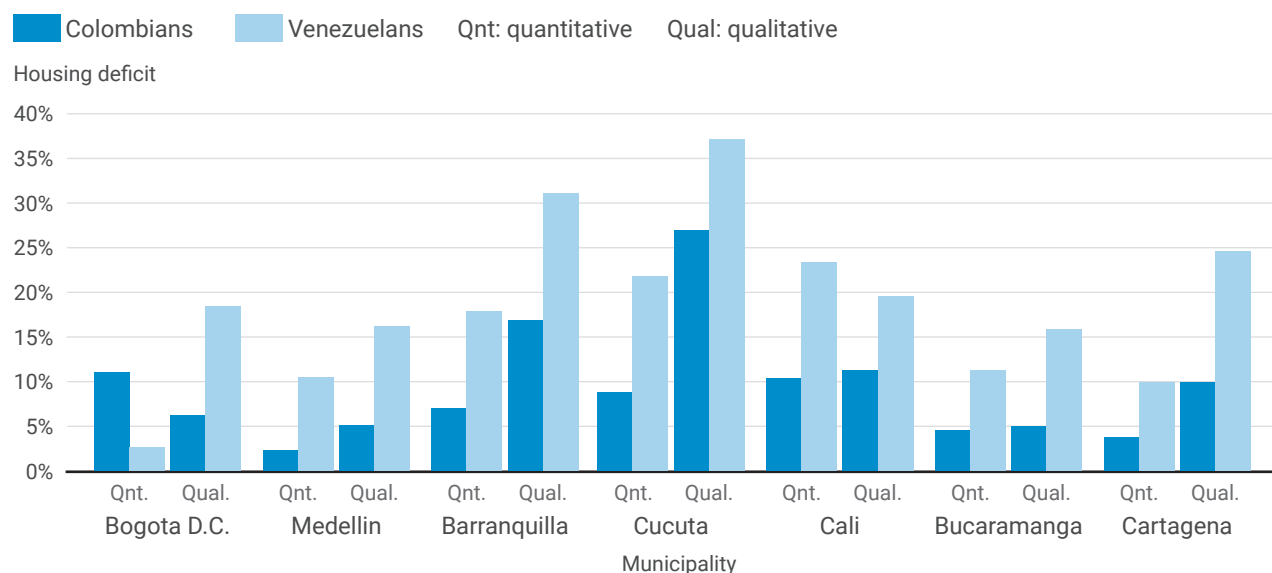
SOURCE: Original figure for this publication, based on data from DANE – GEIH.

FIGURE A44 | **Percentage of income spent on lease by income**



SOURCE: Original figure for this publication, based on data from DANE – GEIH.

FIGURE A45 | **Percentage of leaseholder households with quantitative and qualitative housing deficit in key cities for Venezuelan migrants in Colombia**



SOURCE: Original calculations for this publication, based on data from DANE – GEIH.

### F.3 Efforts to Assist the Venezuelan Migrant Population in Colombia

Since 2017, Colombia has been receiving aid from various international sources to assist Venezuelan migrants. The resources provided by international organizations and donors have mainly been targeted at providing food, health, and social services, though some programs have focused on labor inclusion and benefits for receptor communities.

While some grants have had specific entities as beneficiaries, such as the Erasmo Meoz Hospital in Cucuta or shelters at the border, other programs have been directly managed and executed by international entities. For example, Save the Children is helping migrants in five key locations, concentrating on the needs of pregnant women, children, and survivors of gender-based violence. They establish ‘friendly’

places for Venezuelan children to play, learn, and receive emotional support, while their vulnerable families receive help to cover their food and health needs, obtain legal status, and receive educational services. Likewise, the International Red Cross implemented a program that facilitates access to health, medical assistance, and medicine for refugee shelters on the border between Colombia and Venezuela. The International Organization for Migration (IOM) is integrating migrants into the labor market in Cali and Barranquilla, providing information about rights and social security in Colombia, establishing an effective bridge between supply and demand, and enabling certifications in various technical competencies.

However, despite all of the efforts by the Colombian government and international institutions, the multi-dimensional needs of the Venezuelan migrant population have not been met. In 2018 and 2019, institutional efforts were frequently unable to cope with the massive inflow of migrants, an issue exacerbated by the difficulty in identifying migrants with no legal status. The crisis led the Colombian Government to recognize the impact of the Venezuelan migrant situation, and to recognize that migrants – especially those without legal status – lacked access to public services.

In order to address this, in 2018 the National Council for Economic and Social Policy (CONPES) issued a new policy guideline, CONPES 3950, to support strategies aimed at addressing the needs of Venezuelans. The document particularly focuses on health, education, early childhood development, labor, temporary accommodation, and security. It articulated the institutional framework and created new governmental institutions, such as the *Gerencia de Frontera* under the Presidency, to deal with Venezuelan migration, seeking to grant migrants access to social services and economic integration. As outlined in the CONPES document, the Colombian government set the goal of serving 133,125 children and pregnant women by 2021 through the Colombian Institute of Family Welfare (ICBF); committed to provide technical assistance for different entities and a route for health care through the Health Ministry; established the *Gerencia de Frontera* to advise the government on procedures to deal with migratory inflows from Venezuela; and created the Foreign Workers in Colombia Registry (RUTEC).<sup>5</sup> Finally, CONPES 3950 established two goals relating to potable water: supplementing Department of Water plans, and prioritizing territories with water problems associated with Venezuelan immigrants, whether permanent or transitory.

In fact, multiple potable-water programs aimed at migrants have been implemented in Colombia. For example, in La Guajira the Colombian Government and UNHCR built public washrooms in areas of high migrant concentration, and provided tanker trucks for already-established migrants and refugees. In Cucuta, the local government has connected neighborhoods to the water supply and has plans to reach a larger population through the implementation of new water supply tanks, managed by local communities and *Agua Kapital*, the city's main water provider. Currently, the city has more than 190 water supply tanks and has reached nearly 13,000 houses where both Colombians and Venezuelan immigrants live. The program charges the families US\$5 per cubic meter for the first 16 cubic meters (Col\$19,000). If a house consumes more water than this, the cost is absorbed by *Agua Kapital* as a loss.

CONPES 3950 also describes the vulnerability of the Venezuelan population when it comes to housing conditions, and the housing challenges resulting from their undocumented status and limited access to proper housing. These issues are aggravated by the structural barriers posed by the Colombian social protection system, the segmentation of the labor market, and the multiple problems generated by informality. Additionally, immigrants' lack of documentation is a bureaucratic barrier when the time comes to buy or rent a residence, particularly since they cannot use their land or houses in Venezuela as collateral for credit or rent contracts. This is an issue RUTEC was established to address.

<sup>5</sup> RUTEC is a database established to document formal migrants and to register their professional profiles and work histories. The Ministry of Labor is in charge of RUTEC, which is a useful tool when proposing mechanisms to implement immigrant policy. However, it only registers formal migrants, leaving out a substantial proportion of Venezuelan immigrants.



## F.4 Legal Situation of Venezuelan Migrants in Other Countries

Host countries such as Colombia as well as Argentina, Brazil, Chile, Costa Rica, Ecuador, Mexico, Panama, and Peru have received an increasing number of Venezuelans, and not all could absorb them into their economies under legal and regulated status. Most Latin American countries have instituted various arrangements for Venezuelan migrants that permit them to reside for one or two years with access to social services; Peru and Colombia are two such countries. Others, such as Ecuador, have designed permissions that allow migrants to remain in the country for a limited time period. Nearly 2.4 million Venezuelans are living under different legal allowances that enable them stay in the region. The arrangements include humanitarian visas, labor migration visas, temporary residence permissions, regional visa agreements by MERCOSUR and UNASUR, and even nationalization of migrants.

Meanwhile, asylum status has been widely requested by Venezuelan migrants in all receiving countries. According to information collected from national governments by UNHCR, more than 774,000 Venezuelans have claimed asylum since 2014, and nearly 500,000 were granted asylum status in 2018 and 2019 alone. Of the total asylum applications made by Venezuelans worldwide, two-thirds were registered in Latin America, while the other third was made in North America and Europe. Colombia, Peru, and Chile have the highest numbers of Venezuelans with asylum status; between them, they are home to more than 75 percent of the total, and Colombia alone is hosting 31 percent (table A12). Since 2014, there has been an 8,000 percent increase in the number of Venezuelans seeking asylum; many of these refugees are seeking alternative legal routes to stay in their receiving country.

TABLE A12 | **Venezuelans with asylum status in Latin America and the Caribbean**

COUNTRY	DATA COLLECTION DATE	VENEZUELAN POPULATION
Colombia	29 May 2020	784,234
Peru	7 February 2020	628,976
Chile	30 June 2019	472,827
Argentina	19 May 2020	203,576
Brazil	30 November 2019	123,507
Ecuador	31 May 2019	107,052
Panama	29 February 2020	74,802
Mexico	31 December 2020	52,982
Uruguay	29 February 2020	16,404
Dominican Republic	30 June 2019	7,946
Costa Rica	31 December 2019	6,164
Canada	31 March 2018	5,705
Curaçao	31 December 2018	1,291
Paraguay	8 January 2020	1,191
<b>Total</b>		<b>2,486,657</b>

SOURCE : UNHCR 2020.

The status of most of the Venezuelan population remains irregular due to factors such as lack of documentation, long wait periods, high administrative fees, administrative obstacles, and other barriers. Those with an unresolved legal situation often suffer reduced access to basic rights, as they cannot benefit from public policies like national health or social welfare programs (UNCHR and IOM 2020). They are frequently vulnerable to all forms of exploitation, sexual abuse, violence, trafficking, abuse, forced labor, and discrimination.

In Colombia, only an estimated 43 percent of Venezuelan migrants have legal status, while more than 1 million people have irregular immigration status in the country (Migración Colombia 2020). The main needs of these populations, apart from direct emergency assistance, protection, and socio-economic integration, is regularized status and information about accessing the existing services available for migrants (World Bank 2018b).

While Latin American countries are making great efforts to help this population, the support of the international community is crucial to improving their living conditions. Receiving countries must expedite procedures to legalize refugees' status and integrate them into the domestic economy in order to facilitate employment or validate educational qualifications. To do this, identifying and targeting mechanisms must be improved so as to support this population and extend assistance, from basic services like shelter, food, and sanitation, to education and healthcare.

## Annex G: Municipal Prioritization Index Based on Urban Expansion

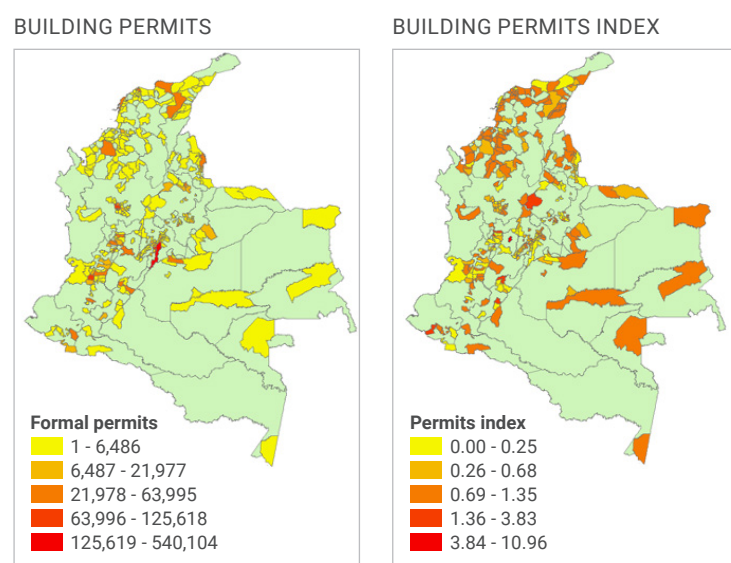
One way of estimating the extent of informal housing is by assessing the gap between household creation and the formal housing supply (see Chapter 4). In this section, we propose an index as a way for policymakers to prioritize action in areas where there is a more acute shortage of formal housing. In this way, we can identify the municipalities where the informality or overcrowding rate is most likely to rise. An index closer to 1 means that household creation outweighed formal supply, indicating that there is a more acute shortage of formal development. A number closer to 0 means that there was sufficient creation of formal housing to meet rising demand.

The formal housing supply data for the index can be estimated based on building permits or formal housing project starts. Although neither is surveyed nationally and there is a high chance of omitting small municipalities, this is a first-approach methodology that makes the most out of the available information. By selecting the time period we have chosen to analyze, we exploit the most reliable population data – the census data. The time period also represents a relatively long span (13 years), which reduces possible temporal effects. Nevertheless, in the future, these dates can be changed to suit the purposes of subsequent analyses.

The results summarized below, covering the period 2005–2018, indicate the municipalities with a more severe shortage of formal permits compared to growth in the number of households, for municipalities where there is information. Given that lack of information could be directly linked with informality, the municipalities without information should be prioritized. As table A13 shows, the majority of the most-deprived municipalities have a very low population and are mainly located in the Caribbean region.

FIGURE A46 | **Formal supply shortage: building permits**

The municipalities in which the number of households decreased during the studied period are not considered. The municipalities in which supply outweighs household creation are manually assigned a 0 value.



SOURCE: Original figure for this publication, based on data from the 2005 and 2018 census and CEED statistics (DANE 2016, 2019a, 2020c).

TABLE A13 | **Formal supply shortage: building permits in the top 15 municipalities**

The municipalities in which the number of households decreased during the studied period are not considered.  
The municipalities in which supply outweighs household creation are manually assigned a 0 value.

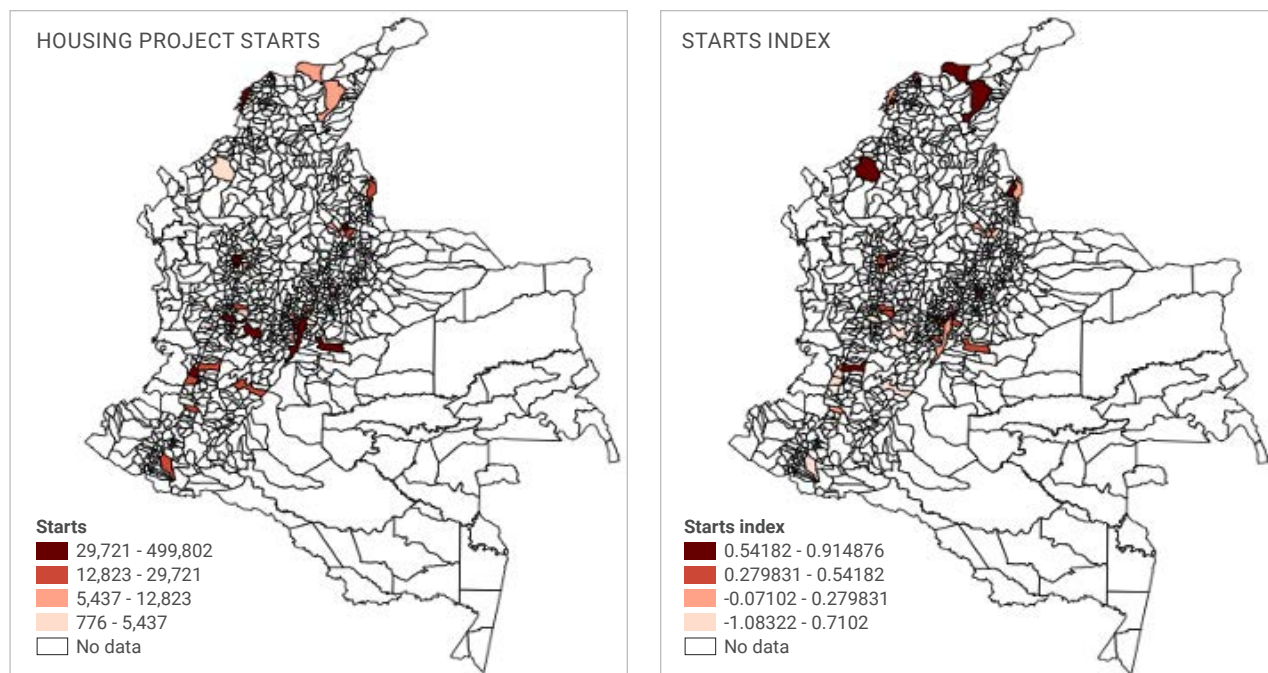
CATEGORY	DEPARTMENT	MUNICIPALITY	FORMAL PERMITS	HOUSEHOLDS 2005	HOUSEHOLDS 2018	HOUSEHOLDS CHANGE	PERMITS INDEX
5. 20-100K	Cordoba	San Pelayo	2	8,547	14,353	5,806	1.00
6. <20K	Cordoba	Momil	1	3,039	5,126	2,087	1.00
5. 20-100K	Magdalena	Puebloviejo	1	5,563	7,601	2,038	1.00
6. <20K	Cordoba	Cotorra	1	3,258	5,170	1,912	1.00
6. <20K	Bolivar	Turbana	2	2,514	4,063	1,549	1.00
6. <20K	Atlántico	Suan	2	1,554	2,923	1,369	1.00
5. 20-100K	Bolivar	Arjona	13	12,821	17,323	4,502	1.00
6. <20K	Cauca	Padilla	3	2,196	3,182	986	1.00
6. <20K	Magdalena	Salamina	4	1,825	2,858	1,033	1.00
6. <20K	Atlantico	Polonuevo	8	2,730	4,707	1,977	1.00
5. 20-100K	Bolivar	Villanueva	11	3,615	6,000	2,385	1.00
5. 20-100K	La Guajira	Villanueva	14	5,056	7,624	2,568	0.99
5. 20-100K	La Guajira	Dibulla	12	4,632	6,618	1,986	0.99
5. 20-100K	Sucre	San Onofre	19	9,664	12,493	2,829	0.99
4. 0.1-0.3M	Cordoba	Cerete	79	19,034	30,388	11,354	0.99

SOURCE: Original calculations for this publication, based on data from the 2005 and 2018 census and CEED statistics (DANE 2016, 2019a, 2020c).

We can also construct the index by estimating supply based on formal housing project starts. In this case, there are fewer municipalities with data, as it must be directly surveyed, which can get very costly. The table below summarizes the results for all the municipalities with data. The index shows that the municipalities with the greatest shortages are Monteria, Valledupar, and Malambo, all in the Caribbean region. There are some municipalities that have been oversupplied with formal housing units.

# FIGURE A47 | Formal supply shortage: housing project starts

The municipalities in which the number of households decreased during the studied period are not considered. The municipalities in which supply outweighs household creation are manually assigned a 0 value. Some data correspond to municipal agglomerations, such as Bogota, which includes information from nearby municipalities as well.



SOURCE: Original figures for this publication, based on data from the 2005 and 2018 census and CEED statistics (DANE 2016, 2019a, 2020c).

TABLE A14 | **Formal supply shortage: formal housing project starts**

The municipalities in which the number of households decreased during the studied period are not considered. The municipalities in which supply outweighs household creation are manually assigned a 0 value. Some data correspond to municipal agglomerations, such as Bogotá, which includes information from nearby municipalities as well.

CATEGORY	DEPARTMENT	MUNICIPALITY	FORMAL STARTS	HOUSEHOLDS CHANGE	STARTS INDEX
Monteria	Cordoba	Monteria	3,859	45,334	0.91
Valledupar	Cesar	Valledupar	6,601	47,156	0.86
Malambo	Atlantico	Malambo	1,916	8,254	0.77
El Zulia	Norte de Santander	El Zulia	799	2,948	0.73
Santa Marta	Magdalena	Santa Marta	10,072	36,760	0.73
Sopo	Cundinamarca	Sopo	776	2,187	0.65
Turbaco	Bolivar	Turbaco	5,242	13,476	0.61
Cota	Cundinamarca	Cota	1,799	4,545	0.60
Funza	Cundinamarca	Funza	5,437	13,693	0.60
Tunja	Boyaca	Tunja	5,523	13,223	0.58
Facatativa	Cundinamarca	Facatativa	6,601	15,690	0.58
Barbosa	Antioquia	Barbosa	1,104	2,596	0.57
Palmira	Valle del Cauca	Palmira	13,384	30,433	0.56
Girardota	Antioquia	Girardota	1,905	4,321	0.56
Copacabana	Antioquia	Copacabana	4,114	8,979	0.54
Chia	Cundinamarca	Chia	8,530	17,964	0.53
Puerto Colombia	Atlantico	Puerto Colombia	3,427	6,864	0.50
Fusagasuga	Cundinamarca	Fusagasuga	9,917	18,784	0.47
Galapa	Atlantico	Galapa	4,569	8,382	0.45
Soledad	Atlantico	Soledad	23,558	40,828	0.42
La Calera	Cundinamarca	La Calera	1,677	2,875	0.42
Mosquera	Cundinamarca	Mosquera	14,954	24,850	0.40
Villamaria	Caldas	Villamaria	5,077	8,418	0.40
Cajica	Cundinamarca	Cajica	9,320	14,653	0.36
Manizales	Caldas	Manizales	21,442	33,617	0.36
Bello	Antioquia	Bello	42,616	65,542	0.35
Villavicencio	Meta	Villavicencio	31,754	47,830	0.34
Medellín	Antioquia	Medellin	141,188	210,170	0.33
Cartagena	Bolivar	Cartagena	38,591	53,586	0.28
Cucuta	Norte de Santander	Cucuta	29,721	40,105	0.26
Villa del Rosario	Norte de Santander	Villa del Rosario	8,356	11,054	0.24
Rionegro	Antioquia	Rionegro	10,342	13,380	0.23
Caldas	Antioquia	Caldas	5,120	6,443	0.21
Popayan	Cauca	Popayan	23,541	29,104	0.19
Yumbo	Valle del Cauca	Yumbo	5,752	6,871	0.16
Zipaquirá	Cundinamarca	Zipaquirá	11,766	13,995	0.16
Bogotá, D.C.	Bogotá, D.C.	Bogotá, D.C.	499,802	582,771	0.14
Los Patios	Norte de Santander	Los Patios	6,301	7,331	0.14
Itagüí	Antioquia	Itagüí	20,436	21,722	0.06
Soacha	Cundinamarca	Soacha	102,237	105,290	0.03
Floridablanca	Santander	Floridablanca	19,676	20,015	0.02



CATEGORY	DEPARTMENT	MUNICIPALITY	FORMAL STARTS	HOUSEHOLDS CHANGE	STARTS INDEX
Giron	Santander	Giron	12,823	12,411	-0.03
Madrid	Cundinamarca	Madrid	20,419	19,065	-0.07
Piedecuesta	Santander	Piedecuesta	20,150	18,483	-0.09
La Estrella	Antioquia	La Estrella	9,078	8,175	-0.11
Ibague	Tolima	Ibague	44,531	37,951	-0.17
Dosquebradas	Risaralda	Dosquebradas	22,010	18,195	-0.21
Envigado	Antioquia	Envigado	31,619	25,418	-0.24
Jamundi	Valle del Cauca	Jamundi	23,724	17,668	-0.34
Bucaramanga	Santander	Bucaramanga	51,641	37,091	-0.39
Barranquilla	Atlantico	Barranquilla	68,769	46,886	-0.47
Neiva	Huila	Neiva	27,262	17,443	-0.56
Armenia	Quindio	Armenia	30,462	18,582	-0.64
Pasto	Nariño	Pasto	28,745	17,264	-0.67
Sabaneta	Antioquia	Sabaneta	29,925	17,196	-0.74
Pereira	Risaralda	Pereira	37,553	20,386	-0.84
Cali	Valle del Cauca	Cali	118,398	56,834	-1.08

SOURCE: Original calculations for this publication, based on data from the 2005 and 2018 census and CEED statistics (DANE 2016, 2019a, 2020c).

The indices constructed in this annex may allow policymakers to prioritize the municipalities that have a larger shortage of formal housing developments. For big cities and agglomerations, the index shows where the government should focus in order to incentivize the formal market. In smaller municipalities, the government should reallocate efforts and budget towards the upgrading approach.

# Annex H: Human Capital and Housing

## H.1 The Human Capital Index and Colombia

### H.1.1 Parameters of the HCI

The ever-growing demand for high-skilled labor, driven by rapid technological changes, poses a risk for developing countries that lack the adequate institutions and policies to invest in human capital. The Human Capital Index (HCI), developed by the Human Capital Project, measures “the amount of human capital that a child born today can expect to achieve in view of the risks of poor health and poor education currently prevailing in the country where that child lives” (World Bank 2021a).

The HCI considers three main components: survival, expected years of learning-adjusted school, and health. Each of these indicators is weighted to form an index ranging from zero to one, with one being the productivity of a future worker with full health and education completed to the full extent available. Survival refers to the need for children to survive their five first years until the formal education process can begin; it is measured by the under-five mortality rate. Expected years of learning-adjusted school refers to the amount of education (in years) a child will have by the age of 18, adjusted by the quality of the education received based on the country’s international standardized test scores. There are two proxies for overall health: stunting, and the adult survival rate, which expresses the share of 15-year-olds who survive until age 60. These two metrics capture the early childhood health environment as well as potential health risks that can compromise human capital accumulation in the subsequent years.

### H.1.2 Colombia’s human capital index component scores

Colombia’s score of 59 on the HCI is calculated from its performance across the three components as shown in table A15.

TABLE A15 | Colombia’s HCI component scores

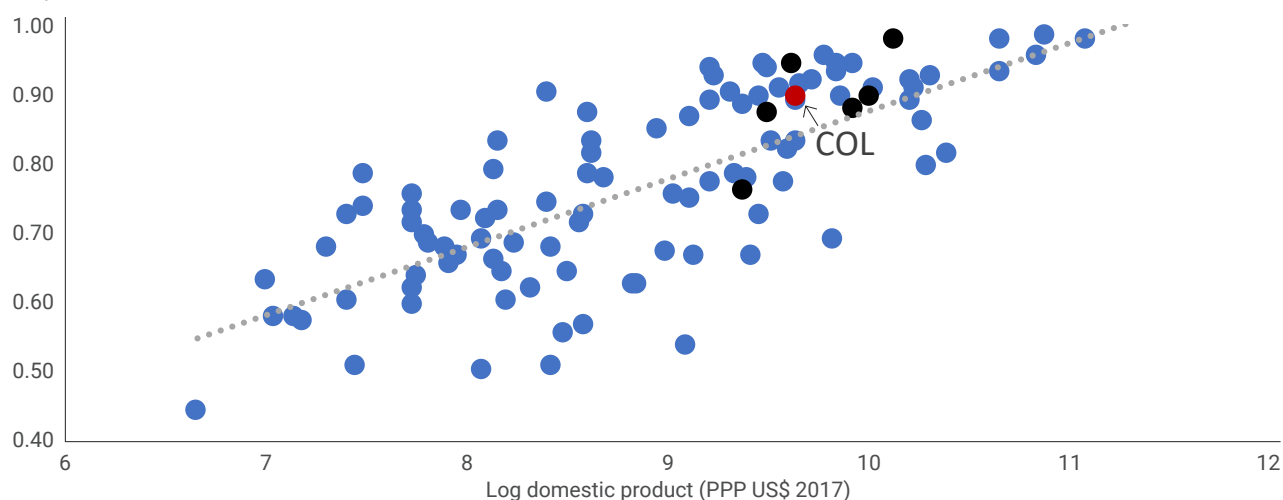
COMPONENT	25TH PERCENTILE	50TH PERCENTILE	75TH PERCENTILE	COLOMBIA
<b>Component 1: Survival</b>				
Probability of survival to age 5	95%	98%	99%	98%
<b>Component 2: School</b>				
Expected years of school	9.5	11.8	13.1	12.48
Test score (out of 600)	375	424	503	423.6
Quality-adjusted years of school	5.7	8	10.5	8.45
<b>Component 3: Health</b>				
Fraction of children not stunted	68%	78%	89%	89%
Adult survival rate	79%	86%	91%	86%
<b>Overall HCI</b>	<b>0.43</b>	<b>0.56</b>	<b>0.72</b>	<b>0.59</b>

SOURCE: World Bank 2021a.

Colombia over-performs in under-five mortality rates. Out of every 100 children, 99 will survive to age five, which will allow them to begin formal education and start accumulating human capital. Additionally, 86 percent of 15-year-olds will survive to age 60. Out of every 100 children, 11 are stunted, resulting in cognitive and physical limitations.

FIGURE A48 | **Fraction of children not stunted**

● Latin American countries ● Colombia  
Proportion of children under 5 not stunted



SOURCE: World Bank.

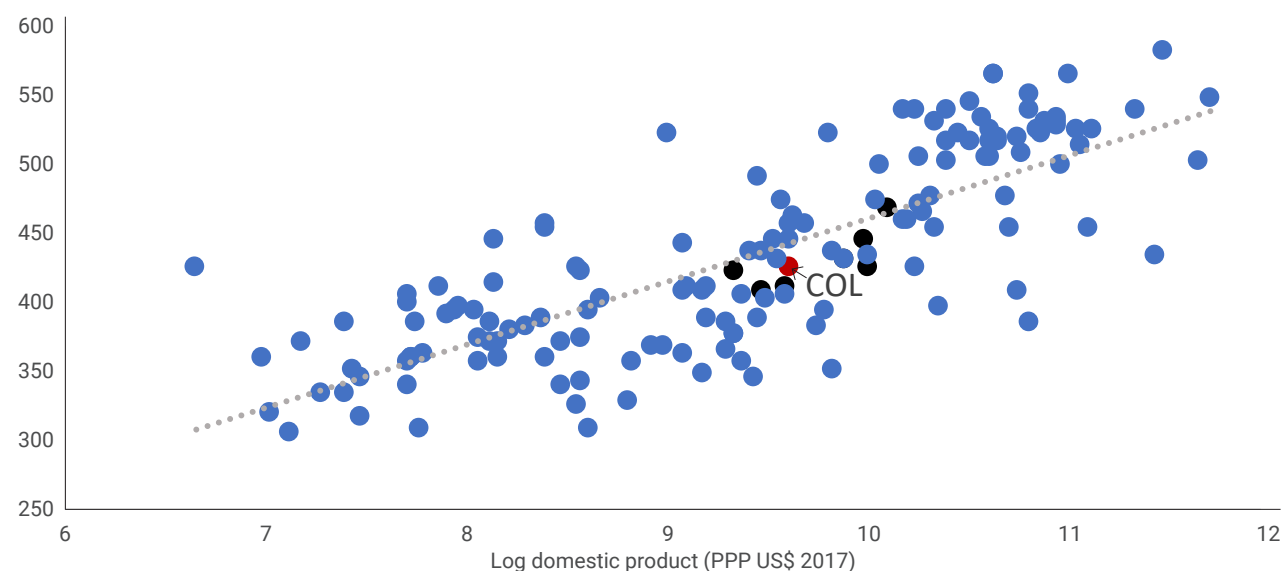
Colombia's score in the education component, however, is brought down by its low standardized test results, even though school enrollment and attainment rates are high. A Colombian child who starts school by age four is expected to have 12.5 years of education by the age of 18, which is approximately the regional average (12.48). International test scores in Colombia average 424 points, putting it just above the minimum-proficiency benchmark set by PISA (400), and coming in once again at the regional average (423.08). When adjusting by learning gained during school years, children in Colombia are expected to have 8.5 actual years of education by the age of 18, which means that up to four years of potential gains in education are lost.

FIGURE A49 | **Standardized test results by country**

Test scores aggregate four different international testing programs (PIMS, PISA, SACMEQ, and LLECE) that are harmonized using a specific methodology.

● Latin American countries ● Colombia

Test results



SOURCE: World Bank.

## H.2 Health Outcomes of Neighborhood Upgrading Programs

Neighborhood upgrading programs can boost human capital accumulation through a variety of mechanisms. Bayona (2016), for example, finds that upgraded schools with better infrastructure have lower repetition rates and improved academic results. Soares and Soares (2005) analyze the effects of Favela-Bairro, an urban upgrading program implemented in 38 favelas in Rio de Janeiro that provided community development and guarantees of property rights. The authors measure the impact of 84 public works and other projects, using propensity score matching with differences-in-differences, given that the allocation of resources took into account observable variables. The new infrastructure resulted in an improvement in the variables directly targeted by the project – water access, sewerage, and rubbish collection. Moreover, human capital variables, which were *not* directly targeted, also improved, which demonstrates the positive externalities of housing intervention policies. After implementation, treated communities showed a decrease in illiteracy and in the number of household heads with fewer than four years of education. Treated favelas also presented a slight decrease in the proportion of deaths caused by disease, although this effect was not statistically significant.

Neighborhood-upgrading programs can have significant impact on human capital by improving residents' health. As discussed in Chapter 6, poor household and neighborhood conditions have been correlated with reduced health outcomes. For instance, an analysis of infant mortality from São Paulo shows higher coefficients of infant mortality for residents of favelas or informal areas (Ventura et al. 2008).

Given this correlation, several countries have had success in improving the health of slum residents through upgrading or retrofitting projects. The list in table A16, though not exhaustive, is meant to illustrate the range of slum-upgrading projects globally, and demonstrate the potential of participatory, integrated projects to improve human health. The authors summarize selected characteristics of each slum-upgrading project and whether and how it was evaluated for impacts on human health.

TABLE A16 | Examples of impacts of upgrading programs in developing countries

PROJECT NAME AND LOCATION	FOCUS OF UPGRADING	HEALTH AND WELL-BEING IMPACTS
Slum Networking Project (SNP) Ahmedabad, India	Infrastructure, governance, electrification	Reduction in water-borne illness
Zonal Improvement Program (ZIP) Manila, Philippines	Water, roads, housing, land rights, electricity	Reduced incidence of diarrhea
Neighborhood Upgrading and Shelter Indonesia	Roads, streetlights, water, toilets, solid waste management	Avoided health costs
Karachi, Orangi Pilot Project (OPP) Karachi, Pakistan	Water, sanitation, capacity-building	Reduced infant mortality
Favela Bairro Rio de Janeiro, Brazil	Infrastructure, housing, social programs	Reduced mortality from parasitic or viral vector-borne infections, infant mortality, and homicides
Bairro Legal Sao Paulo, Brazil	Infrastructure, housing, social and economic development	Improved flood control
Hanna Nassif Upgrading Dar es Salaam, Tanzania	Infrastructure, employment, tenure, transport	Reduced waterborne diseases (unspecified)

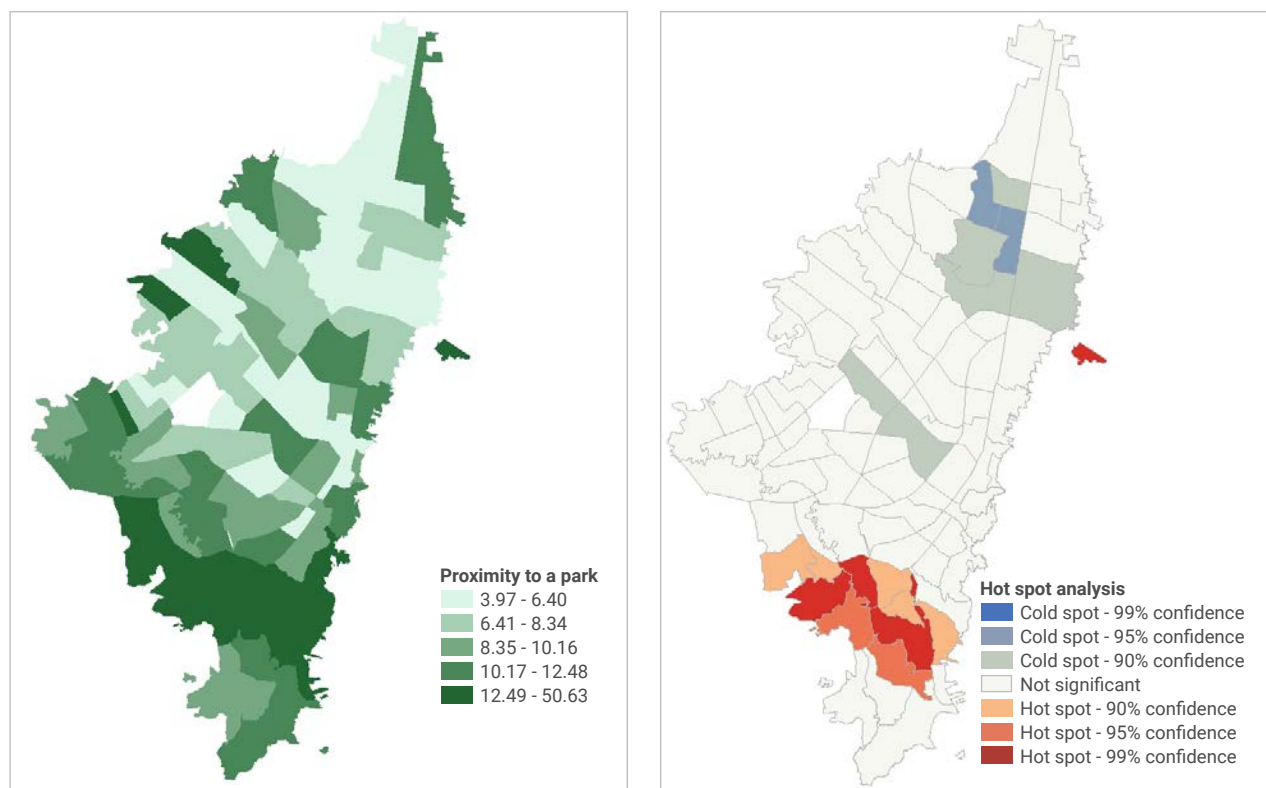
SOURCE: Corburn and Sverdluk 2017.

Another key human capital variable that can be improved through neighborhood upgrading projects – sometimes with a direct effect on health – is the quality of public infrastructure. Eisenberg et al. (2006) show that paving roads is statistically linked to reduced transmission of diarrheal pathogens in rural Ecuador.

But a crucial form of public infrastructure that may boost human and social capital, including by improving health, is recreation space and parks. For example, the *Mi Parque* program sought to improve access to green spaces in the city of Santiago de Chile, targeting lower-income communities. According to CAF (2014), after the program's implementation, these communities frequented green spaces more and had a greater engagement in community activities. By building new parks to increase the number of residents with easy access to a recreation space, or enhancing the quality of extant parks, neighborhood-upgrading programs may also increase their positive impact on health outcomes. There is a relationship between regular physical exercise and the probability of illness, so increasing residents' propensity to exercise by offering easy access to a high-quality park will improve the development of human capital.

Using data from the *Encuesta Multipropósito de Bogotá* (Secretaría Distrital de Planeación de Bogotá 2015), we evaluated how proximity to public green spaces changes the probability of exercising. Figure A50 shows the mean distance to a park from each neighborhood in the city of Bogotá. According to the survey data, the average citizen needs to walk 8.41 minutes to reach a public park. There is an uneven distribution of public green spaces in Bogotá: park infrastructure is concentrated in the city's wealthier neighborhoods. For lower-income families who live in the southern neighborhoods, access to parks is more limited. A lack of parks also coincides with a higher prevalence of housing deficit, which suggests that neighborhood improvements should be one of the goals of housing policy.

FIGURE A50 | Proximity to a public green space in Bogotá and hot spot analysis (walking minutes)



SOURCE: Original figures for this publication, based on data from Secretaría Distrital de Planeación de Bogotá 2015.



Using the same data, we found that proximity to green space is statistically correlated with the probability of exercising even if we control for family income. People who live within a five-minute walk of a park in Bogota are 6 percentage points more likely to exercise regularly than individuals who live outside this radius.

## H.3 Statistical analysis of housing deprivations and human capital in Colombia

### H.3.1 Results

After carrying out a number of statistical analyses, we found several housing deprivations to be correlated with human capital accumulation variables in Colombia. These results build upon the extensive literature on housing conditions and wellbeing presented above and in Chapter 6.

As discussed in Chapter 6, our results suggest that wall deprivations, overcrowding, inadequate meal preparation facilities, lack of access to water supply, poor sanitation, and poor garbage collection all have a negative and statistically significant effect on 11th-grade standardized test scores at the municipal level. Although the low variance deters us from finding any causal effect of housing deprivations on standardized test results at the municipal level, we did find that the program has a statistical effect on the housing deficit (see below for the full analysis). These expected results are consistent across different subjects and control variables.

TABLE A17 | Standardized 11th-grade test scores and housing deficit indicators

CONTROL	SOCIAL SCIENCE SCORE	NATURAL SCIENCE SCORE	MATH SCORE	READING SCORE
Wall deprivation	-4.31***	-5.37***	-5.39***	-3.36***
Cohabitation	-1.01	-0.16	-0.17	-0.92
Overcrowding	-9.34***	-7.61***	-7.83***	-7.94***
Kitchen	-3.88***	-3.2***	-3.90***	-3.31***
Water supply	-1.75***	-2.27***	-2.37***	-1.64***
Sewer/restroom	-3.00***	-2.93***	-3.42***	-2.96***
Electricity	-5.25	-4.77	-4.1	-6.15
Garbage	-1.44***	-1.72***	-2.14***	-1.91***
Population	0.000029**	0.000029**	0.000014**	0.000026**
Income per capita	3.34	3.06	2.99	5.98
Teacher quality	6.55***	6.43***	7.25***	5.91***
Parents' education	0.90***	0.50***	0.58*	0.58
Fixed effects	YES	YES	YES	YES
Robust errors	YES	YES	YES	YES
Observations	1,024	1,024	1,024	1,024
R-squared	0.59	0.6072	0.650	0.667

SOURCE: Original calculations for this publication, based on data from DANE, Ministry of Education.

Our second estimation related the probability of school attendance to housing deprivations. Using individual data for all children in the country, we found that good housing conditions are positively correlated with school attendance. In this specification, both the dependent variable and the housing covariates are binomial, so results can be read as follows: a child living in a housing unit that presents a specific housing deprivation is  $(100 \cdot \beta)$  percentage points less likely to attend school. Re-

sults are presented in table A18, keeping in mind that the attendance rate for the urban sample is 84.23 percent. Despite the statistical correlation between the covariates used in the exercise, the test results for multicollinearity are negative for the independent variables (see below).

To assess health effects, we relied on self-response forms in which people were asked if they had been sick during the previous 30 days, using data only from families in which at least one member is younger than 18.<sup>6</sup> We regressed this information on housing deprivations present in the housing unit the children lived in, using control variables that included household employment status and home strata. The coefficients of the regression can be interpreted thusly: living in a housing that presents a deprivation  $k$  increases or decreases by  $(100 * \beta)$  percentage points the probability that at least one child member of that family was sick during the last month.

### H.3.2 Model Specifications

To discover the correlation between housing deprivations in Colombia and human capital accumulation variables, we performed a statistical analysis at two levels of aggregation. First, we relied on administrative data to estimate the relationship of housing deprivations and human capital accumulation at a municipal level. Collating information provided by the National Agency of Statistics (DANE), the Ministry of Education, and the Ministry of Health, we created a municipal database that combines housing information with education and health data. Second, we used the 2018 census data to perform a statistical analysis on individual information. With more than 33.3 million observations, we found this to be quite a robust estimation to multiple specifications.

The first estimation suggests a very strong relationship between all the housing deprivation categories and human capital variables at a municipal level. This ordinary least squares (OLS) estimation regresses standardized test scores by

TABLE A18 | **School attendance and housing conditions**

CONTROL	ATTENDANCE	EFFECT ON ATTENDANCE (PERCENTAGE POINTS)
Floor deprivation	-0.0245***	-2.45%
Wall deprivation	-0.0244***	-2.44%
Cohabitation	-0.0526***	-5.26%
Overcrowding	-0.0477***	-4.77%
Kitchen	-0.0272***	-2.72%
Water supply	-0.0184***	-1.84%
Sewer/restroom	-0.0200***	-2.0%
Garbage	-0.0340***	-3.40%
Age	-0.1967***	-19.67%
Handicap	-0.086***	-8.6%
Parent working status	0.0018***	0.8%
Parents' education	0.007***	0.6%
Strata	0.036***	2.4%
Fixed effects	YES	–
Robust errors	YES	–
Observations	7,674,216	–
R-squared	0.056	–

SOURCE: Original calculations for this publication, based on data from DANE.

TABLE A19 | **Illness and housing conditions**

CONTROL	CHILD MILD ILLNESS	EFFECT ON MILD ILLNESS (PERCENTAGE POINTS)
Floor deprivation	0.0024***	0.24
Wall deprivation	0.0002***	0.02
Overcrowding	0.0227***	2.27
Kitchen	0.0181***	1.81
Water supply	0.005***	0.05
Sewer/restroom	0.004***	0.04
Garbage	-0.005***	-0.05
Parent working status	0.0005***	
Parents' education	0.006	
Strata	0.0002***	
Fixed effects	YES	
Robust errors	YES	
Observations	5,827,519	
R-squared	0.017	

SOURCE: Original calculations for this publication, based on data from DANE.

<sup>6</sup> Self-reporting data may suffer from measurement error for the dependent variable; however, under the conditional independence assumption, the estimators reported are still unbiased.

subject over housing conditions at a municipal level. In order to reduce endogeneity bias, we controlled for the municipality's gross domestic product, its population, the proportion of teachers with a master's degree, and the average years of education of the head of household. Housing deprivations are measured as the proportion of households that presents each deprivation by municipality. Standardized test scores by municipality are reported as the average subject score, ranging from 0 to 100. Finally, we include a fixed effect by state,  $\delta$ .

$$y_i = \beta X + \gamma Z + \delta_j + \epsilon_i$$

where:

$y_i$  : mean standarized test score for municipality (i)

$X_{i,k}$  : proporpotion of households with deprivation (k) in municipality (i)

$Z_i$  : control variables for municipality (i)

$\delta_j$  : dummy variable for state (j)

Thus, an increase in 1 percentage point in the proportion of households with deprivation (k) is equal to a  $\beta$  increase/decrease in the mean score on 11th-grade standardized tests.

$$\partial y / \partial X_k = \beta$$

Our second estimation relates the probability of school attendance to housing deprivations, using individual data for all children in the country, by means of a linear probability model. We found that good housing conditions are positively correlated with school attendance. Control variables include a proxy variable for income, age, physical condition, parents' job status, and number of schooling years. Finally, fixed effects at the municipality level were included in order to reduce possible omitted-variable bias.

$$y_i = \begin{cases} 1 & \text{if child } i \text{ attends school} \\ 0 & \text{if child } i \text{ does not attend school} \end{cases}$$

$$x_{ik} = \begin{cases} 1 & \text{if child } i \text{ lives a house with deprivation } k \\ 0 & \text{if child } i \text{ does not live in a house with deprivation } k \end{cases}$$

$Z_i$  : control variables for child (i)

$\delta_j$  : dummy variable for municipality (j)

$$P(y_i = 1 | X, Z, \delta) = \beta X + \gamma Z + \delta_j + \epsilon_i$$

### H.3.3 Testing an Instrumental Variable for Housing Deficit

In order to test the robustness of our analysis, we performed an instrumental variable exercise. We took advantage of the free housing program (PVG) that has been implemented by the national government since 2011. Our instrumental variable is obtained through a propensity score matching method. The municipalities where the program was implemented were selected through clear criteria that included poverty levels, population displaced by violence, and major risk zones. We limited our analysis to municipalities with a population less than 30,000.

We performed an output evaluation of the free housing program on the housing deprivation variables. Using a neighborhood-level analysis, we found that our results are robust to multiple specifications. The free housing program reduces housing deficits in municipalities with less than 30,000 inhabitants; the results suggest that the program reduces the qualitative deficit by 4.4 percentage points and the quantitative deficit by 5.05 percentage points. Given that there is a statistically significant

correlation between the program and housing deficits, we can proceed to use this as an instrumental variable. Once we control for the selection criteria, the free housing program should not explain the standardized test results at the municipal level.

TABLE A20 | **Propensity score matching results, PVG on housing deficit**

VARIABLE	SAMPLE	TREATED	CONTROLS	DIFFERENCE	T-STAT
<b>Qualitative deficit</b>	Unmatched	0.253	0.301	-0.0446	-2.51
	ATT	0.253	0.3	-0.044	-2.62
<b>Quantitative deficit</b>	Unmatched	0.065	0.112	-0.047	-3.52
	ATT	0.065	0.115	-0.505	-5.25

SOURCE: Original calculations for this publication.

We found that the housing deficit had on standardized test results once we instrumentalized housing deficit using the free housing program. Although the results are as expected, there is not enough variance in the quantitative deficit, which prevents us from making any causal inference.

### H.3.4 Testing for Multicollinearity

Given that housing deprivations tend to go hand to hand, we performed a multicollinearity analysis for the census data specifications. We first present the Pearson Correlation matrix that shows that, indeed, housing deprivations and strata are statistically correlated. However, this correlation is not as high as expected, with a maximum correlation of 0.48 (between the presence of water supply and sewerage deprivations).

We proceeded to perform a Variance Inflation Factor analysis, in which we regressed every covariate against the explanatory variables and obtained the R-squared for each regression. Although statistically significant, the specification only explains 25 percent of the variance for each variable. We compared the results to the variance inflation factor threshold of 5, which indicates a multicollinearity problem, and no variable presented an index higher than 1.33. We can therefore dismiss this concern as a threat for our model.

TABLE A21 | **IV results**

CONTROL	STANDARDIZED TEST SCORE	Z-SCORE
<b>Quantitative deficit (IV=PVG)</b>	4.371	0.4
<b>Inhabitants</b>	-0.007	-2.52
<b>Income per capita</b>	11.4	2.77
<b>Teacher's education</b>	14.71	7.13
<b>Parents' education</b>	-1.61	1.82

SOURCE: Original calculations for this publication.

TABLE A22 | **Pearson correlation coefficients**

	FLOORS	WALLS	KITCHEN	WATER SUPPLY	GARBAGE	SEWERAGE	COHABITATION	OVERCROWDING	STRATA
<b>Floors</b>	1								
<b>Walls</b>	0.43*	1							
<b>Kitchen</b>	0.32*	0.24*	1						
<b>Water Supply</b>	0.22*	0.31*	0.19*	1					
<b>Sewerage</b>	0.29*	0.33*	0.26*	0.48*	1				
<b>Garbage</b>	0.29*	0.27*	0.23*	0.36*	0.41*	1			
<b>Cohabitation</b>	0.02	0.01*	0.03*	0.01*	0.02*	0.01*	1		
<b>Overcrowding</b>	0.16*	0.14*	0.19*	0.11*	0.16*	0.12*	0.07*	1	
<b>Strata</b>	-0.16*	-0.18*	-0.17*	-0.19*	-0.26*	-0.18*	-0.06*	-0.27*	1

SOURCE: Original calculations for this publication.

TABLE A23 | **Variance inflation factors**

VARIABLE	R-SQUARED	VARIANCE INFLATION FACTOR
Floors	0.25	1.33
Walls	0.24	1.32
Kitchen	0.18	1.22
Water Supply	0.16	1.19
Garbage	0.21	1.27
Sewerage	0.23	1.30
Cohabitation	0.008	1.01
Overcrowding	0.1	1.11
Strata	0.14	1.16

SOURCE: Original calculations for this publication.



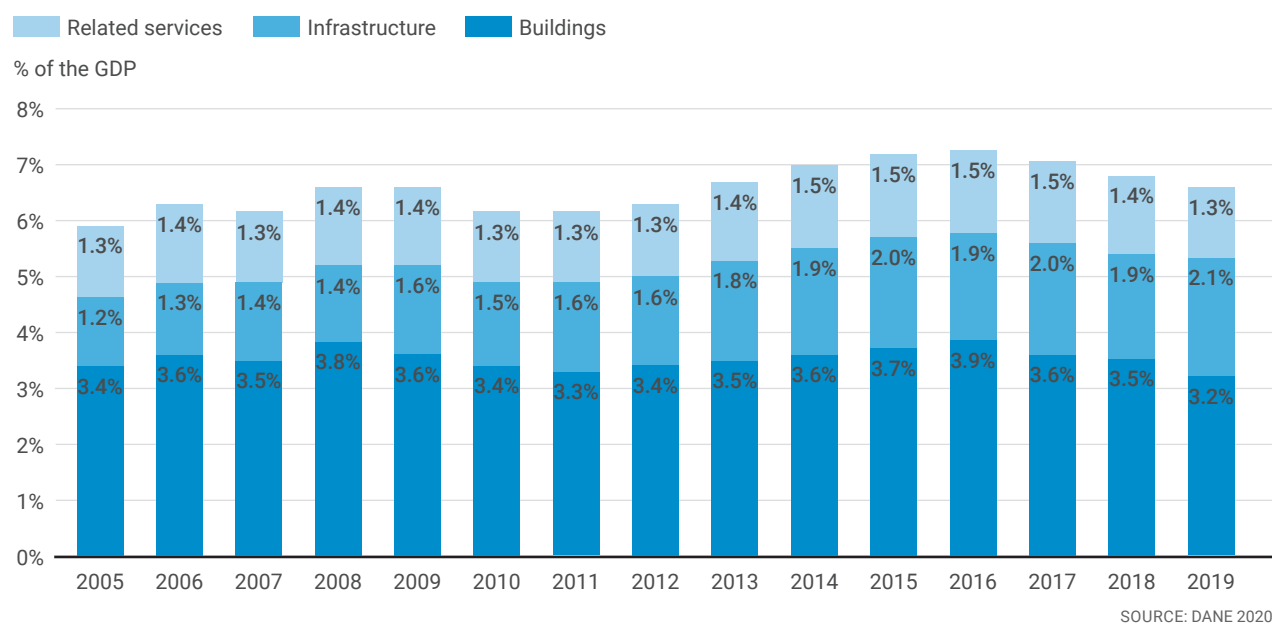
# Annex I: Economic and Employment Impact of the Construction Sector

## I.1 Context: Characterizing the Construction Sector in Colombia

### I.1.1 Construction Output and Employment

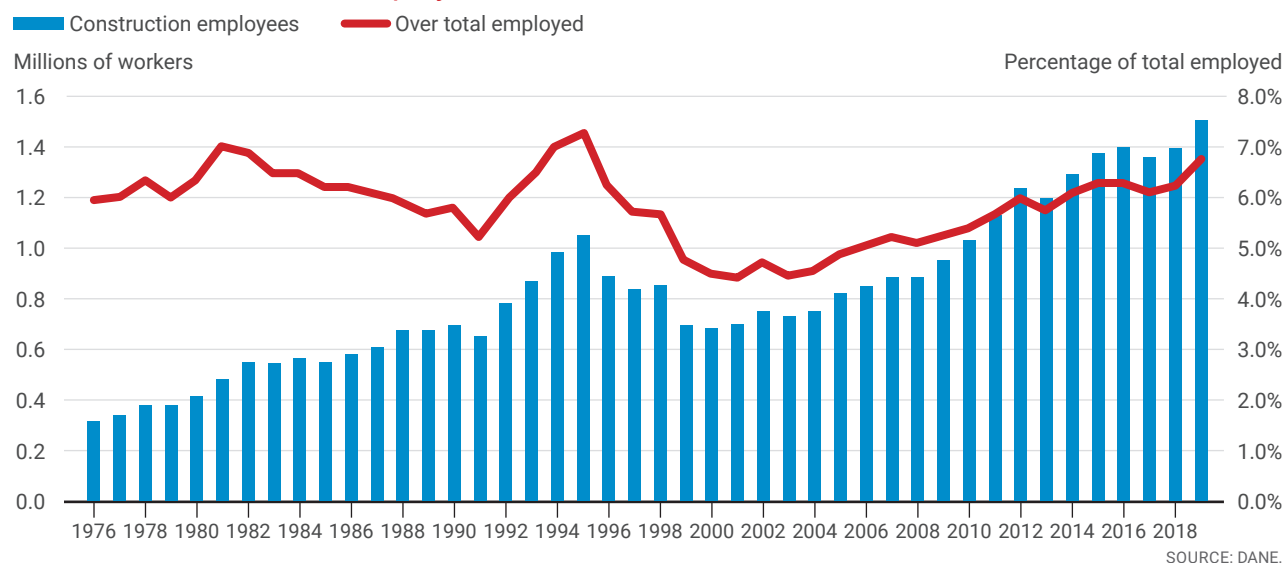
Construction's contribution to GDP (6.6 percent) is higher in Colombia than in high-income countries, where it averages 5 percent, but lower than in low-income countries, where it is greater than 8 percent (UNCTA 2019). As a percentage of Colombia's GDP, the construction sector has shrunk slightly since its 2016 level of 7.3 percent, when private building, fostered by the government's free-housing programs, reached its highest level (3.9 percent of GDP). Infrastructure and construction-related services have remained relatively constant.

FIGURE A51 | Construction's contribution to Colombian GDP, 2005–2019



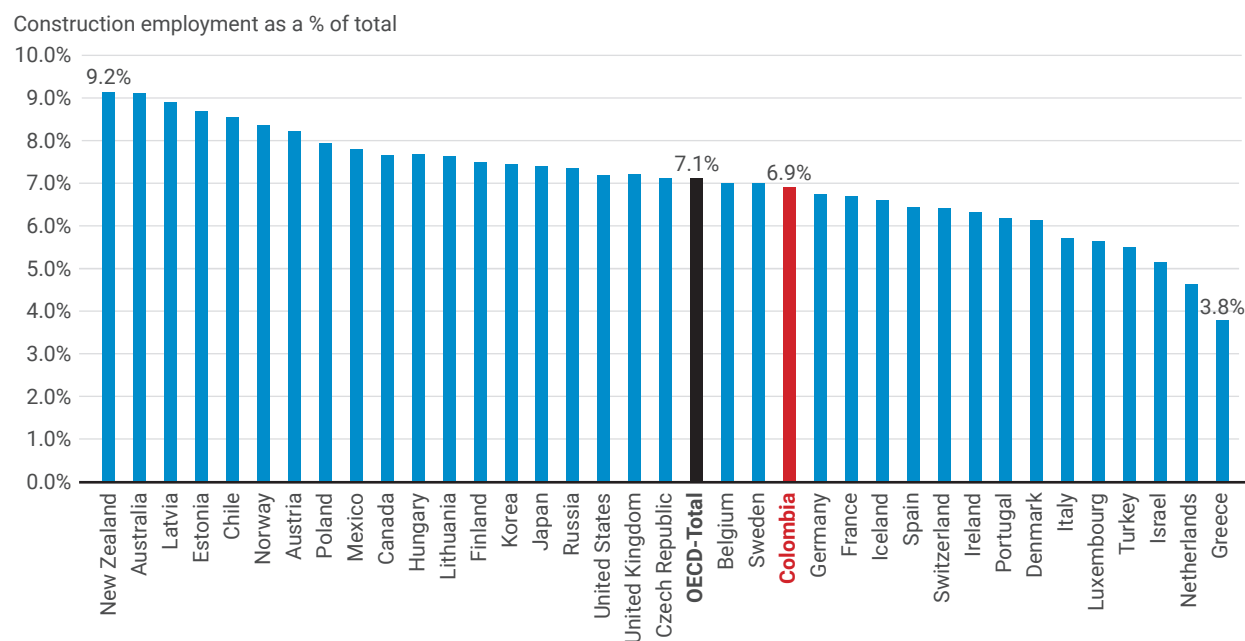
The construction sector accounts for approximately the same proportion of employment as it does of GDP. Overall, the number of construction workers in Colombia has trended upward over the past two decades. The sector peaked in 1995 (7.3 percent of GDP, 1.05 million workers) but experienced a severe slump during the 1999 crisis, reaching its lowest point in 2001 (4.5 percent of GDP, 710,000 workers); since then, it has gradually recovered to its present levels (figure A52).

FIGURE A52 | **Construction employment in Colombia, 1977–2019**



When compared with countries in the OECD (Organization for Economic Co-operation and Development), construction in Colombia contributes slightly less to total national employment than the global average of 7.1 percent (figure A53).

FIGURE A53 | **Construction employment as a proportion of total employment by country**

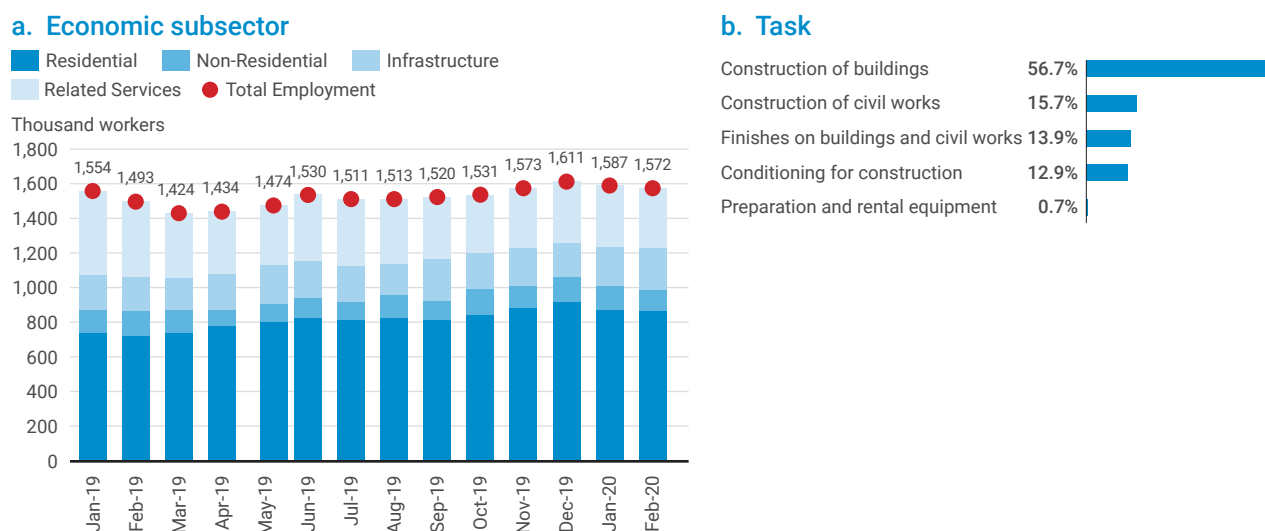


### 1.1.2 Characteristics of Construction Workers

Construction workers can be disaggregated along various dimensions. The first is the construction sector's three subsectors: private construction (both residential and non-residential), public infrastructure, and construction-related services. More than half of Colombian construction workers participate in private residential construction (see panel A of figure A54), the focus of this report. A

second disaggregation considers workers' tasks: 56.7 percent work on the construction of buildings, followed by infrastructure construction (15.7%), finishes (13.9%), and conditioning (12.9%), with a marginal contribution from rental equipment (see panel B).

FIGURE A54 | Construction employment by subsector and task

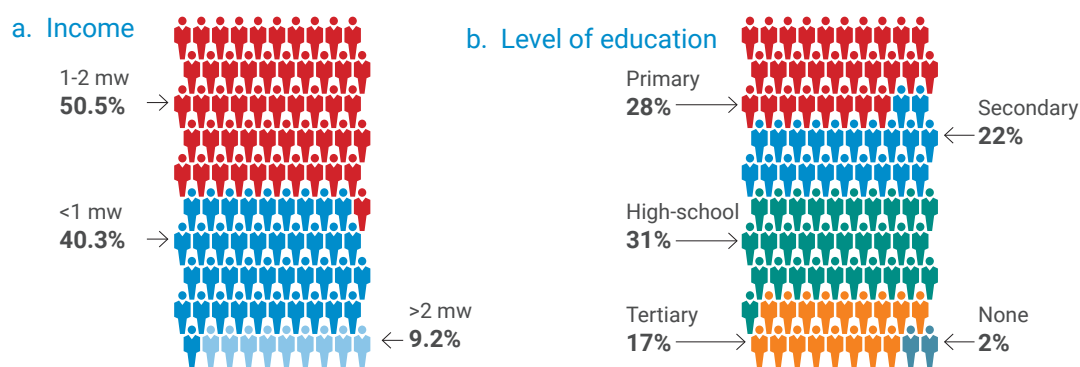


SOURCE: Data provided directly to the authors by the Colombian Ministry of Housing.

Workers can also be disaggregated by various demographic characteristics, an analysis that can help us determine the distributive effects of job loss (or job creation) in the construction sector. When the economy contracts, the sector expels workers, pushing them into either unemployment or informal employment; but the effects of such expulsions can vary based on the average demographic attributes of construction workers.

The first characteristic of note is an extreme gender imbalance: 94.2 percent of the sector is male. The second key characteristic, as discussed in Chapter 6, is that most Colombian construction workers can be classified as vulnerable. As figure A55 shows, construction workers tend to have low income and low levels of education. These characteristics underscore the need to thoughtfully design and implement any policies intended to promote construction (and, consequently, its labor demand), since the economic absorption of these vulnerable populations is essential to keeping them out of poverty.

FIGURE A55 | Demographic characteristics of construction workers in Colombia



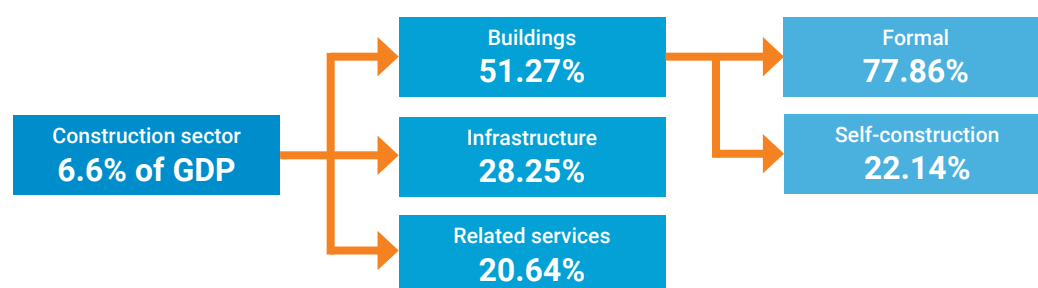
SOURCE: CAMACOL 2019.

## 1.2 Macroeconomic Contribution of Construction to the Colombian Economy

### 1.2.1 Disaggregation of the Construction Sector

In Colombia, construction activity can be disaggregated into three subsectors. The first one – the focus of this analysis – is construction driven by private-sector demand, most of which is residential.<sup>7</sup> As will be shown in this chapter, residential construction can in turn be disaggregated into the formal and self-construction components, with the former representing almost four-fifths of the total added value. The second main subsector of construction activity, infrastructure (or civil works), comprises state demand for the building of public works (roads, bridges, docks, pipelines, etc.). Finally, the third subsector represents complementary services that are specific to the construction sector. In the Colombian economy, these three activities contributed 6.6 percent of GDP in 2018 (see figure A56). The macroeconomic effect of the construction sector is amplified by the forward and backward linkages connecting it to the rest of the economy.

FIGURE A56 | Disaggregation of Colombia's construction sector



SOURCE: DANE 2018; Rangel 2011.

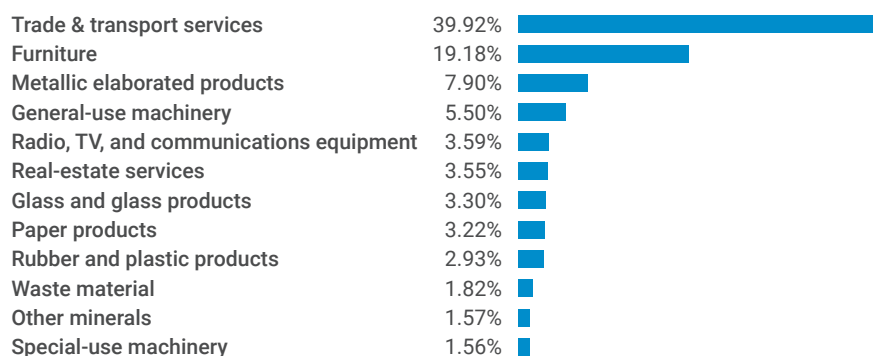
### 1.2.2 Backward and Forward Linkages of the Construction Sector

We can identify economic activities related to the construction sector by performing analyses in two directions: upstream (backward linkages) or downstream (forward linkages).

The upstream analysis identifies the providers for the construction sector – that is, the intermediate inputs that must be procured from other areas of the Colombian economy to successfully complete construction activities. As figure A57 shows, in Colombia, the process of construction relies mostly on trade and transport services (39.2%), followed by furniture (19.2%), metallic elaborated products (7.9%), and general-use machinery (5.5%). Additional minor contributions are made by communications equipment, real-estate services, and products made of glass, paper, rubber, and plastic.

<sup>7</sup> Private construction includes both residential and non-residential buildings, with the former representing almost three-quarters of total output. Non-residential construction includes industrial facilities, trade and office buildings, and warehouses.

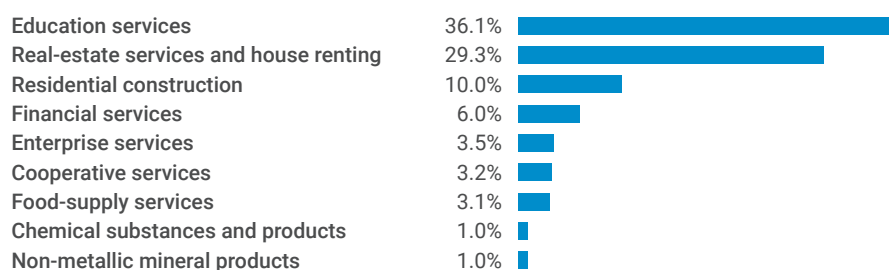
FIGURE A57 | **Backward linkages of the construction sector, 2018**



SOURCE: Original calculations for this publication, based on data from DANE.

The downstream analysis identifies sectors and economic activities that rely on the construction sector as one of the main providers for their production process.<sup>8</sup> Figure A58 demonstrates how demand for construction in Colombia is concentrated in the education sector (36.1%), real-estate services and house renting (29.3%), residential construction (10%), and financial services (6%).

FIGURE A58 | **Forward linkages of the construction sector, 2018**



SOURCE: Original calculations for this publication, based on data from DANE.

### 1.2.3 Labor Intensity of Construction Activities

To calculate different housing policies' impact on employment (as we have done in Chapter 6), we need information about the labor intensity of different types of residential construction activities.

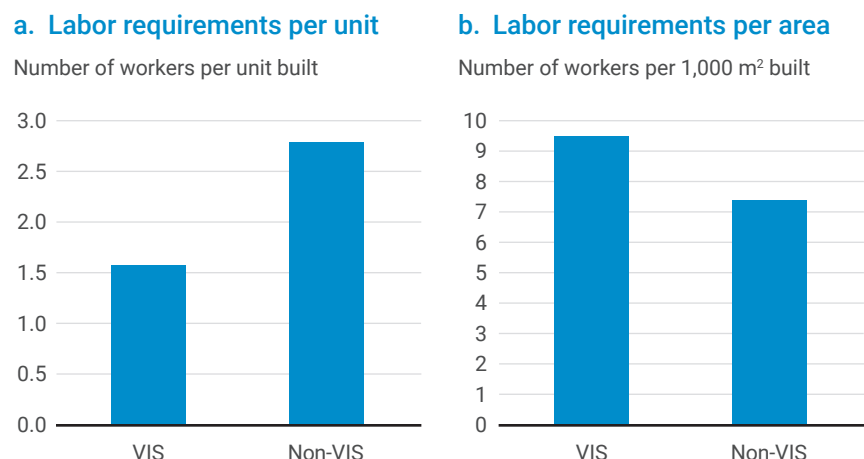
The first step in this process is to differentiate the employment generated by the two types of housing in Colombia. There is a distinction between basic residential buildings (social-interest housing, or 'VIS') and more sophisticated residential buildings ('non-VIS'). The former are targeted toward the low-income population, whereas the latter are acquired by middle- and high-income families. Figure A59 (panel A) shows the labor force required for each unit of VIS and non-VIS housing. As expected, given its higher sophistication and size, non-VIS housing requires a larger number of construction workers (2.78 workers per unit on average) in comparison to VIS housing (1.57 workers per unit). There are two main explanations for this difference. First, the construction process takes considerably longer for non-VIS (between 35 and 41 months) than for VIS housing (18 months at most). Second, the dimensions of the housing types differ: while VIS units average 58.8 square meters, that number rises to 103.8 square meters for non-VIS housing units. We can verify the effect of this sec-

<sup>8</sup> In order to find the backward linkages on the Input–Output matrix, we analyzed the construction sector column, which displays the purchases made by construction from other sectors. In contrast, for the forward linkages, we analyzed not the column but the row of the Input–Output matrix corresponding to the construction sector, which registers the purchases made by other sectors to the construction sector.



ond factor by comparing the labor requirements per area, shown in panel B: the quantity of workers required to construct 1,000 square meters of VIS housing (9.5) is actually larger than the workers required for constructing the same area of non-VIS housing (7.4). Because non-VIS houses are larger, however, they require more workers on the whole.

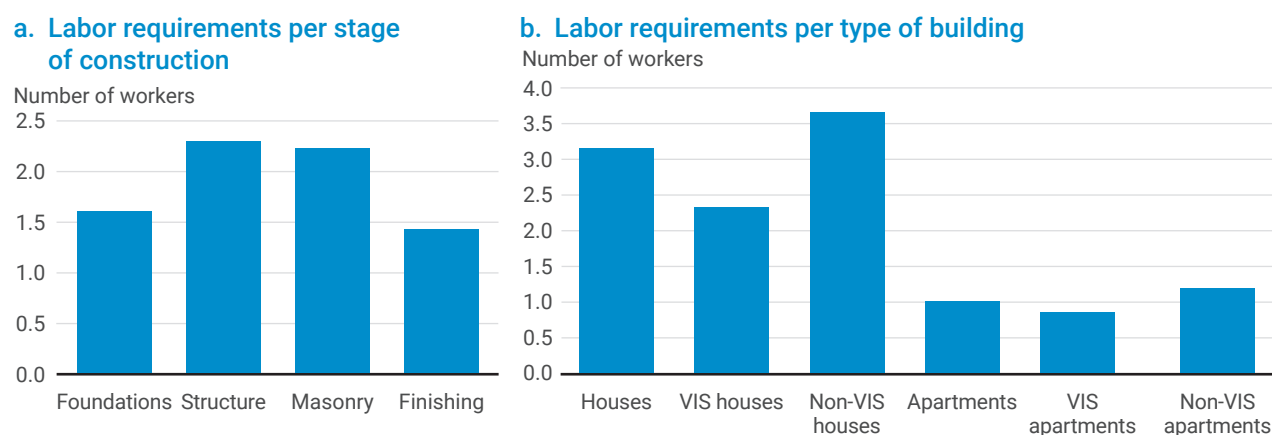
FIGURE A59 | **Labor intensity per type of housing**



SOURCE: Data provided directly to the authors by the Colombian Ministry of Housing.

A second way of disaggregating the labor requirements involves analyzing each stage of the construction process, as in panel A of figure A60. The initial and final stages of construction (foundations and finishings, respectively) demand fewer workers than the middle ones (structure and covering, then masonry). This diversity of labor intensities may explain the differential labor requirements among different kinds of buildings. As panel B shows, apartments demand a much lower quantity of workers than houses, arguably because of economies of scale in the foundations and structure stages.

FIGURE A60 | **Labor intensity per stage of construction and type of building**



SOURCE: Data provided directly to the authors by the Colombian Ministry of Housing.

### 1.3 Calculating the Construction Sector's Macroeconomic Multipliers

As with most economic activities in Latin American economies, construction in Colombia can be divided into its formal and informal (or self-construction) branches. Unfortunately, as in the rest of Latin America, informality is quite pervasive in the Colombian economy: in the 13 largest cities, 47

percent of the total workforce is engaged in informal labor, a figure that rises to 62 percent if rural areas are taken into account (GEIH 2019). The informal branch of construction absorbs a large portion of the labor force, but its productivity is far lower than that of its corresponding formal branch. There are several causes for this low productivity, ranging from informality's small-scale, labor-intensive production technologies – with very low levels of capital per worker – to its minimal or complete lack of access to credit and to productivity-enhancing technologies. Unlike formal construction – which may be properly supported by access to credit facilities, wholesale acquisitions of construction inputs, and sophisticated mechanisms for marketing and sales – informal projects are characterized by minimal or no access to labor-intensive technologies and credit facilities (with the exception of microcredits supplied by specialized institutions).

Below, we comprehensively quantify the macroeconomic contribution of both branches of the residential construction sector, considering not only direct impacts on supply, but also indirect effects on both the activity of related sectors and on the aggregate demand of households.

First of all, it is important to understand the three main components of an economic multiplier: direct, indirect, and induced effects. The direct effect captures an economic activity's impact on the sector itself and its direct providers; it can be disaggregated into the initial effect on the sector, and the first-round consequences on its providers. As these providers see an increase in demand, there is, in turn, a knock-on effect for their providers; these knock-on consequences are captured by the indirect effect, which also quantifies successive rounds of expenditures. Finally, the induced effect shows how this expansion of output across the whole economy leads to an increase in household salaries, which in turn raises private consumption and additionally boosts total output.

The analysis we used to estimate the construction sector's macroeconomic multipliers captures the successive iterations of demand and expenditure that occur in the economy whenever a positive shock is produced by construction activity, and enables us to estimate macroeconomic multipliers for Colombia's private construction sector in terms of output, employment, salaries, and taxes. The subsections below contain results for each of those macroeconomic multipliers for both the formal and the self-construction sectors.

The exercise carried out in this section is related to the backward linkages of the construction sector – that is, it depends on how an increase in the output of construction can foster activity in those sectors that provide the inputs for the construction process. Although the multipliers for the forward linkages do not have the same economic interpretations and relevance, the Ghosh multiplier for output is shown in the last section as a reference, together with the general comparison of both backward and forward multipliers.

### 1.3.1 Methodology for the Estimation of Macroeconomic Multipliers

To estimate the construction sector's macroeconomic multipliers, we use the Leontief methodology, based on information provided by the Input–Output matrix (for intermediate consumption of sectors) and the Social Accounting Matrix (which permits us to include households' consumption and labor remuneration; see Kuehn, Procter, and Braschler 1985). Before explaining the technical aspects of the methodology, it might be useful to discuss these sources of information. The direct and indirect effects can be estimated using the Input–Output (I-O) matrix; for the induced effects, we must use the extended I-O matrix, that is, the Social Accounting Matrix (SAM). The direct effect can be estimated directly from the coefficients of the I-O matrix or the SAM, while the indirect and induced effects, which capture subsequent iterations of economic interrelations, require a further treatment of the matrix.

The Input-Output methodology is essentially based on matrix algebra. Both the I-O and the SAM can be defined as an integrated combination of matrices that show the equilibrium between the supply and demand of goods and services in the economy.<sup>9</sup> While the I-O matrix shows the technology structure of the intermediate consumption of each sector, the SAM extends this information with the remuneration to the factors of production and the demand of institutional agents, such as households, firms, government, and the global market. In this sense, the SAM can be considered a natural extension of the I-O matrix (Bon and Pietroforte 1990; Ilhan and Yaman 2010; Bielsa and Duarte 2011).

The basic Input-Output model comes from the identity:

$$X = AX + Y \quad (1)$$

where  $X$  and  $Y$  are vectors corresponding to the total production and final demand, respectively, of every sector of the economy.  $A$  is a square matrix with the technical requirements, with  $a_{ic}$  being the technical coefficients showing the composition of the intermediate consumption, i.e., the quantity of production of each activity  $i$  required to increase by one monetary unit the production of the construction sector.<sup>10</sup> The  $A$  coefficients only take into account the direct effects of the other economic sectors, but they still do not internalize the additional input requirements needed to satisfy the subsequent rounds of expenditure (Miller and Blair 2009); these are expressed in the indirect and induced effects. So, to estimate the total effects, which capture these economic iterations up to the last round, we need to carry out a series of matrix algebra operations on Identity (1). In order to solve for the  $X$  vector of total production, we have:

$$X = (I - A)^{-1} Y \quad (2)$$

where  $I$  represents the identity matrix and  $(I - A)^{-1}$  is the inverse matrix of the Leontief multipliers, which allows us to estimate the rest of the components of the chain reaction generated by an increase in the demand for (and production of) the construction sector. This increase is denoted as  $\Delta Y$ , so we can rewrite (2) as:

$$\Delta X = (I - A)^{-1} \Delta Y \quad (3)$$

If the estimation of (3) is made with the  $A$  coefficients taken from the I-O matrix, we obtain the type I multipliers, which contain only the direct and indirect effects. In contrast, if the  $A$  coefficients are taken from the extended SAM matrix, we obtain the type II multipliers – i.e., the multipliers that include both the direct and indirect effects, as well as the induced effect on household consumption.

The value of the multipliers depends on the ratio between the intermediate consumption and the gross value of production for each sector. Based on this methodology, we can estimate the specific multipliers for both the formal and self-construction sectors of the Colombian economy.

### 1.3.2 Output Multiplier for Construction

Arguably the best-known multiplier, the output multiplier describes the impact of an economic sector on the total output level of the economy. A sector's output multiplier can be interpreted as the total value of production of all the economic activities that are necessary to satisfy an increase of one

<sup>9</sup> Specifically, they come from the combination of the Supply matrix, the Utilization matrix, and the Integrated Economic Accounts matrix, which are published each year by the National Administrative Department of Statistics (DANE).

<sup>10</sup> The  $A$  matrix is obtained by the division of each element of the I-O matrix by the sum of each of the columns. The latter corresponds to the Gross Production Value of each sector.

monetary unit in the final demand of that sector. In other words, this multiplier captures the sum of all the direct and indirect inputs from other economic activities that are required for the sector to increase its production by one unit.

Since we have disaggregated the construction sector, we can estimate the output multiplier for both the self-construction and formal branches of Colombia's construction sector. As table A24 shows, the total output multiplier for formal construction activity is 2.25. This number is the result of similar contributions from the direct (1.006) and indirect (1.027) effects, plus the induced effect (0.217). The total multiplier of the self-construction branch is somewhat larger, at 2.88, with greater contributions from the indirect (1.454) and induced (0.431) effects.<sup>11</sup>

TABLE A24 | **Output multiplier for construction activity**

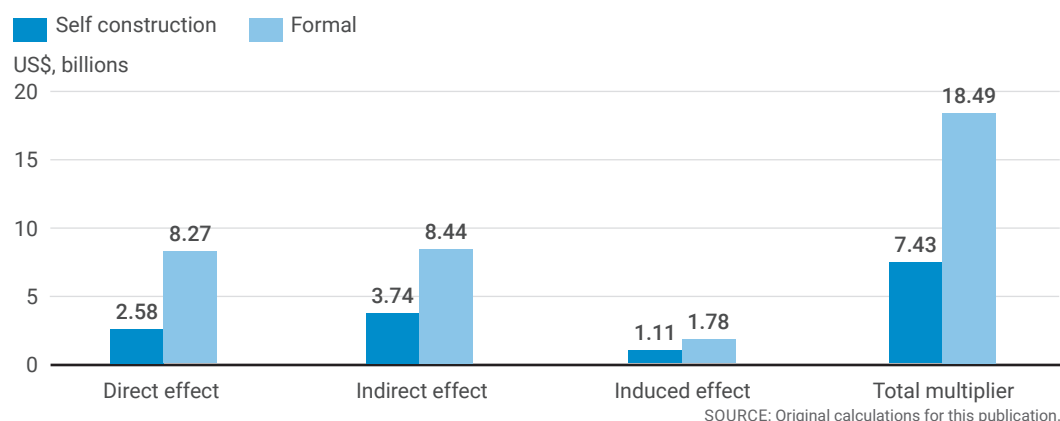
OUTPUT MULTIPLIER	CONSTRUCTION OF BUILDINGS			
	INFORMAL		FORMAL	
	MULTIPLIER	% OF TOTAL EFFECT	MULTIPLIER	% OF TOTAL EFFECT
<b>Direct Effect (1)+(2)</b>	<b>1.003</b>	<b>34.7%</b>	<b>1.006</b>	<b>44.72%</b>
Initial effect (1)	1.000	34.6%	1.000	44.45%
First round (2)	0.003	0.11%	0.006	0.27%
<b>Indirect Effect</b>	<b>1.454</b>	<b>50.3%</b>	<b>1.027</b>	<b>45.64%</b>
<b>Induced Effect</b>	<b>0.431</b>	<b>14.9%</b>	<b>0.217</b>	<b>9.64%</b>
<b>Total Multiplier</b>	<b>2.888</b>	<b>100.0%</b>	<b>2.250</b>	<b>100.00%</b>

SOURCE: Original calculations for this publication.

The figures shown in table A24 correspond to an increase of one unit in the final demand of the construction sector. Thus, the next step is to multiply these numbers by the sector's GDP in order to find the total contribution of the sector to the Colombian economy in absolute terms. The results exhibited in figure A61 do that using Colombia's 2019 GDP. Despite the informal branch's slightly larger output multiplier, when the size of each subsector is taken into account, the total contribution of the formal sector is more than twice that of the informal one, at US\$18.49 billion and US\$7.43 billion, respectively.

<sup>11</sup> A question that might arise is why the multiplier of the self-construction subsector is greater than that of the formal subsector. The difference is explained mostly by the indirect effect. Technology used in the self-construction subsector is less productive, meaning that, for a given number of inputs, its output is lower than that generated by formal construction activities (mainly because the latter are more capital intensive). Reversing this conclusion, we can deduce that, for a required amount of output, the self-construction subsector requires more inputs to be able to produce one unit. Both multipliers assume an increase in final demand of one monetary unit; to meet this required output, the self-construction subsector needs more interactions with its providers, while the formal subsector's higher productivity implies that it can produce one unit with fewer inputs, fewer workers, and reduced interaction with the rest of the economy. Thus, the output multiplier, and specifically the indirect effect, is greater for the self-construction sector.

FIGURE A61 | **Absolute effects of the output multiplier for private construction**



### I.3.3 Employment Multiplier for Construction

The second macroeconomic estimate is the employment multiplier. This indicator can be interpreted as the total expansion of employment throughout the economy that results from an increase in final demand sufficient to create one additional job in both the formal and self-construction branches. The figures in table A25 show that the total employment multiplier of the self-construction subsector, 3.65, is almost double that of the formal one (1.98). The difference is clear in the indirect effect (self-construction's indirect effect is almost double that of the formal subsector), but is most evident in the induced effect, where there is a fourfold difference between the two subsectors.

TABLE A25 | **Absolute effects of the salary multiplier for private construction**

EMPLOYMENT MULTIPLIER	CONSTRUCTION OF BUILDINGS			
	INFORMAL		FORMAL	
	MULTIPLIER	% OF TOTAL EFFECT	MULTIPLIER	% OF TOTAL EFFECT
Direct Effect	1.003	27.52%	1.006	50.90%
Indirect Effect	1.400	38.41%	0.631	31.93%
Induced Effect	1.241	34.06%	0.339	17.17%
Total Multiplier	3.645	100.00%	1.977	100.00%

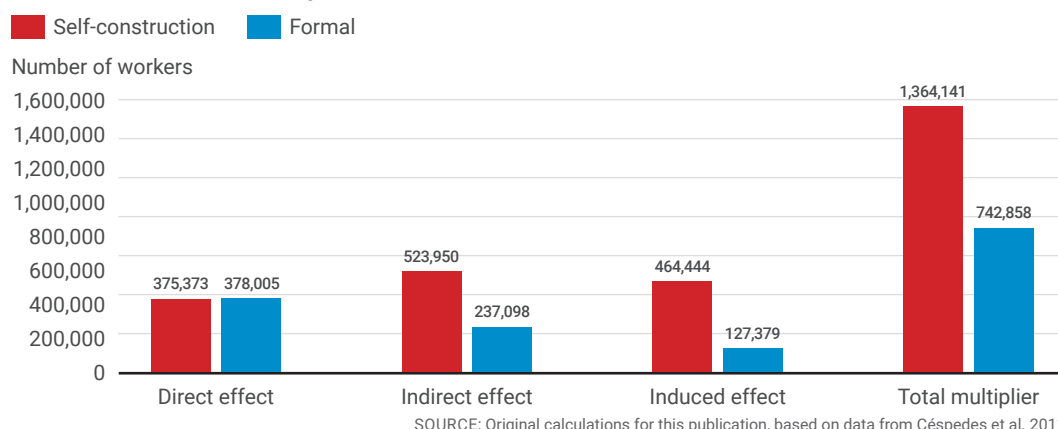
SOURCE: Original calculations for this publication.

This can be explained by the fact that self-construction activities are more labor-intensive and, as they are less productive, they require higher interactions with other sectors in order to produce one monetary unit of output. Additionally, while the formal construction subsector assigns the vast majority of its surplus to capital – which is concentrated in a few enterprises and can be at most re-inverted, but not consumed – self-construction activity distributes this surplus into a wide number of workers who, given their socioeconomic condition, have a much higher marginal propensity to consume. They therefore return this surplus in a greater proportion to the economy through consumption of goods and services. This explains the significant differences observed in the induced effect.

Now we can apply the multiplier to the current macroeconomic data for Colombia. Approximately half of total construction employees work in residential construction, representing nearly 750,000 people, and we find that these workers are evenly distributed between the formal and self-construction branches. With these assumptions, the total employment directly and indirectly related to self-construction activity can be calculated at 1.36 million people, compared to 740,000 related to the formal construction subsector.



FIGURE A62 | **Factors of production in formal and self-construction subsectors**



### 1.3.4 Salary Multiplier for Construction

The third analysis is intended to find the effects of an increase in construction demand on remuneration to labor throughout the Colombian economy. Using the same methodology as for the previous multipliers, it is possible to estimate a matrix of salary coefficients. The coefficients are derived from the technical requirements of salaries in each sector (that is, the salary paid divided by the gross value of production for each activity). The salary multiplier thus captures the impact of a change of one monetary unit in construction salaries on labor remuneration throughout the whole production chain, including the several iterations of economic interactions among the providers.

Since the formal branch has a higher level of capital per worker, a payment of one dollar to a worker in the formal branch is associated with a greater increase in the total output of the construction sector compared to that associated with the same salary payment in self-construction activities. This higher productivity of formal workers is reflected by the salary multiplier, which is larger for formal (2.78) than for the self-construction workers (1.85).

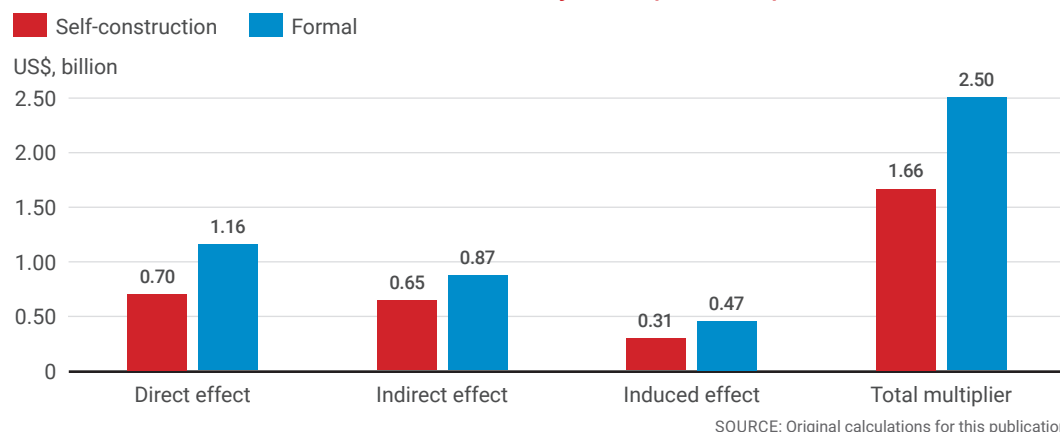
TABLE A26 | **Salary multiplier for construction activity**

SALARY MULTIPLIER	CONSTRUCTION OF BUILDINGS			
	INFORMAL		FORMAL	
	MULTIPLIER	% OF TOTAL EFFECT	MULTIPLIER	% OF TOTAL EFFECT
Direct Effect	0.785	42.33%	1.285	46.19%
Indirect Effect	0.720	38.79%	0.972	34.93%
Induced Effect	0.350	18.88%	0.526	18.88%
Total Multiplier	1.855	100.00%	2.783	100.00%

SOURCE: Original calculations for this publication.

The number of salaries paid in the Colombian economy by the informal and formal branches is almost identical (0.8% of total salaries in the economy for each branch). Given that the salary multiplier is greater for the formal construction subsector, the total absolute effects on the aggregate economy are vastly different. The formal branch's total effect (US\$2.5 billion) exceeds by almost 50 percent the effect of salaries in the informal branch (US\$1.6 billion).

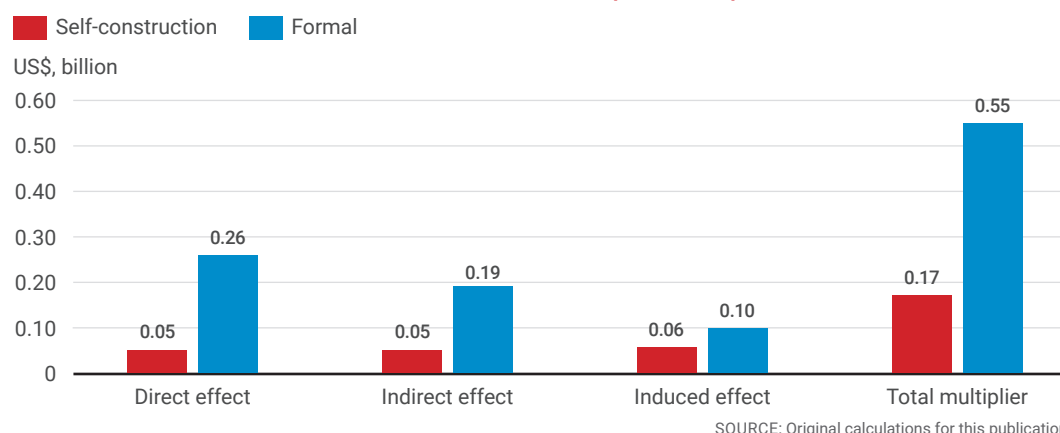
FIGURE A63 | **Absolute effects of the salary multiplier for private construction**



### 1.3.5 Tax Multiplier for Construction

The tax multiplier shows to what extent an increase of one monetary unit in the payment of taxes by the construction sector is associated with an increase in the payment of taxes across the total economy. The informal subsector does not pay the salary taxes associated with formal employment, but it pays a portion of the total indirect taxes, as it demands a proportion of intermediate consumption that has to pay taxes. Because of the marginal amount of taxes paid by the informal subsector (0.5% of total output), the tax multiplier for informal activities is large. As a result, the absolute effects of the tax multiplier give a tax distribution similar to the distribution of total output, with the informal subsector accounting for 23.7 percent of the taxes generated by an increase in construction demand.<sup>12</sup>

FIGURE A64 | **Absolute effects of the tax multiplier for private construction**



### 1.3.6 Linkages of the Construction Sector

Although Input–Output Leontief analysis can be applied to the sector’s forward linkages as a reflection of the backward linkages (by changing the column estimations for row estimations), in reality,

<sup>12</sup> The tax multiplier for the self-construction subsector is quite large, at 28.5. It is explained mostly by the induced (10.87) and indirect (8.42) effects. Given that tax payment is very low for self-construction activity, each monetary unit generated in taxes is related to a substantial increase in final demand for construction activity, which implies a considerable boost in the related sectors that pay taxes as well. This is why the best interpretation is based on the absolute macroeconomic contribution of each branch of construction and not on the multipliers by themselves.

their economic interpretation is substantially different. The multiplier for backward linkages implies that an increase in the final demand of construction will pull forward provider activities, as it increases the demand for inputs and thus implies an increase in final demand in the related sectors. In this sense, the backward-linkage multipliers can be interpreted as demand-driven.

The forward linkages, in contrast, represent the effect that an increase in construction output has on the sectors that demand construction. In other words, it can be seen as a supply-driven multiplier. However, it is more difficult to assume that an increase in a sector's output will generate a boost in the downstream economy, given that the production level of the sectors that acquire this output depends on the final demand for their goods and services, and will not necessarily increase just because there is now greater availability of inputs. Given this differential interpretation of the multiplier analysis, the only multiplier for forward linkages we will demonstrate here is the output multiplier; the three specific multipliers estimated for the forward linkages (taxes, salaries, and employment) are not as relevant as those already described.

The output multiplier for forward linkages, called the Ghosh supply-driven multiplier, represents the (expected) effect that an increase of one monetary unit in construction output will have on the economic output of those sectors that rely on construction as an input for their production process.<sup>13</sup> Table A27 shows that the formal-branch output multiplier (3.20) exceeds by more than 60 percent that of the informal subsector (2.02), a difference primarily due to the indirect effect (2.13 versus 0.98, respectively). These results highlight the differential role of each branch of construction in the economy: since the demand for formal construction comes from a wide array of sectors, such as education, finance, and corporate services, it generates far more downstream economic interactions than informal construction, which is focused on housing and small rental activities.

TABLE A27 | **Supply multiplier (Ghosh supply-driven multipliers)**

SUPPLY OUTPUT MULTIPLIER	CONSTRUCTION OF BUILDINGS			
	INFORMAL		FORMAL	
	MULTIPLIER	% OF TOTAL EFFECT	MULTIPLIER	% OF TOTAL EFFECT
<b>Direct Effect</b>	1.003	49.7%	1.006	31.43%
<b>Indirect Effect</b>	0.978	48.4%	2.135	66.69%
<b>Induced Effect</b>	0.039	1.9%	0.060	1.88%
<b>Total Multiplier</b>	2.020	100.0%	3.201	100.00%

SOURCE: Original calculations for this publication, based on data from DANE.

From the macroeconomic exercises in this section, we can see that the production technology of the informal subsector of the economy, which can be characterized as less productive and more labor-intensive than that of the formal subsector, produces a greater backward multiplier for output and employment, but a lower multiplier for salaries. In contrast, the output multiplier based on the forward linkages of the formal subsector is far greater than that of the informal branch – highlighting the role of formal construction as an input for other economic activities, in opposition to the focus of self-construction on housing.

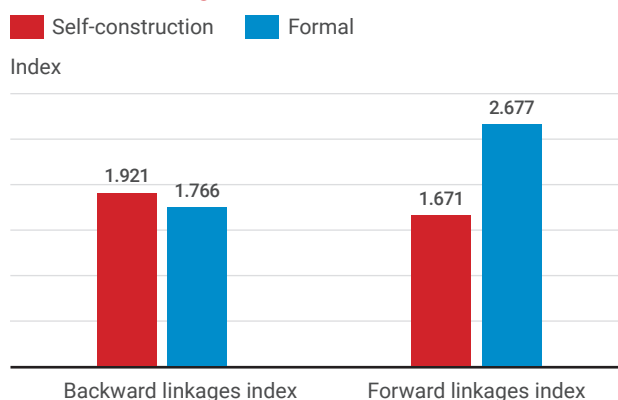
<sup>13</sup> As mentioned, this makes the (dubious) assumption that any increase in the output level of the analyzed activity (construction, in this case) will immediately encounter a proportional demand on downstream sectors.

### 1.3.7 Conclusions: Employment Created by Various Housing Policies

These estimations allow us to calculate the total jobs generated by each of the five housing policy alternatives we considered. The final results of this calculation are displayed in Chapter 6. Table A28 below shows the inputs for this macroeconomic estimation.

The first column presents the average cost per household built or intervened upon for each of the policy alternatives (this cost is described in Chapter 5). The second column presents the number of beneficiary households per program, derived by dividing the US\$1 billion budget by the cost per household. While non-VIS subsidies could reach 100,000 households (which is, in fact, the objective of the policy currently in place), and VIS housing slightly less (since the subsidy includes both the credit interest rate and the lump-sum payment), the same amount of money could serve five or 10 times that number of families if applied to non-structural and microcredit subsidies, because the per-household cost is considerably lower.

FIGURE A65 | Backward linkage index versus forward linkage index



SOURCE: Original figure for this publication, based on data from DANE.

TABLE A28 | Employment created across the economy by housing programs

	TOTAL COST PER HOUSEHOLD (US\$, THOUSANDS)	BENEFICIARY HOUSEHOLDS (THOUSANDS)	DIRECT EMPLOYMENT PER HOUSEHOLD (EMPLOYEES)	DURATION OF CONSTRUCTION PROCESS (YEARS)	DIRECT JOBS CREATED (THOUSANDS)	INDIRECT JOBS CREATED (THOUSANDS)	INDUCED JOBS CREATED (THOUSANDS)
Non-VIS subsidies	10	100	2.78	1.50	419.5	263.1	141.4
VIS housing subsidies	11	90.9	1.60	1.00	143.6	90.1	48.4
Structural retrofitting	5	200	0.67	0.50	67.3	94.0	83.3
Non-structural retrofitting	2	500	0.67	0.33	111.1	155.1	137.5
Microcredit subsidies	1	1,000	0.67	0.33	222.2	310.2	274.9

**Note:** Direct employment for rows 1 and 2 were obtained from figure A59; estimates of direct employment generated by the retrofitting alternatives was derived from data from the Casa Digna–Vida Digna program (by dividing the total jobs created by the number of houses intervened upon). As the length of the employment activity is different – 3 months for non-structural retrofitting, 6 months for structural retrofitting, 10 months for VIS housing construction, 18 months for non-VIS housing – employments per household were transformed into yearly contracts (12 months= 1 year). This adjustment was included in the third column. Direct jobs were estimated by multiplying the number of houses with an intervention by the number of employees generated per housing unit, adjusted to account for the duration of the construction process, to get the number of workers per year.

SOURCE: Calculations originally made for this publication based on data from the Ministry of Housing.

The third column presents the annual direct employment generated per household for each policy. If we multiply the direct employment generated from each policy alternative by the employment multiplier for both the indirect and induced effects (as discussed above), we can get a final estimate of the indirect employment generated by each policy.<sup>14</sup> The results are presented in the last three columns (for direct, indirect, and induced jobs, respectively). The final employment effect for each case will be the sum of these three numbers.

<sup>14</sup> The formal multipliers are used for the first two policy alternatives, and the self-construction multipliers for the remaining three.

## Annex J: Intervention Prioritization Methodology

### J.1 Explanation of Methodology

Large-scale retrofitting projects must prioritize interventions in communities with the greatest housing needs. In Colombia, like in other Latin American countries, the housing deficit is spatially concentrated within cities, which generates decreasing marginal costs for large-scale retrofitting projects. Here we present a simple methodology to prioritize retrofitting interventions in Colombian cities.

Administrative data – specifically, the 2018 census – allows us to identify housing deprivations for each family in the country. A massive improvement in the latest census is the inclusion of each urban family’s spatial location down to the block level. We take advantage of this feature to characterize the housing deficit more precisely, combining the administrative data with information generated by the Global Program for Resilient Housing (provided by the World Bank). The geospatial merging of these two datasets provides a clearer picture of the retrofitting needs of housing-deprived communities. The combined information allows us to identify a greater spectrum of housing and neighborhood conditions.

Using census data, we located the blocks that have the greatest proportion of housing deprivations; these include inadequate walls and floors, overcrowding, lack of access to adequate water and sanitation (WASH) facilities, and inadequate cooking facilities. Critical blocks for deprivation ( $k$ ) are defined as blocks with a greater proportion of a deprivation than the mean of that deprivation for the entire city plus half a standard deviation.

$$\begin{aligned} \text{Very Critical}_{i,k} &= \{ 1 \quad \text{if } D_{ik} \geq D_k + (\sigma_k) \quad 0 \text{ otherwise } \} \\ \text{Critical}_{i,k} &= \{ 1 \quad \text{if } D_{ik} \geq D_k + (\sigma_k/2) \quad 0 \text{ otherwise } \} \end{aligned}$$

$D_{ik}$  : Proportion of households with deprivation ( $k$ ) on census information ( $i$ )

$D_k$  : The mean deprivation of ( $k$ ) for the entire municipality

By applying this process, we can prioritize retrofitting interventions for deprivation at the block level. Census data also enables us to enumerate the households with a specific deprivation for all the prioritized blocks.

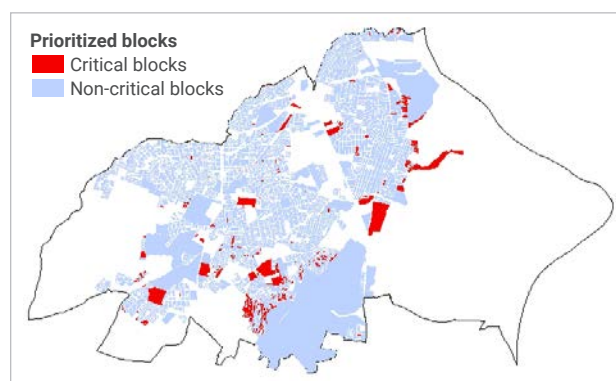
The intervention zone for each city is defined as the union of all deprivation layers. In this sense, even if a household is located in a block prioritized by deprivation, it might also be eligible for all the other retrofitting interventions. As upgrading processes should be integrated, once a vulnerable household is identified, we ought to improve all of its deprivations. Performing a multiple-deprivation improvement offers diminishing marginal costs, as workers may perform a combined upgrading process on a single housing unit. We observe an overlay over the different prioritized deprivation layers, indicating that households with multiple deprivations are geographically concentrated. Figure A66 shows the prioritized census tracts for bathroom and sanitation facilities improvements in the municipality of Soledad, near Barranquilla, on the northern coast of Colombia.

This information is complemented by the analysis made as part of the Global Program for Resilient Housing (GPRH). Using artificial intelligence and machine learning, the World Bank and Colombia's Ministry of Housing have generated a database that contains the physical characteristics of some homes and neighborhoods for three municipalities: Neiva, Cartagena, and Soledad. The physical characteristics of individual units include roof quality and material, wall material, completeness of the unit, area, and an assessment of the unit's general condition. The dataset also contains neighborhood conditions of concern, specifically the quality of roads and the availability of green space. Complementing our deprivation analysis based on the census data, the additional information from the GPRH helps characterize housing needs in deprived neighborhoods and estimate the cost of integrated retrofitting interventions.

Not all housing units in these cities were evaluated by the GPRH. For the present exercise, units in prioritized blocks that were assessed by the program constitute a representative sample for the ones that are to be intervened upon in the rest of the city. In conducting our analysis, we first obtained the proportion of housing units with a roof deprivation, adding another type of intervention to the previous four identified using census information. We then proceeded to identify the average size of a GPRH-prioritized housing unit. This information allowed us to perform a better estimation of the cost of the retrofitting intervention.

Figure A67 shows an example of the exercise that could be carried out by combining these two sources of information. The picture on the left shows some blocks that have been prioritized given their high deprivation of adequate restroom facilities, with the information aggregated at the block level. By adding the GPRH information layer, we are able to observe the distribution of housing units within these blocks. Each pink polygon on top of a red surface represents a household located in a prioritized block. GPRH geospatial data allows us to identify housing units with inadequate roofs and obtain their average size, which are shown in the second map. By adding GPRH data to census data, we can estimate more precisely the total cost of an integrated retrofitting intervention for the municipality of Soledad.

FIGURE A66 | Prioritized blocks in Soledad for sanitation facilities retrofitting

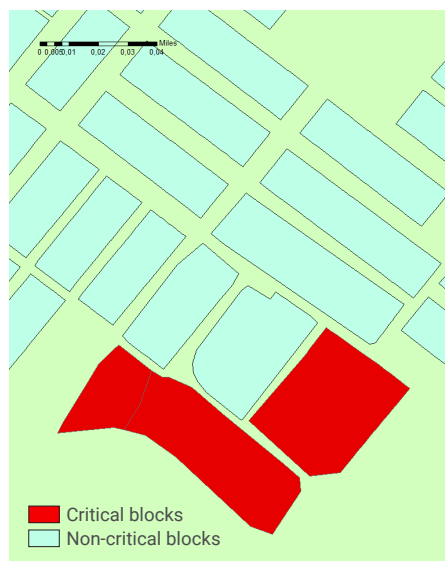


SOURCE: Original figure for this publication, based on data from DANE.

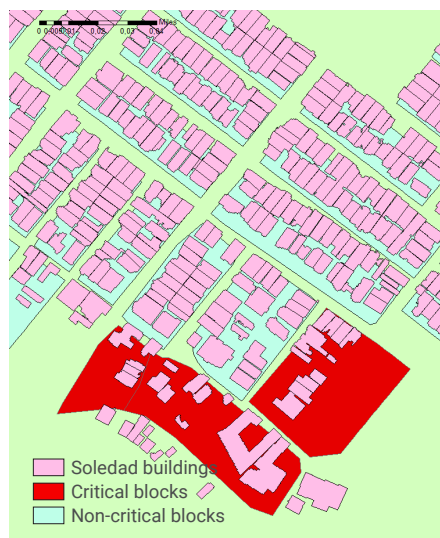


FIGURE A67 | **Deprivation identification process for retrofitting cost estimation**

IDENTIFICATION OF CRITICAL BLOCKS



ENUMERATION OF HOUSING UNITS IN CRITICAL BLOCKS



SOURCE: Original figure for this publication, based on data from DANE and Global Program for Resilient Housing.

## J.2 Example Application: Retrofitting Intervention in Neiva

As an example, the methodology for prioritizing large-scale retrofitting projects is applied in the city of Neiva. Based on administrative (census) data, the methodology suggests that 818 blocks conform to the critical prioritization zone and 511 to the very critical. The major deprivation in the city, affecting a total of 602 blocks, is a lack of adequate facilities for meal preparation, meeting the criteria in the critical intervention zone. Retrofitting interventions should be spatially concentrated on the east outskirts of the city.

TABLE A29 | **Prioritized blocks by deprivation type**

	NUMBER OF CRITICAL BLOCKS	NUMBER OF VERY CRITICAL BLOCKS
<b>Walls</b>	389	284
<b>Floors</b>	421	276
<b>Kitchen</b>	602	332
<b>Sewer / Restroom</b>	488	299
<b>Total intervened blocks</b>	818	511

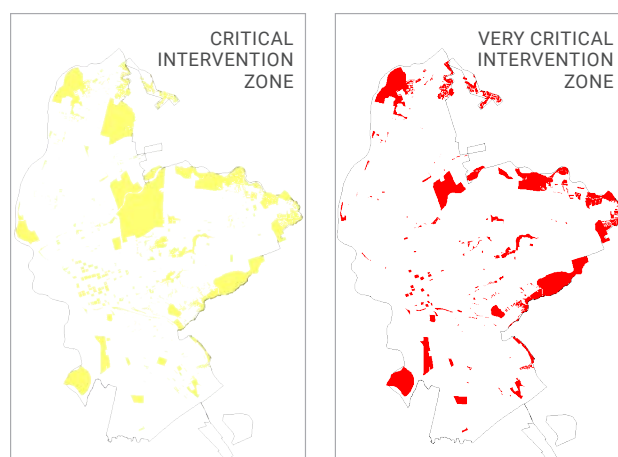
SOURCE: Original estimations for this publication, based on data from DANE.

Households in the area of study suffer from both qualitative and quantitative housing deprivations. According to the 2018 national census, 15.8 percent present at least one qualitative deprivation, and basic quantitative conditions remain unmet for 9.3 percent. Amongst the most relevant qualitative deprivations for households in the area are inadequate wall structure (5.17 percent) and inadequate floor material (4 percent). The most notable qualitative concern is overcrowding, with an incidence of 15 percent across the total area of study. Other problems indicated by the census are sewerage unavailability (5.3 percent), inadequate food storage and cooking area (3.3 percent), and water, sanitation, and hygiene (WASH) deprivations (2.8 percent).

According to the GPRH, 23.5 percent of the total housing units are in poor structural condition.<sup>15</sup> Other relevant findings are poor roofing (23 percent of the units) and the poor condition of roads (affecting 8 percent). The database also provides technical specifications: housing units identified as a priority have an average area of 84.45 square meters, an average volume of 363 cubic meters, and an average height of 2.96 meters.

Combining census and GPRH data, we estimated the number of households per intervention for each critical scenario and the unitary costs for these interventions. The retrofitting project would have a total cost of Col\$50.9 billion or US\$13.59 million and would benefit 7,174 families. Under a more restrictive intervention for very critical blocks only, the total retrofitting intervention cost would be Col\$41 billion or US\$11.05 million.

FIGURE A68 | **Retrofitting intervention zone**



SOURCE: Original estimations for this publication, based on data from DANE.

TABLE A30 | **Number of interventions and households benefited in Neiva**

	NUMBER OF INTERVENTIONS IN CRITICAL BLOCKS	NUMBER OF INTERVENTIONS IN VERY CRITICAL BLOCKS
Walls	2,572	2,237
Floors	1,990	1,719
Kitchen	1,840	1,378
Sewer / Restroom	3,017	2,469
Roof	1,650	1,125
Households benefited	7,174	4,893

SOURCE: Calculations originally made for this publication based on data from the Ministry of Housing.

<sup>15</sup> The difference in rates provided by the national census and the World Bank analysis results from differences in data-collection methods. The World Bank's analysis is based on image recognition, inferring household conditions by how the unit looks from the outside and what the machine learning method recognizes as "unfit" conditions. The census data, on the other hand, is collected by directly surveying the families and inquiring about their socioeconomic and housing conditions.

## Annex K: **Neighborhood Improvement in Valledupar through *Casa Digna, Vida Digna***

The municipality of Valledupar was selected as one of three municipalities prioritized to participate in the neighborhood improvement component of CDVD in 2019. The Ministry of Housing determined that Valledupar met six requirements that made it eligible: (i) the municipality belongs to a city system; (ii) it is a first-category municipality; (iii) the city has experienced one of the highest population growth rates in Colombia; (iv) the area marked for intervention was a formal settlement or was in the process of legalization; (v) the neighborhood already had water supply and sewer systems; and (vi) the local authorities are actively participating in the co-financing of the project. Before this intervention, the municipality had already implemented a regularization process, and had expanded the water supply networks to focus the intervention on improvements to the surroundings.

The project had four main stakeholders: the Ministry of Housing, whose role was to assess the financial viability of the project; Findeter, which managed the financial resources; the municipality of Valledupar, which determined the scope of the intervention; and the contractors, who executed the project.

There were two main reasons that neighborhood improvement projects were needed in Valledupar. Firstly, the city was a net receptor of refugees escaping from the violence of Colombia's civil war. This vulnerable population built informal settlements on the outskirts of the once-compact city center. Secondly, over the last decade, the municipality undertook many social housing projects that were not properly integrated into the urban fabric of the city. Most of them still lack the necessary complementary infrastructure.

Three neighborhoods were selected for the improvement project: Mayales, Nuevo Milenio, and El Paramo, all located within the third commune. According to the pre-feasibility assessment made by Findeter (2020), 7,380 residents living in 5,854 housing units would benefit from the intervention. Although the assessment determined that residents had adequate water and electricity supply, and that children had access to public education, Findeter determined that the neighborhoods lacked adequate green space and that roads were in a suboptimal state.

An investment of US\$1.8 million was necessary to address these deprivations. The investment is distributed between the upgrading of 1.7 kilometers of road networks, including the improvement of sidewalks and a dedicated bike lane, and the construction of two parks with additional equipment for fitness activities. While the project did not consider access to some other key public goods, like health facilities and libraries, the third commune intervention is a good example of a neighborhood upgrading project that seeks to integrate informal and underserved settlements with the municipal core by demarginalizing their inhabitants.





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