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Abstract
Favela Bairro (FB) was a pioneer approach for integrating informal neighborhoods with the urban grid, and it remains today a reference for many developing countries. FB in its second phase (FB II) ran between 2000 and 2008 in Rio de Janeiro, Brazil, and it significantly improved the access in 88 favelas to water supply, storm water and sewage systems, street pavement, sidewalks public lighting, and community facilities such as day care centers, schools, recreational and sport areas. This document revisits the neighborhoods improved through FB II with the purpose of learning the long-term challenges that upgraded neighborhood programs face. The research presented here was done in two parts carried out in parallel: (1) a qualitative study based on focus groups to capture the perception of direct beneficiaries on the upgrades; and (2) an standardized assessment of the state of maintenance of the infrastructure 88 favelas upgraded by FB II. Both parts of the research showed that improvements achieved through FB II had dissimilar longevity. Focus groups identified improvement in residents living standards immediately after the upgrades, but current issues with sewers, electricity, public lighting and streets. The standardized assessment found issues with streets pavement and drainage systems in one out of three upgraded favelas, and poor street lighting and sewers in two out of three. This research offers important lessons to improve the long-term sustainability of urban upgrading programs.

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Executive Summary

Favela Bairro (FB) was a pioneer approach to integrating informal neighborhoods[1] with the urban grid, and it remains today a reference for many developing countries.

1. In this report we use the terms favela and informal neighborhoods as synonyms.
2. These findings agree with the impact evaluation of FB II performed in 2005 by Atuesta and Soares (2016).

The FB II program ran between 2000 and 2008 in Rio de Janeiro, Brazil, and in 88 favelas it significantly improved access to water supply, storm water and sewage systems, street pavement, sidewalks public lighting, and community facilities such as day care centers, schools, recreational and sport areas. This document revisits the neighborhoods improved through FB II with the purpose of learning the long-term challenges that upgraded neighborhood programs face.

The research presented here was done in two parts carried out in parallel:

1 A qualitative study based on focus groups to capture the perception of direct beneficiaries on the upgrades.

2 A standardized assessment of the state of maintenance of the infrastructure in the 88 favelas upgraded by FB II.

In both parts, we included controls based on research performed on never upgraded favelas that met all the requirements to be included in the FB II program.

Both parts of the research showed that improvements achieved through FB II had dissimilar longevity. The standardized assessment found issues with street pavement and drainage systems in one out of three upgraded favelas, and poor street lighting and sewers in two out of three. Focus groups identified improvement in residents' living standards immediately after the upgrades[2] but noted current issues with sewers, electricity, public lighting, and streets. Also, focus groups reported overcrowding in health centers and schools.

The causes for the deterioration in the infrastructure are multiple and complex, many beyond the realm of FB II. Rapid population growth is one of them.

Source: IDB, 2018.

According to the 2000 and 2010 Censuses, the population in Rio's favelas grew nearly 27 percent, while in the rest of the city it has grown just 3.4 percent.

In addition, insufficient maintenance, endemic insecurity, and steep topography all contributed to the deterioration of the infrastructure.

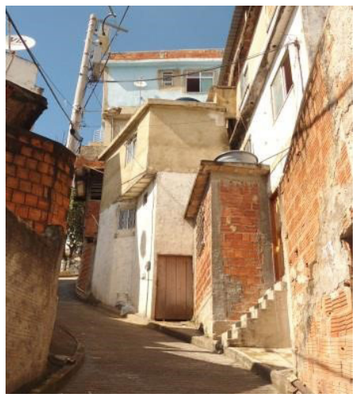
This research offers five important lessons to improve the long-term sustainability of urban upgrading programs.

First, design for endurance by choosing materials and layouts that require minimum maintenance and incorporating a recurrent expenditure item for repair and maintenance on a regular basis, with extra resources allocated to hilly and densely populated areas. Second, involve and educate residents on preserving the infrastructure of their neighborhoods. Third, recognize that upgraded projects are likely to attract more people and hence demand on the built infrastructure will only increase. Fourth, understand that built interventions are not sustainable in neighborhoods that face endemic local violence. Fifth, note that long term sustainability requires constant action from all invested stakeholders.

Introduction

The Favela Bairro program (FB) was a significant breakthrough in public policy.

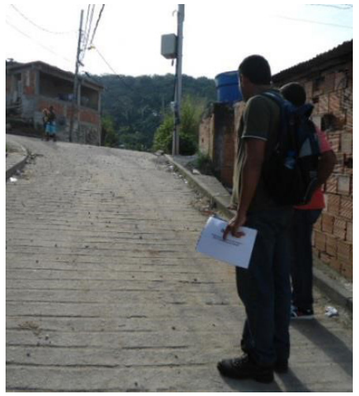
Source: IDB, 2018.



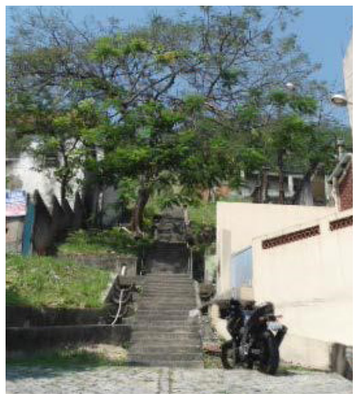
Source: IDB, 2018.

For most of the 20th century, the standard approach to informal neighborhoods had been to eradicate them. Brazil was no exception; favelas were categorized as "subnormal agglomerations" that the city needed to clear (Perlman, 1976). The intent of FB was the opposite: to integrate the favelas into their surrounding urban fabric and to bring their urban services up to the same level as the rest of Rio de Janeiro through infrastructure upgrades and service increases on site. FB remains one of the most ambitious programs to upgrade informal neighborhoods in developing cities. Its scale of intervention, 70 favelas in its first phase (FB I) and 88 in the second (FB II) should have allowed it to make a real and lasting difference in the targeted communities and become a model for future upgrading in Brazil and elsewhere.

The success and the timeliness of this approach become evident in the echoes that followed it. FB embodied a paradigm shift in the policies for and discourses about the favelas. In 1996, just a year after FB began execution, the Declaration of the United Nations Conference on Human Settlements called for "the upgrading of informal settlements and urban slums as an expedient measure and pragmatic solution to the urban shelter deficit" (UN, 1996). FB's novel approach received wide international acclaim for its contributions in sustainable development, including the Hanover (Germany) 2000 Expo Convention, a venue that presents works and visions of technology with the aim of achieving equilibrium between humans and nature,[3] and Harvard's Veronica Rudge Green Prize in Urban Design (in 2000), which recognizes projects that contribute significantly to the quality of urban life.[4] In Latin America, FB became the main reference for similar programs targeting informal settlements, including in Argentina (1996), Uruguay (1997), Ecuador (1997), and Bolivia (1998), among others. As FB is seen as a model for other places, the findings of this study are especially important.



Source: IDB, 2018.



Source: IDB, 2018.

Early studies of FB showed that it effectively improved the lives of the people who lived informal neighborhoods. Qualitative literature described FB as a paradigm shift that had its seed in the late 1950s (Duarte and Magalhaes, 2009) as a reaction to the state policies of the dictatorship, which lacked any kind participatory approach (Cavallieri and Pamuk, 1998). FB's innovative participatory approach included the full involvement of diverse stakeholders, with the active participation of residents, architects, academics, non-governmental organizations, and construction workers (Barke, Escasany, and O'Hare, 2001; Brandao, 2006). Also, even as FB did not provide land titles to all favela residents, it positively contributed to residents' security with tenure (Handzic, 2010). Significantly, FB helped promote a new appreciation of the culture of the favelas among those living inside and outside of them, leading to recognition of the artistic value of their music and artistic expressions (Barke et al., 2001).

Of special interest to the development community is FB II, which included well-conceived elements for integrated urbanization, including slope protection, reforestation, sports fields, open plazas, social centers, daycare centers, computer centers, and public street lighting accompanied by soft services for children and adolescents and income generation and greater emphasis on community participation. Using rigorous impact evaluation and based on data collected during the execution of the project, Atuesta and Soares (2016) found that FB II had a positive and significant impact on people's lives. The data was from 2005, when FB II (2000–2008) work in around half of the favelas had been completed. Specifically, these authors found improved sewerage, better public lightning, distribution of mail in properties' mailboxes, and reliable water supply. In sum, early literature following qualitative and quantitative methods highlights the improvement in the lives of people inhabiting informal settlements in Rio brought by FB.

3. http://www0.rio.rj.gov.br/habitacao/favela_bairro.htm
4. For more information about this prize, see https://urbandesignprize.gsd.harvard.edu/.

Revisiting FB II

Today, ten years after FB was completed, there is much to be learned by revisiting it again.

We still know little about the long-term sustainability of these projects and, given the scale of the challenge of informality, learning from the FB experience is an opportunity not to be missed.

One of every five people in Latin America and the Caribbean (LAC), or 120 million people, live in an informal neighborhood (Figure 1). An informal neighborhood is one built on land that is unsuitable for residence, either because it lacks basic urban infrastructure or proper legal requirements, or both. The presence of informal neighborhoods is a defining feature of LAC cities. If the current urban population growth rate continues, two million of the three million households that move into LAC cities every year will suffer some housing deficit, since most them will locate in an informal neighborhood (IDB, 2012).

Since the 1980s, the policies of LAC governments regarding informal neighborhoods have moved from resettlement to providing upgrades on site and promoting integration with the rest of the urban fabric. This change has occurred as a result of many factors, including the cost of expanding urban areas (Libertun de Duren and Guerrero Compeán, 2015), the proactive actions of many local organizations, and the difficulties of relocating residents to peripheral areas (Libertun de Duren, 2017). Typically, urban upgrading programs fund basic urban infrastructure (water, sanitation, and electricity); pavement and lighting of streets and sidewalks; regularization of land and property titles; and community services such as youth counseling and training. These programs have been replicated in almost all LAC countries.[5]

Given the magnitude and complexity of these programs, they are expensive interventions. For example, in Brazil, a typical conditional cash transfer program costs around US$400 per household per year, while a typical neighborhood upgrading program is estimated to cost around US$4,000 per household (Magalhaes, 2013).[6] Despite the relevance of neighborhood updating programs both in terms of their funding and impact on LAC cities, little is known about their long-term sustainability. While it is evident that in the short term these programs improve access to basic services, it is still unclear if these gains are sustained over time. As demand for neighborhood upgrading programs continues to increase, it is essential that we gain a better and more integral understanding of their durability.

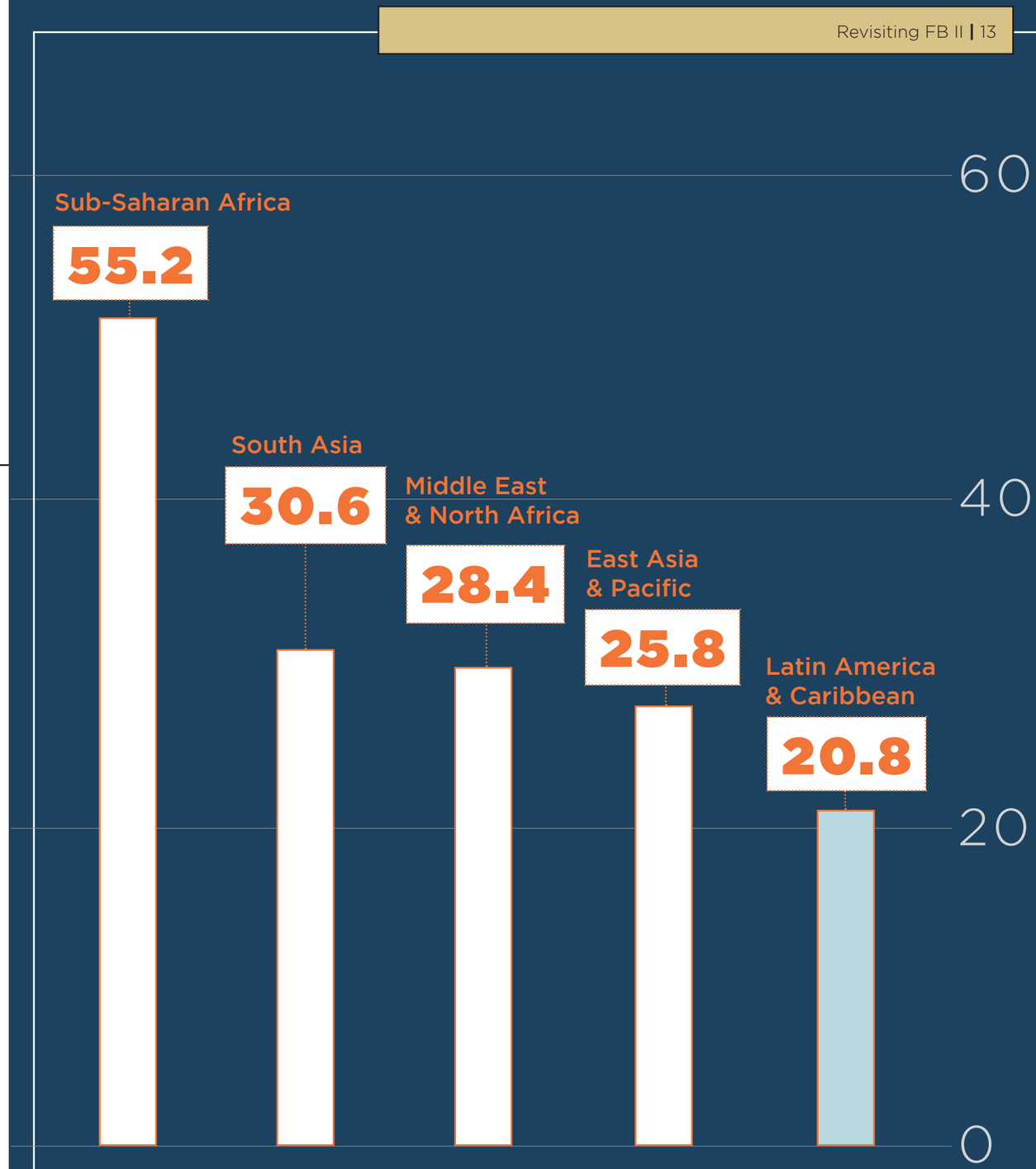
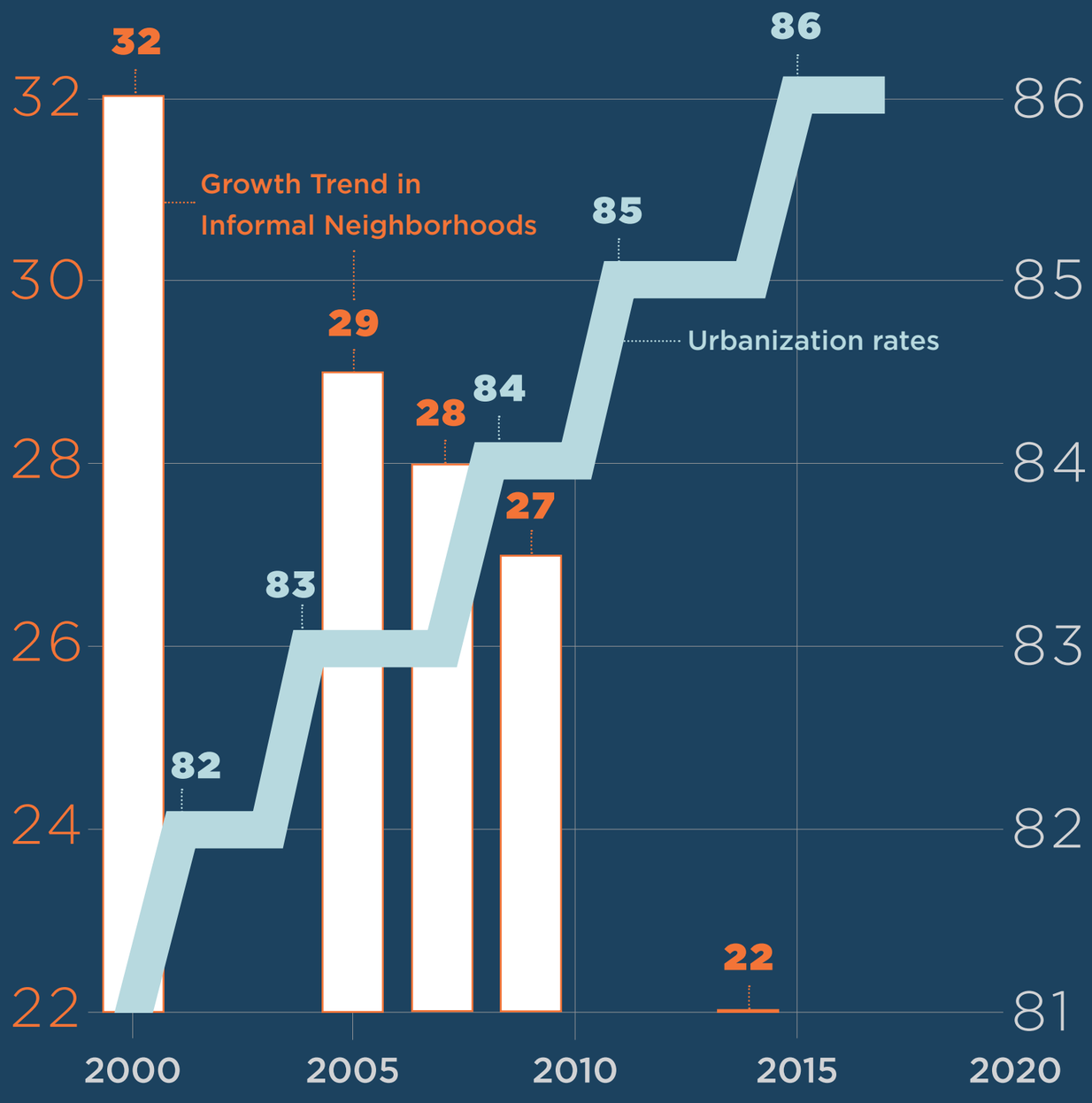


Figure 1.
Percentage of the population living in informal neighborhoods

Source: Authors' elaboration based on the United Nations Millennium Development Goals database (2016). Data for Middle East and North Africa is from 2005.

5. Many of these projects have received support from the IDB, including projects in Argentina, Brazil, Bolivia, Nicaragua, Trinidad and Tobago, Paraguay, and Uruguay.
6. LAC national governments have consistently allocated a substantial amount of funding for housing programs, at a level that historically has ranged between 1 and 2 percent of their respective gross domestic products, according to the Economic Commission for Latin American and the Caribbean. Available from: http://interwp.cepal.org/sisgen/ConsultaIntegrada.asp?idIndicador=3127&idioma=e (accessed September 20, 2017).



Source: Author's elaboration.

Figure 2.
Brazil: Urbanization rates and Growth Trend in Informal Neighborhoods

Even though in Brazil the population trend shows that the percentage of the total population of the country living in informal neighborhoods is declining (Figure 2), in Rio de Janeiro informal neighborhoods have grown at an incredible rate. According to the 2000 and 2010 Censuses in Rio, informal neighborhoods grew 28.0 percent compared to just 3.4 percent in the rest of the city.

Mindful of this situation, the municipality of Rio de Janeiro started upgrading several favelas with both its own funding and funding from multilateral agencies.[7] The project was known as Favela Bairro (FB). This is perhaps one of the most iconic urban interventions in the world. Its objective was to improve the living conditions of the favela's population by providing urban infrastructure and social services, and regularizing land tenure. FB started in 1994 and is now in its third phase. The three phases of the FB program targeted communities of between 500 and 2,500 families. Thus far, the program's completion rate has been high: 62 favelas and 8 irregular subdivisions (informal neighborhoods that have not been recognized officially by the Instituto Pereira Passos as favelas) in the first phase (FB I), and 64 favelas and 24 subdivisions in the second phase (FB II) (Jaitman, 2015). Combined, the first two stages of FB accounted for a US$600 million budget in nominal terms. The third stage continued with upgrades to favelas in 2010, with a total budget of US$300 million. As of September 2018, the municipality announced a fourth stage for 2019 with a budget of US$300 million.[8]

FB I lasted from 1995 until 2000 and provided US$300 million to upgrade infrastructure. Improved infrastructure included water pipes, the sewerage system, streets, rainwater drainage, garbage collection, and public lighting, and reinforced slopes and staircases. It also included reforestation, daycare centers, squares, areas for recreational sports, and community participation centers.

FB II, which began in 2000 and ended in 2008, cost US$300 million (half provided locally and half by the IDB).[9] This phase covered 64 favelas and 24 irregular subdivisions. In addition to the improvement in infrastructure like those completed in FB I, FB II included activities to support child development, adult education, social services, community development, and property regularization. The aim was to increase the wages of household members to lift them out of poverty. The young were specially trained to work in their community's health, education, sports, environment, culture, and tourism centers. Some of these centers provided youth with basic education and complemented it with artistic and sports activities. Professional training courses and education for adults was also provided. Training was given to self-employed professionals to increase sales and revenues in whatever business they were operating. Another clear improvement of FB II over its predecessor was the wealth of data it generated, thus allowing the program to be studied.

Of the US$300 million invested in FB II, US$250 million was for direct costs of the program. The infrastructure upgrade cost US$211 million (or 70 percent of the whole FB II budget) Funding to assist children and adolescents was US$25.5 million. Funding for job training and income generation was US$9 million. Another component was for institutional strengthening, with a budget of US$4.5 million for monitoring and evaluation. The indirect costs included interest, credit fees, inspection, supervision, administration, and management support, which, combined, accounted for the rest (US$50 million) of the budget.

7. Between 1995 and 2018, the IDB provided loans for a total of US$450 million during the three stages of the FB program. The municipality of Rio de Janeiro provided an equal amount, for a total budget of US$900 million in nominal terms.
8. See em http://prefeitura.rio/web/guest/exibeconteudo?id=7203186. Acessed Setember 2018.
9. The FB program was co-funded by the municipality of Rio de Janeiro and the IDB, which performed an impact evaluation of the program in 2005. That evaluation provided a reference to select the favelas for this study.

Against this background, the objective of this report is to learn about the long-term challenges to the sustainability the neighborhood upgrading programs, revisiting upgraded favelas ten years after their completion. For that purpose, similar favelas were compared, some of which were beneficiaries of FB II (treatment group) and some were not (control group). There were 64 favelas and 24 irregular subdivisions in the treatment group and 10 favelas in the control group. To evaluate the state of the infrastructure, the analysis relied on a two-pronged strategy: a formal inspection by a well-trained team of engineers and architects, and focus groups with beneficiaries of the intervention.

This strategy allowed us to capture both the physical state of the infrastructure and its impact on users.

The results showed that FB II improved conditions in the favelas right after the work was completed, but after ten years, most of the favelas in the treatment group had reverted to conditions like those in the control group. The results were the same based on the formal inspection and on responses from interviewees. The inspection by the team of experts showed that nearly one out of three upgraded favelas had streets with pavement in poor condition, one out of three had congested drainage, and two out of three had poor street lighting and sewers that overflow or reverse flow, especially when it rains.

While a rigorous investigation to find out what caused the rapid deterioration of the infrastructure is out of the scope of this report, the team of experts provided a possible explanation. Lack of maintenance, vandalism catalyzed by gang violence, intense population growth, and steep topography are probable causes of the rapid deterioration of the infrastructure built by FB II. We note that these possible causes are often closely interrelated. For example, people in favelas ruled by gangs said that gang members purposefully destructed infrastructure, such as breaking streetlamps and digging holes in the pavement, to better control their territory and to prevent other gangs and policemen from freely circulating within the favela. However, this also impeded access for garbage trucks and maintenance teams. Further, heavy rainfall on steep slopes eroded the pavement and sewers, which required extra funding for proper maintenance. Finally, tremendous population growth in the favelas put a lot of pressure on the infrastructure.

Source: Santa Marta, 2017. iStock. Access 03/12/2020. iStock.com

Review of Empirical Studies on Neighborhood Upgrading Programs

Considering the importance of neighborhood upgrading programs to improve the quality of lives in the community, the empirical literature on their effects is quite slim. The difficulties in assessing interventions that are complex, territorial, and not randomly assigned challenge the development of such programs and limit the generalization of results. That is, even as there are several robust studies with internal validity, one should be careful before assuming that similar outcomes would be obtained under other conditions (Jaitman, 2015).

One of the most studied aspects of neighborhood upgrading programs is their impact on the value of the housing units.

The hypothesis is that value increases as a result of tenure being regularized. The idea is that owners who have a legal title invest more in their housing units as fears of eviction diminish and they have access to credit markets (de Soto, 2001). For example, in Nairobi, regularization of titles has better allowed the execution of public works in the neighborhood, which helped to increase the value of the area (Gulyani and Talukdar, 2008). Also, a quasi-experimental study in Peru exploited the variation in ownership status induced by a nationwide titling program, in which 1.2 million property titles were distributed to urban squatters on public land between 1996 and 2003. A *difference-in-difference* analysis compared the change in housing investment in households that participated in the program to those that did not. The results indicated that strengthening property rights in urban informal neighborhoods has a significant effect on residential investment due to the decreased threat of eviction (Field, 2005) rather than due to increased access to credit markets (Field and Torero, 2003). Another quasi-experimental study in Argentina explored the impact of titling on property values. It found that the titling premium, which is the difference in value paid for a house of similar characteristics between titled and untitled properties, was 18.5 percent, controlling for housing investments (Galiani and Schargrodsky, 2010). An empirical study in Nairobi, Kenya, and in Dakar, Senegal, found that, after the upgrading programs were completed, rent prices in informal neighborhoods increased, which led to significantly worse living conditions for tenants than for owners. Higher rents usually lead to gentrification since tenants may be forced to move to more affordable housing locales (Basset, Gulyani, and Talukdar, 2012). In other cases, upgrading has been related to gentrification, but only when the government vacated the land from all informally built housing units and allowed new constructions, as happened in some areas of Johannesburg, South Africa (Winkler, 2009).

However, an alternative hypothesis for demographic changes in upgraded neighborhoods suggests that these programs incentivize poor households from other parts of the city to relocate to these neighborhoods, hence increasing their density but not their average income level. This hypothesis is consistent with our findings. In LAC, this view emerges from the fact that populations in informal neighborhoods have consistently grown at higher rates than populations in formal neighborhoods. For example, in 1961, the total urban population of Rio de Janeiro was 3 million people, with 10 percent residing in favelas. The 2010 Census showed that the urban population stood at over 6 million people, with 22 percent residing in favelas. Also, there is some evidence that upgraded neighborhoods densify rapidly after civil works are completed, often generating demand for services that exceed planned capacity. Densification is a result of people migrating to informal neighborhoods as soon as it is known that the neighborhood will be included in an upgrading program

10%
residing in favelas in Rio de Janeiro in 1961

(Abramo, 2009). This happened in Lima, Peru, between 1996 and 2000 (Calderon, 2004) and in Buenos Aires, Argentina, between 2000 and 2010, where the areas built informally increased 12 percent after the government announced a change in its policies toward informal neighborhoods (Galiani and Schargrodsky, 2010).

There is evidence that residents' satisfaction with their neighborhoods increases after public lighting programs are in place, which in turn makes them more willing to pay for public services (Lora, Powell, van Praag, et al., 2010). There might have been other positive externalities as well, such as increased perception of safety in neighboring areas, which ends up increasing real estate prices. This issue has been empirically studied for programs that improved housing for extremely poor households in El Salvador, Mexico, and Uruguay. The findings showed that better houses had a positive effect on overall housing conditions and general well-being (Galiani, Gertler, Cooper, et al., 2017). Also, there is evidence that paving a street increases the value of nearby properties. For example, in Mexico City, paving local roads led to an increase of 16 percent in the value of nearby properties (Gonzalez-Navarro and Quintana-Domeneq, 2016).

The literature on FB is quite vast, but with only a small share of empirical research.

We focused on two rigorous studies of the impact of FB that were done immediately after the upgrades were completed. The first study, by Soares and Soares (2005), compared outcomes in FB-treated favelas with a control group of favelas included in the FB program but where the intervention had yet to be made. Per FB regulations, the program only included favelas with a population of 500 to 2,500 households. The study applied a difference-in-differences approach with propensity score matching using data from post-intervention as an identification strategy. It relied on a logit model that had treatment as a binary variable. The second study, by Atuesta and Soares (2016), conducted an impact evaluation of FB II by collecting data in 85 favelas (43 treated and 42 controls).[10]

It relied on information from the 2000 Census for the baseline and data collected in 2005 after the intervention in 43 favelas. The authors also collected post-intervention data in the 43 treated and 42 control favelas after 2004–2005. With data for before and after implementation in both treated and control favelas, both studies found that FB had a positive impact on households' rate of access to water, sanitation, and garbage collection services and found no effect on the values of properties except among those with worse-than-average accessibility before the upgrade.

10. The variables the data collected on the households (HH) were: housing unit (HU) receives mail; HU has connection to water, sanitation, trash collection; HU is on a paved street; HU is on a street with public lighting; HU is close to green public areas; HH owns land with title; HH invests in improvements of HU; assessment of property value (self-assessment); feelings of safety in the favela; commuting time to public transportation; HH income and employment; age and gender of HH head; number of children under five and number of children in school. The total number of observations in both treated and control favelas was 25,049 households.

Source: Santa Marta, 2017. iStock. Access 03/12/2020. iStock.com

Empirical Study of the State of Infrastructure of FB II

Methodology

To study how the impact of FB II on infrastructure lasted through time, the analysis compared the current state of favelas that benefited from the FB II program with those that did not. A decade has passed since the work associated with FB II was completed, thus the effects on the variables of interest can be adequately captured.

Treatment and Control Groups

To make this comparison relevant, we created a control group that was as similar as possible to the treated group except that the favelas did not benefit from the FB II program.

The treatment group was constructed from the database of the 88 favelas and irregular subdivisions (informal neighborhoods that had not been declared consolidated favelas by the municipality of Rio de Janeiro) that did benefit from FB II.

88 favelas in treatment group

Selection of the control group followed the same two-step criteria used by Atuesta and Soares (2016): a logit model followed by an expert assessment of the favelas using the criteria and maps from Secretaria Municipal de Habitacao. The logit model established the FB II treatment as the dependent variable: 1 if the favela was treated between 2000 and 2008, and 0 if not. The controls were selected to make the group as similar as possible to the treatment group. The control favelas were as close as possible to the treated favelas based on the Human Development Index built using the 2000 Census, and the team also chose those favelas that physically resembled the geography and location of the treated favelas and had between 500 and 2,500 families.

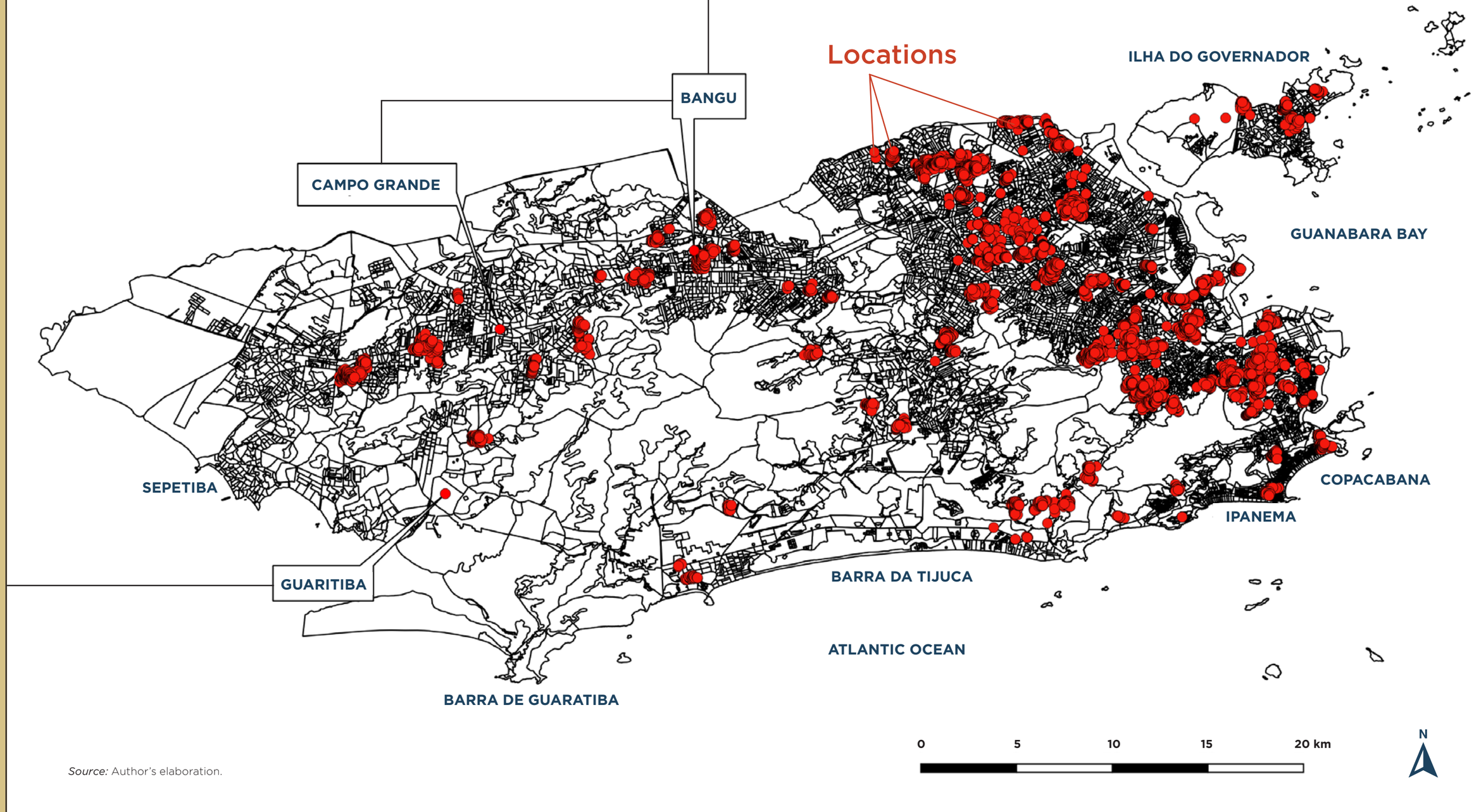
Besides the database from the Soares' papers, the 2000 Brazilian Census was used, which registered data on favelas nationally, including the roughly 600 favelas in Rio at the time. The explanatory variables were averages at the favela level of access to water, sewerage, garbage collection, children under 4, teenagers under 15, illiteracy of household (HH) head, age of HH head, gender of HH head, income of the HH, and number of HH per favela. The probability of treatment was calculated and ranked the favelas that did not benefit from the FB intervention or any other program according to their probability of treatment from highest to lowest and ensured that there were no other programs confounding the results.[11] Per Instituto Pereira Passos, in August 2017 there were at least 300 favelas that had not seen any intervention by any project similar to FB. Thus, we ended up with two groups:

10 favelas in control group

1. **Treatment group:** 64 favelas and 24 irregular subdivisions that benefited from FB II
2. **Control group:** 10 favelas that experienced no upgrades from FB II or any other program

11. The two other programs similar to FB II were Grandes Favelas, aimed at favelas with more than 2,500 households, and Bairrinho, for smaller favelas of less than 500 households.

Figure 1.1
Favela Bairro II (2000–2008)
Locations



Source: Author's elaboration.

Infrastructure Evaluation

The analysis used a two-pronged strategy to evaluate the state of the infrastructure built through FB II:

1. **a formal inspection by a well-trained team of engineers and architects, and**
2. **focus groups with beneficiaries of the intervention. This strategy allowed us to capture both the actual state of the infrastructure and its impact on users. Further, this dual approach was intended to give credibility to —or raise questions about— the validity of the results of each approach.**

In sum, information was collected from all of the favelas that benefited from FB II between 2000 and 2008 (88) and 10 untreated favelas (control group), and focus group interviews were conducted in nine favelas (three treated and six control).

The formal inspection consisted of a technical examination of the state of the infrastructure. For that purpose, a team of technical experts was sent to visually check and grade the state of maintenance according to an established methodology known as Participatory Rapid Mapping (MRP).[12] MRP is a tool developed by the Instituto Pereira Passos of Brazil to assess built urban infrastructure.[13] MRP generates primary data that allows researchers to produce systematized diagnoses and periodical reports on the capillarity, coverage, and quality of infrastructure.

In general terms, the MRP approach to data collection combines direct observation of infrastructure conditions with interviews with residents who have specific knowledge of the area. Civil engineers perform the direct observation and grade the infrastructure according to its condition (amount of deterioration) and capacity to meet demand. As topography and socioeconomic conditions impact infrastructure's durability, FB II-upgraded favelas were compared with others that were similar in terms of these variables before the intervention.

The interviews with residents (different from the focus groups) were held with people knowledgeable about the type and quality of services offered in different locations within the same territory. These people were usually older residents and community leaders, mainly presidents of residents' associations, and local public managers. They were interviewed using a semi-structured questionnaire that allowed us to quantify the state or condition of preservation of the infrastructure.

The questionnaire included closed categories for responses. Each question included a textual explanation with an example using illustrations, photos, or situation drawings for each answer option. The questionnaire was organized into ten infrastructure types or public services, as shown in Table 1.2. This process resulted in standardized variables, which, in turn, made it possible to generate indicators. The list of questions with illustrations and photos are provided in Appendix B.

12. A full description is found at http://www.data.rio/datasets?q=MPR. Accessed August 17, 2018.
13. The Instituto Pereira Passos developed the MRP at the time of the Pacifying Police Unit (Unidade de Policia Pacificadora, UPP) program. The UPP program was a pacifying program by law enforcement aimed at combating gangs and drug dealers in the state of Rio de Janeiro. It started in the late 2000s and was composed of police officers strategically placed in areas of high crime and distributed in roughly 40 units that served 231 favelas, as of 2013. https://www.cadaminuto.com.br/noticia/62543/2010/04/21/bairros-com-upp-tiveram-queda-na-criminalidade

Formal inspection

Number of favelas:

- 88 Treated[a]
- 10 Control[b]
- 98 Total

Number of favelas, treating those in complexes as separate favelas:

- 143 Treated[a]
- 17 Control[b]
- 160 Total

Focus groups

Number of favelas

- 3 Treated
- 6 Control
- 9 Total

Number of favelas, treating those in complexes as separate favelas:

- 3 Treated
- 6 Control
- 9 Total

Table 1.1. Study groups

Source: Author's elabortation.

a Upgraded during FB II (2000–2008).
b Considered similar to the treated favelas by the team of experts in terms of the Human Development Index and the infrastructure previous to the intervention to the treated favelas. Although the study refers to 98 favelas, some are in complexes or groups linked like a network, meaning that some favelas are a complex of several favelas. Counting each favela individually, there are a total of 160 favelas.

Sewerage system

Pipes, tubes, ducts, and conduits to collect wastewater.

7 questions

Garbage Collection

Quality of the collection service, time to nearest bucket, frequency of overflow, and accumulation of garbage on streets.

8 questions

Public lighting

State of conservation of lighting posts.

4 questions

Infrastructure for mobility

Conservation of pavement on streets, alleys, walkways, staircases, and ramps. Feasibility of free circulation by car or motorcycle.

11 questions

Public transportation

Walking time to nearest public transportation option: buses, vans, elevators, taxis. Waiting time of most used transportation option. Quality of service of most used transportation option.

16 questions

Electricity

Coverage of electricity supply and frequency of interruptions.

2 questions

External appearance of houses

Appearance of the external walls of houses.

4 questions

Street signs and postal services

Signs visible on the streets. Accessibility to postal services. Mailboxes installed in every house.

2 questions

Water supply

Existence of water supply. Irregular connections to water supply. Interruptions of water supply during summer and rest of the year.

7 questions

Rainwater drainage system

Quality of stormwater drainage infrastructure. Overflow of surface water and subterranean conduits. Presence of garbage and sediment in the drainage system.

5 questions

Table 1.2.
Infrastructure Types and Public Services Included in Infrastructure Interview

With the data collected for each favela, the team generated a synthetic indicator from 0 to 6, where 0 meant non-operational and 6 meant excellent condition. Finally, a composite indicator was created, the General Infrastructure Index, which is the geometric mean of the indicators of each infrastructure type or public service at the level of the favela. The higher the value, the better the state of the infrastructure. The objective was to represent urban conditions on a numerical scale to be able to compare the results across the sample of treated and control favelas.

Focus groups with beneficiaries of the intervention. The focus groups with beneficiaries of the intervention took place during the last quarter of 2017 and beginning of 2018. The aim was to get perceptions from direct beneficiaries of the FB program: how it changed their lives and how the infrastructure deteriorated over time. Thus, a glimpse was captured of the perspectives of the inhabitants' memory of how FB II performed when the cement was still wet and fresh and contrast it with the current conditions. Additional interviews were conducted with people in untreated favelas with similar characteristics surrounding the treated favelas. In total, 80 people were interviewed in nine favelas. Table A.1 in Appendix A provides the list of favelas chosen for the focus group interviews and the number of people per favela.

An experienced local moderator conducted the focus groups using a pre-set questionnaire developed by the research team.

The moderator began the meeting by first explaining the confidentiality of the opinions and discussions that occurred in the group and noted that there were no right or wrong answers but different opinions on the themes. The discussion was audio recorded for later analysis. During this type of methodology, video recording is common, but because some favelas were dominated by drug dealers, video recording was not performed to guarantee the security of our team.

The focus group conversation was organized into three parts. During the initial part, the moderator began the guided discussion along three lines:

1. **How did residents perceive the overall quality of life in the favela?**
2. **What changed in the favela through the years?**
3. **What did residents think should improve in the favela?**

Then, the moderator turned to specific aspects of infrastructure, mobility, and services, with the goal of extracting views regarding the services provided in the community, assessing strengths and weaknesses. The moderator encouraged debate and asked if any infrastructure work had been carried out recently. Then, the moderator asked if this work had improved their life and enquired about examples of such recent works. Finally, the moderator asked about the infrastructure improved by FB II; namely, sewerage, paved streets, staircases, garbage collection, street lighting, water access, child and recreation centers, and health. Appendix A provides a detailed explanation of how the interviews were arranged and conducted.

Findings

Results of the Field Visits by Experts

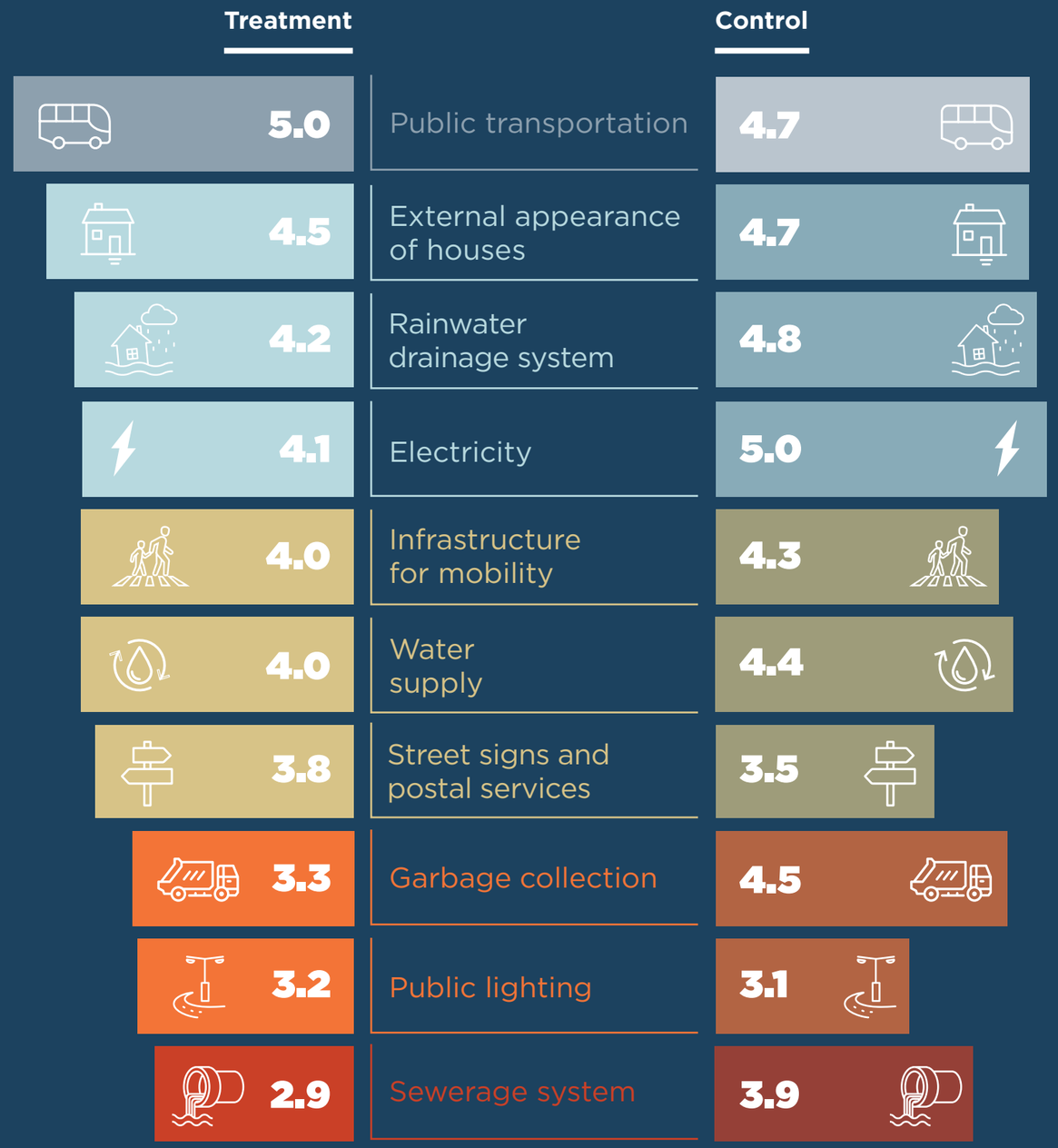
During the field visits, our team of architects and civil engineers filled out a standard questionnaire for the 98 favelas (88 treated and 10 control). The General Infrastructure Index was created to classify the infrastructure according to how well it was preserved based on field visits, visual inspection, and semi-structured interviews with residents (different from the focus groups).

Infrastructure was in a similar state across favelas. The most shocking result of this investigation was that the control group had marginally better infrastructure than the treated group. The average mean General Infrastructure Index for the treated group was 3.5 compared to 3.9 for the control group. A test of the mean was conducted and failed to reject the null hypothesis with a p-value of 0.17 (see Table 1.3).

The most shocking result of this investigation was that the control group had marginally better infrastructure than the treated group.

Source: IDB 2018.

Figure 1.2. Index by Type of Indicator and Treatment Status



Source: Authors' elaboration with data from Overview Pesquisa.
Note: Score: 0 = non-operational; 6 = excellent condition.

	# of favelas	Control	Treated	P Value: Ho:Control=Treated
General Infrastructure Index	**160**	**3.934**	**3.534**	**0.178**
Sewerage system	160	3.939	2.928	0.041**
Infrastructure for mobility	160	4.335	3.954	0.206
Public lighting	160	3.126	3.192	0.869
Street signs and postal services	160	3.529	3.839	0.449
Public transportation	160	4.674	4.986	0.397
Water supply	160	4.446	3.950	0.206
Garbage collection	160	4.455	3.286	0.030**
Electricity	160	4.959	4.121	0.033**
External appearance of houses	160	4.722	4.465	0.408
Rainwater drainage system	160	4.821	4.464	0.209

Source: Authors' elaboration. Notes: Score: 0 = non-operational; 6 = excellent condition. Level of statistical significance: ***p-value = 0.01, **pvalue = 0.05, *p-value = 0.10. Although we refer to 88 favelas upgraded in FB II, some of these 88 are in complexes or groups linked like a network, meaning that some favelas are a complex of several favelas. Counting each favela individually, there are a total of 160 favelas reported in this table.

Table 1.3. Index by Type of Indicator and Treatment Status

Sewerage system, garbage, and electricity scored worse among upgraded favelas.

Treated and control favelas scored extremely low for their sewerage systems, garbage collection, and public lighting. But the most appalling result was that any gain the treated favelas experienced in these services were lost and reverted to the same level as —or worse than—control favelas, which reflects the conditions in 2010 of the treated group. In other words, the upgraded infrastructure was not maintained, and it deteriorated during the ten years after the FB II upgrades were completed. Table 1.3 shows that the upgraded favelas had statistically significant lower scores than the control favelas for their sewerage systems, garbage collection, and electricity, with a pvalue of 0.10.

Sewerage systems in the upgraded favelas had the worst score of all types of infrastructure and services, among all favelas.

The score of 2.9—heavily skewed to the right—showed the seriousness of this issue (Figure 1.3). Even if FB II connected domestic sewerage to the public network, it was evident from field visits that the installed capacity could not cope with demand. Field data showed that two out of three favelas had clogged sewerage systems. During the field visits, many locals complained of reflux and about proximity to open manholes.[14]

Garbage collection was a big issue in more than half of the treated favelas.

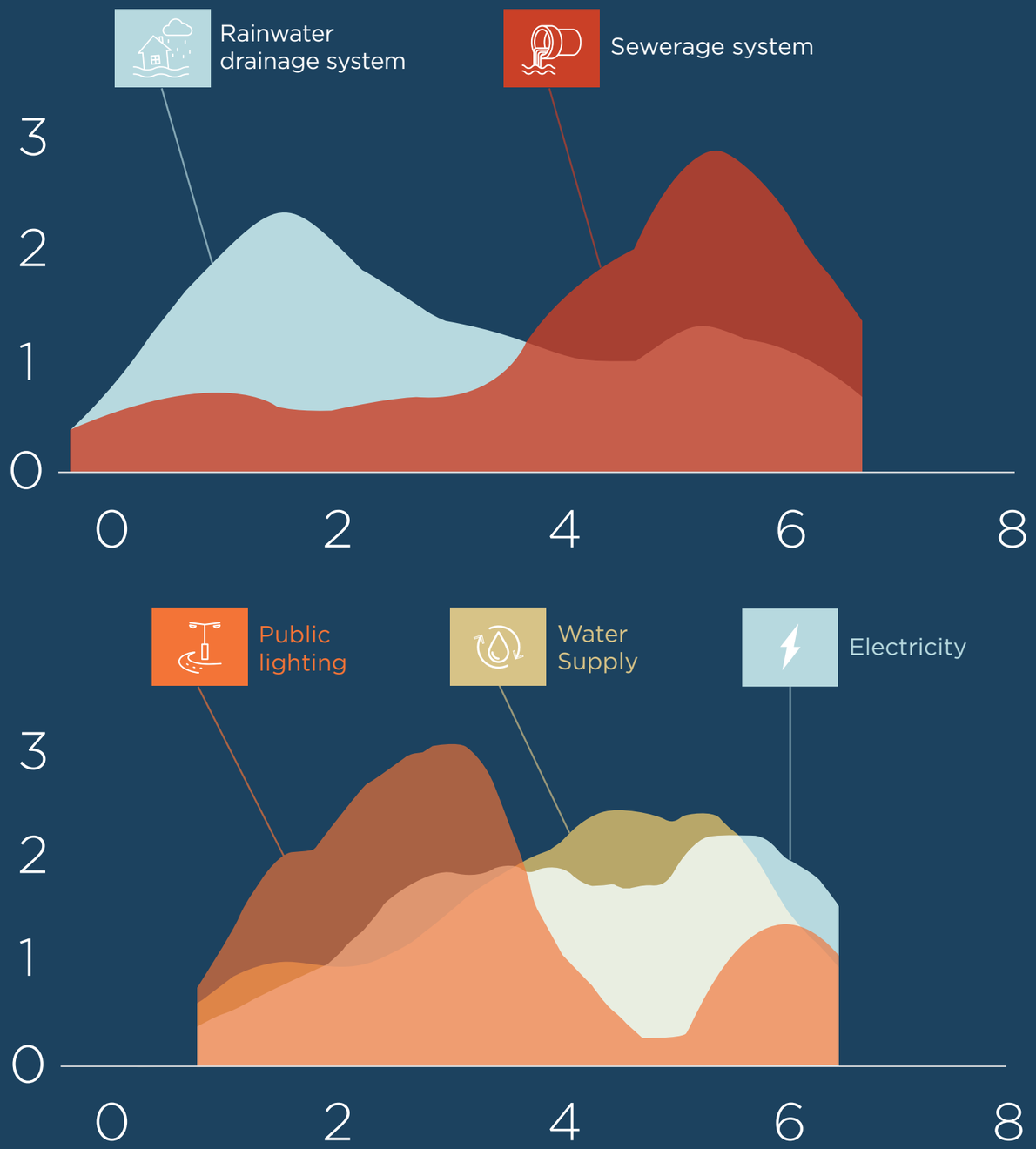
Garbage collection ranked among the bottom three of the ten infrastructures and services assessed. The mean was 3.3 and its frequency distribution was bimodal (Figure 1.3, Panel ii). The bimodality indicated that there was a group of treated favelas where garbage collection was problematic and another group where it was not. However, the largest mass of its distribution was concentrated to the left, indicating a big problem. Domestic waste collection was not done door-to-door for 40 percent of the favelas in the treated group. Another common complaint was the absence of waste bins on the streets.

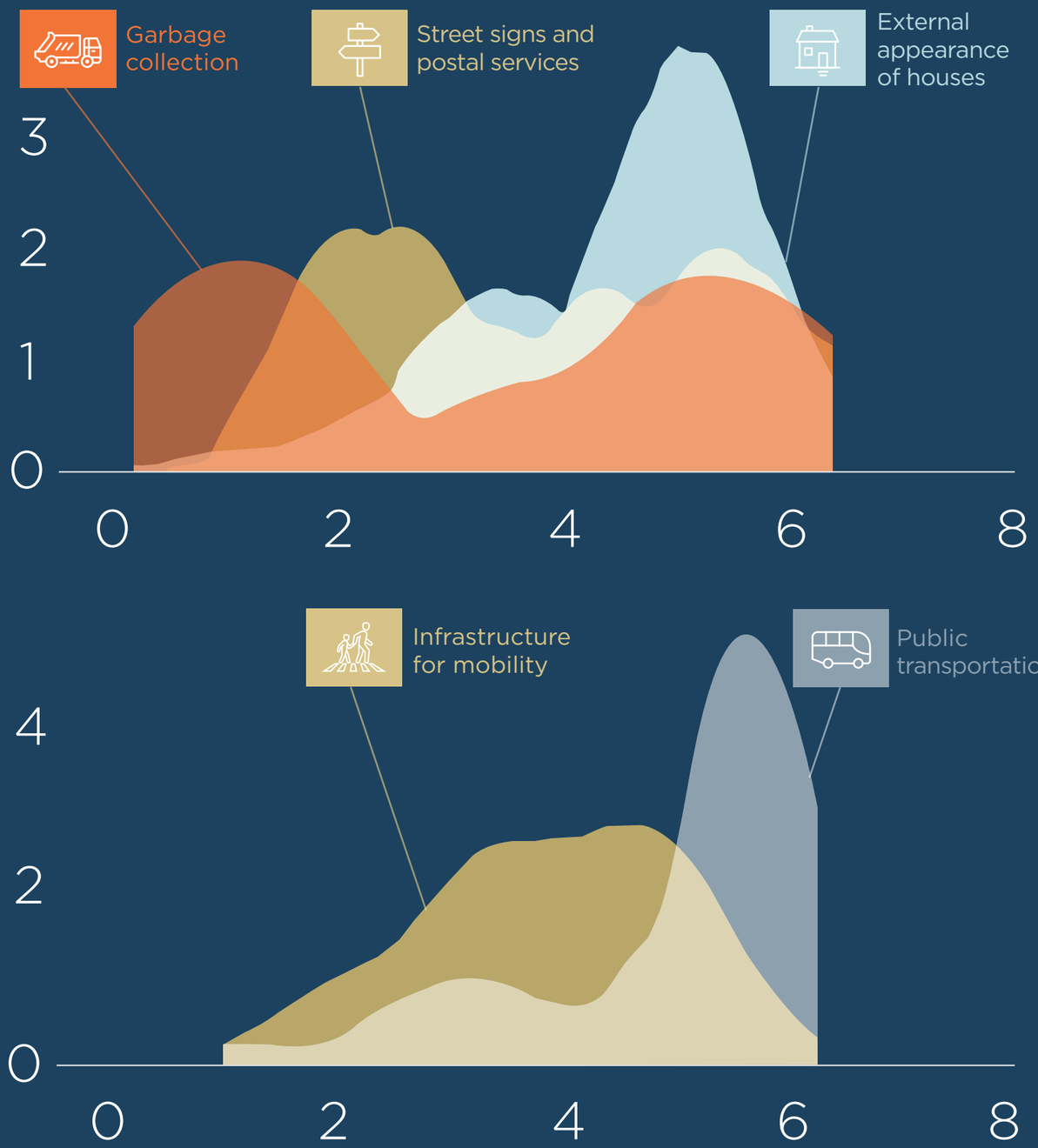
The high score for the external appearance of houses in the treated favelas was also noticeable, with the mass distribution to the right (Figure 1.3, Panel ii). This was the only indicator that directly depended on individual behavior, which indicated that people cleaned up and maintained the fronts of their own houses. Street signs and postal services presented a slightly bimodal distribution. Thus, about half of the treated favelas needed improvements to their street signs and postal services, but the other half had street signs and postal services in good condition.

14. The most common complaint from the focus groups was sewage overflows, especially during heavy rains.

Figure 1.3. Smoothed Distribution for the 10 Indicators in the Treated Favelas

Source: Authors' elaboration with data from Overview Pesquisa.
Notes: Score: 0 = non-operational; 6 = excellent condition. Areas shifted to the left indicate worse infrastructure.





Public lighting was in terrible condition in the treated favelas.

This indicator ranked second from the bottom with a mean of 3.2, and its distribution was concentrated to the left. The residents interviewed in half of the favelas visited in both treated and control groups noted a lack of routine maintenance of public streetlamps. Oddly, electricity presented a more centered distribution, which indicated that lack of electricity service was not causing poor public lighting. Water service presented a centered distribution, with a slight lean of the mass to the right, indicating that about one-third of the favelas had some problem with water service, but in most of them water service was not a big issue.

Infrastructure for mobility and public transportation improved but some favelas needed attention.

Paved streets, alleys, staircases, and other infrastructure for mobility were not in terrible condition; the mass of its distribution was shifted to the right. Similarly, access to local public transportation was first in the ranking among the treated group, but it was also high in ranking among the control group. In both the treated and control groups, 80 percent claimed that it does not take more than five minutes to walk to a nearby street with access to public transportation. In two of three favelas, the people interviewed said they had many transportation options to the same destination.

Notwithstanding these improvements, 30 percent of the favelas in the treated group had potholes that impeded normal circulation of vehicles larger than a motorcycle. No statistical difference was found in the mean of the control and treated groups. Thus, even though FB II focused mostly on paving streets and building staircases, walkways, and sidewalks, the control group had infrastructure of mobility similar to that of the treated favelas when assessed ten years later.

Results of the Focus Group Interviews

The results from the second approach were consistent with the first. The main conclusion from the focus groups is that, even though in the beginning FB II improved their lives, over time the infrastructure and public services suffered deterioration and neglect. In fact, over time, the infrastructure degraded considerably and most of the public services reverted to conditions like those in favelas that were not upgraded (control). People in the focus groups complained to the interviewers that sewage overflows, garbage accumulates, and electricity fails, and that streets have poor public lighting, among other complaints. Further, while in most focus groups residents expressed positive opinions regarding certain indicators, consistently, they credited this result to their own actions and not to those of the city or FB. For example, residents repair some of the potholes by filling them with sand to allow smooth circulation of cars and motorcycles. In other cases, residents reported that they fixed the electrical wiring themselves whenever possible.

The residents evaluated the evolution of the locality over the years, comparing the present with the past. In general, elder residents who arrived in their communities when there was little or no infrastructure recognized that they now live in a much better place. However, many still considered the conditions precarious and complained about basic infrastructure problems.

The following are the main issues for each of the types of infrastructure analyzed:

Sewerage system

One of the most frequent and major criticisms was in relation to the sewerage network. Residents cited that the facilities were inadequate for the size of the local population. Therefore, when it rains heavily during the summer, the sewage overflows and reflows back into the houses (Table 1.4). It is worth recalling that the impact evaluation done at the completion of FB II showed a significant and positive impact on sewerage coverage (Atuesta and Soares, 2016).[15]

Paved streets

There were plenty of complaints regarding the condition of the streets. Residents considered them a disaster in almost all favelas (treated and control). They reported that the streets were filled with potholes, accumulating water when it rains and making it impossible to get around by motorcycle or car. The only favela where the residents offered glowing reports about paved streets was in Parque São Sebastião, surprisingly part of the control group. In this favela the residents praised themselves for paving their streets, claiming that they, as opposed to the public agencies, maintained their streets.

15. In the study by Atuesta and Soares (2016), the estimated coefficient was statistically significant with a p-value = 0.001, n = 18,008.

Public lighting

Public lighting also received poor evaluations in almost all favelas (treated and control). Again, residents claimed that service providers did not show up when they were called for lamp replacements or repairs. Residents often said that they ended up doing maintenance themselves to keep their neighborhoods from going dark. As a solution, some residents put lights outside their own doors to provide light in front of their houses.

Postal services

Residents complained that, due to the post office's limited financial resources, the mail was not distributed individually to each resident's property. Even when the address of each house was made clear by FB II, the situation regressed to one where everyone's mail was delivered on a specific day at a single place and, hence, all residents had to converge in one place and at a particular time for mail delivery. This contrasts with the results of the study by Atuesta and Soares (2016) who found a positive and statistically significant impact of FB II on the outcome "mail delivery to property" in 2005.

Public transportation[16]

Another complaint was infrequent and scarce public transportation. It was worst in control favelas such as ITD, Ficap, Jardim América, Barreira do Jucá, and Moreira Pinto, but it was also a big issue in some of the treated favelas, such as Morro da Providência.

Water supply

The results for water supply were mixed in both the control and treated groups. Water supply was considered appropriate in some of the control favelas (Barreira do Jucá, Ficap, and Jardim América) as well as in some treated favelas (Morro da Providência and Bairro Proletário do Dique). In the rest of the control and treated favelas, the residents complained of inconsistent service, which they attributed to the inadequate size of the pipes given the population growth in recent years. The worst water service was in Parque São Sebastião.

Garbage collection

The results for garbage collection were also mixed. There were both positive and negative perceptions in treated and control favelas. In Barreira do Jucá, Vila União, Nossa Senhora da Apresentação, ITD, and Parque São Sebastião, collection was considered adequate since it happened daily or with regularity. Members of the focus groups did, however, point out that garbage bins needed to be provided in the streets, though they understood that keeping their own front yards clean was their own responsibility. In other favelas, garbage collection was not adequate either because of the irregularity of pick up or because the garbage was only collected from the most accessible parts of the favelas.

Electricity

In both treated and control favelas, residents complained that the large growth in population meant more home appliances were being used, mainly in the summer, which caused power outages. A typical complaint was the delayed response by the utility company when blackouts occurred. Often residents came together to solve community problems such as wiring and maintenance of power meters themselves.

Education, health, and recreational services

Residents were very critical of education, health, and recreation services in all favelas (treated and control). For education, they complained about the lack of kindergartens or spots in schools. For health, residents reported that, to benefit from health care, everyone is required to go through family clinics (Primary Care Units of Health) instead of the former health centers, but that the care was very precarious and the centers were very often closed due to a lack of doctors and medicines. Thus, the perception of a poor service was aggravated by the transformation of health centers into family clinics. For recreation, residents complained that there were not enough recreational areas, toys for kids, or gym equipment.

These qualitative assessments by the residents themselves pointed to one conclusion. Despite the initial improvement in their quality of life, in the favelas where the team conducted the focus group interviews, the current situation mirrored that of favelas that were never upgraded. Further, any maintenance in some of the favelas was perceived by the residents to be thanks to their own proactive measures to clean and maintain their communities. Thus, poor services and inadequate maintenance was perceived in the treated and control groups.[17]

Table 1.4 compares the different indicators presented in this report and the original impact evaluation conducted by Atuesta and Soares (2016). Although the indicators presented here are not directly comparable, they are useful to better understand the direction of the effect of the FB II intervention in relation to untreated favelas in two different points in time, 2005 and 2018. The table shows that the evaluation by the experts during the field visits and information from the focus groups are consistent for all but one indicator, transportation. The most dramatic finding was that, while Atuesta and Soares (2016) found an important and statistically significant improvement in most types of infrastructure in 2005 relative to a comparable control (untreated) group, in 2018 both the field visits by experts and the focus groups showed that the infrastructure suffered deterioration and neglect.

16. Even though public transportation was not part of the FB intervention, upgrades in infrastructure facilitate the circulation of vehicles.

17. During field visits, the professional inspectors assessed and rated most of the infrastructure carried out by FBII except for community services.

Table 1.4.
Comparison of Current Indicators and Previous Evaluation of FBII

Type of indicator	2005 Atuesta and Soares Statistically Significant Coefficient of Regression	2018 Field Visits 0 (non-operational) to 6 (excellent)	2018 Focus Groups Opinions
Sewerage system	Improved sewerage	Worst indicator of all, mass of distribution leaning to the left.	Frequent complaint of overflow.
Public lighting	Improved public lighting	Second worst indicator. Mass of the distribution leaning heavily to the left.	Lamps broken frequently. Maintenance crews do not repair them.
Postal services	Improved distribution of mail in property	Fourth worst indicator. Mass of the distribution to the left with distribution to the right.	Mail not distributed in properly. People must converge at a point in time and at a specific location to pick up their mail.
Public transportation	No improvement	Not a problem, ranked first.	Common complaint was that transportation was delayed or infrequent.
Water supply	Abastecimento de água melhorado	Ranked in the median. Mass of the distribution equally distributed around the center.	Mixed reviews. In some it was a problem, in others not so much.
Garbage collection	No improvement	Third worst indicator. Bimodal with most of the mass of the distribution to the left.	Poor condition.

Source: Author's evaluation.

Analysis of Findings

Our analysis showed that, after ten years, much of the infrastructure in favelas that was improved by FB II were in similar or worse condition than in comparable favelas that were never upgraded. What has happened during all these years? What factors are behind the regression of the treated group to the mean of the control group?

The research team sent to the favelas—a team of highly trained engineers and architects who had lived and worked in Rio their entire lives—hypothesized that extra demand on infrastructure in hilly favelas (morros), population size, and high levels of local violence were to blame for underperforming infrastructure. To test for empirical evidence to support this hypothesis, we correlated infrastructure indicators with local levels of topography indicators, population size, and indicators of local violence.

Analysis by Topography Indicators

It is possible that hilly favelas (such as the one in Image 1.1) perform worse than those on flat land because when it rains heavily it is harder to manage water accumulation and maintain infrastructure properly. Plenty of literature shows that sloped topography increases damage to paved streets in rainy weather[18] (Baldachin, Willway, Reeves, et al., 2008).

18. There might be other confounding factors. For example, the people in hilly favelas may use heavier vehicles, like 4x4 trucks, to get up into the hills.

Hilly Favela Morro dos Prazeres in Rio de Janeiro, 2018

Flat favelas had better infrastructure indicators than hilly favelas.

Flat favelas (such as the one in Image 1.2) are those which have no significant slope and mostly flat areas. Conversely, hilly favelas have accentuated and constant slopes. Table 1.5 summarizes the statistical test of the mean between hilly and flat favelas. The results support the hypothesis that topography is a relevant factor. Flat favelas had better infrastructure indicators than hilly favelas. This was true especially for infrastructure associated with mobility and transportation. This is to be expected since asphalt in hilly favelas is more easily damaged when rainfall debilitates the binder film applied to the streets. A joint test of the mean for six areas of the city by type of indicator was conducted and rejected the null hypothesis that the infrastructure was equal across the city in the 88 upgraded favelas (the results are provided in Appendix D). Thus empirical evidence was found that hills might suffer more damage because their topography facilitates water eroding the pavement when it rains.

Flat Favela da Maré in Rio de Janeiro, 2018

Table 1.5.
Test of the Means by Type of Infrastructure or Service among Treated Favelas

	Hilly	Flat	P-Value: Ho: Hilly = Flat
General Infrastructure Index	**3.36**	**3.86**	**0.012****
Sewerage system	**2.90**	**2.97**	**0.944**
Infrastructure for mobility	**3.59**	**4.63**	**0.000****
Public lighting	**3.16**	**3.26**	**0.759**
Street signs and postal services	**3.55**	**4.38**	**0.001*****
Public transportation	**4.86**	**5.23**	**0.006*****
Water supply	**3.73**	**4.35**	**0.008*****
Garbage collection	**2.87**	**4.06**	**0.000*****
Electricity	**4.04**	**4.26**	**0.434**
External appearance of houses	**4.31**	**4.75**	**0.017****
Rainwater drainage system	**4.23**	**4.19**	**0.661**

Source: Author's elaboration. *Note:* Score: 0 = non-operational; 6 = excellent condition. Levels of statistical significance: ***p-value = 0.01, **p value = 0.05, *p-value = 0.10. Although the analysis includes 88 favelas upgraded in FB II, some of these 88 are in complexes or groups linked like a network, meaning that some favelas are a complex of several favelas. Counting each favela individually, there are a total of 160 favelas reported in this table.

Source: IDB 2018.

It is worth noting that flat favelas are predominantly located in the west of Rio, while hilly ones are in the north, center, and south of the city. Also, most of the FB II funding went to the north of Rio, which at the time FB II was implemented, had the highest concentration of favelas. Figure 1.4 shows the favelas with the worst infrastructure conditions in red and the ones with better conditions in green. It is evident that the northern area has the highest number of favelas with underperforming infrastructure. In contrast, in the west of Rio, where flat favelas Guaritiba and Campo Grande are located, green indicates better infrastructure.

To the south, some favelas next to the beaches of Copacabana and Barra de Tijuca present mild deterioration in yellow and some in green. This is surprising because these are on hills and hence worse infrastructure is expected. However, these favelas are in privileged locations, for example, close to premium amenities such as beaches, better schools, and shorter commutes, which could have facilitated gentrification and provided more local resources for maintenance. It is also possible that the municipality invested more resources in these favelas because of their proximity to tourist areas.

It is evident that the northern area has the highest number of favelas with underperforming infrastructure.

Source: IDB 2018.

Figure 1.4.
Map of the State of the Infrastructure Using the General Infrastructure Index

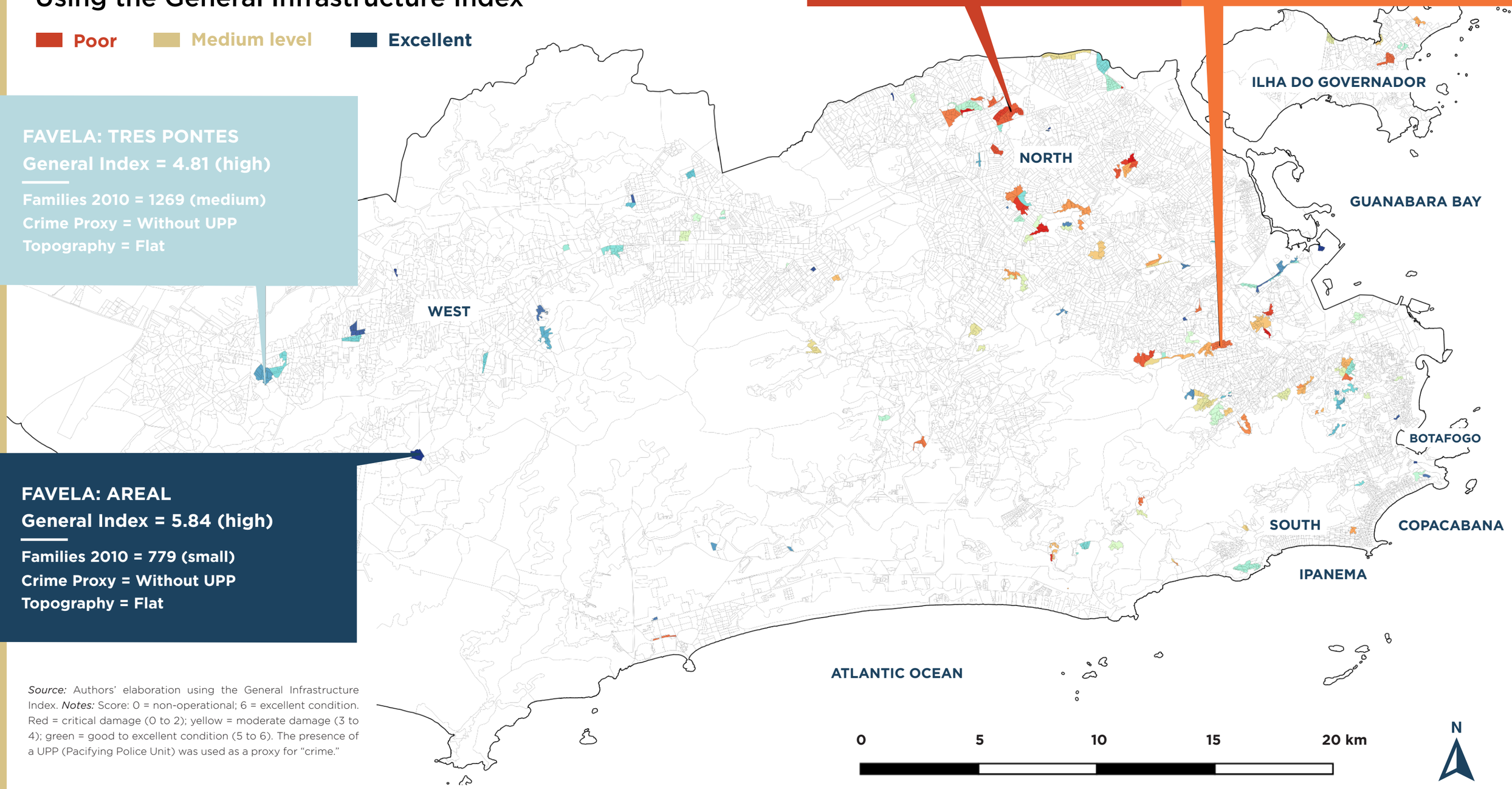
Poor **Medium level** **Excellent**

FAVELA: PARQUE ACARI
General Index = 1.85 (poor)
Families 2010 = 1884 (large)
Crime Proxy = Without UPP
Topography = Flat

FAVELA: MORRO DOS MACACOS
General Index = 2.3 (poor)
Families 2010 = 1384 (medium)
Crime Proxy = With UPP
Topography = Hilly

FAVELA: TRES PONTES
General Index = 4.81 (high)
Families 2010 = 1269 (medium)
Crime Proxy = Without UPP
Topography = Flat

FAVELA: AREAL
General Index = 5.84 (high)
Families 2010 = 779 (small)
Crime Proxy = Without UPP
Topography = Flat



Source: Authors' elaboration using the General Infrastructure Index. *Notes:* Score: 0 = non-operational; 6 = excellent condition. Red = critical damage (0 to 2); yellow = moderate damage (3 to 4); green = good to excellent condition (5 to 6). The presence of a UPP (Pacifying Police Unit) was used as a proxy for "crime."

Analysis by Population Size

The next analysis was according to population. The favelas were divided into three groups: large (1,700–2,500 families), medium (1,100–1,700), and small (500–1,100). Next, a joint test of the mean was performed for the three groups. Some favelas in the north are the most populated, have a lot of crime, and have hills. However, as always, it is difficult to attribute the deterioration to one factor when others are present. With a test of equality of the means, other factors cannot be isolated. For example, looking at Figure 1.4, Morro dos Macacos, in the treated group, has poor infrastructure, is violent, is hilly, and is medium sized. Consider also Parque Acari, which has a large population (1,884 families) and poor infrastructure, although it does not have extreme levels of violence or hills. To the west, Areal and Tres Pontes have good infrastructure and mostly flat topography.

The results are presented in Table 1.6. The sewerage and rainwater drainage systems showed a significant difference between large and small favelas, but not between small and medium ones. This points out that the larger the favela, the worse the results of these indicators and the greater need for investment when favelas are more populous. Therefore, there is evidence that the projected capacity is smaller than the current population served, a fact that was also verified and confirmed when the analysis with the focus groups was implemented.[19]

19. Additional tests for population growth and the indicators were conducted, but there were no statistically significant results, possibly because all favelas have grown tremendously but with little variation in their growth.

Table 1.6.
Test of the Mean Kruskal-Wallis by Size of Favelas According to Population Among Treated Favelas

	Small (1)	Medium (2)	Large (3)	P-Value H0:1=2=3
Índice Geral de Infraestrutura	**3.73**	**3.82**	**3.38**	**0.092***
Sewerage system	3.40	3.80	2.47	0.001***
Infrastructure for mobility	4.14	4.02	3.91	0.643
Public lighting	3.77	3.21	3.12	0.519
Street signs and postal services	3.85	3.85	3.84	0.979
Public transportation	4.38	4.65	5.21	0.223
Water supply	4.33	4.15	3.82	0.352
Garbage collection	3.43	3.93	2.97	0.109
Electricity	4.31	4.03	4.14	0.800
External appearance of houses	4.41	4.78	4.32	0.029**
Rainwater drainage system	4.56	4.78	3.92	0.010***

Source: Author's elaboration. *Note:* Score: 0 = non-operational; 6 = excellent condition. Levels of statistical significance: ***p-value = 0.01, **p value = 0.05, *p-value = 0.10. The null hypothesis H0:1=2=3 is that favelas of different sizes have statistically equal indicators.

Analysis by Crime Level

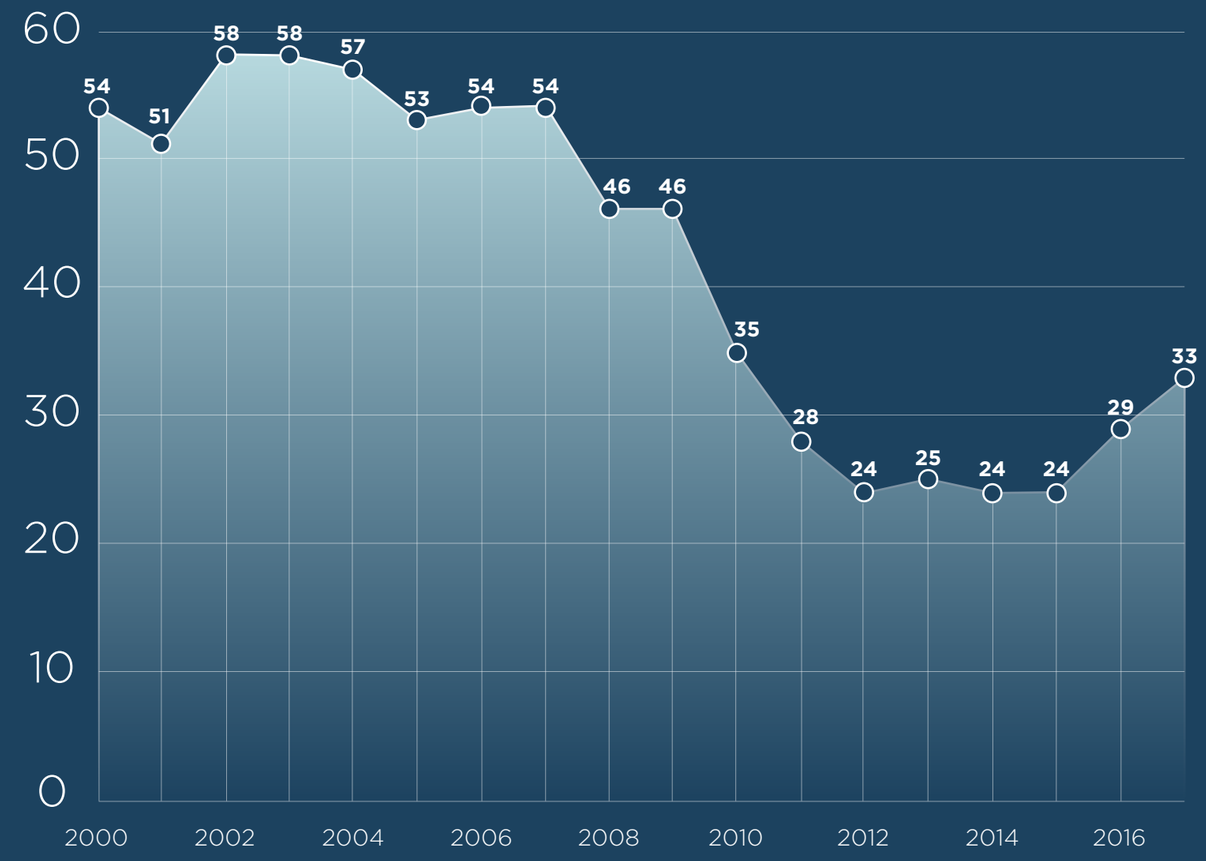
Endemic, high-level violence undermines adequate maintenance and hence triggers infrastructure decay overtime because crews responsible for water supply, electricity, public lighting, and public transportation cannot safely enter these areas. According to what the team of engineers and architects witnessed firsthand, violence affects paved streets, public lighting, garbage collection, and sewerage. Rio de Janeiro favelas have very high levels of crime. During the years FB II was executed, Rio had a rate of 50 homicides per 100,000 inhabitants in one year. This homicide rate was as high as that of some of the most violent cities in the world, such as San Pedro Sula in Honduras or Ciudad Juarez in Mexico. The rate began to decline in 2009, reaching a brief plateau of 24 homicides per 100,000 inhabitants between 2012 and 2015, rising again to 33 in 2017, which is still considered a high level.

Data on homicide rates is considered the most reliable crime data since other types of crime, such as theft and assaults, are usually underreported. However, this rate lacks geographic information at the scale needed because the only spatial indicator was the records gathered by police stations. Therefore, the locations of Rio's UPPs were used as a proxy for the spatial distribution of crime.

During the years FB II was executed, Rio had a rate of 50 homicides per 100,000 inhabitants in one year.

UPPs are an extension of police stations and are located where police expect higher-than-average levels of crime and violence (Felbab-Brown, 2011). UPPs are staffed by officers mainly trained in nonviolent policing and human rights. In 2008, the State of Rio de Janeiro, in coordination with the municipal and federal governments, implemented the UPPs to combat and dismantle organized crime in the favelas. UPPs also had the support and supervision of non-governmental organizations and organized civilians. Installing a UPP usually required the intervention of the Rio de Janeiro military police, who, depending on the conditions of resistance offered by the local criminal groups, counted on the help of the Special Police Operations Battalion of Rio de Janeiro and the Armed Forces. Each installed UPP was linked to the nearest battalion of the Military Police.

Figure 1.5.
Homicide Rate in Rio de Janeiro City (Homicides per 100,000 inhabitants)



Source: Institute of Public Safety (Instituto de Seguranca Publica, ISP). http://www.ispdados.rj.gov.br/Arquivos/SeriesHistoricasLetalidadeViolenta.pdf. Accessed August 21, 2018.

A favela with a UPP would be expected to have higher-than-average crime levels, jeopardizing mobility within the favela and spreading fear among those responsible for cleaning and maintenance, thus lowering the quality of the infrastructure. Alternatively, if a UPP has achieved its purpose, the expected effect would be better maintained infrastructure. But the net impact of a UPP on crime depends on which of these two effects dominate. The impact of UPPs on local levels of violence seems to vary through time. Initially, favelas with a UPP showed lower levels of homicides, although there were confounding factors beyond more police officers. Empirical literature on the effect of UPPs on homicide rates in favelas found them to have very little impact (Franco, Magaloni, and Melo, 2015).[20] The situation has worsened since the conclusion of Rio's Olympic Games in 2016. Further, UPPs have been underfunded because of Brazil's financial crisis.[21] Levels of local violence have increased and the federal government has intervened in the State of Rio to improve public safety.[22] So it is likely that as security declined, infrastructure maintenance also declined, since it is often impossible for municipal crews to enter violent areas.

Intentional Street Hole in Favela Morro da Quitanda in Rio de Janeiro, 2018. Source: Overview Pesquisa.

Drug dealers and gangs operate within a well-established territory, which they defend and demarcate through confrontations with the police and with other factions. Besides impeding proper maintenance, they mark their territory by purposefully destructing infrastructure or vandalism (see Image 1.3). The team of engineers and architects sent to perform the technical inspection often observed gangs breaking public lighting fixtures in some parts of a favela to make it easier for them to hide. They also make potholes (see Image 1.4) in the streets that access the favelas to create barricades and hinder the entrance of police cars and rival gangs. Finally, they destroy internal mobility structures, such as public stairs and ramps, to hamper access to their hideouts.

Table 1.7 confirms that infrastructure for mobility, street signs and postal services, garbage collection, external appearance of houses, and rainwater drainage systems are in worse condition in favelas with a UPP (a proxy for high levels of crime) than those without. These simple tests suggest that violence may affect infrastructure both through direct vandalism and through the indirect effect of intimidating maintenance crews.

Intentional Roadblock in Favela Morro da Quitanda in Rio de Janeiro, 2018. Source: Overview Pesquisa.

20. Other empirical literature about the effect of police on local crime has found that police presence decreases crime. See Di Tella and Schargrodsky (2004) and Levitt (1997).

21. See the following articles for more information: Governor of Rio is looking to eliminate 18 UPPs (Governo do RJ estuda acabar com 18 UPPs): https://g1.globo.com/rj/rio-de-janeiro/noticia/seguranca-do-rj-estuda-acabar-com-18-upps.ghtml. Will Rio's state budget cut affect UPPs? Experts respond (Corte no orçamento do estado do Rio afetará UPPs? Especialistas respondem): https://noticias.uol.com.br/cotidiano/ultimas-noticias/2015/01/27/corte-no-orcamento-do-estado-do-rio-afetara-upps-especialistas-respondem.htm. How are the UPPs after fund cuts and loss of autonomy (Como ficam as UPPs após corte de verbas e perda de autonomia): https://www.nexojornal.com.br/entrevista/2017/12/15/Como-ficam-as-UPPs-ap%C3%B3s-corte-de-verbas-e-perda-de-autonomia

22. 7 points to understand the federal intervention in Rio de Janeiro (7 pontos para entender a intervenção federal no Rio de Janeiro): https://www.terra.com.br/noticias/brasil/cidades/7-pontos-para-entender-a-intervencao-federal-no-rio-de-janeiro,a51957369ba93a351fef808a86a0d0346w8av0c2.html.

Table 1.7.
Test of the Mean between Violent-Treated and Non-violent-Treated Favelas

Does the favela have a UPP?	No (1)	Yes (2)	P-Value
Number of observations (favelas)	91	53	Ho: 1 = 2
General Infrastructure Index	3.63	3.37	0.148
Sewerage system	2.98	2.84	0.728
Infrastructure for mobility	4.12	3.68	0.045**
Public lighting	3.08	3.38	0.110
Street signs and postal services	4.11	3.38	0.003***
Public transportation	4.91	5.12	0.268
Water supply	3.94	3.97	0.884
Garbage collection	3.75	2.51	0.000***
Electricity	4.12	4.12	0.980
External appearance of houses	4.65	4.15	0.007***
Rainwater drainage system	4.32	4.05	0.076*

Source: Author's elaboration. *Note:* The proxy for violence is the existence of a UPP. Score: 0 = non-operational; 6 = excellent condition. Levels of statistical significance: ***p-value = 0.01, **p value = 0.05, *p-value = 0.10. Results of Mann-Whitney Indicators according to the existence of a UPP.

Conclusions

Summary of Findings

FB II upgrades took place between 2000 and 2008. In 2005, a rigorous empirical evaluation found that these upgrades had significantly improved the lives of the residents.[23] This study revisited the upgraded favelas to assess the long-term sustainability of the benefits of FB II.

The study relies on a double pronged strategy: (i) focus groups and (ii) expert assessments. For the focus groups, a pre-set questionnaire was used with residents from nine favelas (three treated, three control near treated favelas, and three control further from treated favelas) about the state of the infrastructure currently in their favela. The perception was that FB II brought significant improvements in the short term, but that over time these improvements faded.

The assessment evaluated the state of the infrastructure in all 88 favelas (144 counting each favela in a complex of favelas separately) upgraded by FB II plus 10 additional favelas that served as a control group (17 counting those in a complex separately). The inspections showed that nearly two out of three upgraded favelas had poor street lighting and sewerage channels that overflow or reverse flow, and that one out of three had streets with pavement in poor condition and congested drainage systems.

The fact that both the quantitative and qualitative assessments indicated that many of the original gains of FB II were lost speaks volumes about the imperative need to focus on the sustainability of these investments. Why did the infrastructure upgraded by FB II deteriorate? Experts in the field hypothesized it was mostly due to inadequate maintenance, a consequence of overpopulation, topography, and crime and vandalism. Hence, the empirical results were revised considering these factors.

There was a strong correlation between population size and the state of infrastructure.

There was a strong correlation between population size and the state of infrastructure. In more populous favelas, built infrastructure was further deteriorated and garbage and sewage accumulated more often. This needs to be taken into account when designing urban upgrading programs since upgrades tend to attracting more residents to the neighborhoods.

Topography of the favelas was also associated with deterioration of infrastructure.

Topography of the favelas was also associated with deterioration of infrastructure. In hilly favelas, typically found north of Rio, the infrastructure did not cope well with rainfall and pavement degraded faster than in flat favelas. Hilly favelas also had high levels of crime and large populations. Due to the confluence of factors, the northern favelas of Rio presented the worst indicators of both the treatment and control groups. In contrast, flat favelas located to the west of the city presented the best indicators.

Notoriously, crime and violence correlate with deteriorated infrastructure.

Notoriously, crime and violence correlate with deteriorated infrastructure. The mechanism is direct in the case of vandalism and indirect as increased violence impedes proper maintenance of infrastructure. Gangs often break public lighting to hide from police and create potholes in the streets or set up barricades to hinder the entrance of police cars and rival gangs. All this makes it very difficult for municipal maintenance crews to enter the favelas and keep the infrastructure in optimal condition.

23. Atuesta and Soares, 2016

Policy Recommendations

In sum, our research shows that FB II achieved important successes in the short-term but there were significant difficulties in sustaining these same successes through time; particularly in providing sewerage systems, public lighting, postal services, water supply, and garbage collection. Now, considering these results, three basics questions need to be addressed when considering physical interventions in informal urban neighborhoods:

1. **Under what conditions should urban upgrading programs be pursued?**
2. **Which tools are critical to accomplish the projects?**
3. **What mechanisms are in place to assure the sustainability of interventions?**

Regarding the first question, understanding the social organization of the neighborhoods is critical before any intervention. One of the main beauties of urban upgrading programs is that, by having a territorial focus, they allow for a comprehensive update. But the downside of this approach is that it has often come at the expense of assuming that all households residing in informal neighborhoods are similar, regardless of their needs. There are many reasons people end up living in these neighborhoods. In the majority of cases, the reasons are related to a lack of key material or legal resources, but in a few, but relevant, cases, they are related to the opportunities for illicit activities offered by the lack of rule of law. In this case, public works need to go side by side with social programs to create true improvement in the quality of life of those living in favelas.

Households who live in informal neighborhoods are diverse in many dimensions and thus find in informality answers to a diversity of needs.

But the analysis of the social fabric should go beyond dividing those engaged in criminal activities from those who are not. Households who live in informal neighborhoods are diverse in many dimensions and thus find in informality answers to a diversity of needs. Some of these needs cannot be addressed through neighborhood improvements. For example, if the issue is insufficient household income to afford accommodation outside of informal neighborhoods, it is evident that programs to support affordable housing markets are key. Also, it is often the case that the main obstacle for these households is the nature of their income, which is often informal and erratic and thus excludes them from formal real estate and credit markets. Therefore, revisiting financial institutions, supporting creditworthiness among low-income residents, and promoting affordable housing are building blocks for an inclusive city.

Likewise, the issue of social networks and access to information needs to be addressed. Often, newcomers to the city settle in informal neighborhoods simply because they already know someone living there. These social networks are important and need to be preserved. But they also need to be complemented with local institutions (e.g., schools and hospitals) as sources of valuable information and resources to newcomers. In this way, individuals can better understand the diversity of accommodations cities offer, which should increase their freedom to choose where to live. This is essential given that local networks influence future job and work opportunities for households. In our research it was clear that residents were almost fully embedded in the networks of their neighborhoods, with little to no access to information from other resources.

On their own, territorial upgrading programs do not effectively create a new social paradigm within informal neighborhoods. Many of the issues of violence entrenched in informal neighborhoods are rooted in causes beyond the specific issues of substandard housing and irregular tenure. Therefore, it is important to understand which problems can or cannot be solved by urban upgrading programs. Access to basic services at the household level, paving and streetlamps, and certain improvements in the tenure conditions of those residing in favelas are achievable and worthy goals of neighborhood upgrading programs. Pacifying communities torn by violence not directly associated with the neighborhood itself (e.g., selling illegal goods and trafficking drugs) is beyond the scope of these programs.

Neighborhood upgrading programs should go hand in hand with pacification and not be used as a means to achieve it. It was clear from the research that favelas with high crime presented worse indicators than less violent ones. Most interventions in urban planning did not coordinate with citizen security initiatives because the corresponding agencies belong to different ministries. This is not to say that there are not opportunities for synergies between clean and well-preserved communities and crime rates, as the famous broken window theory predicts. There is certainly a vicious circle whereby the lack of apparent presence of the state or of a local community that cares can enable anti-social behavior where urban landscapes look broken (Wilson and Kelling, 1982). So, improving citizen security must be part of the solution rather than a completely different issue. But the level of crime the favelas of Rio de Janeiro face has different triggers and complexity and will not be dissuaded just by signs of a well-maintained street.

Once works are completed, more people would like to settle in the neighborhood and hence the demand for services will increase more than in other areas.

Regarding which tools are critical for the successful accomplishment of such projects, good design and good construction cannot be stressed enough. The design of public spaces and infrastructure needs to account for the likely possibility that once works are completed, more people would like to settle in the neighborhood and hence the demand for services will increase more than in other areas. Also, projects need to account for the topography and the conditions of the terrain in which these neighborhoods unfold. It is often the case that the terrain is harder and more expensive to urbanize than the areas of the city that developed first.

The design of the infrastructure should consider resilience to inclement weather and climatic events.

Also, the design of the infrastructure should consider resilience to inclement weather and climatic events, which usually have a greater impact where informal neighborhoods are located because they are often settled on less desirable land (Garschagen and Romero-Lankao, 2013). Infrastructure needs to be designed with higher environmental standards than in the past, considering climate change (Nguyen et al., 2011). It is imperative that the materials used, and the designs, are resilient to the inclemency of weather, steep hills, heavy use in populous favelas, and the natural wear and tear that occurs. In the upgraded favelas visited, all infrastructure degraded as soon as it was exposed to normal conditions. As soon as damage appears, repair and maintenance need to be done immediately to help prevent further damage.

And the notion of resilience is closely connected to that of sustainability. Maintenance and repair are too big to ignore (McGrattan and Schmitz, 1999). Proper maintenance requires an institutional mechanism to be in place to deal with repairs as soon as the need arises. Clearly, repair and maintenance were not done, possibly to impair mobility in violent favelas. Thus future projects ought to incorporate a recurrent expenditure item that considers cleaning, repair, and maintenance on a regular basis, especially in hilly favelas. Historically, within favelas, the poorest of the poor located in steep hills where they built in precarious conditions, thus making reinforcing the surrounding terrain more challenging. Hence, educating the local people on how to preserve and protect the infrastructure, and empowering them to do so, is a valuable tool. The external appearance of the houses was excellent, meaning that residents are diligent in keeping their houses well maintained. But this did not extend beyond the walls of the houses facing the street. Thus, basic cleaning done by the residents could protect the communities. Cleaning garbage from the streets could prevent sewage channels and the stormwater systems from becoming congested.

Urban upgrading programs need to promote the full integration of the local real estate market with that of the rest of the city.

Last, and aiming for long-term sustainability, urban upgrading programs need to promote the full integration of the local real estate market with that of the rest of the city, in which rights are recognized and residents have physical mobility. More than anything, neighborhood upgrading programs need to be conceived of as stepping stones to help those who benefit from them to further improve and determine their own futures.

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Appendixes

A. Focus Group Interviews

This section contains more details about how and when the team sent by Overview Pesquisa interviewed the focus groups.

Favelas	Intervention	Date	Number of participants
Morro da Providência	Treatment	16/12/2017	8
Nossa Senhora da Apresentação	Treatment	02/12/2017	10
Bairro Proletário do Dique	Treatment	11/12/2017	9
Moreira Pinto	Control next to treated favela	16/12/2017	8
Ficap	Control next to treated favela	12/11/2017	9
ITD	Control next to treated favela	20/12/2017	10
Barreira do Jucá	Control	18/12/2017	8
Vila União	Control	18/12/2017	8
Parque São Sebastião	Control	20/12/2017	10

Table A.1.
Focus Groups

Source: Overview Pesquisa.

Lists of items asked by the moderator during interviews in focus groups.

1. **Basic sanitation/sewerage**
2. **Addition of house rooms or extensions**
3. **Delivery of correspondence (postal services)**
4. **Circulation inside the community (how access is accomplished, e.g., motorcycle, car, etc.)**
5. **Access to public transportation**
6. **Water supply**
7. **Garbage collection, street/alley**
8. **Electricity**
9. **Street lighting**
10. **Paved streets**
11. **Land titling**
12. **Nursery**
13. **Schools**
14. **Health centers**
15. **Resident associations**
16. **Sports and recreation centers**
17. **CRAS (Reference Center for Social Assistance)**

The moderator also asked specifically who was responsible for reparations of the following public services and infrastructure.

1. **Sewerage system**
2. **Water system**
3. **Street lights**
4. **Public phones**
5. **Holes in streets**
6. **Sports equipment**
7. **Toys or equipment in the square and recreation area**
8. **Handrails and staircases**

The Invitation

This section aims to describe how recruitment for participation in focus groups was carried out. It also describes the strategies adopted to optimize the work and the difficulties encountered.

The focus groups were held on December 2, 11, 16, 18, and 20, 2017. There were three groups of favelas with three favelas in each group:

1. **Treatment group (upgraded during FB II): Nossa Senhora da Apresentação, Morro da Providência, and Bairro Proletário do Dique.**
2. **Control group near (favelas near FB II projects but not upgraded): Moreira Pinto, Ficap, and ITD.**
3. **Control group far (favelas farther from FB II projects): Barreira do Jucá, Vila União, and São Sebastião Park.**

A focus group was held in each community and ten residents were invited. Initially, search agents from Overview Pesquisa visited residents' associations to identify possible locations for the meetings. In general, the presidents of the associations collaborated with the team, and some groups were held at the office of the residents' association.

After defining the location and date for the focus groups, recruiters began their search for participants. Participants were recruited through a home visit by an Overview Pesquisa agent. The target group was people who had lived in the community for at least 20 years and were at least 35 years old. People who were associated with political associations, non-governmental organizations, or churches were not invited to participate to avoid introducing political or religious bias into the opinions. Some residents' associations provided the names of older residents who worked in the community as suggested participants. The residents were invited to attend a one-hour meeting to talk about their perceptions of their community.

Some families indicated other people known to attend meetings in the community, which facilitated identifying volunteers for the focus groups. During recruitment, drug dealers from the Barreira do Jucá and Bairro Proletário do Dique communities approached the team, questioned their presence, and took away their equipment. The team explained the reason for the research. Fortunately, nobody was hurt, and our team left but with a warning. For this reason, we avoided recording the interviews in video thereafter.

Each person invited to the discussion received a letter containing an invitation stating the purpose of the work, how the meeting would take place, and the location and date. Contact information and other data were recorded, including participant name, telephone number, address, age, and how long they had resided in the community.

The day before each focus group was held, group leaders phoned each guest to confirm participation. It was not possible to contact some guests because their phones were out of the area or disconnected.

The groups lasted between 50 and 90 minutes and had at least eight guests (a maximum of 10). All themes were discussed as determined by the methodology.

B. Participatory Rapid Mapping

The field team was composed of 40 architects and engineers. Before data collection, the team was trained using images and simulations to discuss all observable aspects of the infrastructure they were going to assess. They were also trained to identify the boundary limits of the favelas' census tracks and how to travel the perimeter. Further, they learned how to collect the geographic coordinates of the identified structures. Each observer carried out the following activities:

1. **Filled out a form with the favela as the observation unit.**
2. **Mapped the structures identified in each census sector of each favela.**
3. **Produced a map of each sector of each community identifying the geographical coordinates of the designated structures.**

After the training, the team began collecting data, focusing on filling out the MRP form—one for each favela. They also collected the coordinates of the main identified structures, such as paved streets, stairways, nurseries, health units, schools, and so on, and manually mapped the structures relative to the home census track of the favelas that were part of the study. They identified the position of each structure and linked it to the geographic coordinates file. Data collection work was planned for four weeks.

The completed standardized forms generated a database of variables that allowed the researchers to measure a range of characteristics within the perimeter of these favelas. The methodology used 66 variables to build ten thematic indicators, in addition to a synthetic index (the General Infrastructure Index), which refers to the general urban conditions of favelas.

The methodology was constructed to generate a synthetic indicator from 0 to 6, where 0 means non-operational and 6 excellent condition; the lower the value, the greater the urban precariousness for that indicator, while values close to 6 represent conditions near adequate standards of coverage and quality of infrastructure and urban services. This scale was defined based on the previously established objectives of facilitating the classification of the results into six classes.

The number of variables that make up each indicator differed according to the infrastructure or service: 7 for the sewerage system, 11 for infrastructure for mobility, 4 for public lighting, 2 for street signs and postal services, 16 for public transportation, 7 for water supply, 8 for garbage collection, 2 for electricity, 4 for external appearance of households, and 5 for the rainwater drainage system. The full list of indicators per type of infrastructure or service is presented in Table B.2.

The indicator produced for each type of infrastructure varied from 0 to 6, with the state of preservation varying as shown in Table B.1.

RED	< 1,50 (Least suitable condition)
PINK	From 1,51 to 2,50
ORANGE	From 2,51 to 3,50
YELLOW	From 3,51 to 4,50
LIGHT GREEN	From 4,51 to 5,50
DARK GREEN	> 5,51 (Most suitable condition)

Table B.1. Variation of the MRP indicator

Source: Overview Pesquisa

Thematic final indicator	Intermediate indicator	Original variables
Sewerage system		Place of sewage discharge of most households
		Place of sewage discharge of the considerable minority of households
		Existence and recurrence of reflux/overflow in the official network
		State of conservation of the official sanitary sewerage infrastructure
		Frequency and dimension of open sewage in ducts without plumbing
		Recurrence of open sewage on unpaved roads
		Frequency and extent of open sewage in ditches, gutters, rivers, reservoirs, or vegetation
Infrastructure for mobility	Street infrastructure	Capillarity of transitable streets by motorcycle
		Capillarity of transitable streets by car
		Predominance of transitable streets with passage for two cars
	Access to transitable streets	Average walking time to nearest transitable street
		Existence of areas with medium or high slope on the route to the transitable street
	Coverage and quality of street paving	Pavement cover for alleys, stairways, and walkways
		State of conservation of the pavement of most alleys, stairways, and walkways
		State of conservation of the pavement of the possible minority of alleys, stairways, and walkways
		Coating of paving of transitable streets
		State of conservation of the paving of most of the transitable streets
		State of conservation of the paving of the possible minority of transitable streets
Public lighting		Coverage of public street lighting infrastructure in the households
		State of conservation of public lighting posts
		State of conservation of public lighting brackets
		Quality of public lighting maintenance
Street signs and postal services	Street signs	Existence of street sings on most corners
	Postal services	Form of access predominantly to the postal service

Table B.2.
MPR variables

Source: MRP Methodology of the Instituto Pereira Passos.

Thematic final indicator	Original variables
Public transportation	Average walking time to the nearest public transport terminal
	Line alternatives at the nearest point
	Waiting time at nearest point
	Average walking time to the inclined plane/elevator used on the way to the nearest public transport point
	Slope/elevator service quality used on the way to the nearest public transport point
	Average walking time to local van or van transport used on the way to the nearest public transport point
	Frequency of the interval between the kombis or vans used on the way to the nearest public transport point
	Average walking time to the motocycletaxi used on the way to the nearest public transport point
	Average walking time to the most used public transport point
	Line alternatives at the most used point
	Waiting time at the most used point
	Average walking time to the inclined plane/elevator used on the way to the most used public transport point
	Quality of service of the inclined plane/lift used on the route to the most used public transport point
	Average time on foot to the local public transport on the way to the most used public transport point
	Frequency of the interval between the kombis or vans used on the route to the most used public transport point
	Average walking time to the motocycletaxi used on the way to the most used public transport point
Water supply	Form of water supply for most households
	Form of water supply for a considerable minority of households
	Frequency of water supply
	Existence of irregular connections
	Recurrence in interruptions in water supply throughout the year, except summer
	Recurrences of interruptions in water supply in summer
	Need to use pumps to supply
Garbage collection	Coverage of the door-to-door collection service
	Walking time to the nearest bucket
	Walking time to the point of irregular disposal with periodic removal
	Presence of garbage accumulated in overflowed buckets/containers
	Coverage of accumulated garbage with periodic removal (without bucket/container)
	Coverage of accumulated garbage without periodic removal (without bucket/container)
	Presence of garbage accumulated in dumps
	Existence and size of scattered garbage
Electricity	Coverage of the regular electricity supply in households
	Frequency of interruptions in electricity supply
External appearance of houses	Poor appearance of external walls in most households
	Poor appearance of external walls in some households
	Poor appearance of external walls in a small minority of households
	Dwelling overcrowded
Rainwater drainage system	Existence of official drainage infrastructure
	Existence of unofficial drainage infrastructure
	Rainwater runoff capacity
	State of conservation of the official drainage infrastructure
	Presence of garbage in the official drainage infrastructure

Table B.2. MPR variables

Source: MRP Methodology of the Instituto Pereira Passos.

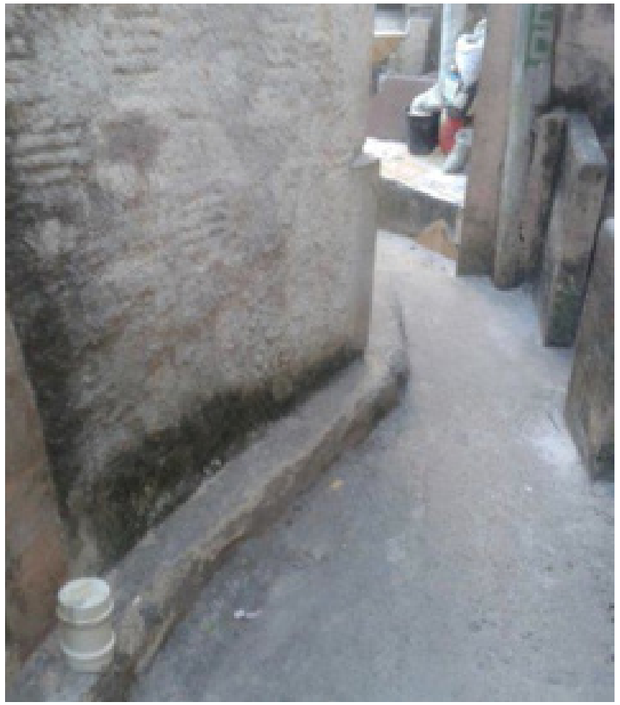
The manual maps were presented in GIZ and KMZ format archives where it was possible to identify the sectors, favelas, and mapped structures. The shape files were delivered to the team from the Inter-American Development Bank along with the census track codes and the mapped structures. Originally these shapes were produced in ArqGis, but they can be read by free software such as QGis and Terra View. The team from the Bank also received the original Excel files where each indicator per infrastructure was graded according to the variables presented in Table B.2.

The following are some of the pictures used to train the group of experts sent to the field. These were used to help them understand how to grade paved streets.

Type A: Well-Maintained Paving.

Most of the transitable streets in the favela look like the photos, even if there is residual damage.

Source: MRP Methodology of Instituto Pereira Passos.



Type B: Recurring Maintenance Required.

Damage in the paving is recurrent. The frequency of damage is important for the definition.

Source: MRP Methodology of Instituto Pereira Passos.

Type C: Major Repairs Needed.

Wear interferes with traffic on most of the transitable streets.

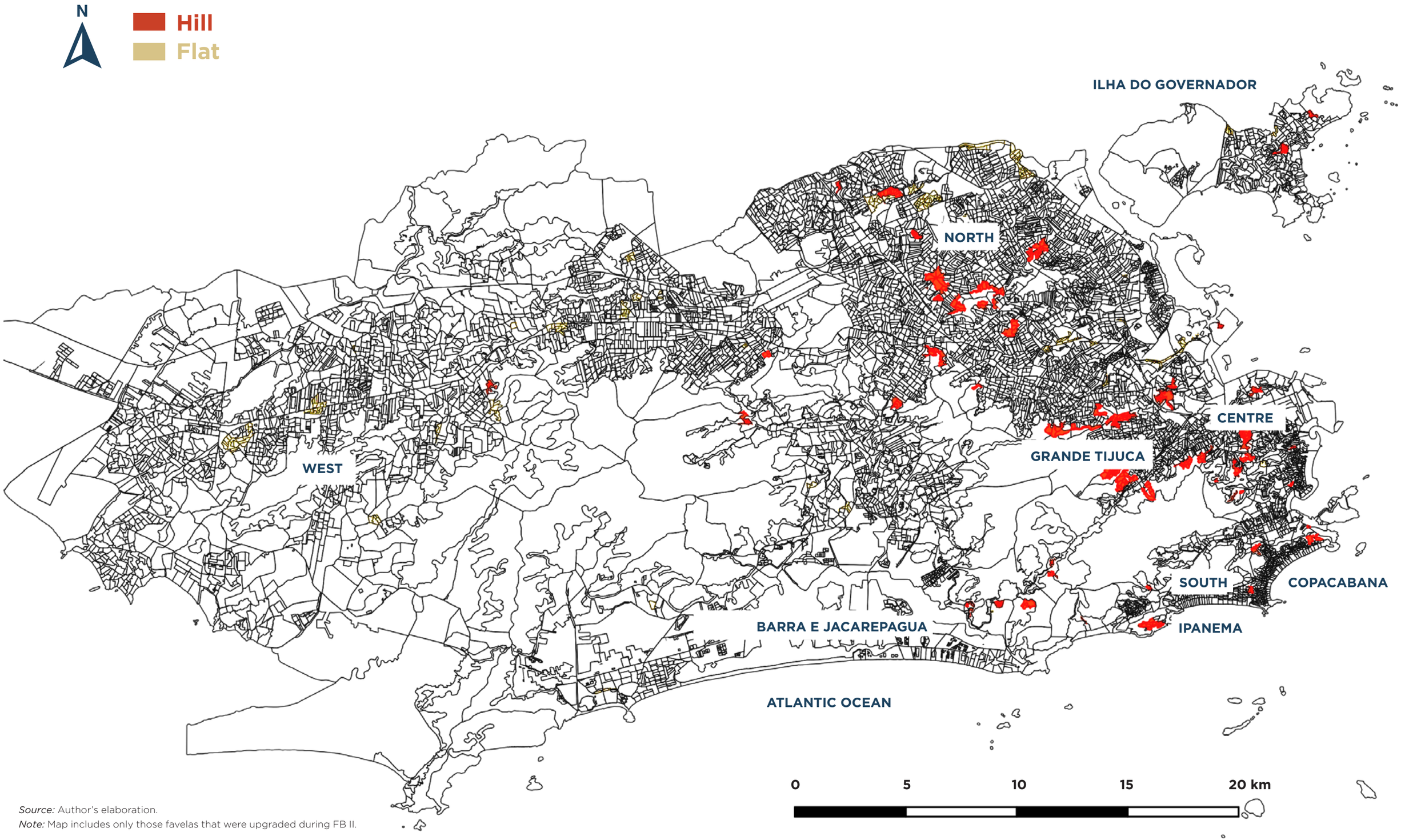
Source: MRP Methodology of the Instituto Pereira Passos.

C. Topography by Neighborhood in Rio

Region	Hill		Flat		Total
	N	%	N	%	N
Barra e Jacarepaguá	5	50.0	5	50.0	10
Centro	18	78.3	5	21.7	23
Grande Tijuca	18	94.7	1	5,3	19
Ilha do Governador	3	50.0	3	50.0	6
North	33	64.7	18	35.3	51
West	2	10.5	17	89.5	19
South	14	93.3	1	6.7	15
Total	**93**		**50**		**143**

Table C.1.

Source: Authors' elaboration with data collected in 143 favelas.



Source: Author's elaboration.
Note: Map includes only those favelas that were upgraded during FB II.

D. Joint Equality of the Mean in Favela Bairro II Infrastructure Index by Type and Area

Table D.1. Infrastructure Index by Type and Area Among Treated Favelas

	Barra e Jacarepaguá (1)	Centre (2)	Grande Tijuca (3)	Ilha do Governador (4)	North (5)	West (6)	South (7)	P-Value Ho: (1)=...=(7)
General Infrastructure Index	**3.43**	**3.82**	**3.41**	**2.64**	**3.02**	**4.47**	**4.25**	**0.000*** **
Sewerage system	**2.36**	**3.13**	**3.05**	**1.55**	**2.26**	**3.99**	**4.31**	**0.001*** **
Infrastructure for mobility	**4.01**	**4.10**	**4.04**	**3.54**	**3.52**	**4.75**	**4.22**	**0.003*** **
Public lighting	**2.58**	**4.11**	**3.52**	**2.33**	**2.71**	**3.46**	**3.40**	**0.002*** **
Street signs and postal services	**3.85**	**3.72**	**3.58**	**3.25**	**3.37**	**5.05**	**4.63**	**0.001*** **
Public transportation	**5.26**	**5.40**	**4.83**	**3.69**	**4.85**	**5.19**	**5.10**	**0.152**
Water supply	**4.87**	**4.13**	**3.05**	**2.29**	**3.61**	**5.22**	**4.40**	**0.000*** **
Garbage collection	**3.46**	**3.47**	**2.63**	**3.31**	**2.72**	**4.67**	**3.88**	**0.003*** **
Electricity	**4.34**	**4.71**	**3.97**	**3.05**	**3.65**	**4.60**	**4.71**	**0.018** **
External appearance of houses	**5.38**	**4.16**	**4.24**	**4.54**	**3.97**	**5.23**	**5.29**	**0.000*** **
Rainwater drainage system	**3.98**	**4.39**	**4.83**	**2.53**	**3.45**	**5.42**	**5.12**	**0.000*** **

Source: Authors' elaboration with data collected in 88 favelas. *Notes:* Score: 0 = non-operational; 6 = excellent condition. Kruskal-Wallis tests of joint equality of the means. P value > 0.10 indicates null hypothesis of equality is not rejected.

Source: Authors' elaboration with data collected in 88 favelas. *Notes:* Score: 0 = non-operational; 6 = excellent condition. Kruskal-Wallis tests of joint equality of the means. P value > 0.10 indicates null hypothesis of equality is not rejected.

Key Messages

The joint t-tests suggest that different areas have different quality of infrastructure. We rejected the null of joint equality of the mean in all but one indicator. This is evidence that the most important factor for maintaining the infrastructure was possibly topography.

The General Infrastructure Index shows that the flat West and the South are the two areas with the best infrastructure. The North and Ilha do Governador showed the worst infrastructure across all indicators.

Public transportation is homogenous and relatively good in most of Rio. This is consistent with the fact that most people said they have access to many means of public transportation. Also, it could have been a positive externality of the two large events in Rio recently (the Olympics in 2016 and the FIFA World Cup in 2014).

E. Analysis of the Neighborhoods Near the Olympic Corridor

The legacy of work done for and investment in major events such as the Olympic Games and the FIFA World Cup are often relevant for the countries in which the event has taken place. This is one of the objectives of the International Olympic Commission at least (IOC, 2017) because it wants the Olympic Games to be a force of positive change in infrastructure development in host countries. Thus, after the games, the citizens of the host countries ought to be the main beneficiaries of the legacies of such mega events. This was the expectation for the Rio games at least for places near the "Olympic Corridor." Although they were not part of the improvements brought by FB II, these major events could have triggered a positive impact on the maintenance of the surrounding neighborhoods.

The Olympic Corridor (Figure E.1) is defined as all of the paths between Olympic structures, concentrated tourist areas, and international and domestic airports. After the announcement that Rio would host the Olympic Games, public investments were made in Olympic villas, stadiums, public transportation (e.g., Metro, VLT, BRT, and BRS), and citizen security, among others. Thus, it was expected that favelas in the Olympic Corridor would have at least a few indicators in better than average condition. However, after performing a test of the mean, it was found that the only more positive indicator was public transportation, which, although facilitated by FB II infrastructure for mobility, was not part of it.

It was found that the only more positive indicator was public transportation.

Table E1. Indicators Along the Olympic Corridor of Treated Favelas

Does the favela have a UPP?	No	Yes	P-Value Ho: No=Yes
Number of favelas	130	14	
General Infrastructure Index	3.52	3.61	0.745
Sewerage system	2.97	2.69	0.419
Infrastructure for mobility	3.91	4.24	0.217
Public lighting	3.13	3.58	0.182
Street signs and postal services	3.86	3.74	0.883
Public transportation	4.84	5.81	0.001***
Water supply	3.99	3.72	0.409
Garbage colletion	3.27	3.39	0.968
Electricity	4.03	4.63	0.055*
External appearance of houses	4.49	4.33	0.572
Rainwater drainage system	4.27	3.93	0.284

Source: Author's elaboration. *Notes:* Levels of statistical significance: ***p-value = 0.01, **p value = 0.05, *p-value = 0.10. Results of Mann-Whitney Indicators according to location in relation to the Olympic Corridor.

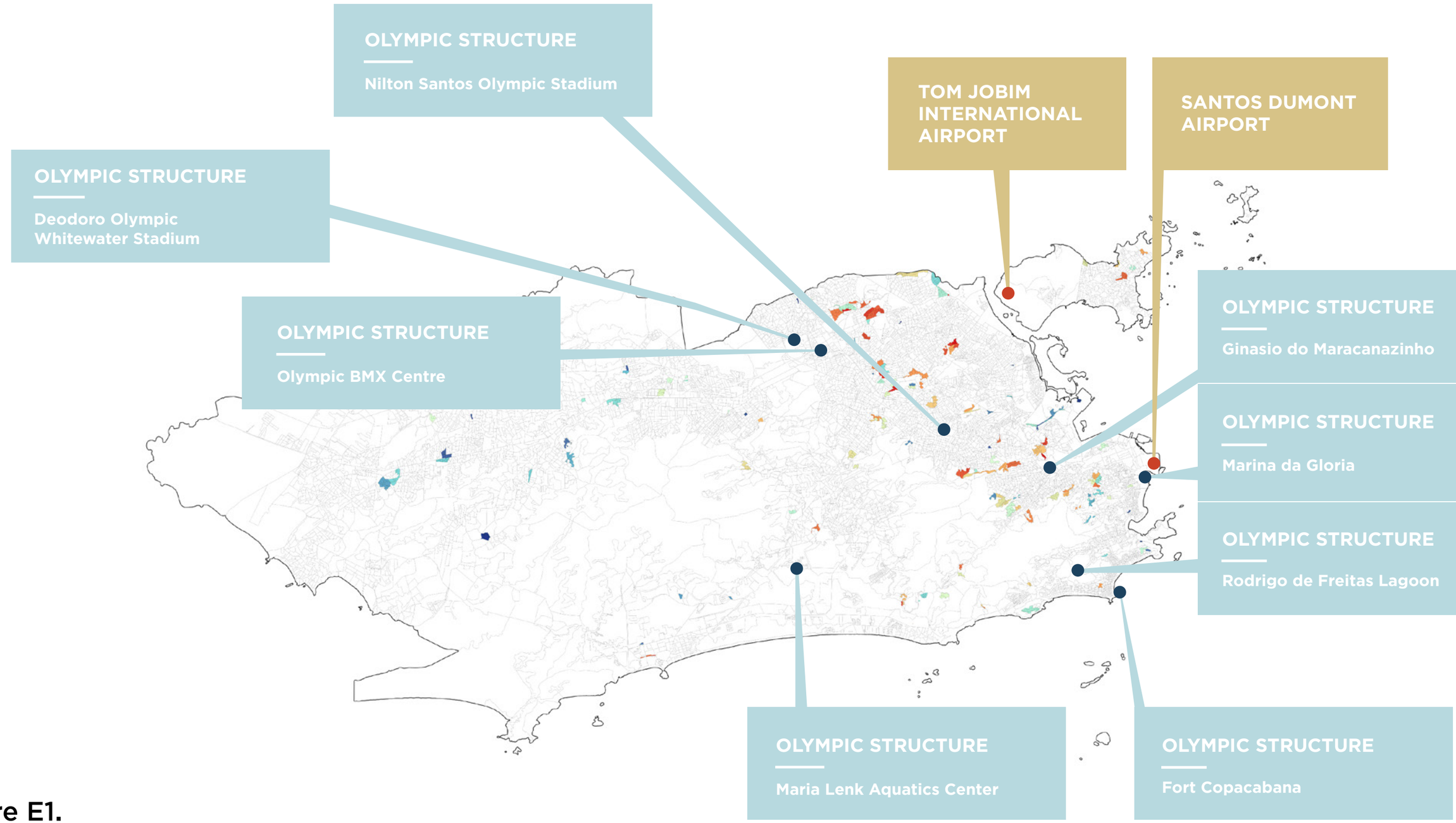


Figure E1.
Location of Olympic Structures and Routes from Airports

The positive aspect of the huge investment in public transportation seems to be improved services. Rio de Janeiro expected a half-million tourists for the Games and the Ministry of Tourism revealed that between July 1 and August 15, 2016, Rio de Janeiro received 572,961 foreign visitors (Prada, 2016). Up to January 2018, when the firm that was hired to inspect FB II finished collecting data, the improvements in transportation seem to have been sustained.

Other than electricity, with a p-value of 0.06, none of the other indicators showed improvement after the mega events. Thus, even if the Olympic stadiums are new and the public transportation system improved, they did not seem to have triggered any change in other indicators in the favelas.

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BAIRRO 10 YEARS LATER

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