risk, resettlement, & renewal

geneviève mae shymanski

Cover Image | Process of eviction from edge of Billings Reservoir waterbank in Grajaú district, São Paulo, image by author, 2022

risk, resettlement, & renewal

Mitigating the displacement of vulnerable São Paulo residents from areas of ecological risk without proper infrastructure

Geneviève Mae Shymanski
5466067
Global Housing Graduation Studio 2022-2023
São Paulo: Repair and Consolidate
TU Delft MSc AUBS Thesis

Design Mentor | *Ir. Harald Mooij*
Research Mentor | *Dr. Nelson Mota*
Building Technology Mentor | *Ir. Stephan Verkuijlen*

TUDelft Department of Architecture
BK Bouwkunde

Architecture & Dwelling

abstract

As the Global South continues to rapidly urbanize, finding affordable and sustainable housing solutions is paramount. The Global Housing Graduation studio provides the opportunity to design new housing typologies through environmental and social lenses. São Paulo's challenges with rapid urbanization and social inequality has left more than a million residents vulnerable to the impacts of water scarcity, lack of public infrastructure, climate, environmental risk, and climate change. Urban expansion during São Paulo's economic boom in the 1970s led to a considerable increase of illegal land occupations in the city's peripheries. The development of the informal settlements formed in the peripheries thus superseded the speed at which proper public infrastructure for potable water, sanitation and electricity could be implemented.

Residents in the peripheral neighborhoods occupy open land in areas of varying environmental risk, susceptible to soil degradation, flooding, landslides, and health risks due to waste discharge. They cannot access publicly supplied water or sanitation and must rely on water cisterns, illegal connections or self-made sanitation disposal to acquire the necessary infrastructure to lead a healthy life. These risks, in addition to the future risks of climate change, disproportionally impact those living in informal settlements, due to their social vulnerability and socio-economic status.

Development-induced displacement of residents within informal settlements is enforced by the São Paulo municipal government, to permit the implementation of public infrastructure such as water lines, sanitation, drainage, street paving, and the removal of housing structures in at-risk areas. While the purpose of displacement contributes towards a positive outcome - upgrading neighborhoods with much-needed services, or rehousing residents to safer environments – the social impact of displacement is palpable. Forced displacement may move residents away from their sources of income and social networks, considerably impacting their mental well-being or exposing them to financial precarity. Readaptation to new neighborhoods or lifestyles can also be difficult for residents.

The project seeks to create a balance between social and climate resiliency to address the challenges of environmental risk and resettlement. The project proposes a new social housing system, built on the principles of clustering and the Radburn Plan, to achieve an urban design which integrates public space with rainwater flows, public infrastructure, and housing. The project location, Jardim Campinas in Grajaú, São Paulo, is used as a framework for the urban system to rehouse displaced residents from various communities onto one site. The socio-ecological design approach is implemented at each scale – urban plan, sector, cluster, and dwelling unit. The design aim is a renewal of the urban fabric, by building upon existing social and ecological networks to reinvigorate social connections and relationships between natural and built environment.

acknowledgements

To my parents *Greg, Dominique, Robyn, & Gary,*
For your love, being my main cheerleaders since the very beginning, no matter the distance, and for the "professional consults" on site drainage and construction phasing.

To *Ana,*
For the countless Zoom calls, hours of continuous feedback and help, and your company. You have shown me unwavering support throughout this entire year and this thesis experience would not have been the same without your amazing friendship.

To *Paul,*
My partner, for your patience, attendance to almost every final crit I have had, witnessing of my academic and personal growth, and being my cherished source of comfort and laughter over the past 7 years.

contents

1
background

Human survival is dependent on four fundamentally basic needs – air, food, shelter, and water. The United Nations recognizes access to water and adequate housing as human rights. Correspondingly, the UN also establishes another human right - sanitation that is hygienic, secure, and ensures dignity. However, over two billion people, that being 1 in 4, lack access to safe drinking water, and over three billion people lack access to proper sanitation (Human Rights to Water and Sanitation, 2022).

The impact of water scarcity and proper housing is disproportionate – over 30% of the global population live in informal settlements, where access to public infrastructure for water, sanitation, and electricity is inconsistent (Lejano & Del Bianco, 2018). As the Global South continues to rapidly urbanize to accommodate exponential population growth, dense informal settlements are often built-up before proper infrastructure can be developed. Consequently, municipal intervention for installing new infrastructure in densely urbanized areas becomes a difficult task (Satterthwaite et al., 2020).

Cantinho do Céu, Grajaú district, São Paulo in September 2009 (Franca & Barda, 2012)

Project Location
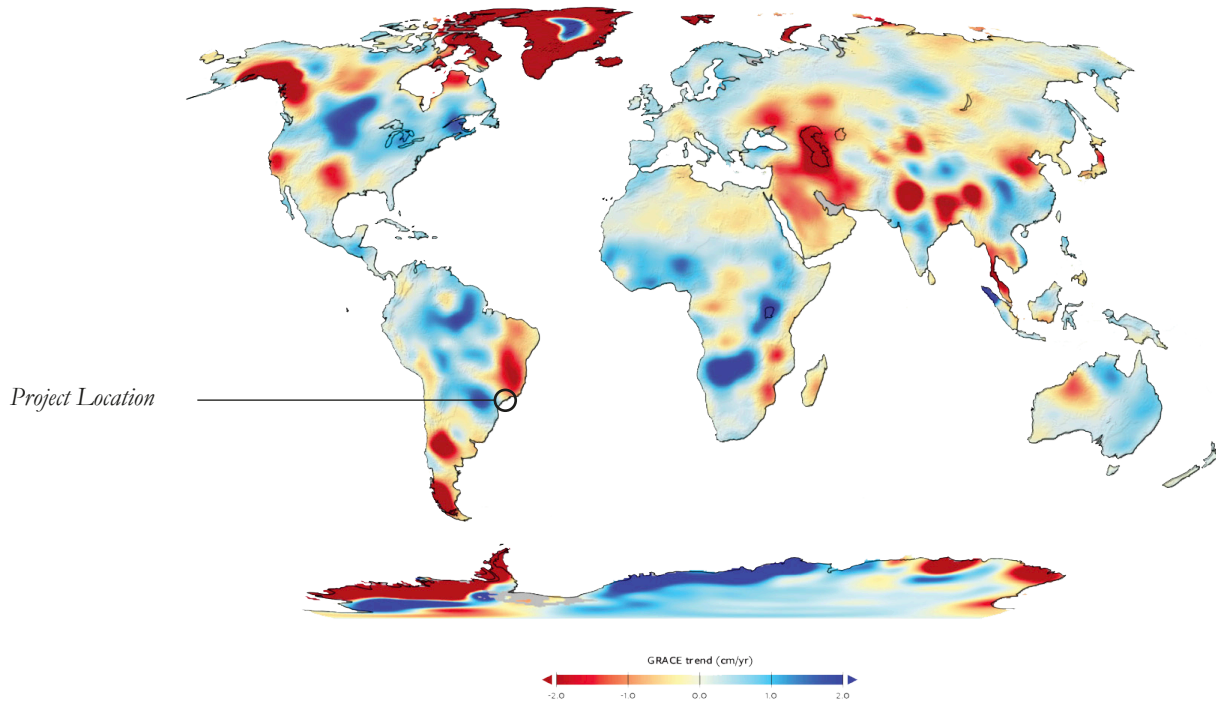
Global freshwater availability trends from 2002 to 2016 (Famiglietti, 2019)

This thesis project finds itself in São Paulo, Brazil, a country that holds more than 12% of the world's freshwater (Kaipper Ceratti, 2018). Yet, Brazil continually struggles with water scarcity - over 1.5 million residents in the state of São Paulo still did not have access to publicly supplied water in 2018 (World Bank Group, 2022). Moreover, the population without access to sewage collection was almost 4.5 million, and the average income of people with sanitation was almost 2.5 higher than those without (World Bank Group, 2022).

São Paulo, Brazil - the 4th largest city in the world with over 11 million residents as of 2020 (Google Earth, 2023)
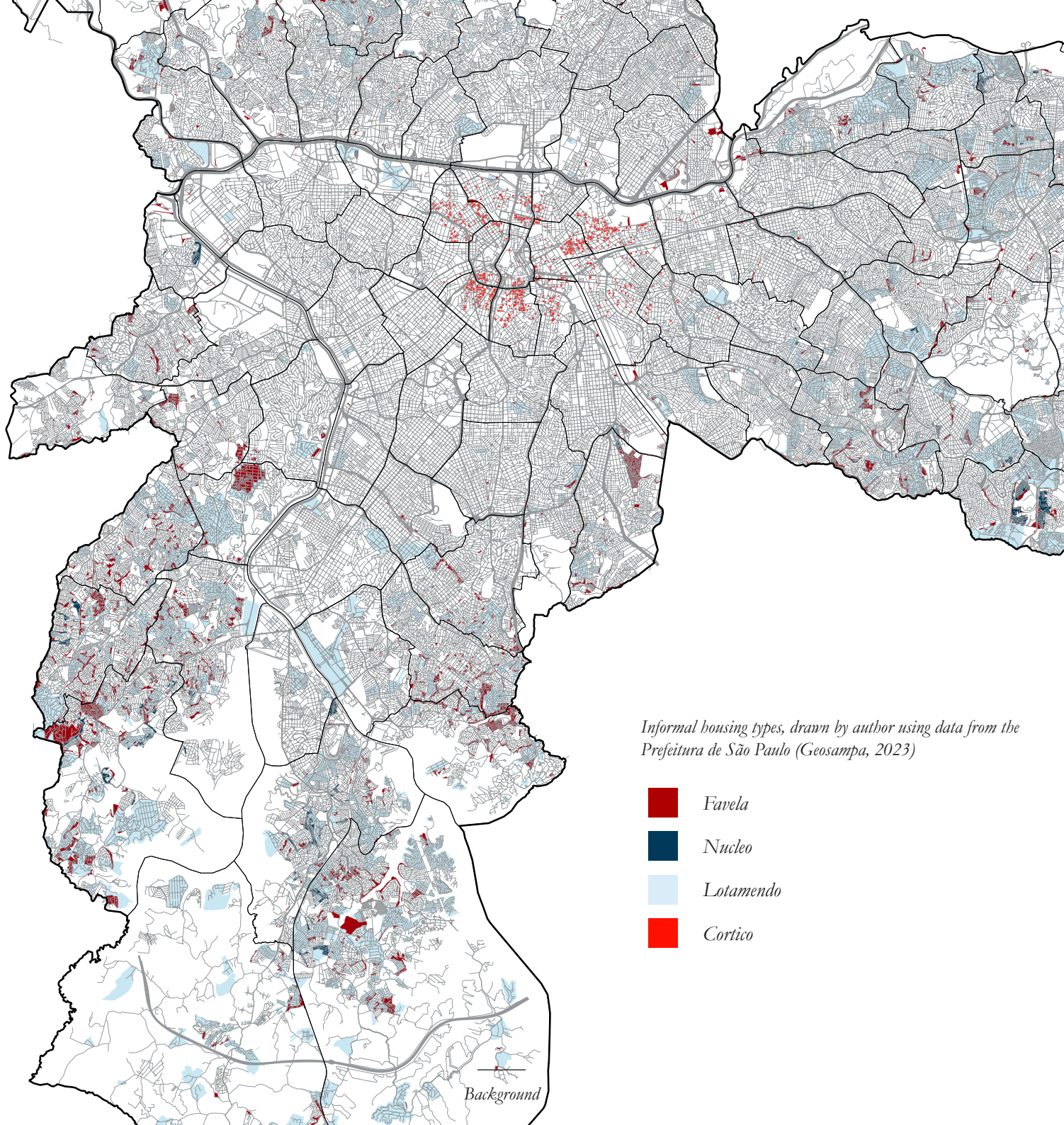
Informal housing types, drawn by author using data from the Prefeitura de São Paulo (Geosampa, 2023)

■ Favela

■ Nucleo

■ Lotamendo

■ Cortico

Background

São Paulo's tremendous urban growth, which began in the 1970s and is still continuing to this day, has pushed lower-income residents to the city's outskirts, where land is more open and inexpensive compared to the city center. Peripheral land was first seen as advantageous to residents of lower-income status who were in immediate need of housing, as they had a lower likelihood of eviction living in th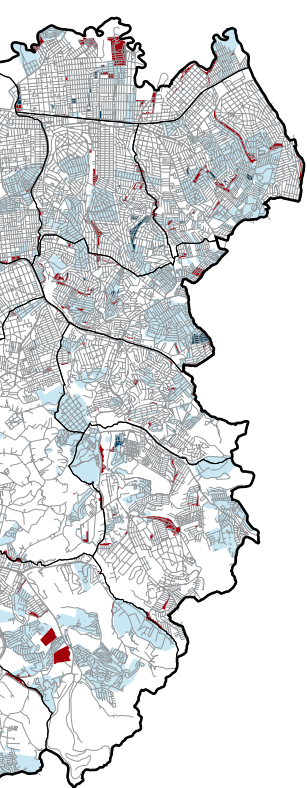ese areas. Informal settlements, otherwise known as favelas, are most common form of housing in São Paulo's peripheries.

Born outside of legal frameworks, they are result of illegal land occupation to produce self-built housing. Residents generally follow informal building practices using mutirão, or cooperative effort, "a mutual self-help process where families contribute an equitable allocation of hours to help build" (Lejano & Del Bianco, 2018). Ownership is built through sweat equity, the value of the labor they put in to build their homes. Temporary infrastructure is improvised by residents fighting for land tenure until the municipality can provide legal titles and implement proper infrastructure such as roads, sidewalks, drainage, water, sewage, street lighting & power systems.

Informal settlements are founded on sweat equity, cultural ties, and social capital. Self reliance becomes the main mechanism of these communities.

"The evolution and development of an informal settlement is usually a process involving relationships among inhabitants and relationshps within the place. The age and height of the house reflects the history of its occupants. The process starts with the settlement of the first family, which tends to arrive through contacts with pre-existing friends or through common roots."

(Lejano & Del Bianco, 2018)

Top Left & Right Images | Process of mutirão during construction of Comuna Urbana Dom Hélder Câmara (USINA CTAH, 2012)
Middle Image | Anchieta neighborhood, image by author, 2022
Bottom Image | Parque Novo Santo Amaro neighborhood, image by author, 2022

0-70

70 - 120

120 - 170

170 - 230

230 - 350

350 - 500

500 - 700

700+
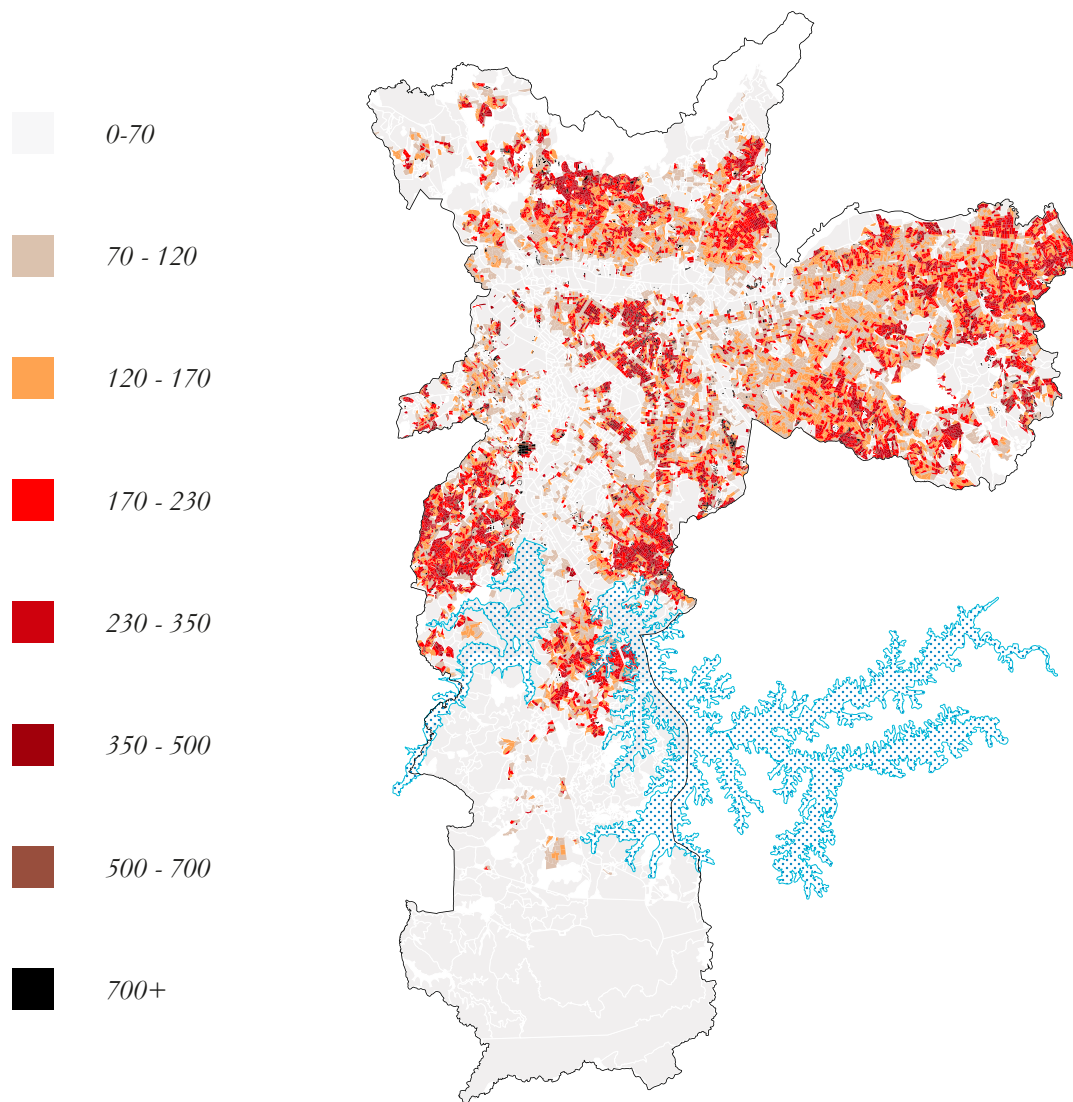
Density - inhabitant/ha

Over 2 million people live in the Billings and Guarapiranga watershed areas. These two reservoirs are São Paulo's main source for water consumption and energy production.

Drawn by author using data from Prefeitura de São Paulo (Geosampa, 2023)

Families who move into informal neighborhoods which are already extensively urbanized must use what little land is left to build their own housing, typically in less-desirable locations with various levels of environmental risk. About 900,000 homes in the city of São Paulo are located in zones requiring environmental protection or ecologically fragile areas, which may be prone to landslides and flooding (Pimentel Walker & Arquero de Alarcón, 2018).

Residents living in informal settlements are the most vulnerable to climate change since they are more dependent on local resources and cannot cope with climate extremes as easily as those with economic means (McCarthy, 2020). Informal settlements, which tend to be built outside of legal construction and development frameworks, may not be able to withstand the effects of climate change due to poorer quality building practices in ecologically fragile areas (Satterthwaite et al., 2020). Keeping these factors in mind, resiliency to ecological risk and climate change is a necessary consideration towards adequate housing design.

The 1988 Brazil constitution established adequate housing as a basic right alongside the right to a healthy environment (Constituição Da República Federativa Do Brasil, 1988). According to the São Paulo municipal government, the solution for helping those living in highly densified informal settlements in ecologically fragile areas without access to proper infrastructure requires displacing and rehousing the impacted population to safer environments. In 2002, the city of São Paulo released a city statute with zoning plans for Zonas Especiais de Interesse Social (Special Zones of Social Interest), otherwise ZEIS, with the primary intent of increasing land used as social housing stock for low-income residents in São Paulo's periphery.

The ZEIS policy was developed with several goals - providing affordable housing, implementing urban improvements through infrastructure while preventing forced eviction, regularizing informal settlement plots, and aiding the process of environmental recovery in ecologically fragile areas (Santoro, 2015). ZEIS zones can be separated into two categories, the first of which aims to protect existing informal settlements, and the second of which reserves vacant or underutilised land for new affordable housing.

This affordable housing was designated to two income groups. The first, called Social Interest Housing (HIS), is allocated to families making 0-6 minimum wages, and the second, Low Income Market Housing (HMP), allocated to those making 6-16 minimum wages.

$$$

HMP

6 - 10 minimum wages
R$7812 - R$13 000
€1500 - €2500

HIS 2

3 - 6 minimum wages
R$3906 - R$7812
€990 - €1500

HIS 1

1 - 3 minimum wages
R$1302 - R$3906
€250 - €750
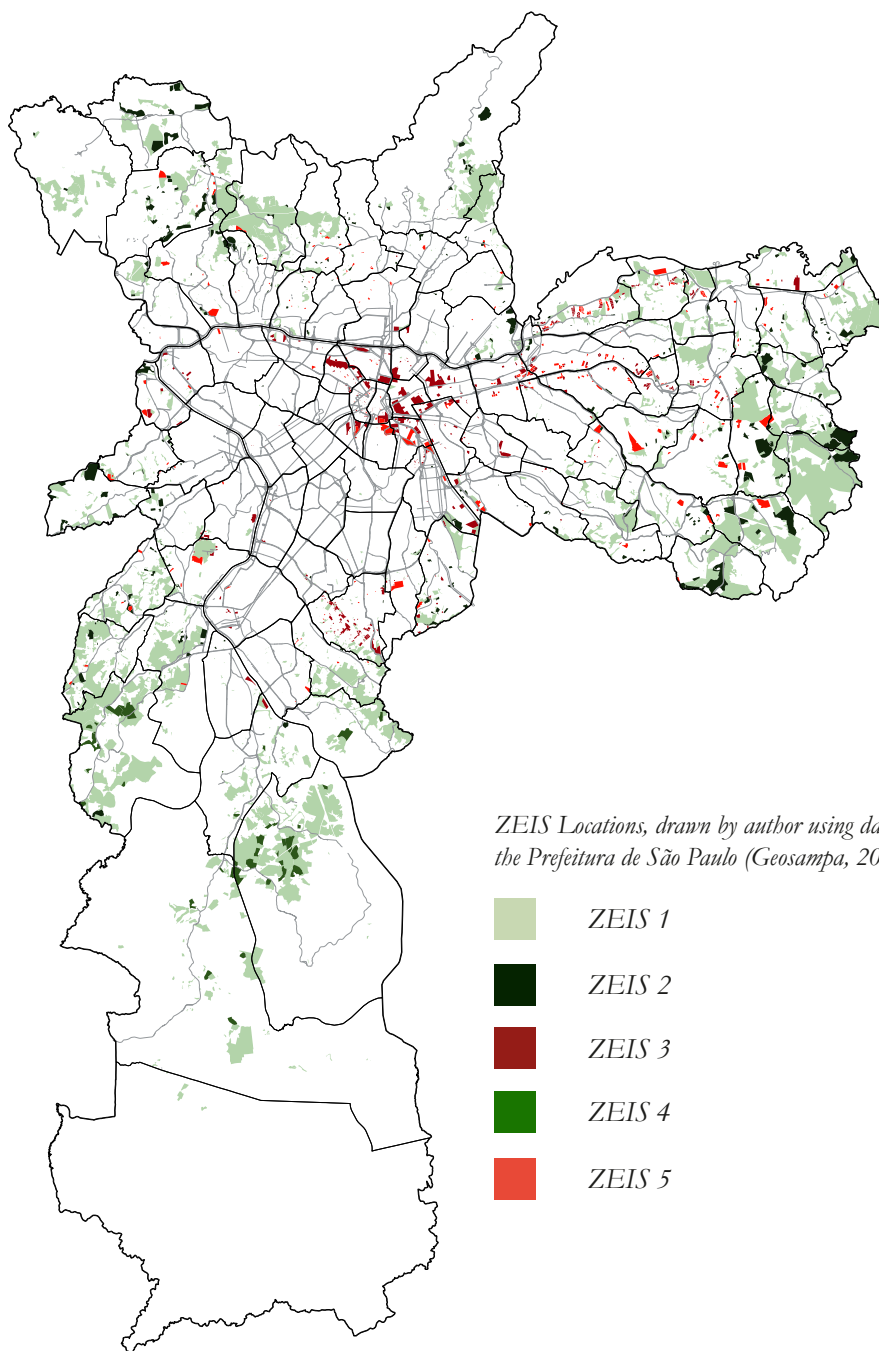
*ZEIS Locations, drawn by author using data from
the Prefeitura de São Paulo (Geosampa, 2023)*

ZEIS 1

ZEIS 2

ZEIS 3

ZEIS 4

ZEIS 5

> HIS 1

>1 minimum wage
R$0 - R$1302
€0 - €250

$

2

problem

statement

São Paulo's informal settlements were quickly built to satisfy the need for immediate housing, overlooking the necessary investments in public space and infrastructure for water and sanitation that contribute towards a healthy, adequate neighborhood. Families living in precarious settlements which have been built near watersheds or in areas of geotechnical risk encounter safety risks regarding health and housing instability, forcing them to face the difficult reality of being rehoused. This has had a significant impact on the low-income residents living in São Paulo.

The problems presented by the current housing situation in São Paulo's ecologically fragile areas can therefore be subdivided into 3 distinct issues.

water and infrastructure scarcity

housing instability due to environmental risk

social impact of development-induced displacement

This problem statement was summarized in a video for the research proposal submission, viewable here: https://youtu.be/-tPpwe_QfGg

Anchieta, Grajaú district, São Paulo, image by author, 2022
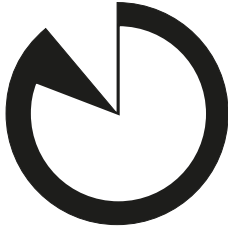
89% *total city sewage collection, of which only*
81% *received proper treatment*
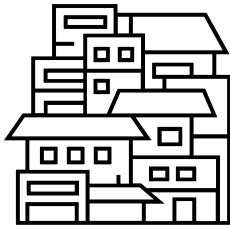
+50 000
households had no adequate water supply

85%
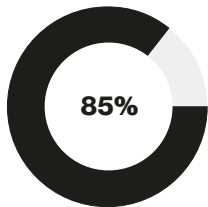
households in favelas had solid waste collection
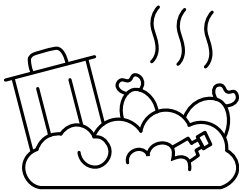
>300
clandestine dumps across the city

Data from the WorldBank (Diskson, 2012)

In the city's periphery, the effects of water scarcity and poor infrastructure are visible. In neighborhoods where precarious settlements have been built prior to infrastructure provided by the city, informal settlement dwellers must rely on illegally constructed connections to city water lines to gain access to potable water and use natural water sources as a means of evacuating sewage and wastewater (Cawood et al., 2022).

These practices have consequences not only on São Paulo's natural environment, but on both upper and lower-class residents. For example, the Billings Reservoir, São Paulo's largest reservoir, supplies water to over 2.3 million people (SP, 2015). However, over one million people live along the Billings reservoir bank, and without sewage systems to service their homes, their waste often ends up in the reservoir and pollutes the city's drinking water (Gerberg, 2015). These inadequate services are detrimental to both São Paulo's environmental ecosystems but also the personal health of millions of residents.

*Precarious housing without sewage infrastructure
in Heliópolis, São Paulo, image by author, 2022*

Even for those connected to São Paulo's public water, the reliability of the supply is inconsistent. Water management failures occurring in tandem with climate change leave residents vulnerable to drought. During the droughts of 2015, peripheral São Paulo residents faced 12-hour water cut-offs (Gerberg, 2015). While wealthier residents can purchase water from private sources, the lower-income population of São Paulo often have to turn to more self-reliant methods, such as rainwater tanks located on roofs, to provide additional emergency water supply.

Alternate Water Sources

Plastic Bottled Water   *~500L Water Tank*
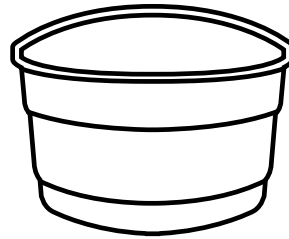
Rooftop water tanks in Copacabana, Rio de Janeiro
(Huub Fenten, 2022)
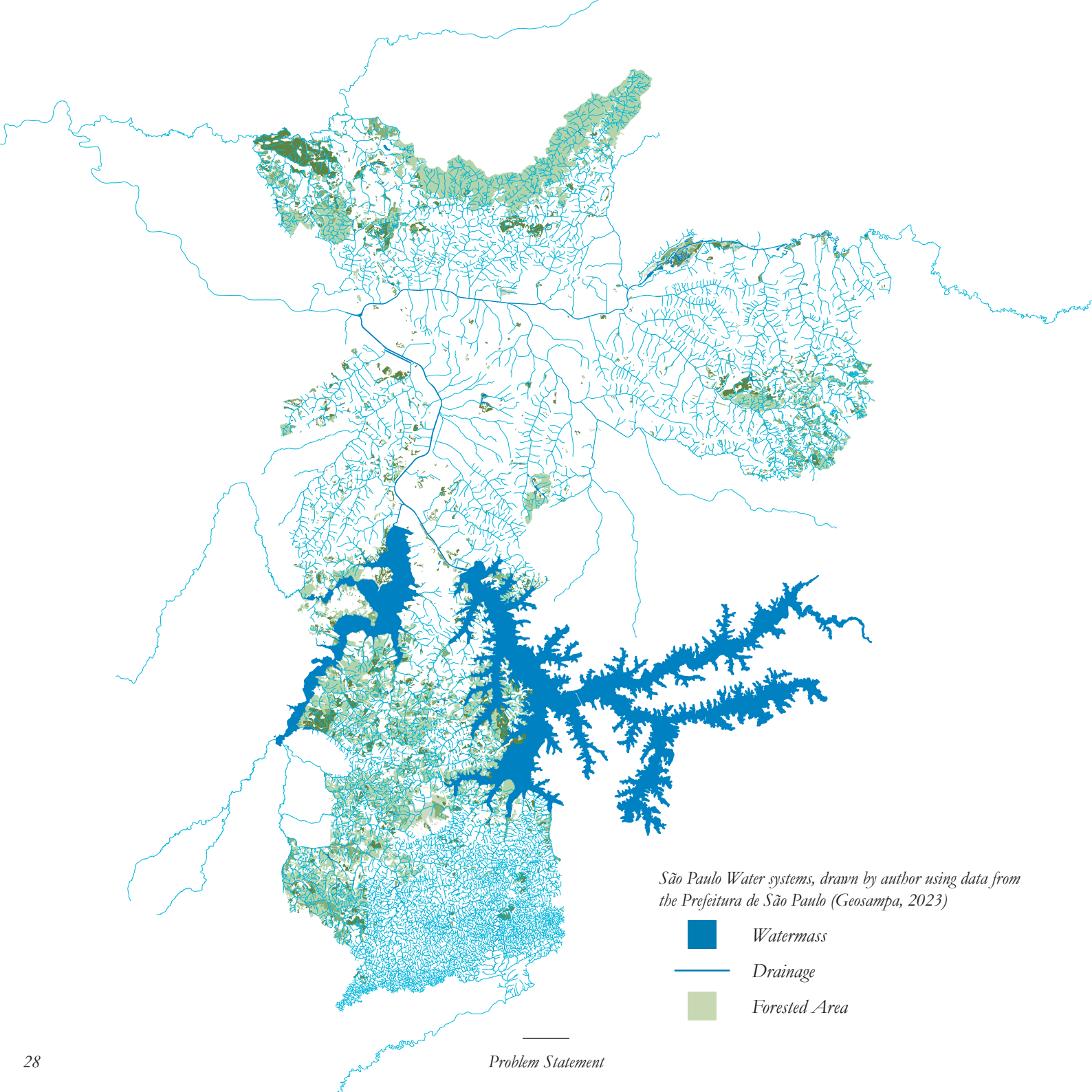
São Paulo Water systems, drawn by author using data from the Prefeitura de São Paulo (Geosampa, 2023)

■ *Watermass*

— *Drainage*

■ *Forested Area*

Problem Statement
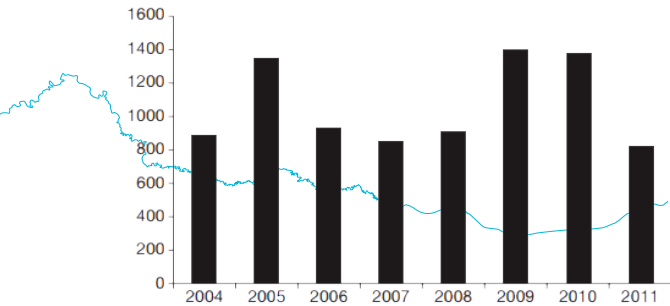
Number of Flooding Points Registered by CGE in São Paulo per year, 2004-2011 (Dickson, 2012)
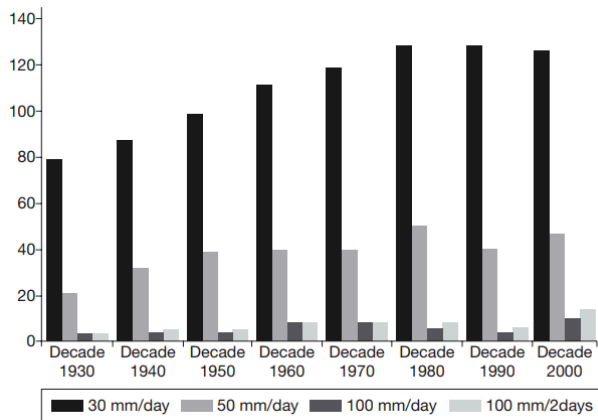
Days with Intense Rainfall per decade (Dickson, 2012)

Located in a humid, subtropical climate, São Paulo experiences considerable rainfall throughout the year. Rainfall of more than 30 mm/day can cause serious floods in the city (Dickson, 2012). Flooding is more likely to occur in dense urban areas with insufficient green spaces and poor drainage from lacking street infrastructure. Insufficient garbage collection ends up blocking drainage pathways which alleviate flooding. Informal settlements situated along river creeks and reservoir banks are even more vulnerable to flooding. Structural damage to housing and infrastructure is expensive to fix and can lead to loss of life. Furthermore, stagnant water from flooding exacerbates mosquito breeding and the spread of waterborne diseases such as leptospirosis and gastroenteritis.

Landslide in Morro São Bento, Santos, State of São Paulo (Felixx Drone, 2020)

Rapid deforestation, a result of rapid urbanisation, leads to erosion, land degradation and unstable soil. São Paulo has become especially vulnerable to landslides due to the combination of unstable/soft soils and flash flooding. In São Paulo, about 25% of land on which precarious settlements are situated are vulnerable to landslide or stream washout risk (Dickson, 2012). This is typically due to the lack of access to formal land markets – informally built settlements built in highly sloped terrain or without safe construction methods are more at risk to foundation failure.

Slope failure prevention in Parque Novo Santo Amaro,
São Paulo, image by author, 2022

Problem Statement
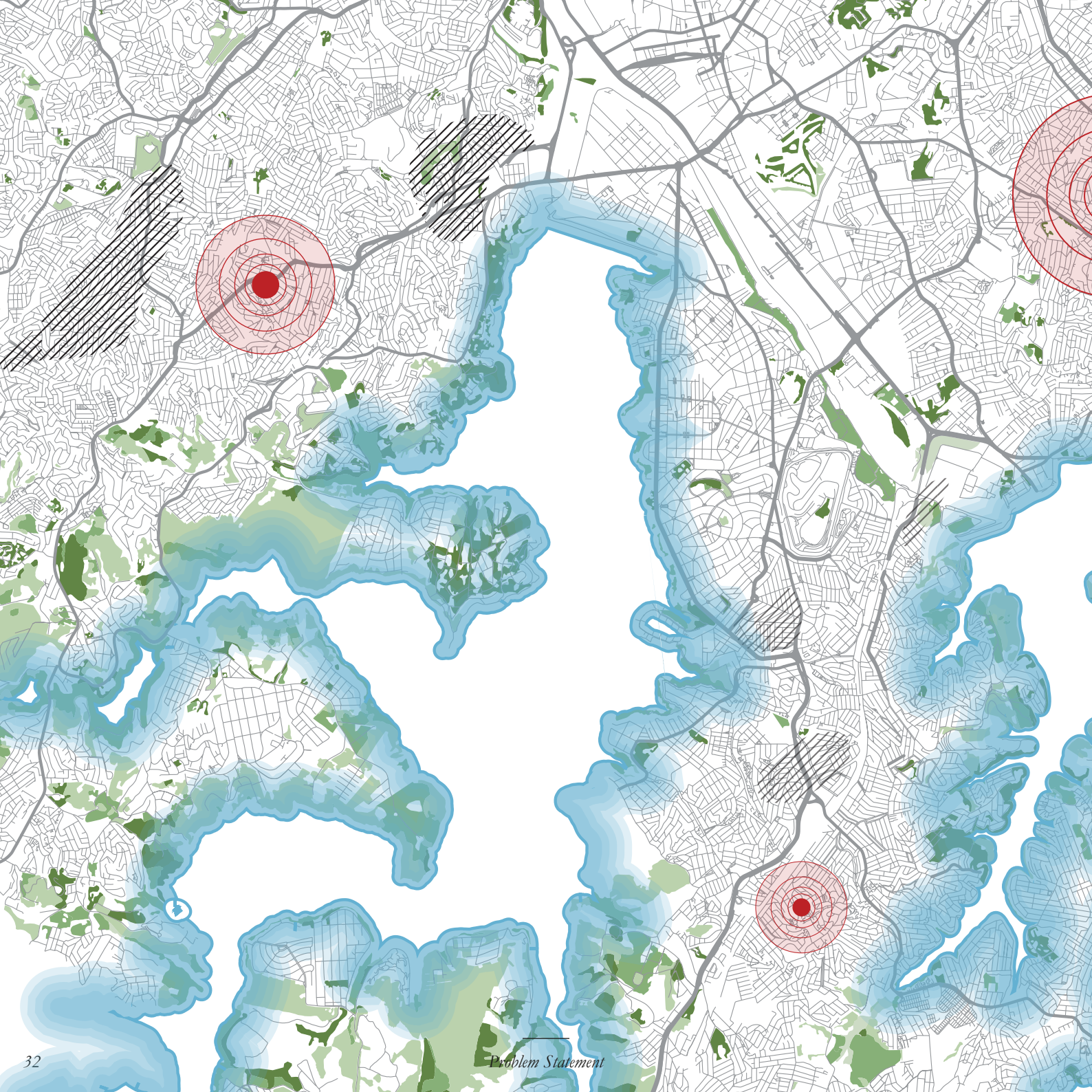
Looking towards the future, climate change will increase these risks as well as introduce new ones. Water scarcity will be further exacerbated by the increasing frequency of droughts. Flooding, caused by heavier rainfall during wet seasons, will progressively damage existing infrastructure in informal settlements (Young, 2013). In turn, this flooding will trigger more landslides. In highly dense informal settlements, heat island effects will be significant as temperatures continue to rise since fully built-up neighborhoods leave little room for public squares, let alone green space.

This last example sheds light on some of the social impacts resulting from rapid density, alongside the health and ecological risks. The rapid urbanisation of the settlements in São Paulo's peripheries has prioritized the regularization of land plots for families to build their homes, leaving public urban space as an afterthought. Consequently, there are very little community spaces for residents to meet, gather, and play.

Climate change risks such as flooding, geotechnical risk areas, minimal green space, and heat island effects, conceptualized over Grajaú, São Paulo, drawn by author using data from the Prefeitura de São Paulo (Geosampa, 2023)

These descriptions of water scarcity, environmental risk, and lack of public space and infrastructure are an everyday reality for São Paulo's peripheral residents. These living conditions arguably go against the Brazilian peoples' right to adequate housing and a healthy environment. However, these two rights are at odds when the installation of public infrastructure that is required to achieve an ecologically balanced environment can destabilize access to adequate housing.

In these peripheral neighborhoods, many households need to be relocated, or entirely removed to implement necessary changes to elevate the standard of housing. The ZEIS zoning plan addresses this challenge: the ZEIS 4 land plot type is defined as vacant land in environmentally protected areas. Since it is designated as land for future urbanization to rehouse those displaced from ecologically fragile areas without proper infrastructure (Pimentel Walker & Arquero de Alarcón, 2018), it is under the ZEIS 4 framework that resident displacement from these areas occurs.

Robert Muggah, the author of Os Deslocados: Conceptualizing Internal Displacement in Brazil (2014), defines internal displacement as

"involuntary population movement resulting in coerced resettlement between or within cities, or among neighborhoods."

He categorizes three forms of displacement in Brazil: violence-induced, development-induced, and disaster-induced. Infrastructure and urban-upgrades are generally the leading factors of development-induced displacement, whereas disaster-induced displacement is typically in response to climate events, such as floods and drought, and long-term land degradation (Muggah, 2014).

While the challenges of insufficient public infrastructure and climate change may present a clear need for development and/or disaster-induced displacement, there is significant literature on how displaced residents become vulnerable to different risks.

Demolished home of an evicted family & fencing along plots slated for eviction in Cantinho do Céu, São Paulo, images by author, 2022

Problem Statement

Forced displacement can have a substantial social and cultural impact, since residents must leave their communities behind to move to new areas, potentially far away, where they are disconnected from their previous social networks. It can expose residents to "risky situations dominated by militias" (Barbosa & Coates, 2021) or financial precarity. They may need to leave their original means of income-generation. Many must accept monthly subsidies for rent instead of moving directly into new social housing, placing them at risk of exploitation by landlords who know the standard rent subsidy amount.

For example, 628 families residing in Grajaú, one of São Paulo's southern districts, were evicted due to living in at-risk areas along the Billings watershed under the Cantinho do Céu urbanisation project. As of 2022, 174 families that were given rent assistance while awaiting resettlement have still not been placed into new social housing (Alvez, 2022). Residents staying in precarious housing anticipating displacement also live in constant fear of eviction. All of these factors can have serious impacts on the mental well-being of displaced residents.

Demolished home of an evicted family
in Cantinho do Céu, São Paulo, image by author, 2022

3

methodology

Future housing design in these communities must therefore negotiate the need for environmental protection with the right to adequate housing. This complex problem thus requires a multi-faceted approach that prioritizes the well-being of residents who face the risk of displacement, while also embracing climate resilience. This begs the question,

"*how can design mitigate the impact of displacement on São Paulo residents that live without proper access to public infrastructure in ecologically fragile areas?*"

Cantinho do Céu, Grajaú district, São Paulo, image by author, 2022

Displacing São Paulo residents from ecologically fragile areas with poor infrastructure removes them from immediate environmental and health risk. However, displacement typically requires urban transformation to rehouse the displaced, disrupting the socio-spatial landscapes of informal settlements (Robinson, 2003).

This process may alter the urban practices of the residents and disintegrate the social cohesion of informal neighborhoods. The long-term effects of climate change will also impact São Paulo residents from all social classes and must be considered for future urbanisation.

Therefore, the problem statements can be categorized into two challenges in need of balance. The challenges of São Paulo residents living in conditions of risk, with the challenges encountered during resettlement. From this, the research question can be broken down into 3 sub-questions.

risk

1 water scarcity & poor infrastructure

- lack of water & sanitation
- health risks
- drainage challenges

2 environmental risk

- flooding
- drought
- landslides
- heat island effects

3 development-induced displacement

- distanced from social networks
- destabilized sense of security
- financial precarity

resettlement

Methodology

renewal

how can an integrated approach to housing and urban public space connect displaced residents to their new place of settlement, socially, culturally, and ecologically?

how can urban spaces within informal neighborhoods combat the effects of water scarcity and poor infrastructure, while promoting climate resilience?
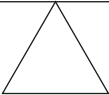
what are examples of safe and ethical processes to displace and rehouse at-risk residents of São Paulo?

risk

resettlement

The intent of this research was to address the four issues below through an integrated approach. the impacts of water and infrastructure, the effects of displacement & rehousing on vulnerable populations, social resilience and climate resilience in informal settlements.

The theoretical framework was used to interrelate the existing literature across the four topics. Building on the concepts outlined in the theoretical framework, the main methodologies were pursued in combination with visualization methods such as modelling, photography, mapping, and drawing. The research was thus separated into five methods: *literature review, case study analysis, mapping, field research, and research-by-design.*

The literature review provided insight on the current academic discussions on the four topics, both on a global scale and in the local

7 Cidade de São Paulo Strat... 16.050 (2014).

8 Millington, Nate. "Linear ... of Permeability: Environm... Brazil," 2018.

4 Campello Torres, P. H., Gonçalves, D. A., Mendes de Almeida Collaço, F., Lopes dos Santos, K., Canil, K., Cabral de Sousa Júnior, W., & Jacobi, P. R. (2021). Vulnerability of the São Paulo Macro Metropolis to Droughts and Natural Disasters: Local to Regional Climate Risk Assessments and Policy Responses. Sustainability, 13(1), Article 1.

9 Muggah, R. (2014). Os de... displacement in Brazil. HA... Situations Other Tham W...

1 Cawood, S., Wahby, N., & Ferrara, L. N. (2022). Hybridity in Practice: Responding to Water Insecurity in São Paulo, Dhaka, and Cairo. 15(3), 21.

2 Dickson, E. (2012). Urban risk assessments: Understanding disaster and climate risk in cities. World Bank.

5 Satterthwaite, D., Archer, D., Colenbrander, S., Dodman, D., Hardoy, J., Mitlin, D., & Patel, S. (2020). Building Resilience to Climate Change in Informal Settlements. One Earth, 2(2), 143–156.

10 Pimentel Walker, A. P., & ... The Competing Social and ... of Private Urban Land: T... Occupation in São Paulo's... 10(11), Article 11.

3 Prefeitura da Cidade de São Paulo. (2022, July 26). Urbanization of Precarious Settlements | Secretaria Municipal de Habitação. Prefeitura da Cidade de São Paulo.

6 Secretaria Municipal de Habitação. (2022). "Programa Mananciais." Prefeitura da Cidade de São Paulo..

water scarcity & public infrastructure   **climate resilience**   **development- a... disaster-induce...**
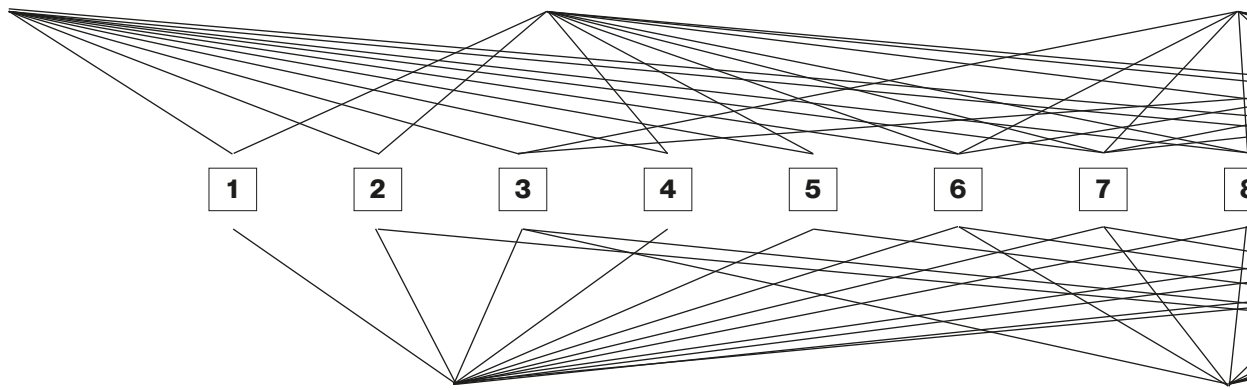
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |

how can urban spaces within informal neighborhoods combat the effects of water scarcity and poor infrastructure, while promoting climate resilience?

what are examples of safe... displace and rehouse at-ris...

context of São Paulo. Furthermore, it was very pertinent to research the "hidden designers" that have an impact on the topic categories, such as laws and regulations that outline public policy.

The lens through which the literature review will be conducted was particularly important, given the influence of Western values on evaluating the success of existing research, case studies, or policies. For example, the sub-question

regarding resettlement required a reflection of what is considered a safe and ethical of displacement, in the context of São Paulo. The safety of an environment based on present infrastructure, the determination of ecological risk, or the ethics of different development-induced displacement methods are all subjects which have variable perspectives depending on the context or agents involved.

egic Master Plan 2014, Pub. L. No.

Parks and the Political Ecologies
mental Displacement in São Paulo,

slocados: Conceptualizing internal
ASOW Humanitarian Action in
ar, July.

Arquero de Alarcón, M. (2018).
d Environmental Functions
he Case of an Informal Land
s South Periphery. Sustainability,

11 Cantinho do Céu Complex Urbanisation, Boldarini Arquitetos Associados, 2009-2012.

12 Chácara Do Conde Social Housing, JAA Arquitetura, 2009-2018

13 Communa Urbana Dom Hélder Câmara, Usina CTAH, 2007-2012.

Jayakody, C., Malalgoda, C. I., Amaratunga, D., Haigh, R., Liyanage, C., Hamza, M., Witt, E., & Fernando, N. (2022). Addressing housing needs of the displaced people promoting resilient and sustainable communities. International Journal of Disaster Resilience in the Built Environment, 13(3), 368–385.

14

15 Sennett, R. (2018). Building and dwelling: Ethics for the city. Allen Lane, Penguin Books.

**and
ed displacement**

**rehousing and displacement
urbanisation case studies**

social resilience

8 **9** **10** **11** **12** **13** **14** **15**
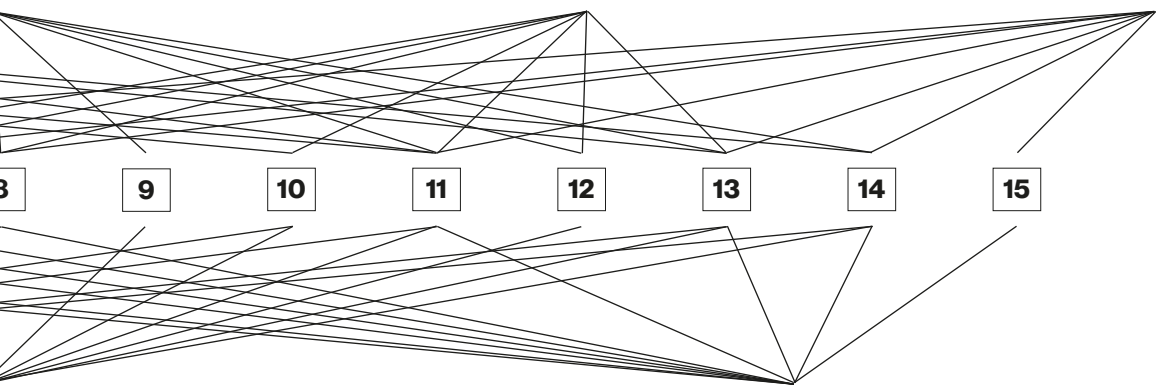
*and ethical processes to
residents of São Paulo?*

*how can an integrated approach to housing and urban
public space connect displaced residents to their new place
of settlement, socially, culturally, and ecologically?*
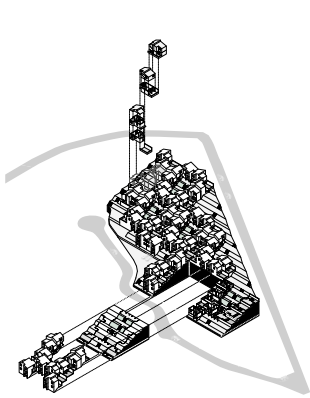
Comuna Urbana Dom Hélder Camara
São Paulo, Brazil
USINA, 2012
(Angelina Torbica, 2022)
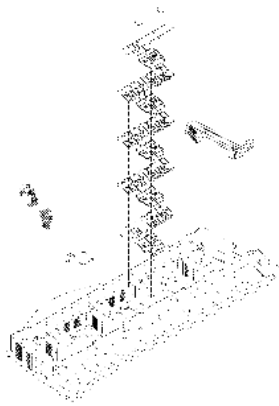
Gleba A Héliopolis Urbanisation
São Paulo, Brazil
Vigliecca & Associados, 2004
(Sanette Schreurs, 2022)
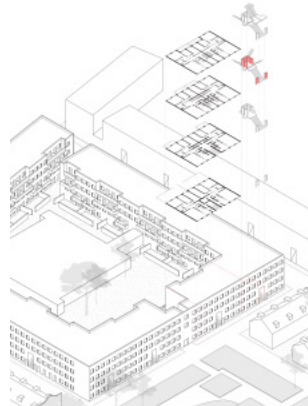
Doedijnstraat Housing
Den Haag, Netherlands
Alvaro Siza, 1991
(Author, 2022)
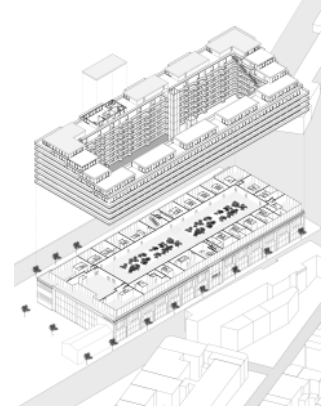
Fenix I Mixed-use Development
Rotterdam, Netherlands
MEI Architects, 2019
(Winnie Goldsteen, 2022)

case study analysis

The case study analysis was essential to examine precedents that have dealt with the lack of public space and infrastructure in informal settlements, as well as the various stages of the displacement process. The analysis used a correlational approach by juxtaposing different projects, such as urban revitalizations, rehousing, or urban planning. Relating or contrasting these case studies revealed how these projects have tackled their target goals and their long-term impact on residents.

The relevant case studies can be found in the Contextual Analysis section of this book.

Screenshot of Geosampa Application
'Sistema de Consulta Do Mapa Digital Da Cidade
de São Paulo'. (GeoSampa, 2023)

Group interview with Conjunto Casarão
Celso Garcia community leader, image by author, 2022

mapping

The mapping research method heavily supported the research-by-design. Google Earth historical imagery and GeoSampa (an official map application by the municipality of São Paulo) enabled a thorough analysis of the project site and its urban activities, social context, and ecological relationships on the site and its surroundings.

field research

Finally, the field research was arguably the most important to the project. The ethnographical approach provided an entirely new experience of São Paulo that could not be found through literature review or case study documentation alone. The field research provided the basis for a first-hand analysis of the socio-spatial factors that influence the urbanisation of informal settlements.

The field research included
- interviews with residents and city employees
- morphological analysis through photography, film and audio
- note-taking on urban atmosphere and sensory experiences
- case study site visits
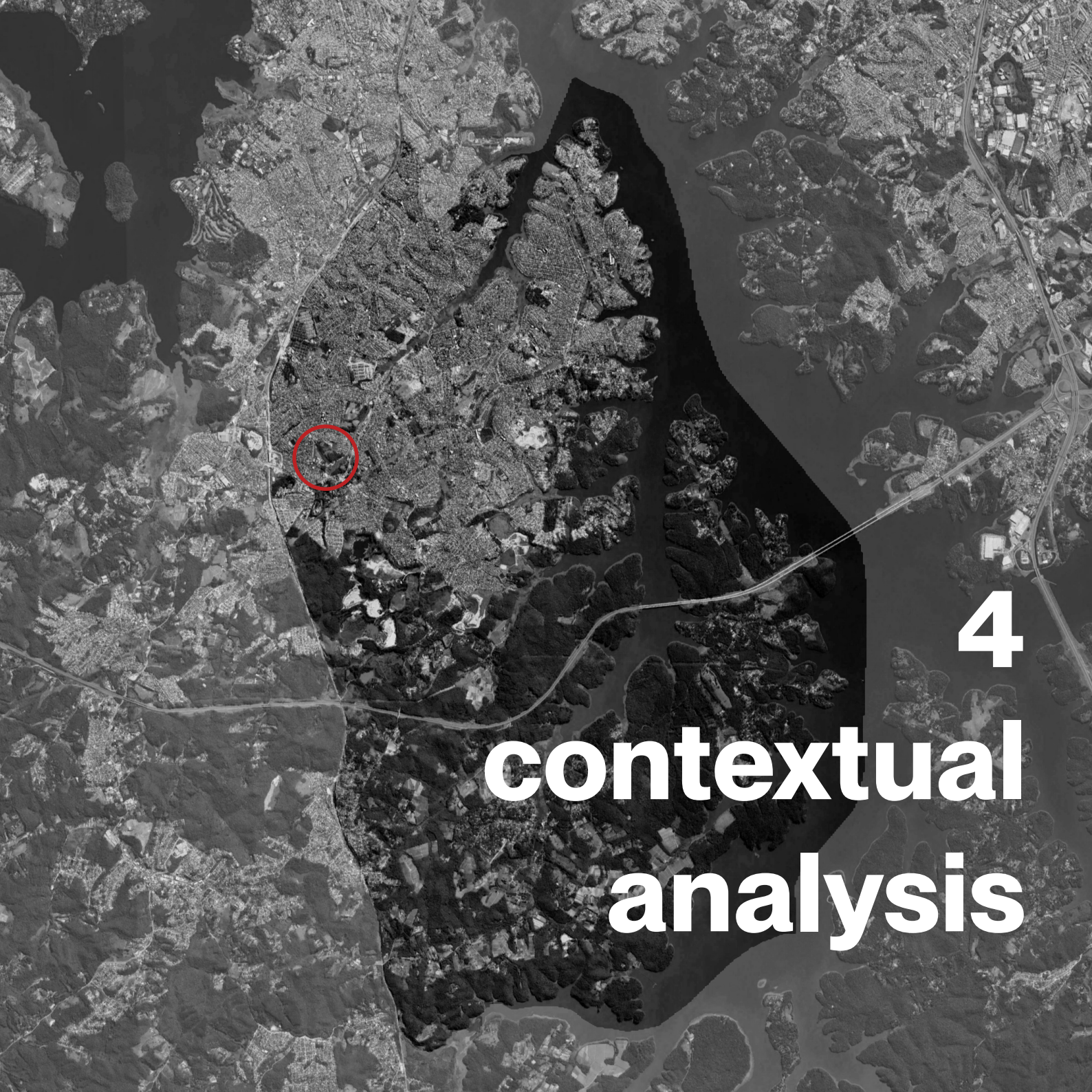
4
contextual
analysis
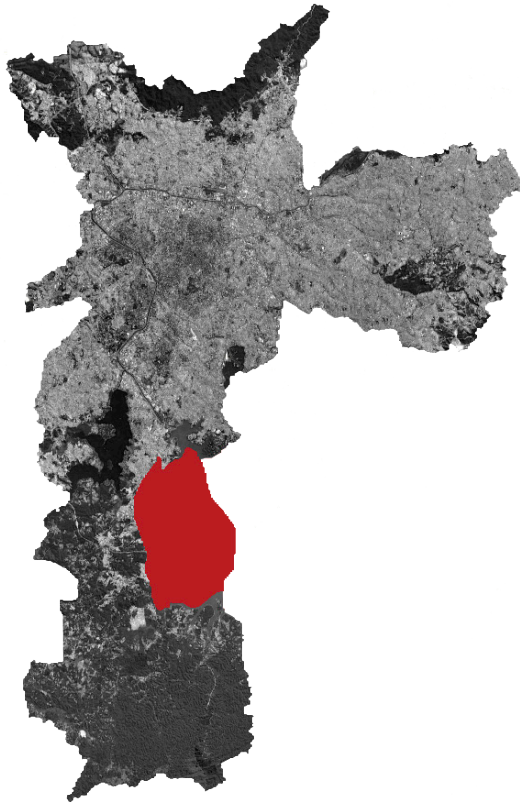
360 800 inhabitants
92.5 km²
3900 people/km²
96% urban population
3.5 people per average household
(São Paulo Census, 2010)

The project site is in Grajaú, one of three districts in Sao Paulo's subprefecture named Capella do Socorro. The peripheral subprefecture is São Paulo's most populous, experiencing its first boost in urban growth in the 1970s. Grajaú is located on the upper edge of the Billings reservoir, with two water channels penetrating the neighborhood.

Grajaú district, São Paulo (Google Earth, 2023)

grajaú

Images by author, 2022

Contextual Analysis
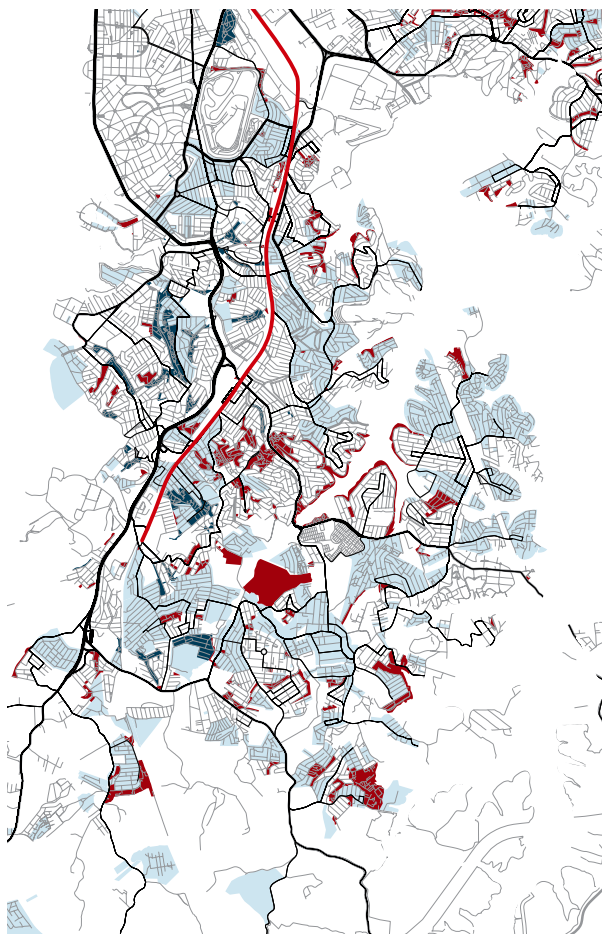
The residents of Grajaú live primarily informal settlements, developed outside of legal frameworks. Grajaú consists mostly of three different types of housing, defined by the the Sao Paulo Secretary of Housing (SEHAB): favelas, núcleos, and lotamentos.

The level of public infrastructure varies across the district. Some neighborhoods do not have established water supply, electricity, or sidewalks, and some have basic infrastructure but do not meet legal standards, while others are fully serviced. The peripheries of Sao Paulo also lack public transportation. Despite the population density, there is only a single train line and bus routes.

Informal housing types, drawn by author using data from the Prefeitura de São Paulo (Geosampa, 2023)

■ Favela

■ Núcleo

■ Lotamendo

——— Bus routes

——— Train line

Aerial view of Grajaú (Boldarini, 2012)

Favelas
Shanty Towns

Favelas are "shack-like" settlements that have been built on occupied areas of public or private land. They are developed without prior planning of individual plots or streets and are equipped with varying degrees of infrastructure. (SEHAB, 2016) The settlements are either self-built or constructed through process of mutirão, using informal building practices. (Lejano & Del Bianco, 2018) Favelas are occupied by low-income families who are exposed to some form of vulnerability, financial, environmental or otherwise. Favela neighborhoods are self-sufficient. They have diverse local economies and self-built spaces for cultural activity such as church-going or outdoor bbqs.
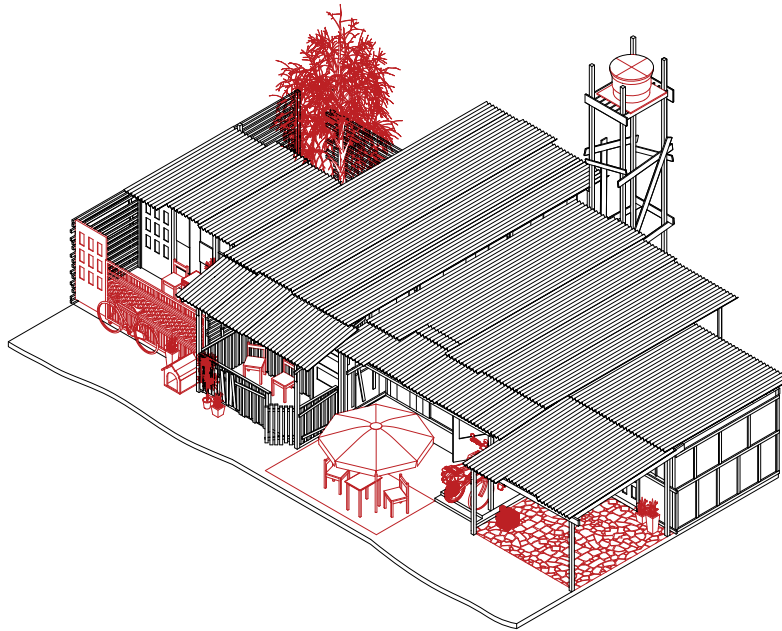
Above & Right | Favela
(Angelina Torbica, Aleksandra Jodłowska, & Beatrijs Kostelijk, 2022)

Contextual Analysis

enclosed backyard
space with foliage

metal corrugated roofing

demarcation of
plot & safety
barriers

make-shift water tank system

porosity between
indoor & outdoor
space

wood structure

found wood &
metal wall panels

income generation &
dwelling use

covered
front porch

individualized
material applications
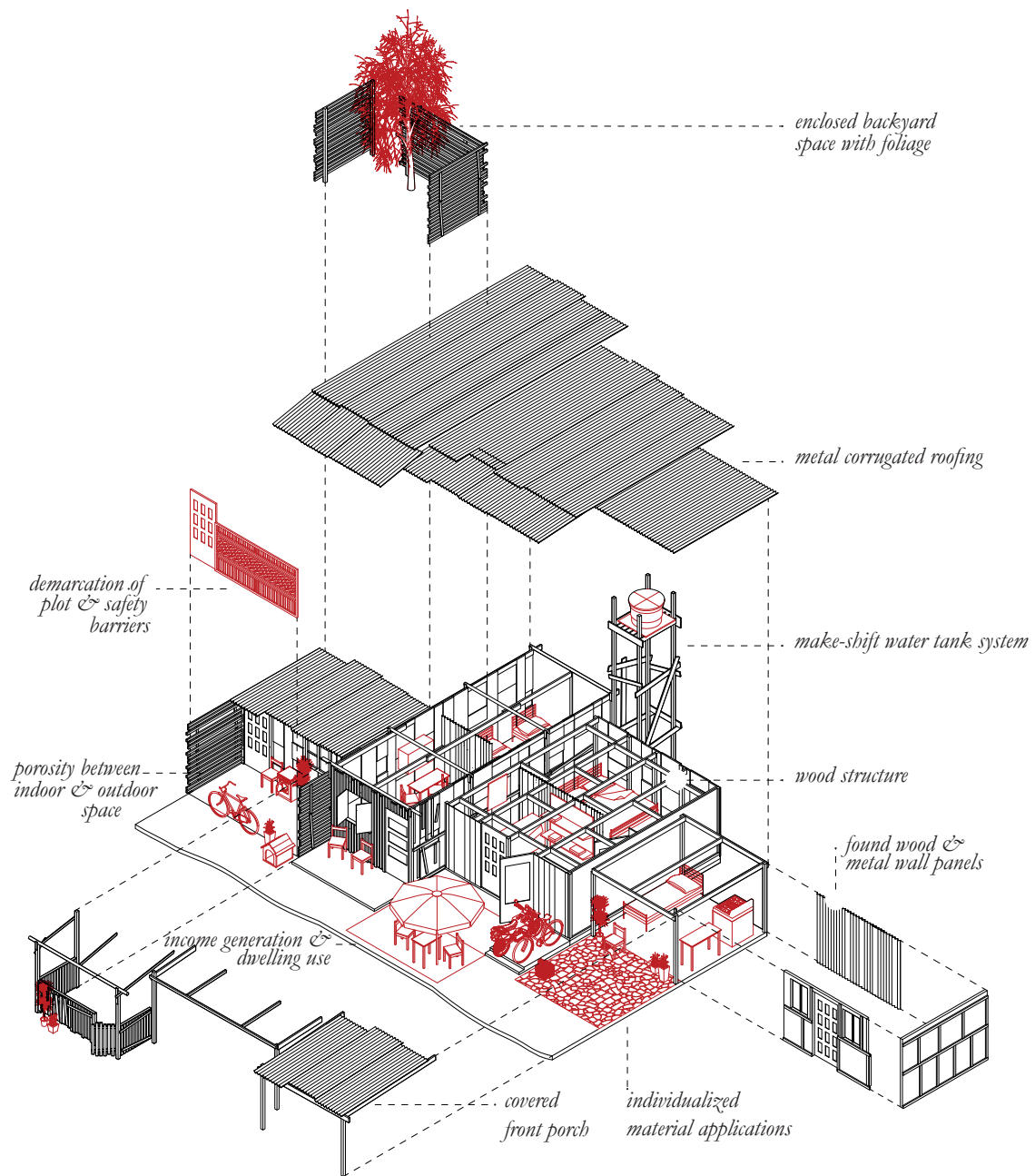
Núcleos & Lotamentos

Nucleus & Irregular subdivisions

Nucleus settlements are characterized as urbanized favelas equipped with all necessary infrastructure – water supply, sewage, drainage, public lighting, garbage collection, etc.(SEHAB, 2016) They are well established – it can take 20 to 40 years before a favela can become fully urbanized(SEHAB, personal communication, October 20, 2022).

Irregular subdivisions differ from favelas/nuclei in that they were sold or promoted by a developer without infrastructure or official licensing. They present some form of legal inconformity, with regards to street width, plot size, or minimum infrastructure requirements. (SEHAB, 2016)

However, favelas, nuclei, and irregular subdivisions all fight for the same thing – land regularization, to accord formal property rights to the plot and settlement. (Lejano & Del Bianco, 2018) The city of Sao Paulo does not grant title deeds to a plot until it is regularized, meaning that the residents in these neighborhoods face tenure insecurity.

There are many housing types within the umbrella of the informal settlement. One house may include multiple households across several stories or feature a shop on the ground floor with the shop owners residing on the upper levels. The settlements are long and narrow, taking up the entirety of the plot. As such, rooms inside the home may not include a window for proper ventilation and light. The house entrance may be connected to the street, behind secure borders. There is little space left over for vegetation or sidewalks. As a result, open public space is scarce across the neighborhood.

balcony to hang-dry clothes

building materials with no
exterior finishes

interior bathroom with
no ventilation

shop owner's apartment

another level of housing
added incrementally

additional bedrooms added
with no exterior windows

upper level apartments accessed
by outdoor staircase

small bedroom for
one or two children

balcony used as extra storage

ground floor shop
for income generation

Left & Above | Informal Settlement
(Sanette Schreurs, Robbert Laan, & Huub Fenten, 2022)

——

Housing Types

Contextual Analysis
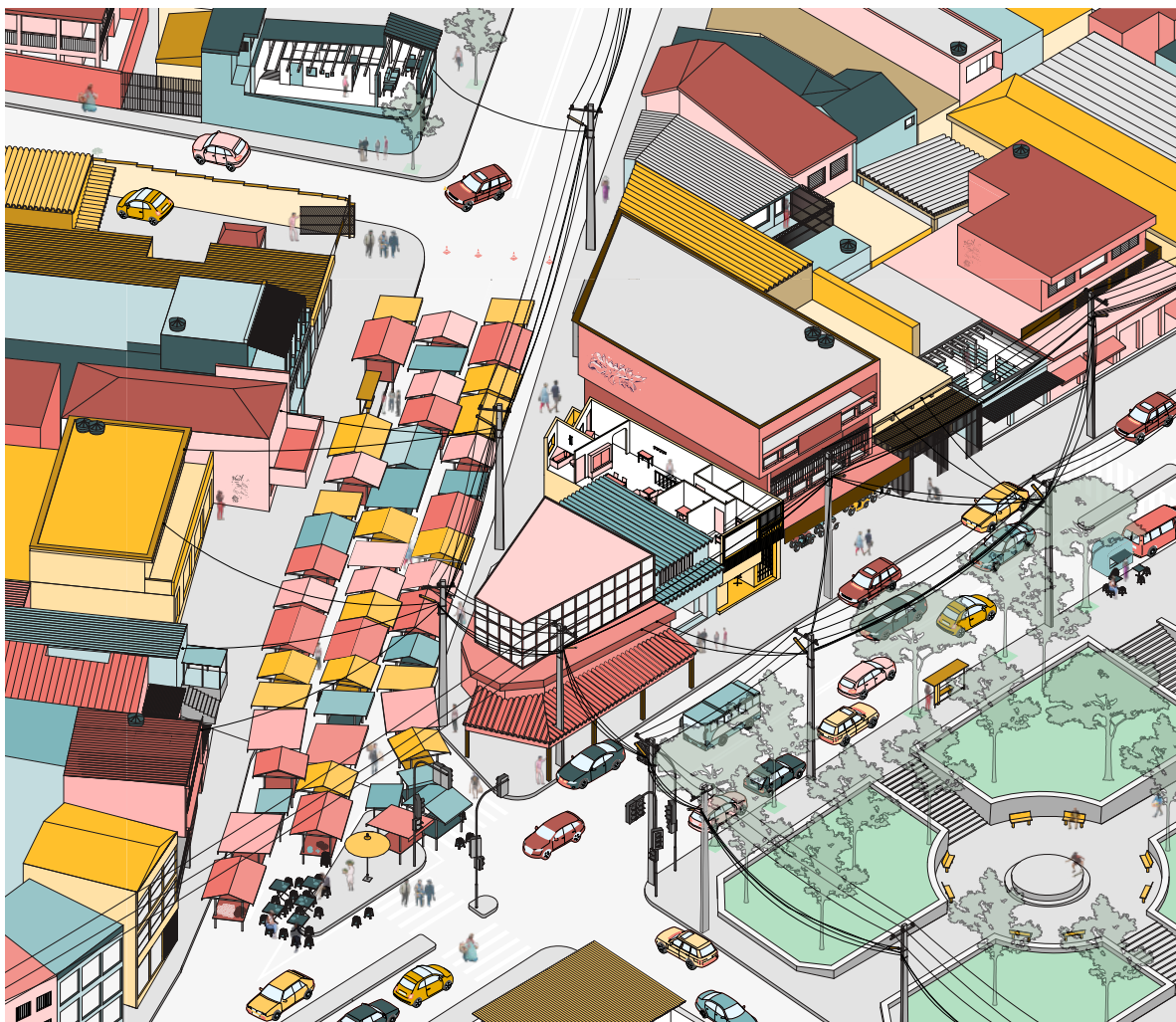
Like many favelas, Grajaú faces chal-
lenges of poverty, crime, and violence. That
said, Grajaú is a vibrant, active, neighbourhood.
During the field research, we observed many
different activities taking place. Shops, cafés, and
household belongings spill onto the sidewalk,
weekly informal markets fill the street, and parks
act as a stage for variety of public events. While
Grajaú does not have much open, public space,
the places that do exist are heavily valued and
used. This is particularly true for green spaces,
such as the linear parks present in Grajaú.

*Atmospheric Synthesis of Grajaú, São Paulo, drawn by
author in collaboration with Winnie Goldsteen, 2022*

risk

The contextual research for the issues defined under "Risk" in the research methodology has been analysed through the lens of the Cantinho do Céu neighborhood and its urbanisation project, led by Boldarini Arquitetos and SEHAB. Cantinho do Céu is an urbanized favela located on the shore of the Billings Reservoir. Until the 1950s, the watershed was completely unurbanized, but the neighbourhood quickly grew to accommodate 160 000 incoming residents (Franca & Barda, 2012).

In response to the rapid transformation of the area along the watershed, the municipality of Sao Paulo began working in the 1990s on the Programa Mananciais (Springs Program), defining zones of intervention for the environmental recovery and management of its watershed areas. New regulations illegalized the improvement of conditions in informal settlements that were not meant to exist in protected watershed areas. Cantinho do Céu therefore could not establish much-needed infrastructure such as water, sewage, or even legal street naming. By 2009, the Billings' Reservoir only provided 9% of city drinking water due to serious eutrophication by wastewater discharge (Mathur & Cunha, 2014).

Contextual Analysis

Cantinho do Céu Linear Park (Boldarini, 2023)

Cantinho do Céu Urbanisation Project

2009 - 2012
154.4 ha
43 556 inhabitants
70 dwellings/ha

By Boldarini Arquitetos & SEHAB

(Franca & Barda, 2012)

      In the early 2000s, the city introduced a new form of the Programa Mananciais (Springs Program), outlining a plan of action which would include the urbanization of precarious settlements, land regularization, and the installation of public facilities, parks, and leisure areas. The program also provides housing assistance and a resettlement plan for those living in areas of flooding and geotechnical risk, or where urban upgrading works require the removal of homes.

      The Cantinho do Céu urbanisation project encompassed each action of the Springs Program; the removal of families along the Billings Reservoir water banks, major infrastructural upgrading to provide necessary services to the neighbourhood. The highlight of the project was the creation of a linear park along the Billings Reservoir water banks, in place of the removed at-risk homes. In 2005, the process of evictions and project design began, with the construction works breaking ground in 2008 (Franca & Barda, 2012).
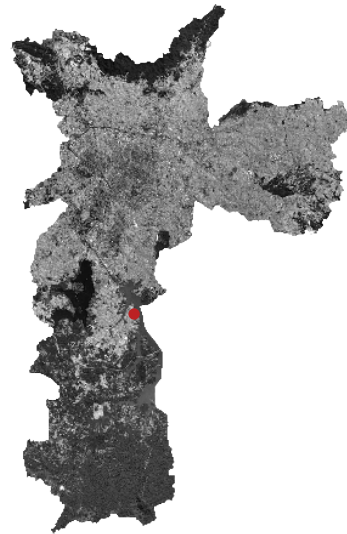
Aerial views of Cantinho do Céu development before, during, and after revitalization by Boldarini Arquitetos (Boldarini, 2023)

Regularized Housing
Removed Homes
High Voltage Line

Green Preservation Area
Green Conservation Area
Institutional
Access
Water Streams
Rainwater Runoff
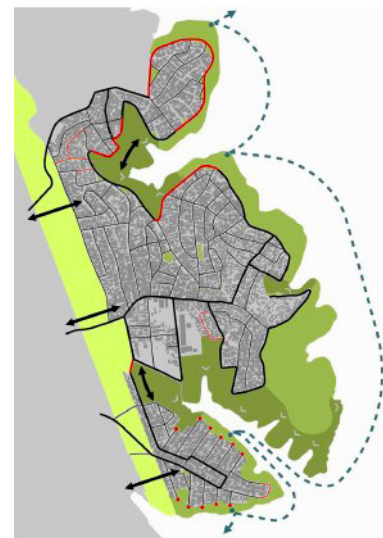
Local Roads
Principal Roads
Proposed Roads
Viewpoints
Connections
Proposed Connections

Cantinho do Céu Urban Upgrading Scheme by Boldarini
Arquitetos (Franca & Barda, 2012)

Before the project took place, there was a lack of public lighting, paving, urban drainage, and in some areas, no water supply or sewage connection. Community leaders had to arrange to have emergency water shipped in containers, which was then stored in cisterns.

The process of urbanization began with defining plots for land regularization and outlining streets, then removing housing to make available space for the installation of streets and basic infrastructure. The final step was the creation of a linear park, to protect the watershed borders and provide a public space with high social value.

Water tanks and cisterns are commonly kept on the roof, since it provides water pressure through gravity and can store 500-1000L of water at a time.
Image by author, 2022

Urbanization of Precarious Settlements Actions (Prefeitura da Cidade de São Paulo, 2022)

- *Basic sanitation works (sewage and water supply network)*
- *Works to contain geological risk areas*
- *Rainwater drainage works*
- *Channelization of streams*
- *Environmental recovery works*
- *Paving existing roads and opening new roads*
- *Installation of urban parks, squares, and leisure areas*
- *Installation of public lighting*
- *Improvements in accessibility and pedestrian circulation conditions*
- *Urban landscaping (planting trees, installing planters and rain gardens, etc.)*
- *Installation of urban furniture (benches, trash cans, parklets, decks, etc.)*

The linear park is a 7km long strip of public space, changing in quality along the route to provide different kinds of recreational areas. The border condition between the land and Billings' Reservoir edge reflects the boundary of private and public. The linear park thus functions as an "in-between" space that protects against land occupation and the water bank by enforcing the separation between public and private (Franca & Barda, 2012).

While 70% of grajau residents use the linear park on a regular basis, this was not always the case (SEHAB, personal communication, October 20, 2022) . The concept of leisure time was not ingrained in the lifestyles of Cantinho do Céu residents. Learning how to embrace the park and take care of public spaces thus required educational meetings with community leaders.

Cantinho do Céu Linear Park (Franca & Barda, 2012)

Contextual Analysis

Placing importance to clearly defined, public, "green" space is critical, not only to Cantinho do Céu, but to all of Sao Paulo. Parks around bodies of water in Sao Paulo changes the relationship between residents and water (SEHAB, personal communication, October 20, 2022). The formalization of borders around these spaces ensure that the spaces remain public and do not become appropriated by residents for housing, or waste discharge.

Thus, the perception of these urban landscapes transforms from being associated with sanitation and health risk, to leisure. This change in perception reassigns their societal position within the city, since entitlement to leisure in a community grants a sense of agency, ownership & increases self-esteem. After integrating with the neighborhood over time, these high value public spaces become heavily used by the residents.

Contextual Analysis

occasionally, as the park transforms to
become a concert venue, a church, a bbq spot,
a dance floor, a political stage

daily, as people come and go to play, exercise, socialize

monthly, as natural environment grows

yearly, as permanent structures degrade or slowly change
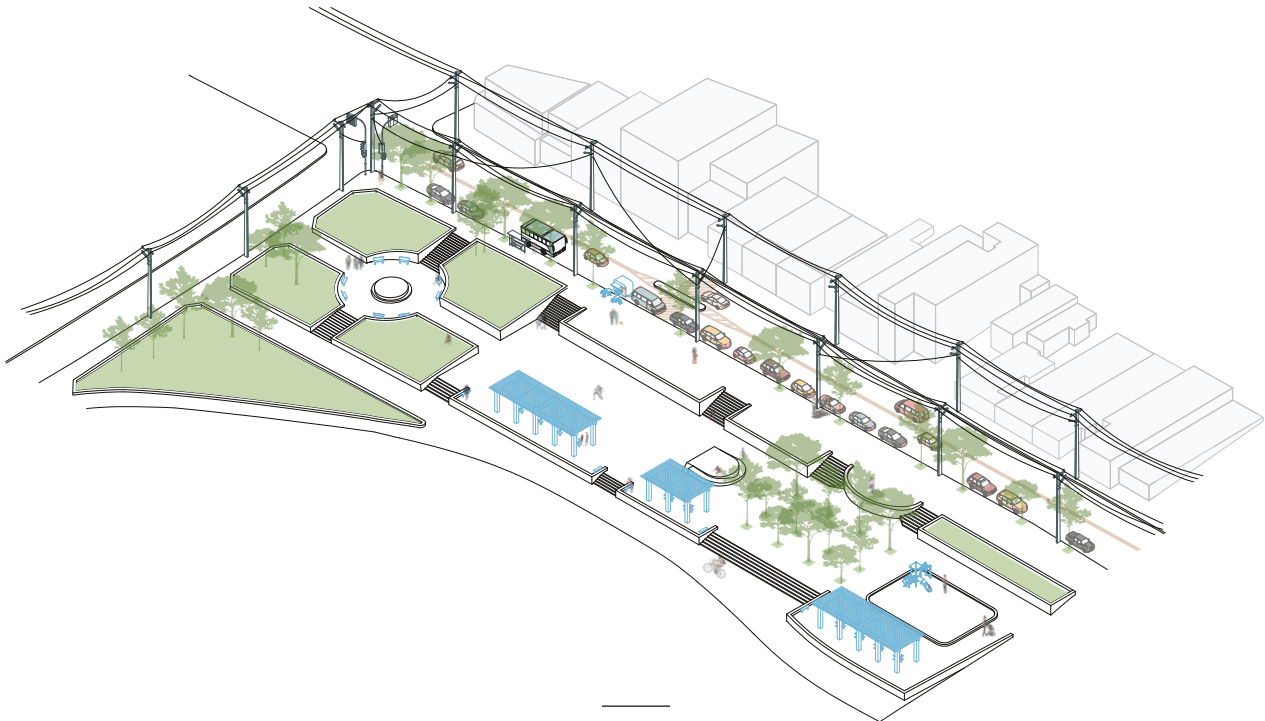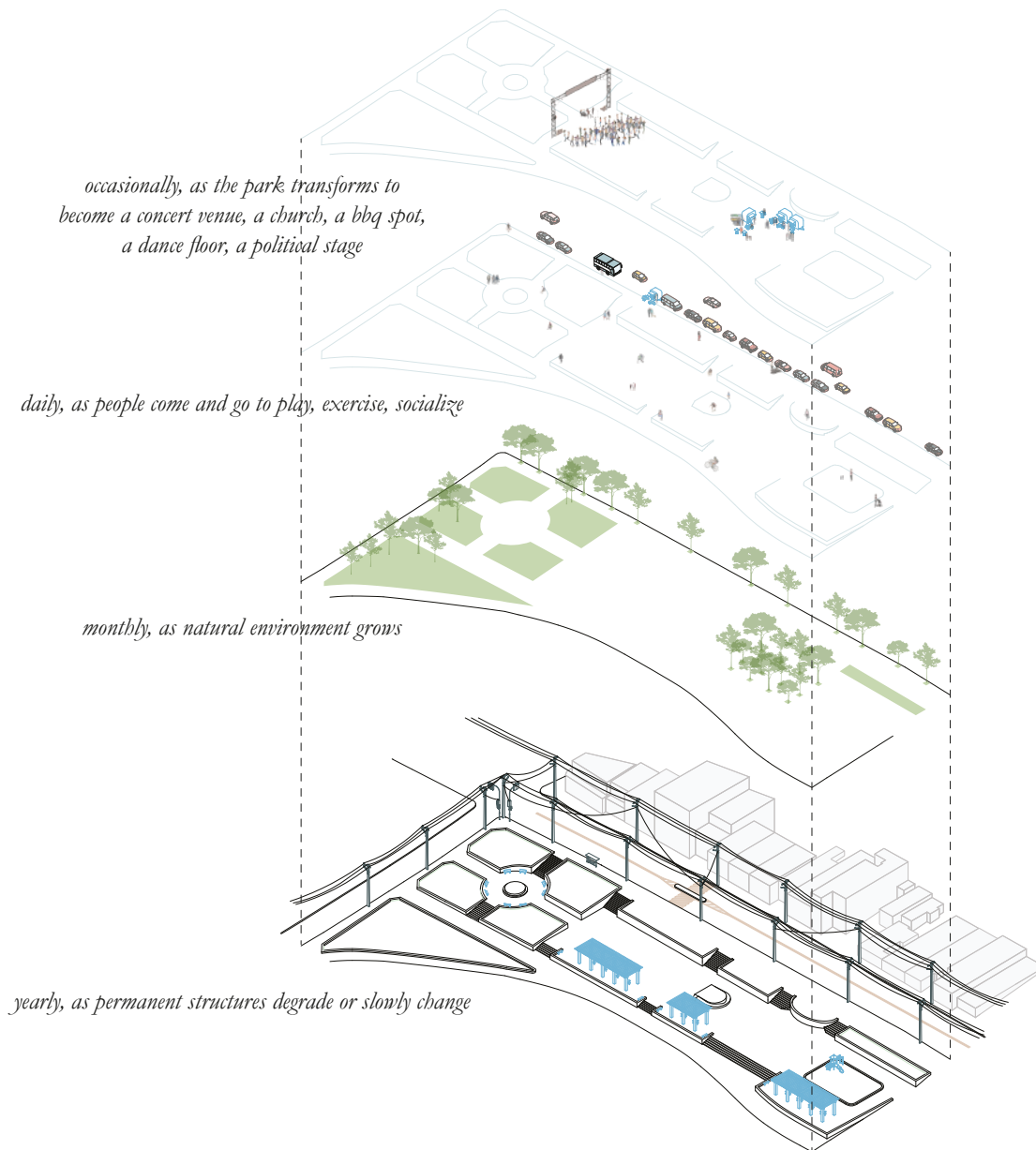
The public park is a diverse space with a strong temporal quality.

Left & Above | Contextual Analysis of Public Space in Grajaú, São Paulo,
drawn by author in collaboration with Winnie Goldsteen, 2022

―――

Risk - Value of Public Green Space

🔴 Eviction site, residents displaced to	→	Chácara do Conde Social Housing	🔴
🔵 Eviction site, residents displaced to	→	Residencial Espanha Social Housing	🔵
🔵🔴 Eviction site, residents displaced to Chácara do Conde or Residencial Espanha			

Contextual Analysis

However, in order to make these spaces possible, over 1000 families in Cantinho do Céu had to be displaced during the urbanisation project. The settlements closest to the Billings Reservoir Banks were the youngest and typically the most precarious, as this was the last available land for appropriation during the neighborhood's urban growth. The removal was deemed necessary for homes in areas of "geotechnical, material loss, or environmental risk" (Franca & Barda, 2012). After eviction, these families were given 3 choices – to receive a one time compensation payment for the value of their home, resettle in social housing, or receive monthly stipend for rental assistance.

The map on the right shows the areas from which residents were evicted from due to risk or urban upgrading. It indicates which social housing project developed by SEHAB they were displaced to and rehoused. The two example housing projects - Chácara do Conde & Residencial Espanha - fall under the contextual research for the issues defined under "Resettlement" in the research methodology.

Housing removal sites & their respective resettlement locations

Map drawn by author using satellite imagery and locations identified using data from the Prefeitura of São Paulo (Google Earth Pro, 2023; Secretaria Municipal de Habitação & Secretaria Especial de Comunicação, 2022; Secretaria Municipal de Habitação, 2018)

resettlement

The displacement and urban upgrading solution presented by the municipality of São Paulo in Cantinho do Céu translates into a large social cost for the sake of environmental preservation. The introduction of the PDE Strategic Master Plan was a way to reconcile the environmental development policies with the right to housing. The definition of ZEIS zones was an instrument of the Strategic Master Plan to "contribute to the recovery of precarious settlements in watershed areas" (Franca & Barda, 2012).

The ZEIS 1 zones are characterized as land occupied by informal settlements, whereas the ZEIS 4 land plot type is defined as vacant land in environmentally protected areas. Since it is designated as land for future urbanization to rehouse those displaced from ecologically fragile areas without proper infrastructure (Pimentel Walker & Arquero de Alarcón, 2018), it is under the ZEIS 4 framework that resident displacement from these areas occurs. ZEIS 4 is also intended to shrink the density of ZEIS 1 zones, by housing those evicted from risk areas in ZEIS 1 zones. The ZEIS 4 zones are primarily found in Sao Paulo's southern peripheral neighborhoods.

ZEIS 4 Goals (Santoro, 2015)

- *ensure low-income families have access to proper infrastructure*
- *avoid urban segregation through means of social mix*
- *promote social cohesion*

ZEIS 4 Requirements (Cidade de São Paulo Strategic Master Plan, 2014)

- *FSI <= 2 - Floor Space Index is the ratio of total floor area to land footprint area*
- *>60% HIS 1 Housing (0-3 minimum wages)*
- *<20% HMP Housing (6+ minimum wages)*

ZEIS 4 Locations, drawn by author using data from the Prefeitura de São Paulo (Geosampa, 2023)

■ *ZEIS 4*

── *Highway*

── *Sub and Arterial Roads*
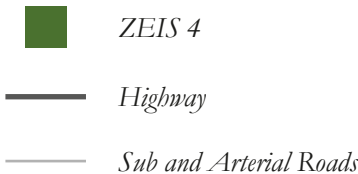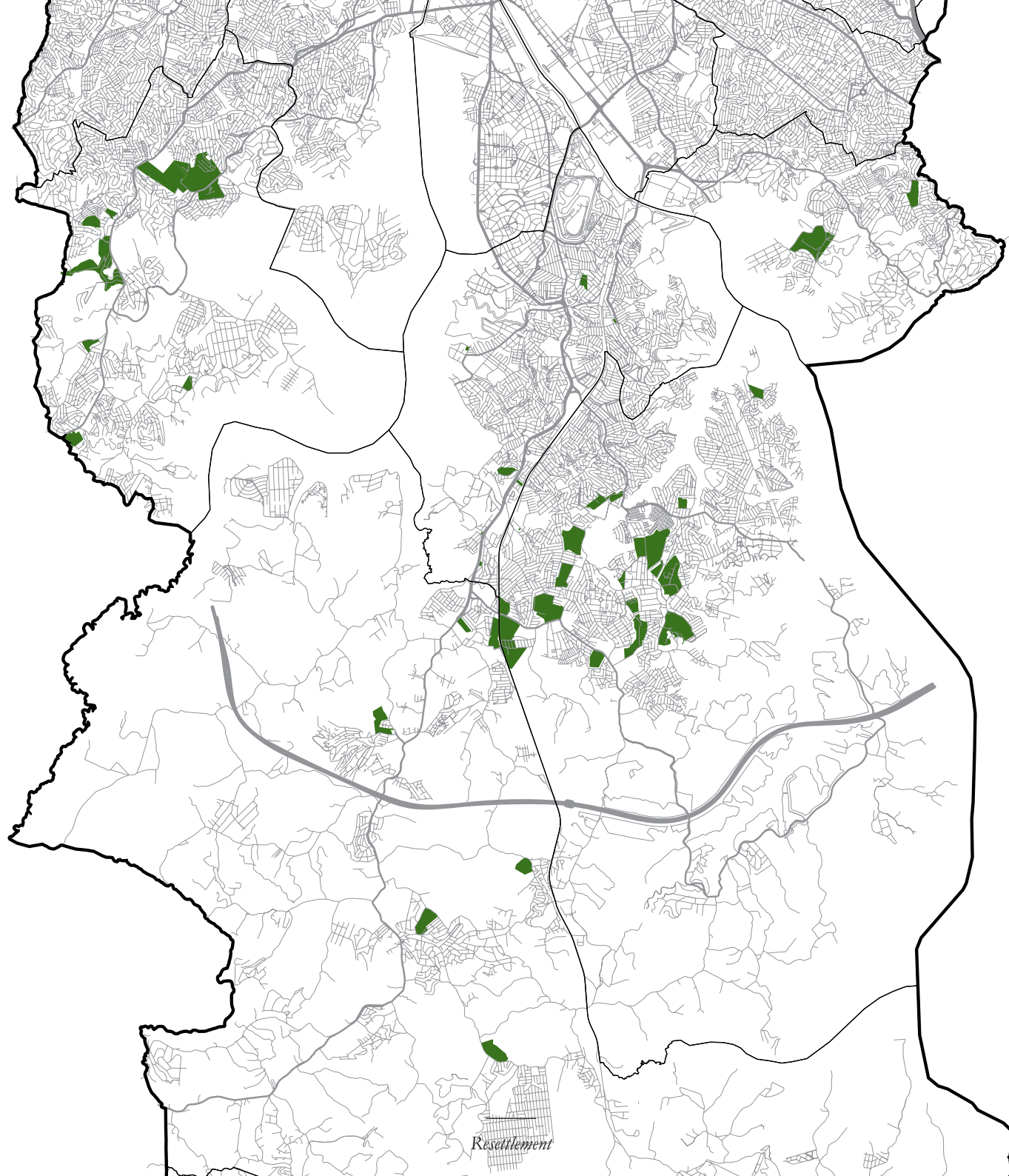
Resettlement

Families evicted by urbanisation projects or from at-risk areas face financial uncertainty after the loss of their household. They must find housing on their own in the formal real estate market or apply for resettlement with under the ZEIS 4 framework. Resettlement to a ZEIS 4 housing complex functions in conjunction with Minha Casa Minha Vida, a program which subsidizes a rent-to-own financing system for homebuyers in HIS 1 and 2 categories.

GROWTH ACCELERATION PROGRAM (PAC)

-Launched in 2007
-Plan for public investment into social and urban infrastructure
(Souza-Lopes & Saab, 2021)

URBANISATION OF PRECARIOUS SETTLEMENTS (UAP)

-Implemented under the Springs Program
-Managed by SEHAB - São Paulo Municipal Housing Secretariat
-Urbanisation program for land regularisation, infrastructure-upgrading, social housing development and family resettlement
(Souza-Lopes & Saab, 2021)

Financial Support for Displaced Families due to UAP

One-time compensation payment equal to value of house constructed in at risk areas (land value not included), or

Rental Assistance for housing in formal rental market, with conditions

Resettlement in a MCMV social housing complex when possible, or

MINHA CASA MINHA VIDA (MCMV)

-Managed by CAIXA - Brazil Federal Savings Bank
-Housing development program for producing social housing and subsidized rent-to own financing scheme for low-income families
(Souza-Lopes & Saab, 2021)

RENTAL ASSISTANCE

(Silva, 2020)

Monthly Rent Benefit	**R$400**
Income qualification	**Up to R$2400**
Registered recipients in 2020	**26 743**
Families displaced by PAC receiving Rental Assistance in 2017	**13 499**
Families displaced by PAC from Billings Reservoir area receiving Rental Assistance in 2017	**1060**

MINHA CASA MINHA VIDA RENT-TO-OWN FINANCING, 2018

(Cidade de São Paulo, 2018)

household income*	property cost subsidy	interest	timeframe
Up to R$1800 (HIS 1)	Up to 90%	0%	R$80 - R$270 monthly for up to 120 months (10 years)
R$1801- R$2600 (HIS 1)	Up to R$47 500	5%	Up to 360 months (30 years)
R$2601-R$4000 (HIS 2)	Up to R$29 000	5.5% - 7%	Up to 360 months (30 years)
R$4001-R$7000 (HIS 2)	None	Variable	Up to 360 months (30 years)

In 2018, the minimum wage was R$954. As of 2023, the minimum wage has increased to R$1302.

Chácara do Conde

2009 - 2018
10.4 ha
1290 units for 5000 inhabitants
124 dwellings/ha

By JAA Arquitetos & SEHAB

(JAA Arquitetos, 2023)

Residencial Espanha

2018
30 ha
3860 units for 15 000 inhabitants
128 dwellings/ha

By SEHAB (Architect unknown)

(Prefeitura de São Paulo, 2018)

Chácara do Conde and Residencial Espanha are two resettlement housing projects intended for families displaced by the Urbanisation of Precarious Settlements Program (UAP). The housing complexes work with the MCMV framework and are built on ZEIS 4 land. The families were chosen prior to their displacement, so the units were all accounted for before construction of the complexes were finished. (SEHAB, personal communication, October 20, 2022). The residents cannot sell, exchange, or rent out their apartment for a minimum of 10 years. The majority of households fall under the HIS 1 range.

The resettlement process into these social housing complexes are accommapined by SEHAB social support services for

- *guidance on housing maintenance*
- *self-management owner associations*
- *enforcing code of conduct*
- *MCMV financing support*
- *employment programs*

Chácara do Conde
Image by author, 2022

Residencial Espanha
(SEHAB, 2018)

The apartments in these housing complexes have either 2 or 3 bedrooms, with different organizations depending on need. For example, there are over 10 typologies of bedrooms in the Chacara do Conde housing complex. Three percent of households are designed to be universally accessible ground floor units. The standard apartment size is between 43 -56 m2, which is the standard for social housing in Sao Paulo. However, these sizes are typically much smaller than the prior households which were built over time in the favelas.

apartment is delivered
unfurnished

shower, sink, toilet, laundry sink, and
a basic kitchen are included

apartment is accessed
through a shared staircase

basic materials and finishes have been
used to construct the housing complex

few opportunities for appropriation
& individualization of the apartment
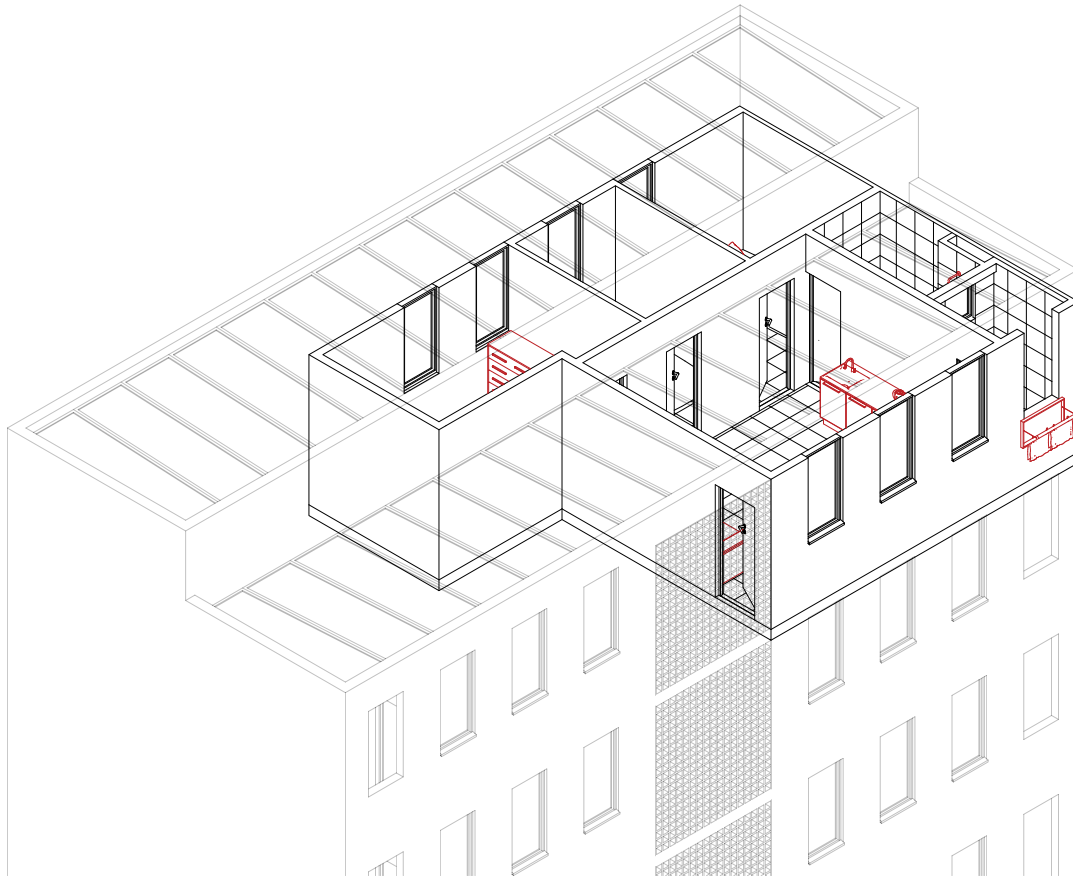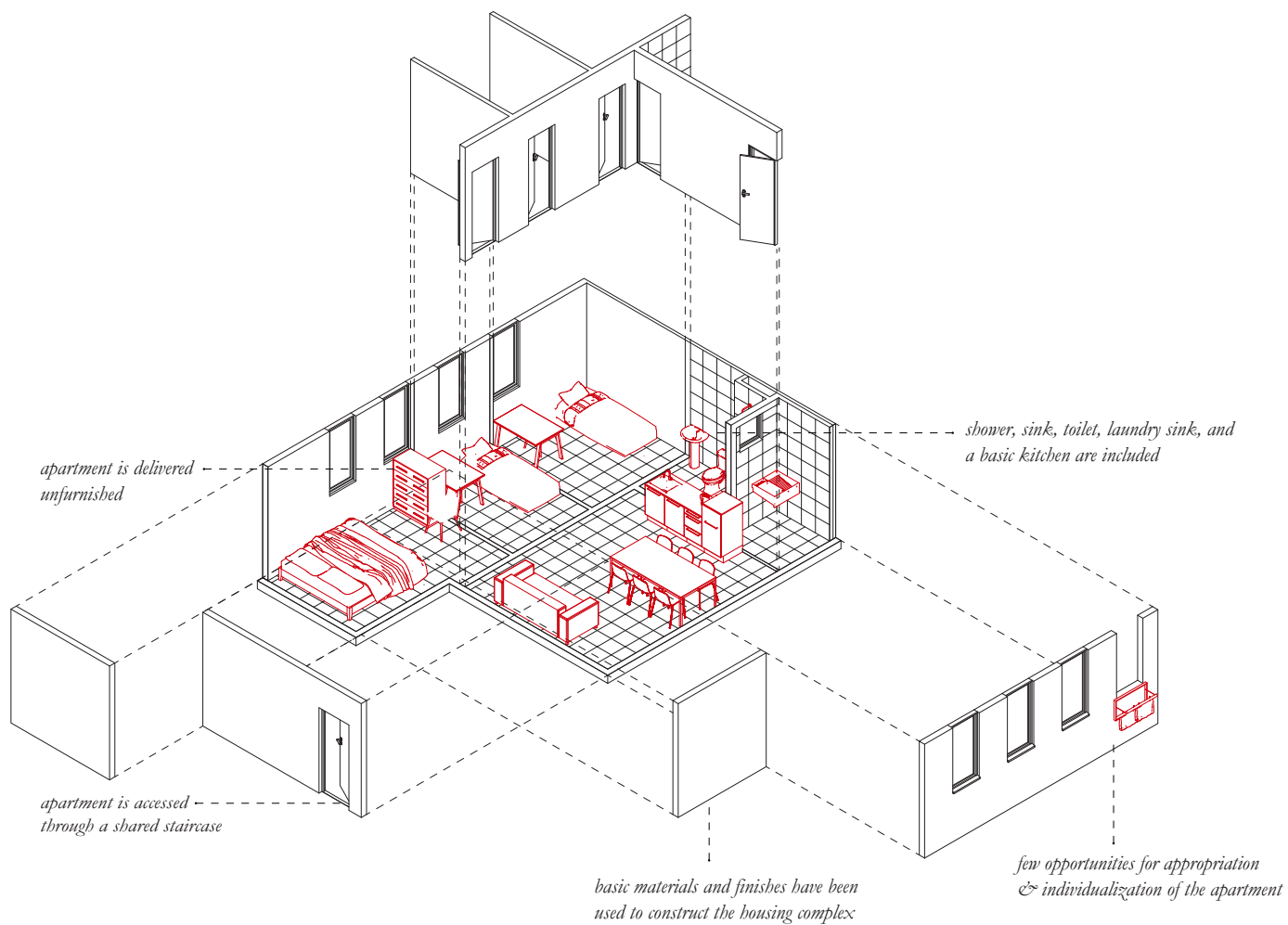
Left & Above | Chácara do Conde Housing Unit
(Sanette Schreurs, Robbert Laan, & Huub Fenten, 2022)

Resettlement - Social Housing

The success of these housing complexes is tangible. For many, this is the first time they have a new, structurally sound home in a safe environment. The neighborhood is clean and efficient, housing many families at once.

However, this success is difficult to achieve and requires a lot of social support from the Housing Secretariat from the municipality. The resettlement process begins with meetings before, during, and after rehousing, in order to educate residents about their new lifestyle, which can be difficult to adapt to. This accounts for "social rules" such as noise curfews, how to keep shared facilities clean, and how to take care of their own homes as new homeowners.

Atmospheric Synthesis of Chacara do Conde Housing Complex (Robbert Laan, Sanette Schreurs & Huub Fenten, 2023)

Contextual Analysis

Resettlement - Urban Context

Chácara do Conde Aerial View
(JAA Arquitetura, 2022)

Contextual Analysis

Residencial Espanha Aerial View
(Lopes Jr, 2019)

The urban plans of the two housing complexes are designed such that become islands, disconnected from the surrounding urban fabric and from existing social networks. Furthermore, the efforts of environmental recovery on the site is pushed to the periphery and not integrated with housing.
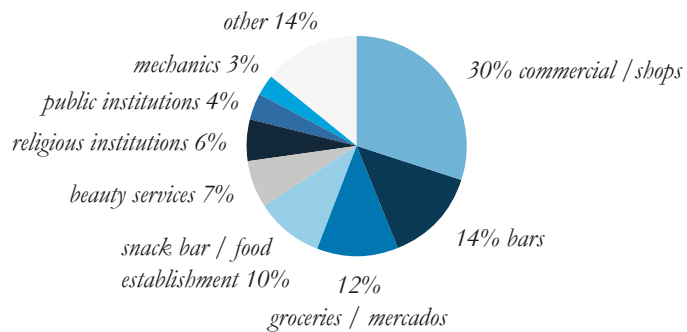
The new housing complexes bring the promise of plenty of social services such as schools, daycares, playgrounds, health centers, etc. However, they lack sufficient spaces for formal and informal income generation. Sao Paulo's peripheral communities have strong informal economies, which are integral to the culture of the favela in building social networks and financial capital.

For example, since the urbanisation project in Cantinho do Céu has grown, each shop typically employs 4 people from the neighborhood (SEHAB, personal communication, October 20, 2022). Therefore, residents in these complexes must adapt and find new ways to promote their businesses.

Lack of Income-Generating Spaces at Residencial Espanha Housing Complex
(Lopez Jr, 2019)

other 14%

mechanics 3%

public institutions 4%

religious institutions 6%

beauty services 7%

snack bar / food
establishment 10%

30% commercial / shops

14% bars

12%
groceries / mercados

Local Economy Statistics in Cantinho do Céu, São Paulo, drawn by author with data from Entre O Céu E A Água (Franca & Barda, 2012)
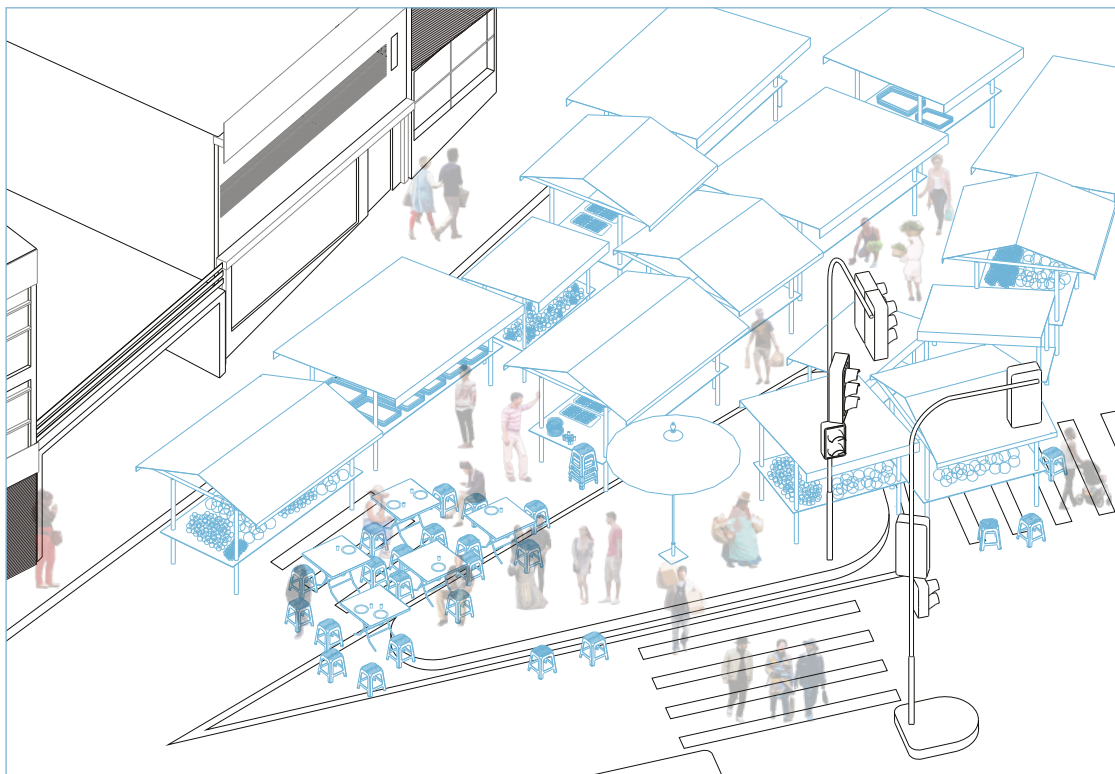
*Contextual Analysis of Informal Economy in Grajaú, São Paulo,
drawn by author in collaboration with Winnie Goldsteen, 2022*

case studies

Communa Urbana
Dom Hélder Camara,
USINA ctah, 2012,
Jandira, São Paulo

Radburn Principle
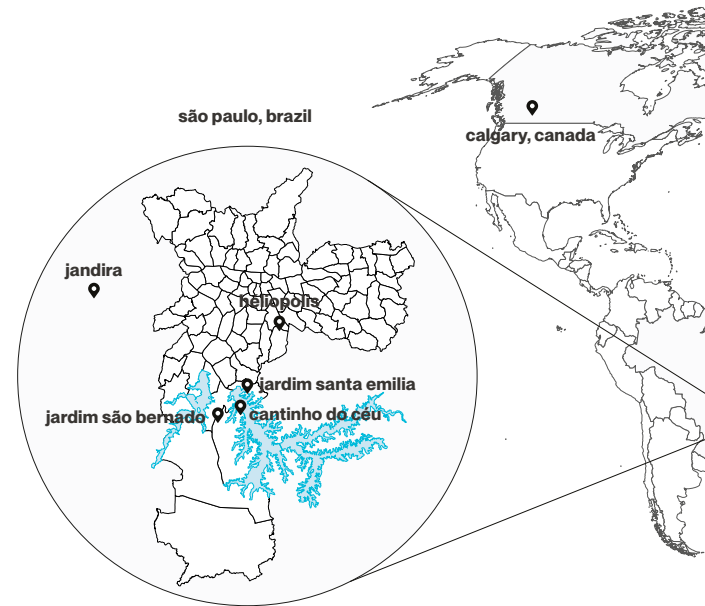Carma Developers LP, 1960s
Varsity Village, Calgary

As explained in the methodology, case studies were an integral portion of the contextual research for the project. In addition to Cantinho do Céu and Chacara do Conde, precedents from outside Grajaú were studied. For the sake of brevity, only the case studies from design ideas were extracted have been included.

Case Studies location map, drawn by author using vector resources (Freevectormaps.com, 2023)

são paulo, brazil

calgary, canada

jandira

heliópolis

jardim santa emilia

jardim são bernado **cantinho do céu**

Chácara do Conde Housing,
JAA Arquitetos, 2018,
Jardim São Bernado, São Paulo

Cantinho do Céu Urbanisation,
Boldarini Arquitetos, 2012,
Cantinho do Céu, São Paulo

Doedijnstraat Housing
Alvaro Siza, 1991
Schilderswijk, The Hague

Fenix I Development
MEI Architects, 2019
Feijenoord, Rotterdam

the hague

rotterdam

netherlands

Residencial Espanha Housing,
SEHAB, 2018,
Jardim Santa Emília, São Paulo

Gleba A Housing
Vigliecca & Associados, 2004
Héliopolis, São Paulo

Communa Urbana Dom Hélder Câmara

2007 - 2012
128 families
51 dwellings/ha

By USINA ctah & Landless Rural Workers
Movement (MST)

(Torbica, 2022; USINA, 2012)

The residents of the Dom Hélder Câmara urban commune lived together as a favela community long before being evicted by the Paulista Metropolitan railway company in Jandira, just outside the city limits of São Paulo. The families joined the MST to build new, collective housing through self-managed collaborative effort (mutirão). The residents used their sweat equity as a method of downpayment towards their homes.

The clustering strategy employed in the thesis was inspired by Dom Hélder Câmara, regarding its inner courtyards and flexibility to topography. It was a meaningful precedent since the evolution of the case study from displacement to resettlement through collaborative effort relates directly to the research topic.


Construction Process of Comuna Urbana Dom Hélder Câmara, (USINA, 2012)

Contextual Analysis

Comuna Urbana Dom Hélder Câmara, São Paulo
Concept Diagrams (Angelina Torbica, 2022)

———

Spatially expressing the idea of "commune," the design concept is a nucleus composed of 10 dwellings, with residents assigned according to the existing relationships from the original community. Clustered around communal courtyards, the dwellings have front entrances that face each other on the interior, reinforcing the act community-making inside the nucleus. The cluster shape supports social solidarity and community surveillance for safe play spaces. The nuclei are connected to form pathways crossing from on cluster interior to another, with each dwelling placed on a different elevation to adapt to the hill topography.

Inner courtyard of nucleus cluster at Dom Hélder Câmara, images by author, 2022

Contextual Analysis
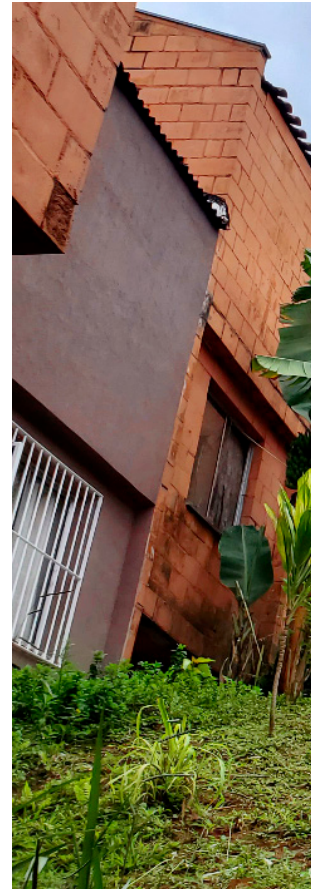
Gleba A Héliopolis Urbanisation

2004 - 2012
537 dwellings
174 dwellings/ha

By Vigliecca & Associados & SEHAB

(Schreurs, 2022; Vigliecca, 2012)

In the area of Héliopolis, Sao Paulo's largest favela, housing located along a contaminated floodplain was removed to channel and restore the Sacoma stream. The Gleba A residential block was built to rehouse the families that were at risk on the site. (Urbanização de Heliópolis, 2022) The focus of the project was on housing and infrastructural upgrading to the area.

The approach of Gleba A is to consolidate and act as an urban stitcher. Rather than demolish the remaining favela, its formal arrangement enables the building to integrate with the surrounding informal settlements.

Reflecting the irregularity of the housing around it, the housing is compositionally broken up to create communal courtyards. These courtyards are exclusive to the residents living in Gleba A, creating a safe place for children to play and for community events.

Gleba A's function as a relational tool between existing and new, as well as its privatized courtyards were a key precedent for the Courtyard Cluster design in this project.

Gleba A Communal Courtyards
(Vigliecca, 2012)

Contextual Analysis
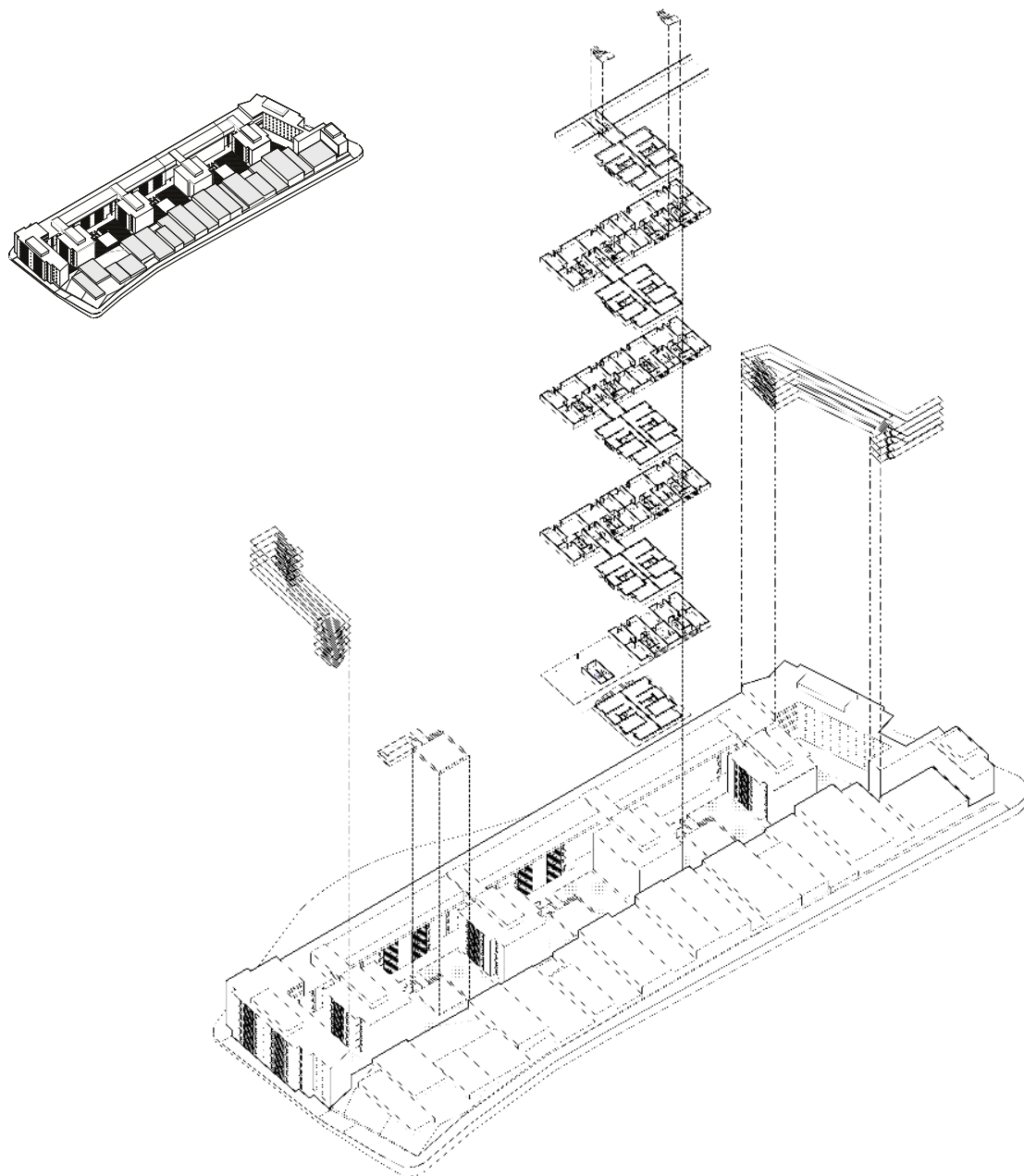
Gleba A Héliopolis, São Paulo
Concept Diagrams (Sanette Schreurs, 2022)

Doedijnstraat Housing

1989 - 1991
246 dwellings
101 dwellings/ha

By Alvaro Siza

(Ridderhof et al., 1994)

The Doedijnstraat Housing project, located in the Schilderswijk area in The Hague, was part of a broader urban renewal project led by Alderman Adri Duivesteijn in the 1980s. Duivesteijn sought out Portuguese architect Alvaro Siza for his experience in urban development projects with high architectural quality. The demographic of the Schilderswijk area was primarily immigrant families. Therefore, the Alderman wanted to strengthen the existing urban structure and accommodate both old and new residents.

Alvaro Siza used a repetitive and restrained design to achieve a cohesive urban proposal. He included the Haagse portico, which had become less popular at the time, to recall The Hague's residential environment. The Haagse portico design allowed Siza to include a doorway with direct access to the street for all eight apartments within a single block, across four storeys.

The Haagse portico concept was an instrumental tool for designing the access for higher income groups in the final design proposal of this thesis.

Haagse Portico Entrance, Doedijnstraat Housing
(Ridderhof et al., 1994)

Contextual Analysis
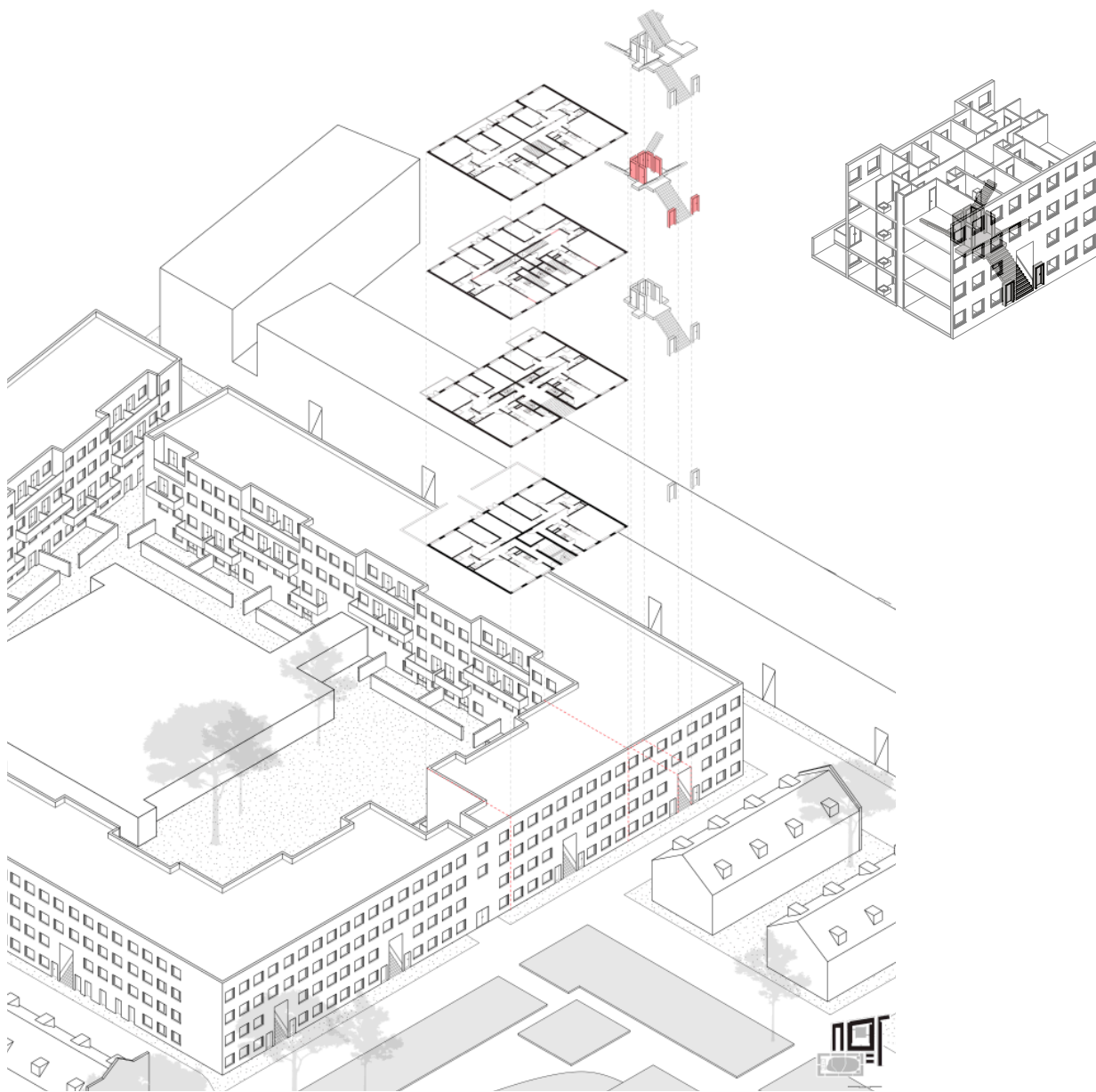
Doedijnstraat Housing, The Hague
Concept Diagrams drawn by author, 2022

———

Case Studies

Fenix I Mixed-Use Development

2013 - 2019
212 dwellings
189 dwellings/ha

By Mei Architects

(Goldsteen, 2022; Viglieca, 2012)

Built from original warehouse in an industrial port neighbourhood, FENIX I features a spacious market and businesses on its ground floors, with loft homes on the upper stories.

The principal concept for circulation was an open gallery on the interior of the building. The balcony overlooks a central courtyard to which residents have access. The balcony railing has integrated planters to promote greenery. Circulation through the building requires passing through the gallery to reach the loft apartments. This communal access way was designed to stimulate social interactions between residents.

The open gallery concept was adopted for the access method for lower income groups in the design of this thesis.

Fenix I Courtyard
(Mei Architects, 2012)
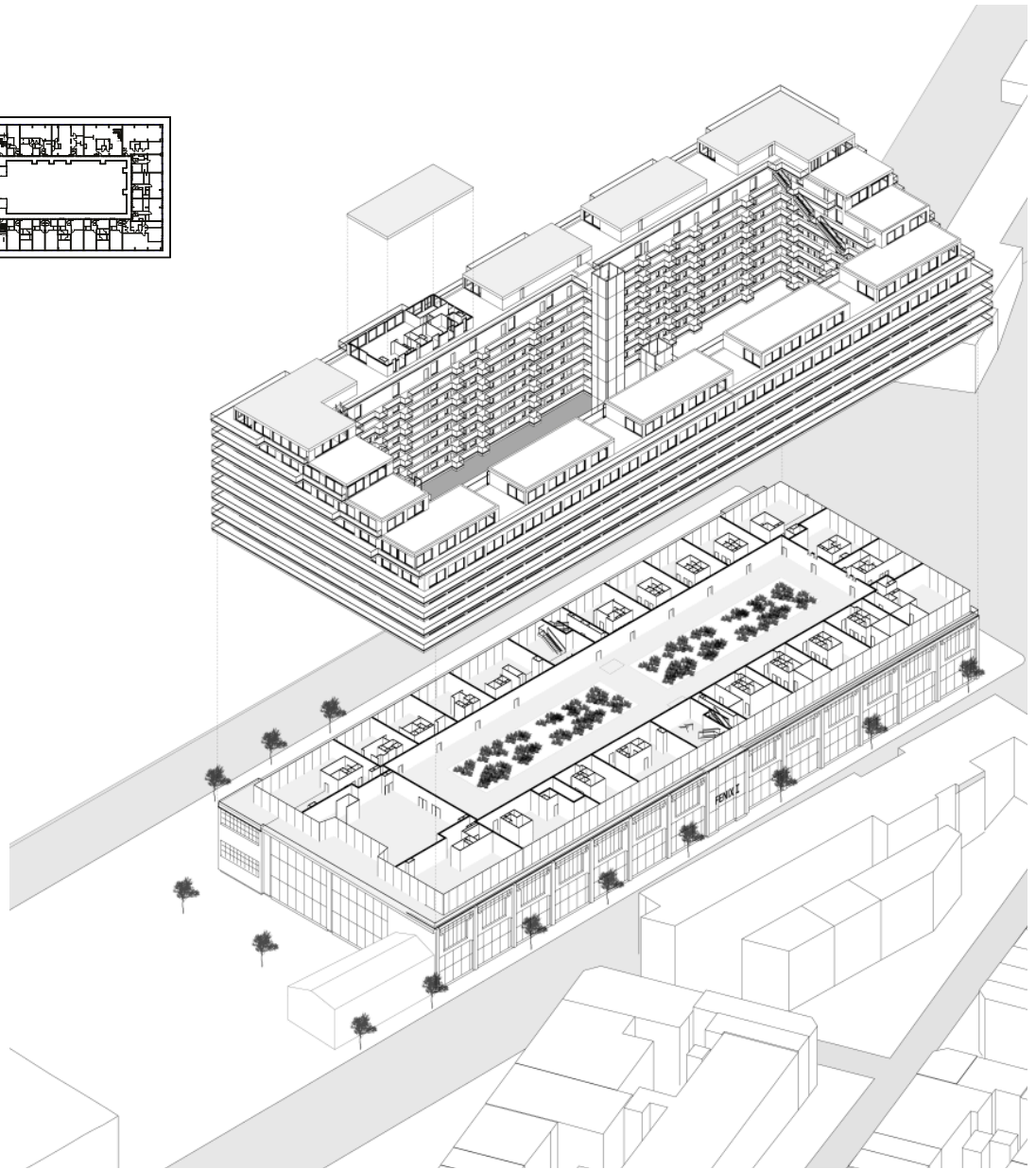
Fenix I Mixed Use Development, Rotterdam
Concept Diagrams (Winnie Goldsteen, 2022)

—————

Radburn Principle in Varsity Village

Late 1960s
~640 dwellings in identified area
13 dwellings/ha

By Carma Developers LP
Radburn Principle devised by Clarence Stein &
Henry Wright in 1928
(Stein, 1989)

Clarence Stein and Henry Wright, proponents of the Garden city movement in early 20th century USA, devised an urban scheme centered on the separation of car and pedestrian circulation using green streets within a traditional single-family home style neighborhood.

While the Radburn principle's first implementation was in New Jersey during the late 1920s, this research project looks at Varsity Village as a precedent since Calgary is my hometown. Having grown up in garden-city suburban neighbourhoods, this case study was an appropriate reference for this research. Varsity Village accurately applies the Radburn principle and uses higher density condos as a buffer against a busy motorway.

This thesis proposes an urban plan that reinterprets the Radburn principle by exchanging single-detached housing for housing clusters. This increases housing density and adds a new layer of privacy - the cluster strategy creates an inner space which is exclusive to its residents. This is more suitable for the context of Sao Paulo, where security is a greater concern.
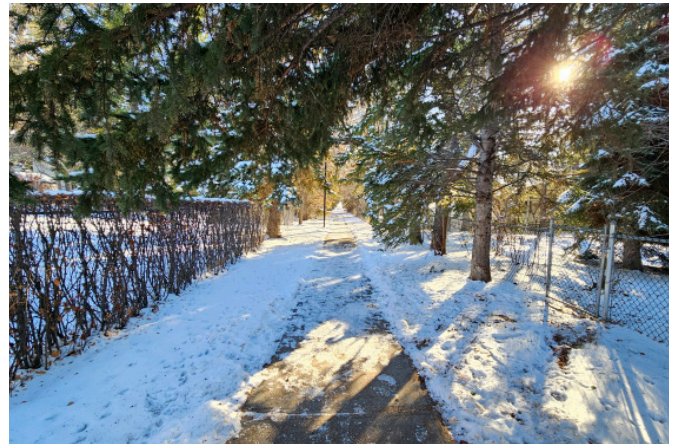
Green Street in Varsity Village
(Allegra Bentrim & Chris Borsos, 2023)

Contextual Analysis

	Boulevard			School	
	Through Street				
	Local Street			Higher density housing	
	Green Street				

Radburn Principle in Varsity Village
Concept Diagram, drawn by author with satellite imagery
(Google Earth Pro, 2023)

The Radburn urban plan is composed of blocks, with large boulevards that connected the community to the city on its peripheries. Amenities are positioned along these boulevards.

Detached, single-family homes are placed along cul-de-sacs for car access, with their backs facing green walkways, leaving space for open, accessible parks in the center.
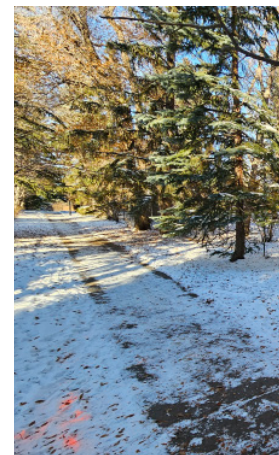
The "double-fro an-friendly comm

High density housing next to elementary school in Varsity Village (Allegra Bentrim & Chris Borsos, 2023)

Cul de Sac at the end of local street (Allegra Bentrim & Chris Borsos, 2023)

Inter (Allegra Bent

nt" quality enables a pedestri-
munity with pleasant walking
routes.

The green streets are safer for children to walk
to school, away from large boulevards and cars.

Each green street connects to the center
parks which act as the "backbone of the
neighborhood" (Stein, 1989).

ecting green streets
rim & Chris Borsos, 2023)

Green street that opens onto semi-private park
(Allegra Bentrim & Chris Borsos, 2023)

Green street that connects through street to large central
park (Allegra Bentrim & Chris Borsos, 2023)

5
site
analysis

jardim campinas

The project site is located in Jardim Campinas, which means Garden Meadow. According to satellite imagery and city maps, the neighborhood has been established since the 1980s. However, all of the housing along the northern border of the site was illegally built on occupied land starting in the late 1990s, now designated nucleus settlements or favelas (Geo-Sampa, 2023). With density varying across street blocks from 150 to 300 people per hectare, it can be estimated that the overall density of the neighborhood is roughly 65 dwellings per hectare.

The site itself is empty plot is zoned for ZEIS 4 development, an urbanization project involving building HIS social housing intended for displaced residents.

≈65 dw/ha

150 to 300 inhabitants per hectare (Geosampa, 2023), with an average of 3.5 inhabitants per household

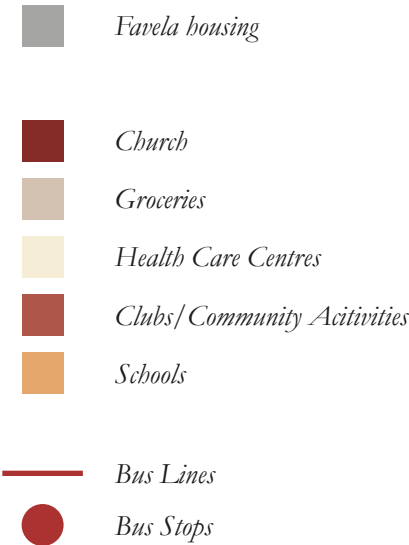*40 to 90 dw/ha across areas*

Types of housing in Jardim Campinas

Top | Regularized land plots with matured housing
Bottom | Newer favela settlements along creek
(Author, 2022)

Project Location Jardim Campinas (Google Earth Pro, 2023)

Jardim Campinas is a dynamic neighbor-hood. There are lot of existing strengths which benefit the community: shopping streets, access to various amenities such as medical centers, schools, groceries that are present on the site and around it, lots of vegetation, existing public transit routes, established streets, and even 3 football fields all within a 1km radius. The football fields are maintained as a public-private partnership in association with a football school and are extensively used by the community (SEHAB, personal communication, October 20, 2022).

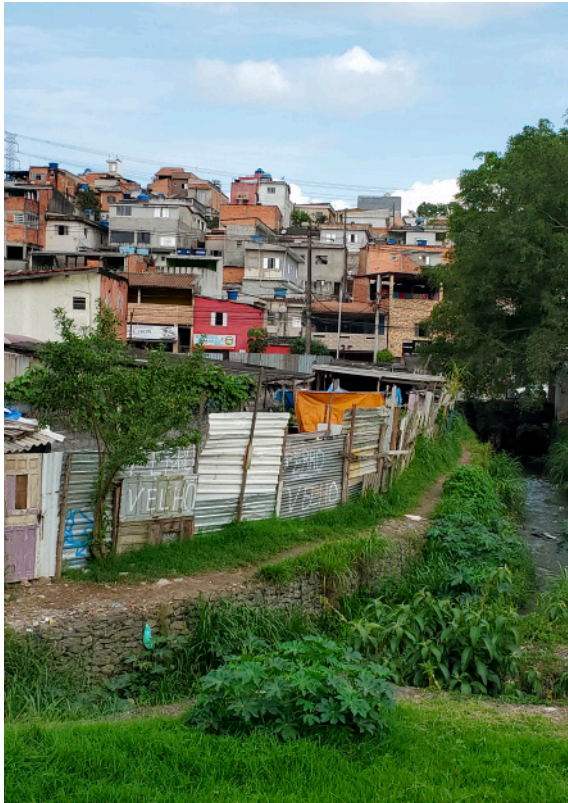*Jardim Campinas Community Analysis drawn by author using data from the Prefeitura de São Paulo (Geosampa, 2023)*

Favela housing

Church

Groceries

Health Care Centres

Clubs/Community Acitivities

Schools

Bus Lines

Bus Stops

City Signage stating it is "Prohibited to dipose of garbage and construction waste"
(Author, 2022)

Site Analysis

Favela settlements bordering creek
(Author, 2022)

Despite the strengths of the neighborhood, the ZEIS 4 land currently has several challenges. The center of the site, where most of the land drainage pools and hidden away from public streets, is currently used as an illegal dumpsite.

The land has been used by nearby residents as a construction waste site since 2011. This contaminates the water and nearby marshland, leading to the rotting of tree roots and surrounding vegetation. This problem stems from the "out of sight, out of mind" mentality employed by the city municipality (SEHAB, personal communication, October 20, 2022). Since city landfills are getting full and waste infrastructure is already suffering, there is not much incentive from the city to clear and police the area from further waste dumping.

Favela settlements have also developed in close proximity to the creek next to the dumpsite, breaking municipal code requirements that housing be built a minimum of 15 meters from any waterbody.
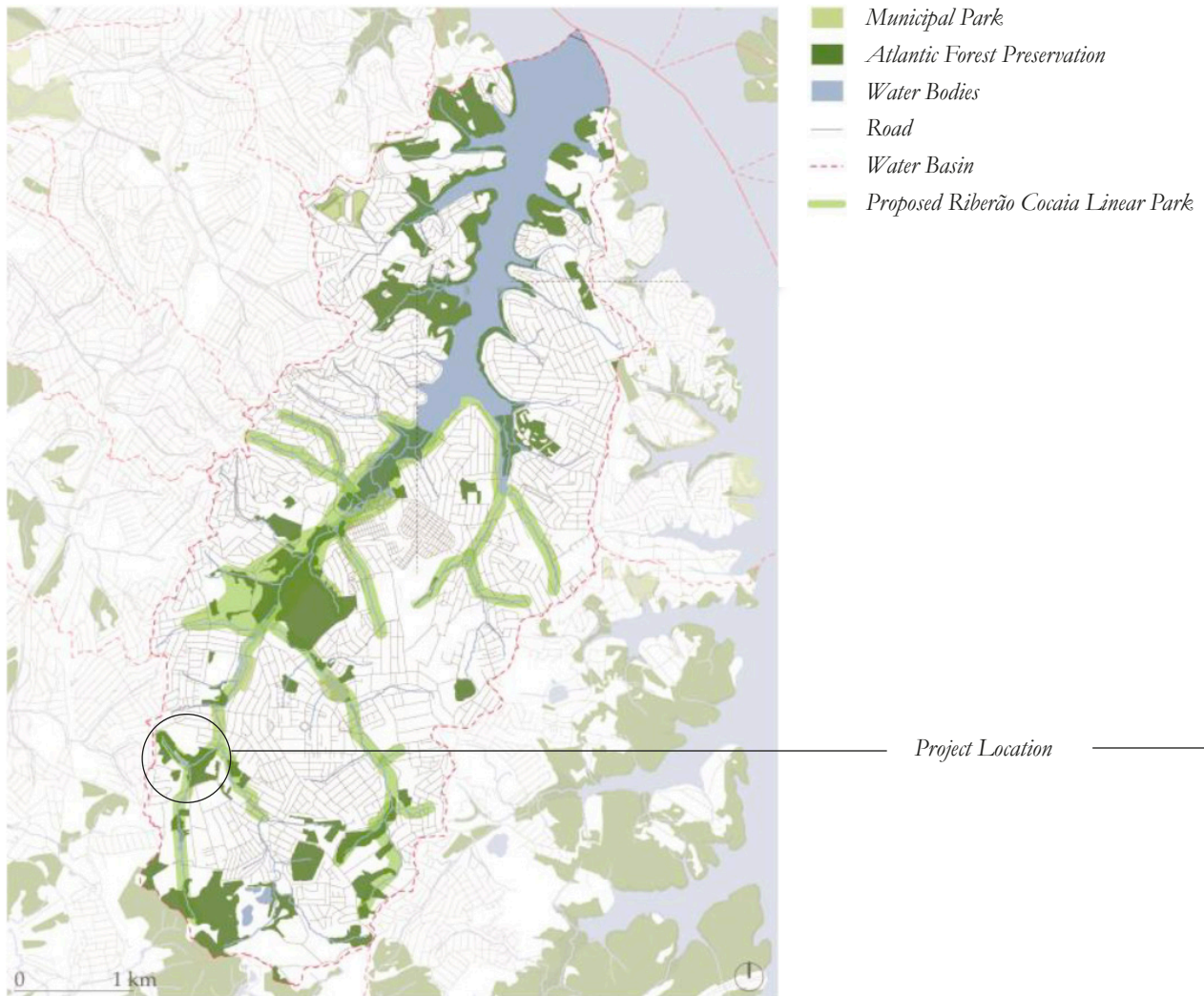
The site is a valley with a height difference of 30 meters between its highest and lowest points. The valley has a small water pond in its center which drains through marshland towards a small creek, eventually connecting back to the Billings Reservoir. Roughly a third of the site is covered by the Atlantic Forest, which is protected by the Mananciais Watershed Protection and Recovery Law.

The site connects to public land which is currently reserved for a linear park proposal by the city of Sao Paulo. The intention is to create 5km park strip which connects parcels of Atlantic Forest and land adjacent to water streams back to the Billings Reservoir, for the purpose of environmental preservation and the creation of public space.

Jardim Campinas Environmental Analysis drawn by author using data from the Prefeitura de São Paulo (Geosampa, 2023)

—— *Proposed Riberão Cocaia Linear Park*

Marsh Vegetation

Floodplain

Dense Atlantic Forest

Forest

Fields / Shrubbery

- - - - *Illegal dump site area*

—— *Drainage*

Water Body

Site Analysis

Legend:
- Municipal Park
- *Atlantic Forest Preservation*
- *Water Bodies*
- Road
- Water Basin
- *Proposed Riberão Cocaia Linear Park*
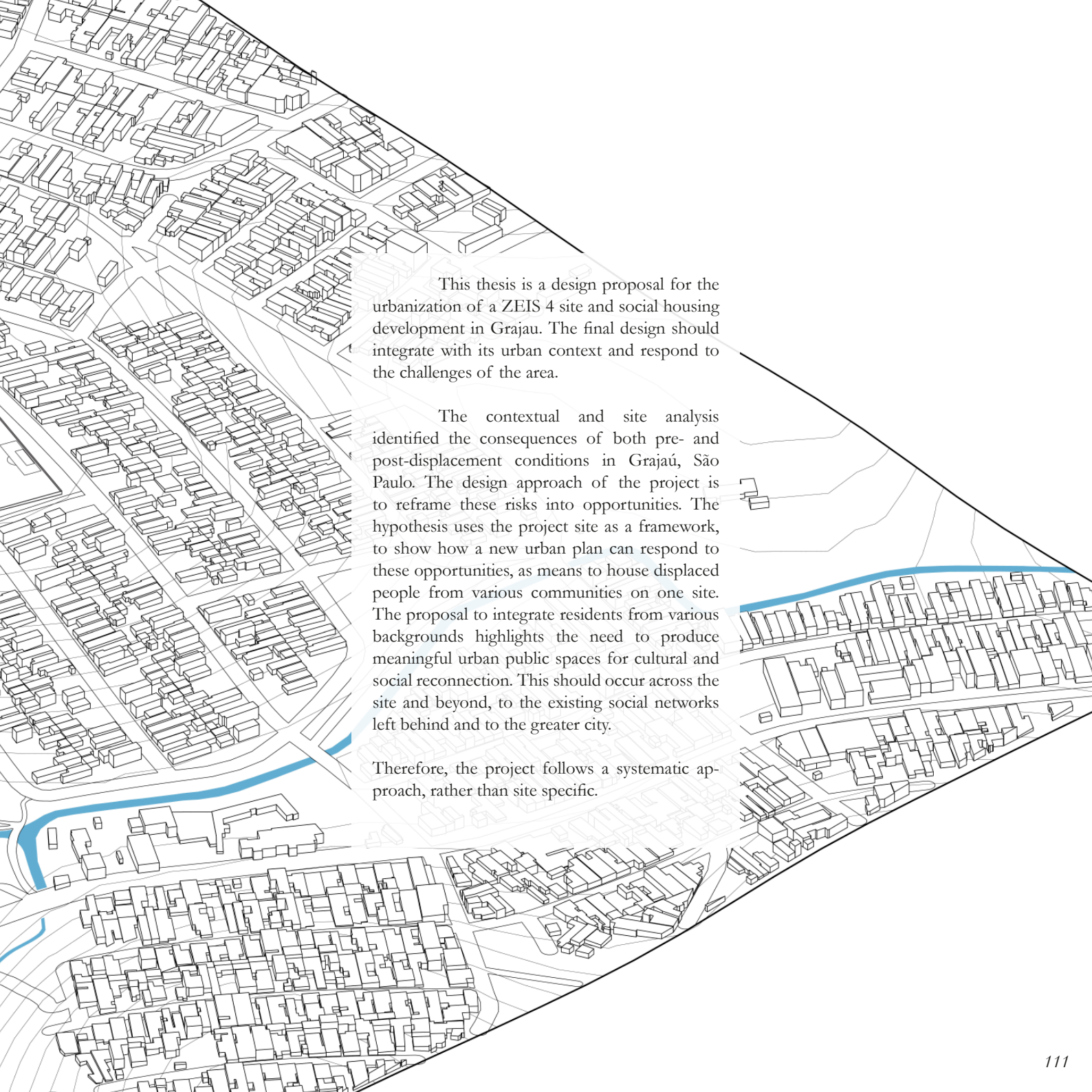
Project Location

Planned linear park named Riberão Cocaia under implementation since 2006 (Walker & de Alarcón, 2018)

Site Analysis

Chosen from five potential ZEIS 4 sites in Grajaú, Jardim Campinas is considered to be a prime project location due to its various urban conditions which target the environmental risk and resettlement challenges identified by the thesis research - the steep topography and water drainage, illegal dumpsite, and at-risk favela housing. The difficulties of the site are complemented by its strengths, such as the established existing community and proposed linear park.
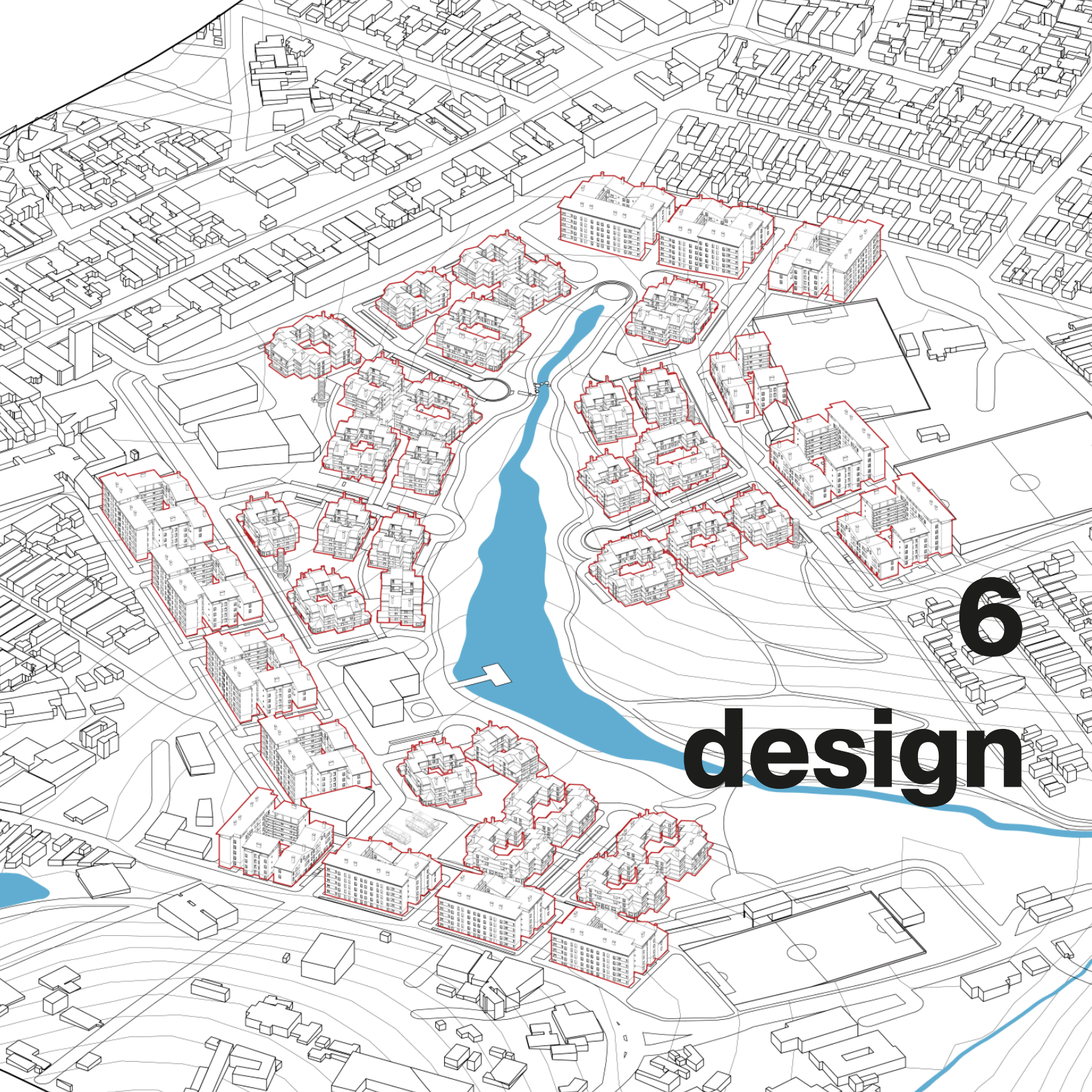
6
design

This thesis is a design proposal for the urbanization of a ZEIS 4 site and social housing development in Grajau. The final design should integrate with its urban context and respond to the challenges of the area.

The contextual and site analysis identified the consequences of both pre- and post-displacement conditions in Grajaú, São Paulo. The design approach of the project is to reframe these risks into opportunities. The hypothesis uses the project site as a framework, to show how a new urban plan can respond to these opportunities, as means to house displaced people from various communities on one site. The proposal to integrate residents from various backgrounds highlights the need to produce meaningful urban public spaces for cultural and social reconnection. This should occur across the site and beyond, to the existing social networks left behind and to the greater city.

Therefore, the project follows a systematic approach, rather than site specific.
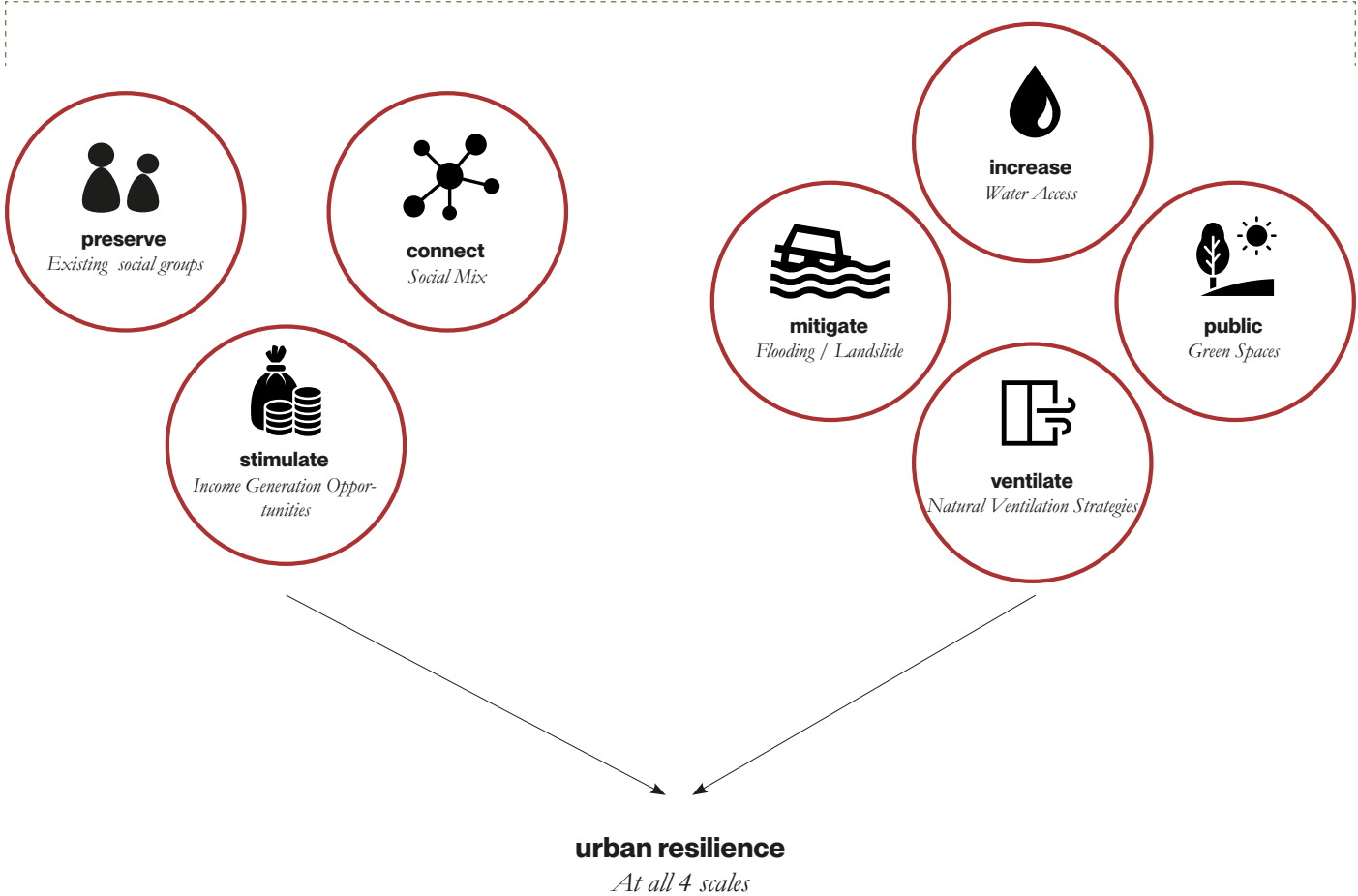
design approach

The project proposes a new type of neighborhood that brings social and climate challenges together into a cohesive design. The design seeks to balance social resilience and climate resilience at each scale of the urban plan.

It aims to do so through four design goals, two of which lead the urban strategy – using existing communities to form housing clusters, which are spatially organized based on topography and rainwater flows. This socio-ecological approach allows the design to respond to its site. Therefore, the design aim is a renewal of the urban fabric, by building upon existing social and ecological networks, their strengths, and reinvigorate the connection between natural and built environment.

The design goals address each scale of the urban plan, which is outlined in the program of requirements.

social resilience

climate resilience

preserve
Existing social groups

connect
Social Mix

stimulate
Income Generation Opportunities

increase
Water Access

mitigate
Flooding / Landslide

public
Green Spaces

ventilate
Natural Ventilation Strategies

urban resilience
At all 4 scales

Dwelling　　　　*Cluster*　　　　*Sector*　　　　*Neighborhood*

using topography and rainwater flows to guide circulation and form social clusters

scalar and replicable approach to site

integrating leisure and community activity with natural environment

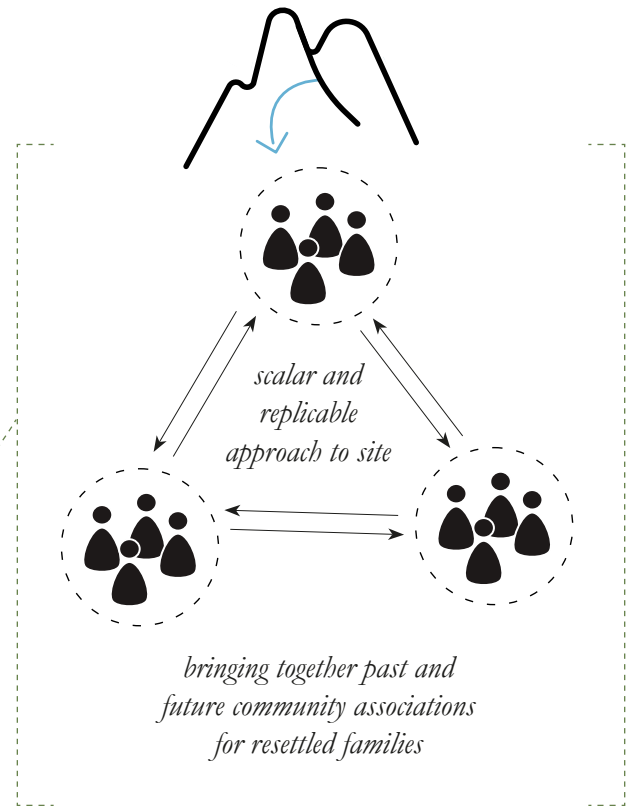*bringing together past and future community associations for resettled families*
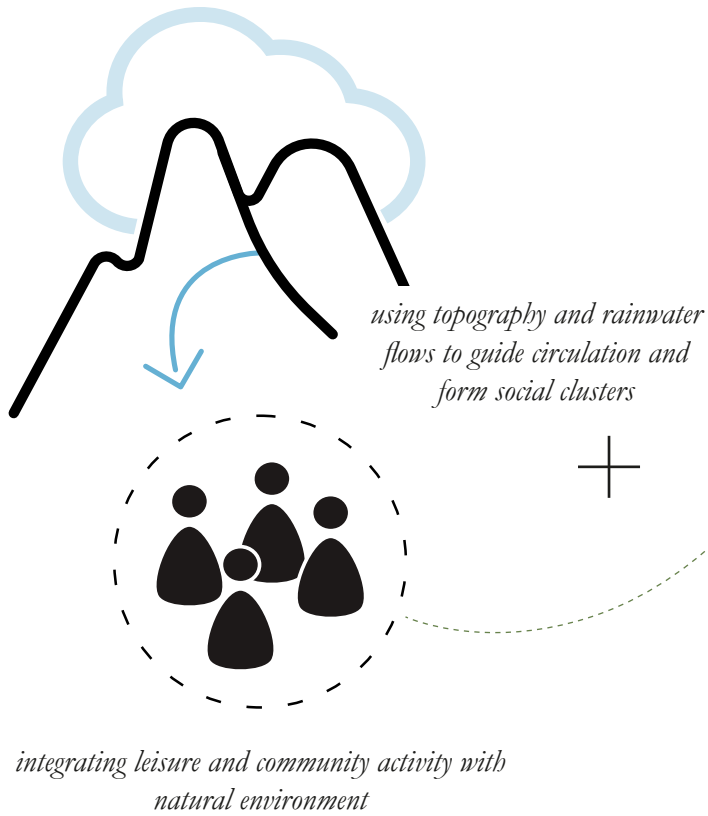
rooted in socio ecological strategy

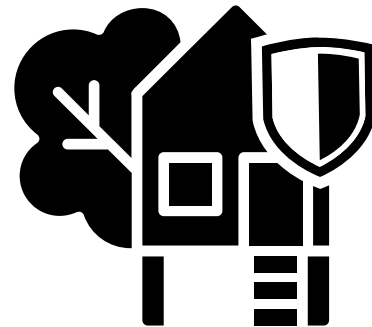**community through spatial organization**

＋

spaces for economic activity to increase economic and social capital
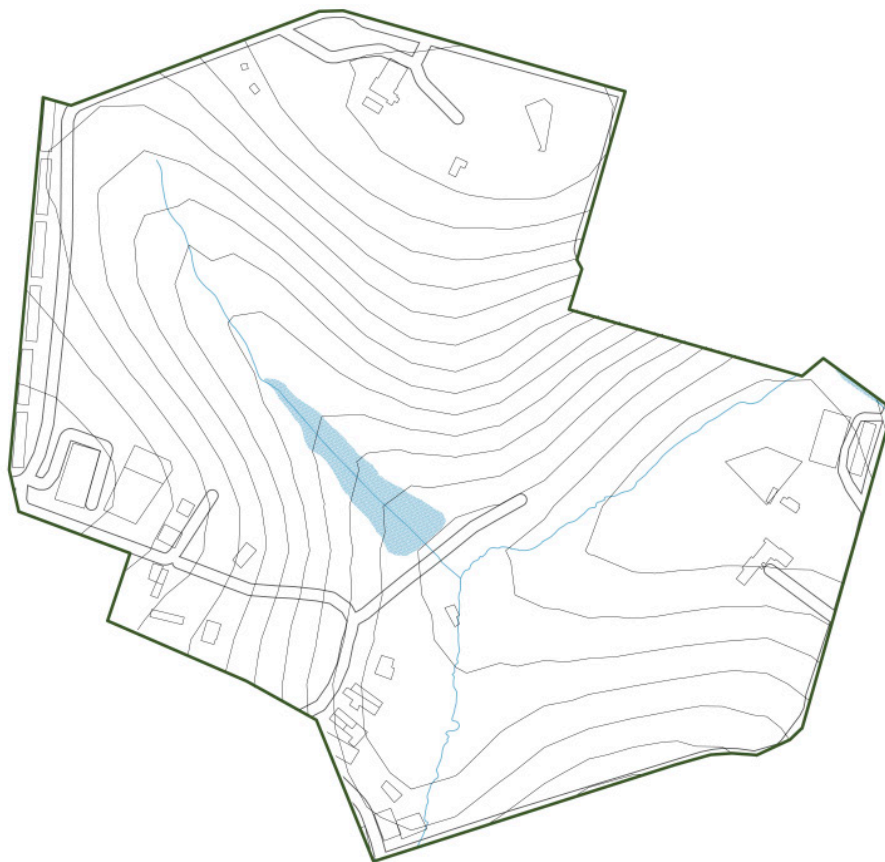
＋

healthy, thermally comfortable and biodiverse environment for residents

landscape and housing design that can respond to climate change risks

economic growth and community integration

climate adaptive design

density

current
≈65 dw/ha

goal
≈100 dw/ha

socio-environmental	social	economical	environmental
Urban strategy centered on water flows **Linear park** Integrate public space with flood management Connect linear park to greater neighbourhood	**Major amenities** including community center, grocery, church, shopping street and transit stop Integration with existing urban fabric Balance of car & pedestrian circulation	FSI <= 2.0 HIS 1 & 2 only >60% HIS 1 **Inclusive financing system** Community labour engagement	**Flood & landslide risk management** through integrated rainwater flow & linear park Abundant greenery for clean air, biodiversity, soil/water-retention Waste & recycling center
Greenery to enhance and shade spaces **Rainwater collection integrated with public space** Community gardening	**Diverse public spaces for social mix** Darying density & cluster sizes for diverse community groups Safe play spaces for children	Permanent & spontaneous spaces for **local income-generation**	**Site adaptability** Bioremediation pond for water & sanitation management
Locally sourced building materials, balancing local skill expertise with environmental impact	**Community continuity** through spatial organisation Clear plot boundaries to avoid land appropriation	**Cluster based managerial strategy** Simplified building methods for community labour in construction	**Rainwater harvesting & recycling** Durable building materials to reduce maintenance costs
Rainwater collection enhanced by dwelling design	**Dwelling type variety** for various income groups & family sizes Opportunity for minor architectural appropriation	Allocated areas for incremental growth - home expansion or income-generation	**Thermal comfort** by pairing natural ventilation (cross & stack) with thermal mass

urban
strategy

The project seeks to build onto the existing strengths and challenges of the site and incorporate them into the final design where possible. This means integrating new urbanization with existing amenities and creating a linear park along the water pond directly on the site. This will achieve a balance between environmental preservation and the necessary housing for residents who have been displaced.
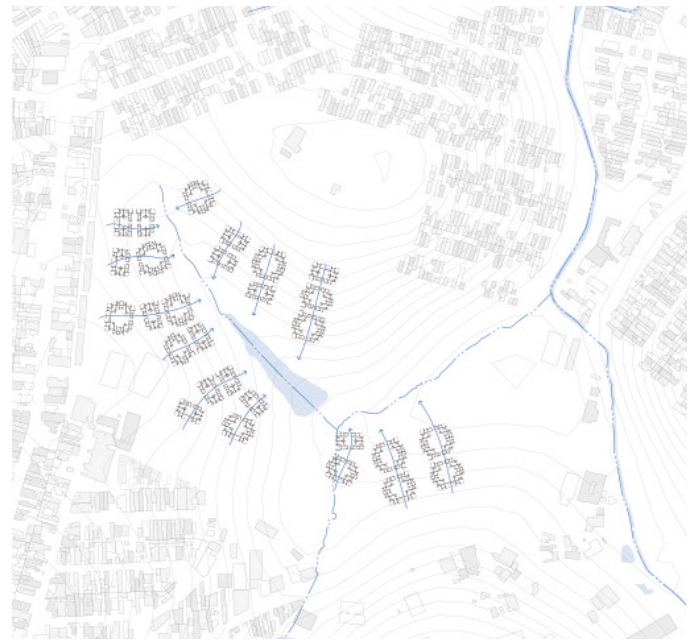
The organization of the urban strategy combines the Radburn Principle with housing clusters, which are aligned with the slope of the site to allow for water drainage towards a linear park.
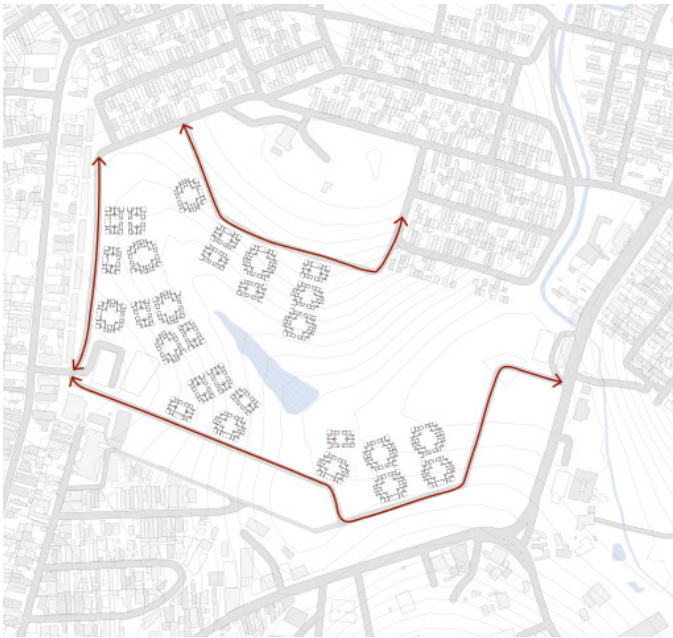
water

Starting with a body of water as the central focus of the site,

rowhouse clusters are aligned with the topography facing towards water body, following drainage flows.
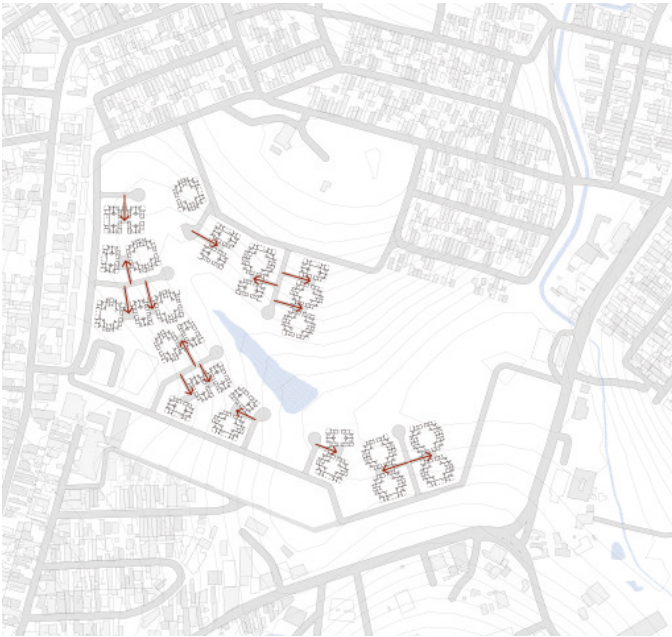
main boulevard

side street

Circulation is then introduced, transitioning from most public to private. Main boulevards connect new housing to the existing streets,

with side streets (Radburn's through street) providing car access to the housing clusters.

local street

The entrances to the housing cluster are then accessed via the pedestrian-only local street.

green street

Green routes fill the space in between housing clusters, which connect to a larger park surrounding the body of water.

A new type of housing bridges the gap between the boulevard and existing surroundings, acting as the urban connector. The main boulevards, which are active shopping streets with amenities, bringing together the two housing clusters.

Finally, the linear park becomes the oasis of the urban landscape. This is the "backbone" of the community, as per the Radburn principle.

To build climate resilience on the scale of the urban plan, the design should be able to mitigate flooding/landslide/drought risks and reduce dependency on inconsistent public water systems. These can be mitigated using different strategies which control water flows across the site. This includes rainwater harvesting & recycling, and water management through a mixture of paved and vegetation materials to detain water.

The socio-ecological strategy is to view public infrastructure as public space. Rather than hiding public infrastructure in spaces meant for building community, as is the traditional approach, the two elements are integrated. Water is embedded in public space; areas which harvest, retain or control water overflow become the place for engaging with others.

The focal point of the site, the water pond, functions as a detention basin for rainwater run off. Design elements such public plazas, fountains allow for water to overflow during heavy rainfall, to reduce flooding risk before the water drains to the detention pond. Drainage systems gather water to be stored in tanks or water towers, to be reused by residents in times of city water scarcity.

Public Infrastructure as Public Space

harvest
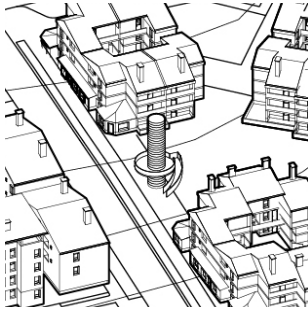
water tower with viewing platform

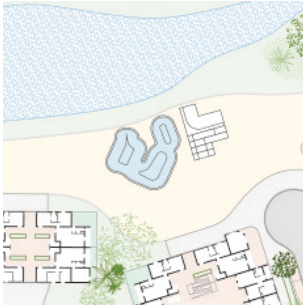*drainage systems*

retain

rain gardens

bioremediation pond

overflow

skateboarding bowl
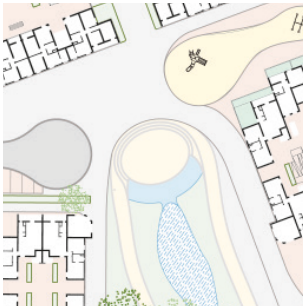
shallow ponds for play

The green streets and linear park absorb water and retain it in the landscape. The linear park act as buffers to prevent flooding of the surrounding housing surrounding the water, and conversely protects the water stream and plant life from contamination. The park spaces promote opportunities for a healthy lifestyle of the residents and connect areas across the site and to the greater community of Grajau.

Public infrastructure as public space across the site therefore supports public activity, biodiversity and a healthy environment.

Clube do Laércio sports club
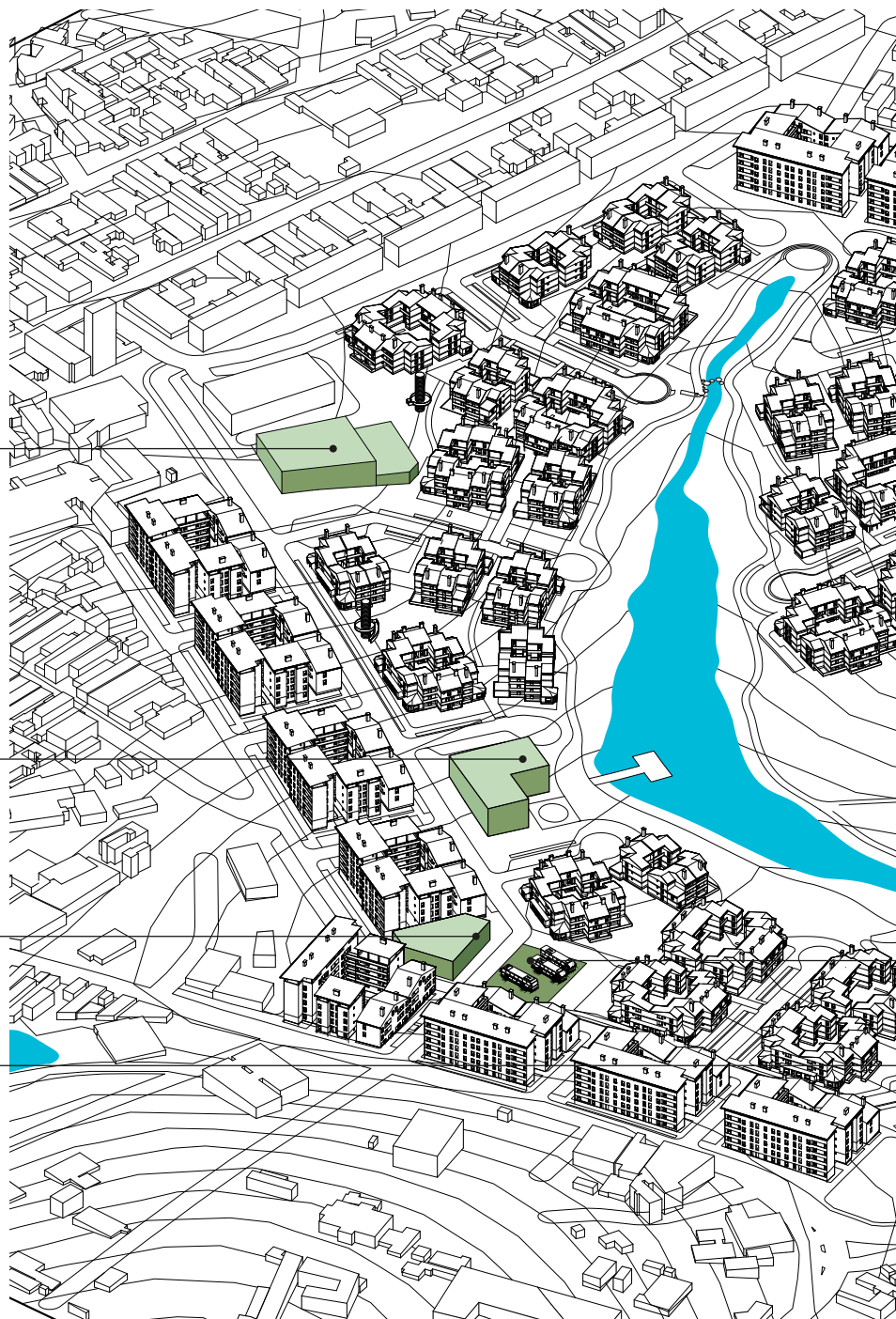and swimming pool
-Now with paved entrance
with street parking

Community centre
-Starting as construction
staging site during urban
development

Grocery store

Campo do Rivelino football club
-Existing football field renovated
with new community space

Church

The amenities are situated along the main shopping boulevards. The public transit terminal, grocery, and community center are centralized in proximity to the linear park to make the area more accessible to the outside community. Existing amenities such as the Clube do Laércio, Campo do Rivelino, and Carlos' Deposito de Reciclagem business are reintegrated into the urban plan to enable more public and inclusive use of the services.
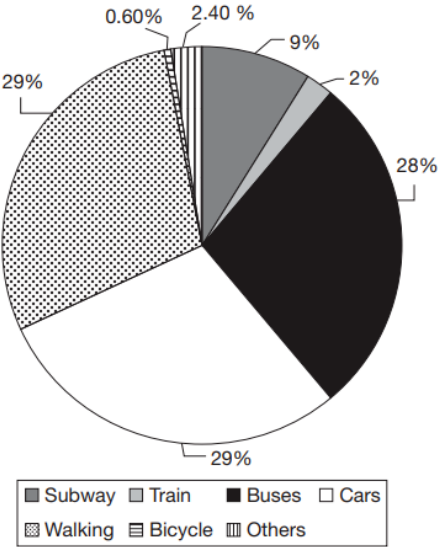
Public transit bus terminal

Carlos' Deposito de Reciclagem
-Existing business renovated into waste &
recycling center for the community

Following the Radburn principle, the urban plan features many routes which are suitable for pedestrians to travel across the site. However, Sao Paulo is still a car-centric city and the masterplan should accommodate that.

Local pedestrian streets between clusters always have minimum width of 4 meters to accommodate emergency and service vehicles. The sidewalk design seamlessly accommodates parking, while protecting pedestrians from street traffic. Raingardens can also replace parking spots to create areas for public seating in front of ground floor shops.

0.60%   2.40 %   9%   2%   29%   28%   29%

Subway **Train** **Buses** **Cars**
Walking **Bicycle** **Others**

Forms of Transportation in São Paulo
(Dickson, 2012)

15.6% *of people favela inhabitants have their own vehicles (São Paulo: A Tale of Two Cities, 2010)*

available parking spot for every **1 in 3 dwellings** *with this urban scheme*

# ≈430

PARKING SPOTS

330 intended for inhabitants
100 intended for amenities and/or
inhabitants

cluster
strategy

Social connection is the basis of any given community. Naturally, people grow attached to their communities, relying on services and opportunities available to them through their local networks. This is especially true in favelas, which are developed through community organization and built using social capital. Displacement destabilizes the social safety of residents, since they are physically removed from the social context through which they may have built their social and potentially economic support. When resettlement is the only option, a housing scheme which spatially articulates community can be used to aid the transition.

This proposal introduces a new type of housing design which groups existing displaced communities into housing clusters. The act of clustering preserves existing social networks and creates a sense of inclusivity within one housing group. The suitable type and size of cluster for a displaced community is based on existing lifestyles, income, and inhabitant needs.
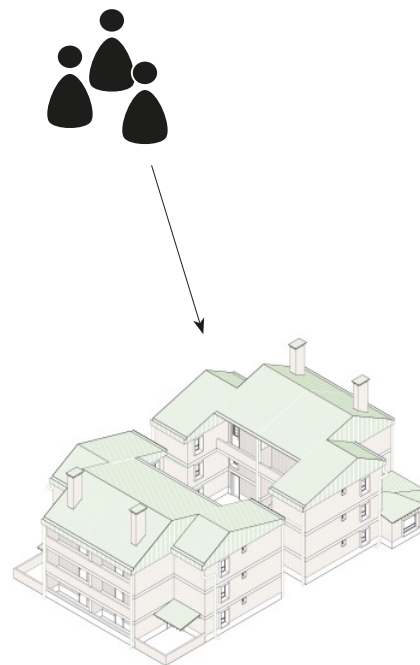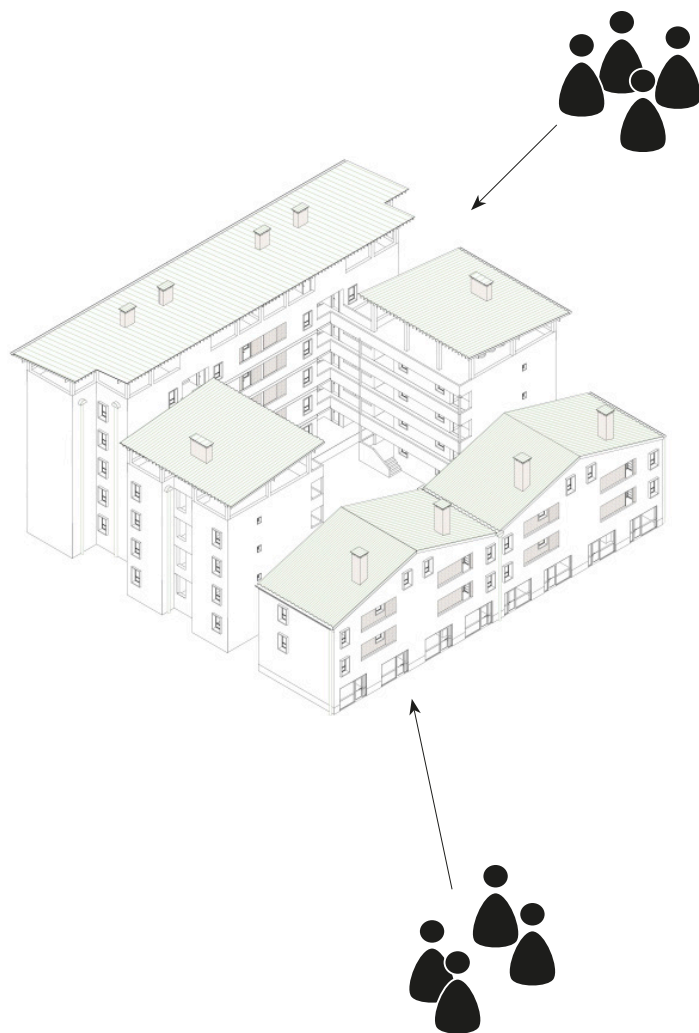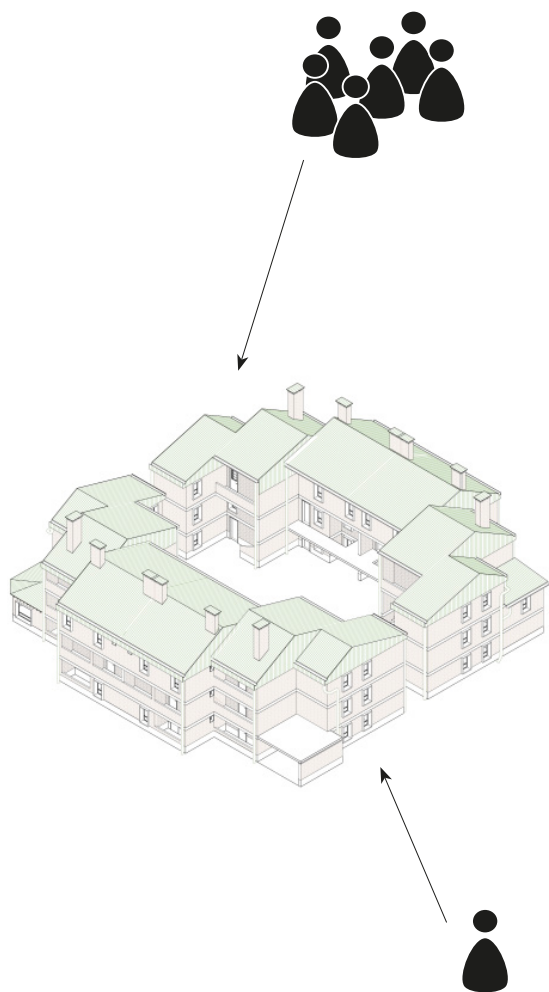
The categorization of cluster types is intended to achieve a balance of efficiency and social enrichment by mixing social incomes and groups. The variety of clusters provide a gradient of dwelling type characteristics which are suitable for different social groups, namely based on the type of access into the dwelling, level of density within the cluster, and number of bathrooms.

> HIS 1

>1 minimum wage
R$0 - R$1302
€0 - €250

HIS 1

1 - 3 minimum wages
R$1302 - R$3906
€250 - €750

HIS 2

3 - 6 minimum wages
R$3906 - R$7812
€990 - €1500

←————————————————————————————→

communal access - shared balcony
higher density
1 - 3 bedrooms
1 bathroom

private access - haagse portiek entrance
lower density
2 - 4 bedrooms
2 bathrooms

All apartments feature

shared water supply
balcony

courtyard cluster

rowhouse cluster
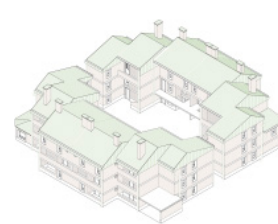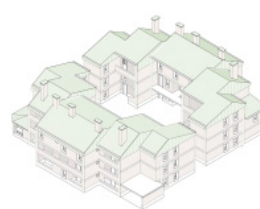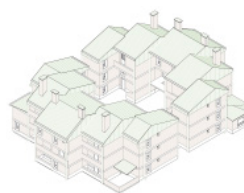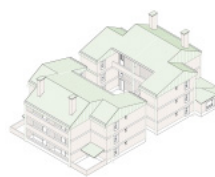
>HIS 1, HIS 1 & HIS 2   HIS 1   HIS 2   HIS 1 & HIS 2

Inside each cluster is a shared communal space, which reinforces social engagement among its inhabitants. Each dwelling entrance is accessed through the communal courtyard, via shared balconies and staircases. The courtyard is a safe, private place for community gatherings and for children to play, since the dwellings provide natural surveillance.

Possible uses for the shared space

- *play set/swing*
- *pergola + seating*
- *bike rack*
- *plants*
- *storage*

Courtyard Cluster

Cluster Strategy
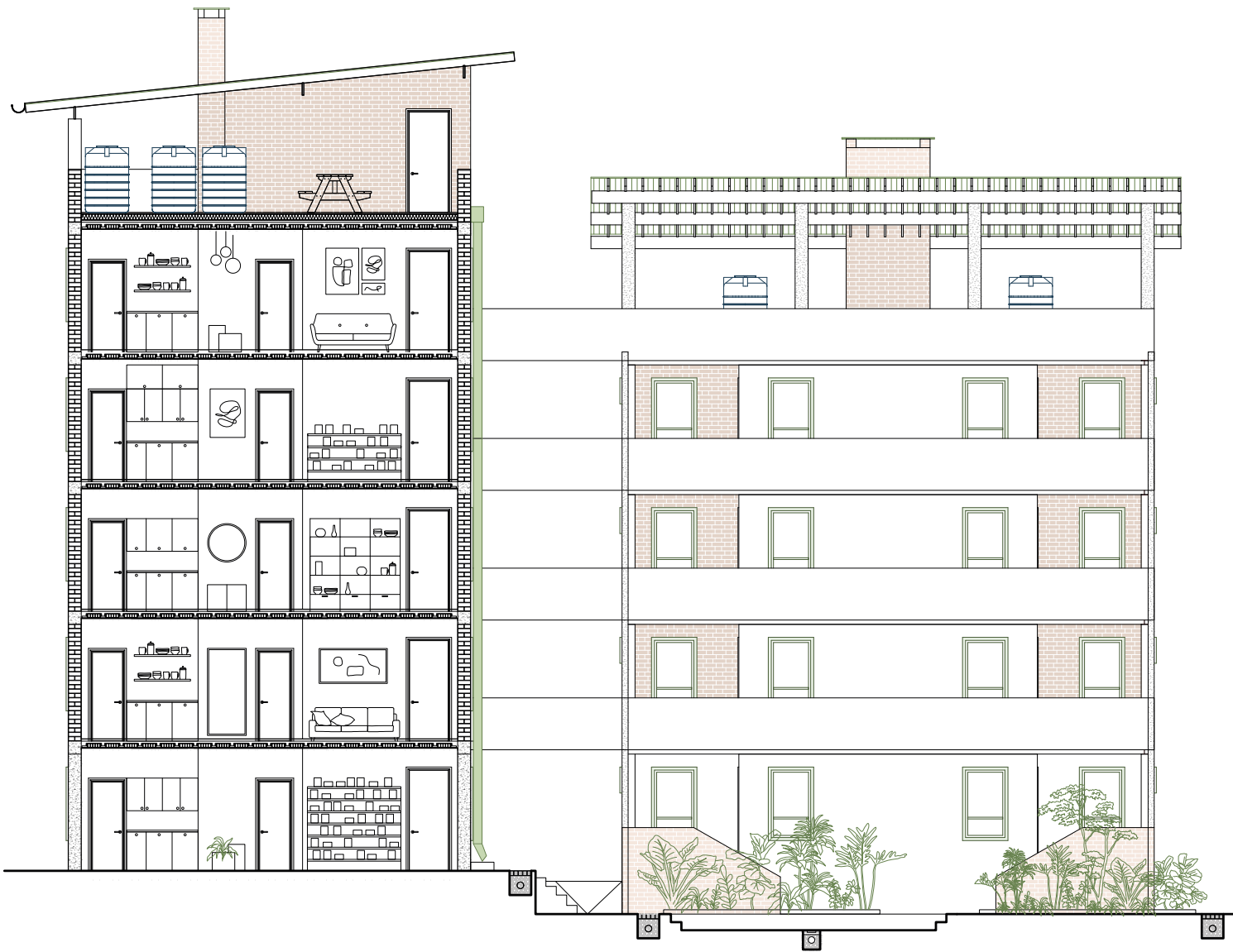
The courtyard cluster housing type serves as the transitional housing type between the existing urban fabric and rowhouse clusters, which have a very different morphology to the surrounding neighborhood. Ground floor shops line the main boulevard, activating the street between the two housing types. The tall housing slab of the courtyard cluster can either act as a sound barrier against a high-traffic street or relate to individual plot favela housing.

The courtyard cluster provides a mix of 3 different housing types, suitable for all social groups. Each dwelling features an outdoor balcony, 2 or more bedrooms, a living room, a kitchen connected to exterior laundry space, and a bathroom with direct ventilation.

The first two types, intended for the HIS 1 income group, are connected via a shared staircase. However, the dwellings in the four-story tower must use a balcony to access their apartments, entering through their personal outdoor balcony. Positioning outdoor balcony space along the shared walkway encourages social interaction among the residents.

The ground floor apartments of the five-story slab feature a universally accessible configuration.
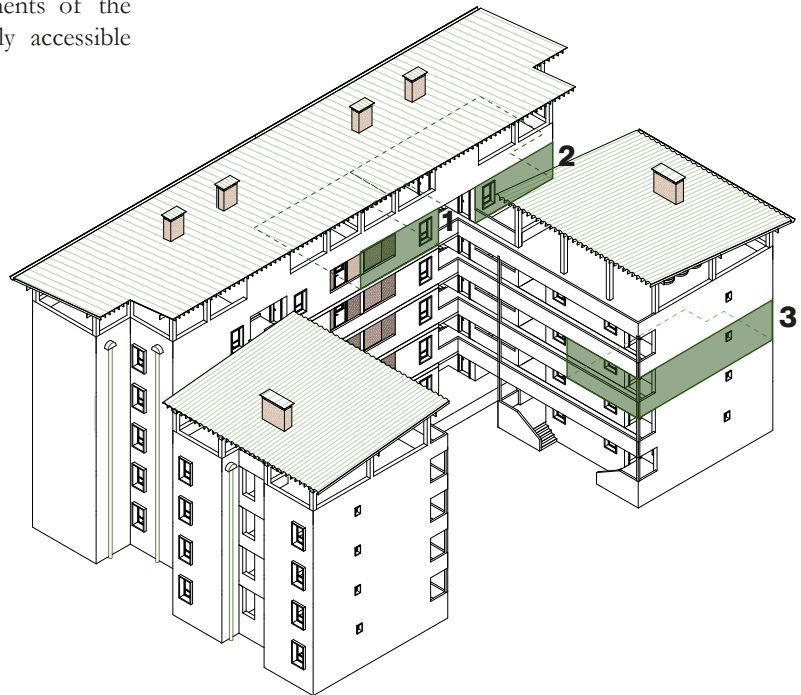
1 - HIS 1

54m2
2 bedrooms
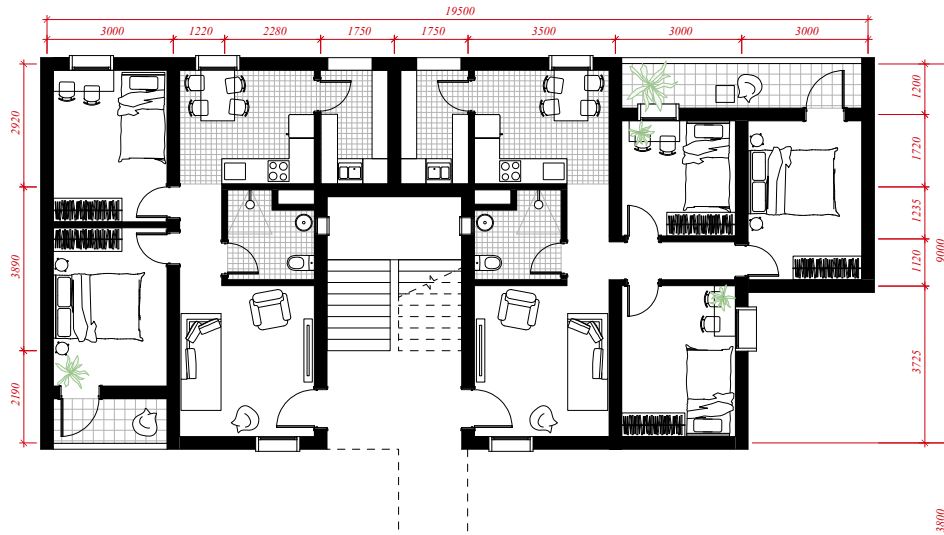
2 - HIS 1

67m2
3 bedrooms

3 - HIS 1

48m2
2 bedrooms
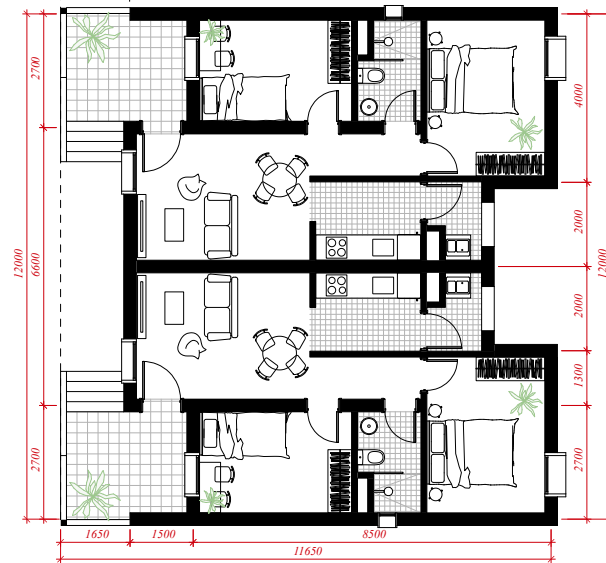
HIS 1 Courtyard Floor Plans

The HIS 2 income group is housed in a separate building, with the Haagse portico as the method of access. The staircase entrance is more private than the shared balcony of the taller HIS 1 building and provides a direct connection between the dwelling front door to the inner courtyard.

As an HIS 2 dwelling type, the plan includes one ensuite bathroom and one shared bathroom, as well as two balconies to overlook the shared courtyard and main boulevard.

The gable roof of this building permits the addition of a mezzanine to the dwelling. The mezzanine has a window for daylight and ventilation, so it can be used as living space or storage.

Cluster Strategy
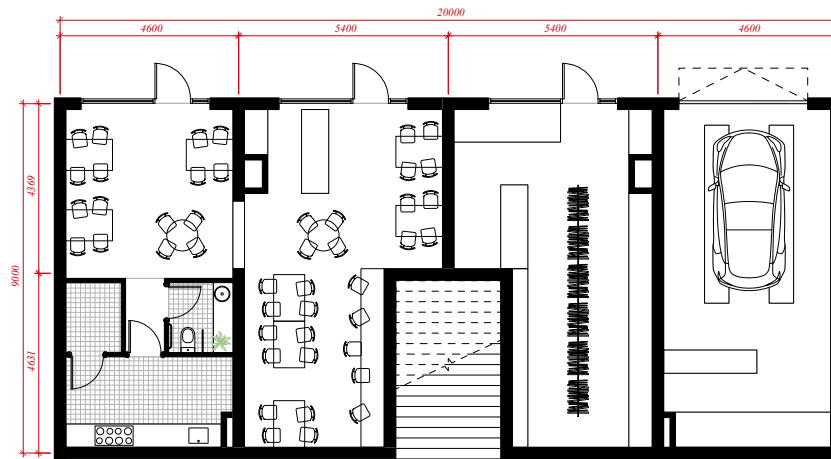
1 - Ground Floor Shop

37m2
community
businesses
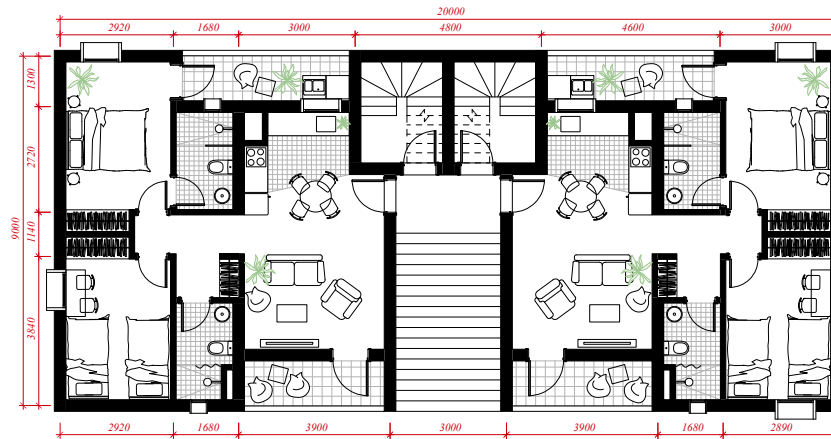
2 - HIS 2

first level - 67 m2
2 bedrooms

3 - HIS 2

second level - 76 m2
2 bedrooms
& mezzanine

HIS 2 Courtyard Floor Plans

rainwater stored
in rooftop cisterns

excess rooftop water
to ground

decorative gutter
with mini pond

city water main

water overflow
pond

irrigation system
for rain gardens

underground water
collection tank

excess water directed to nearby w

Cluster Strategy

downspout, Ø20cm

sand, 5cm

mini-pond

gravel, 35cm

concrete foundation

non-permeable pipe, Ø15cm

drainage bricks, 11cm

textile

concrete foundation

gravel, 45cm

permeable pipe, Ø15cm

filtered rain water
distributed
to flush toilets

water tower

The water management is considered throughout the design - from the roof to when it reaches the water reservoir.

In the courtyard cluster, the water first collects on the corrugated metal roof, which is then transferred to rooftop water tanks. Excess water is then passed through a colorful gutter into a small pond. When the pond overflows, water can travel to the recessed concrete plaza. The recessed concrete plaza functions as a gathering area for cluster events, BBQs, playing, and accommodates water overflow during heavy rainfall. Brick paving strips ring the shared courtyard allowing excess rainwater to drain. The brick strips and temporary pond connect to underground collection tanks for water reuse in the courtyard cluster homes.

The rowhouse cluster is low-rise housing with two main dwelling unit types, the outer edge and the inner unit. The offset of the tetris-shaped edge unit creates an enclosed communal shared space with spatial diversity. This enables a level of privacy for the shared courtyard, emphasizing its sense of community.

The rowhouse cluster type comes in 4 different sizes to cater to the needs of the preexisting communities and different income groups. The size variation also allows for the cluster to adjust to the site topography and complex plot boundaries. Ramps and stairs are included to make each ground floor apartment accessible.

HIS 2

12 dwellings

HIS 1 & 2

18 dwellings

HIS 1

22 dwellings

HIS 1

24 dwellings

Rowhouse Cluster

One half of the rowhouse cluster faces the side street, engaging with street activity through across a balcony set 1 meter above the sidewalk. The other half of the rowhouse cluster adjoins the green corridor, with ground floor balconies opening onto small yards enclosed with fences and vegetation.
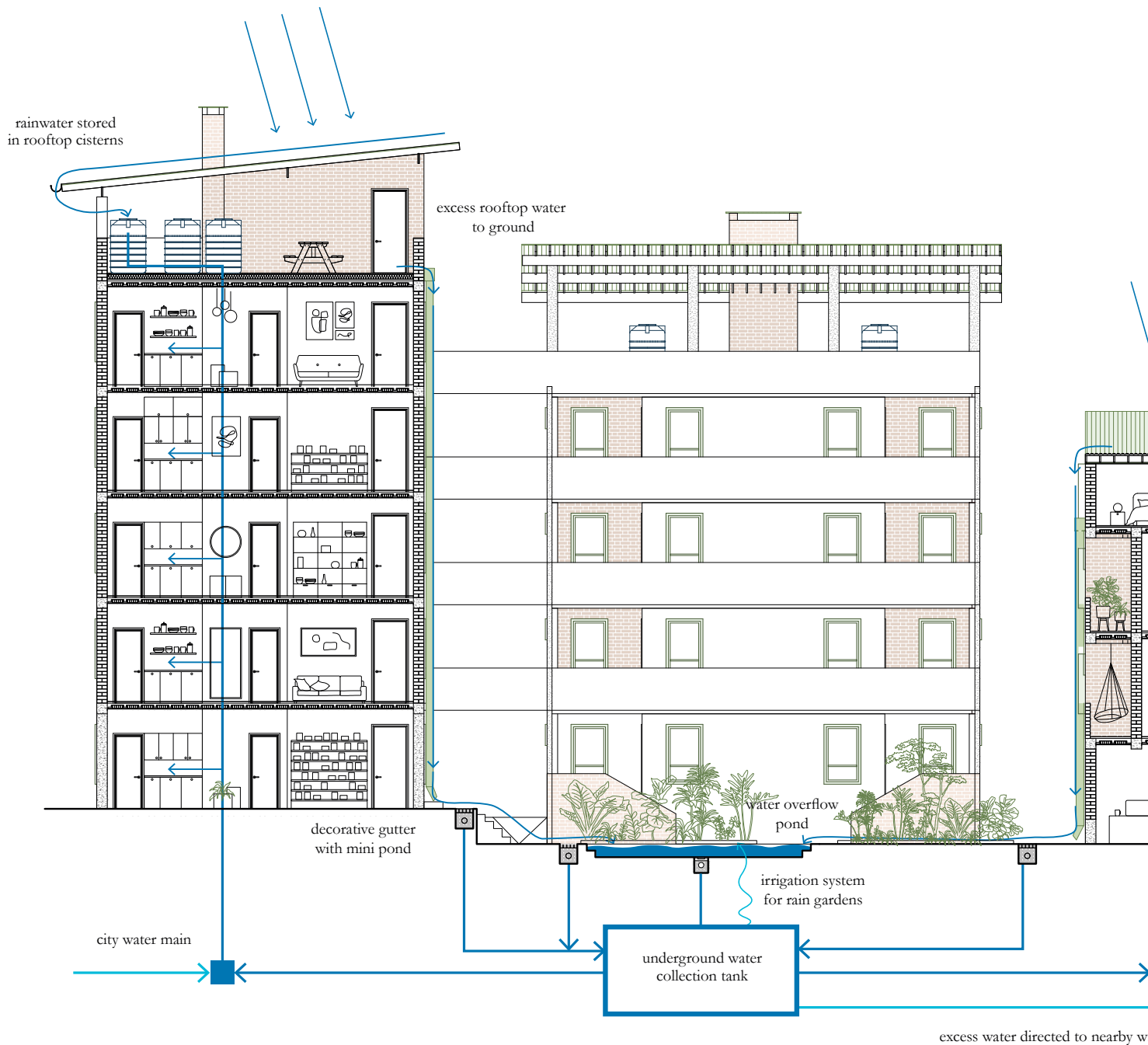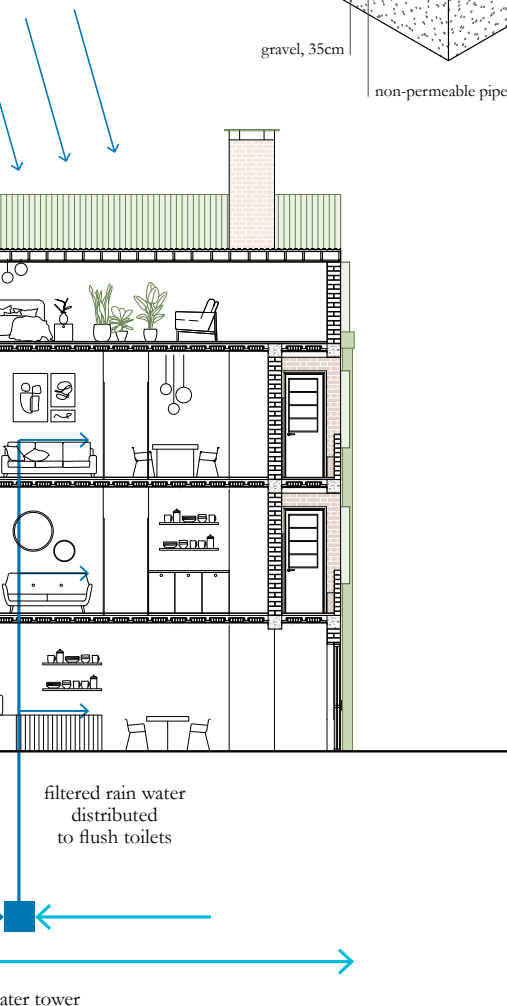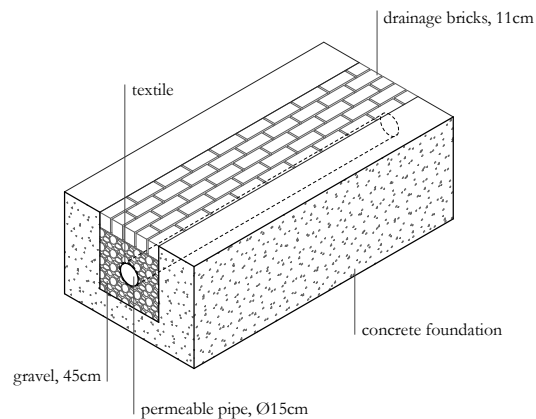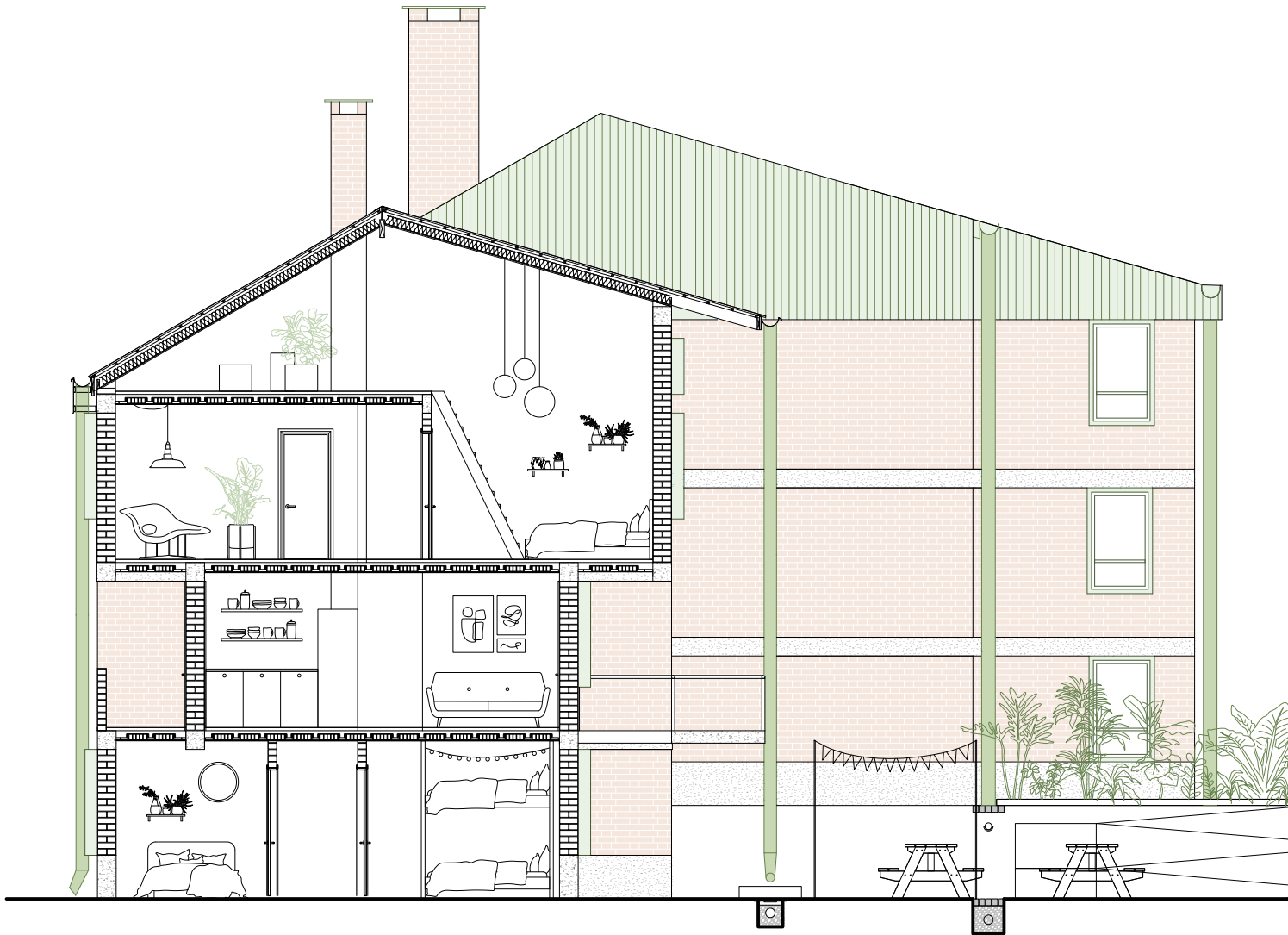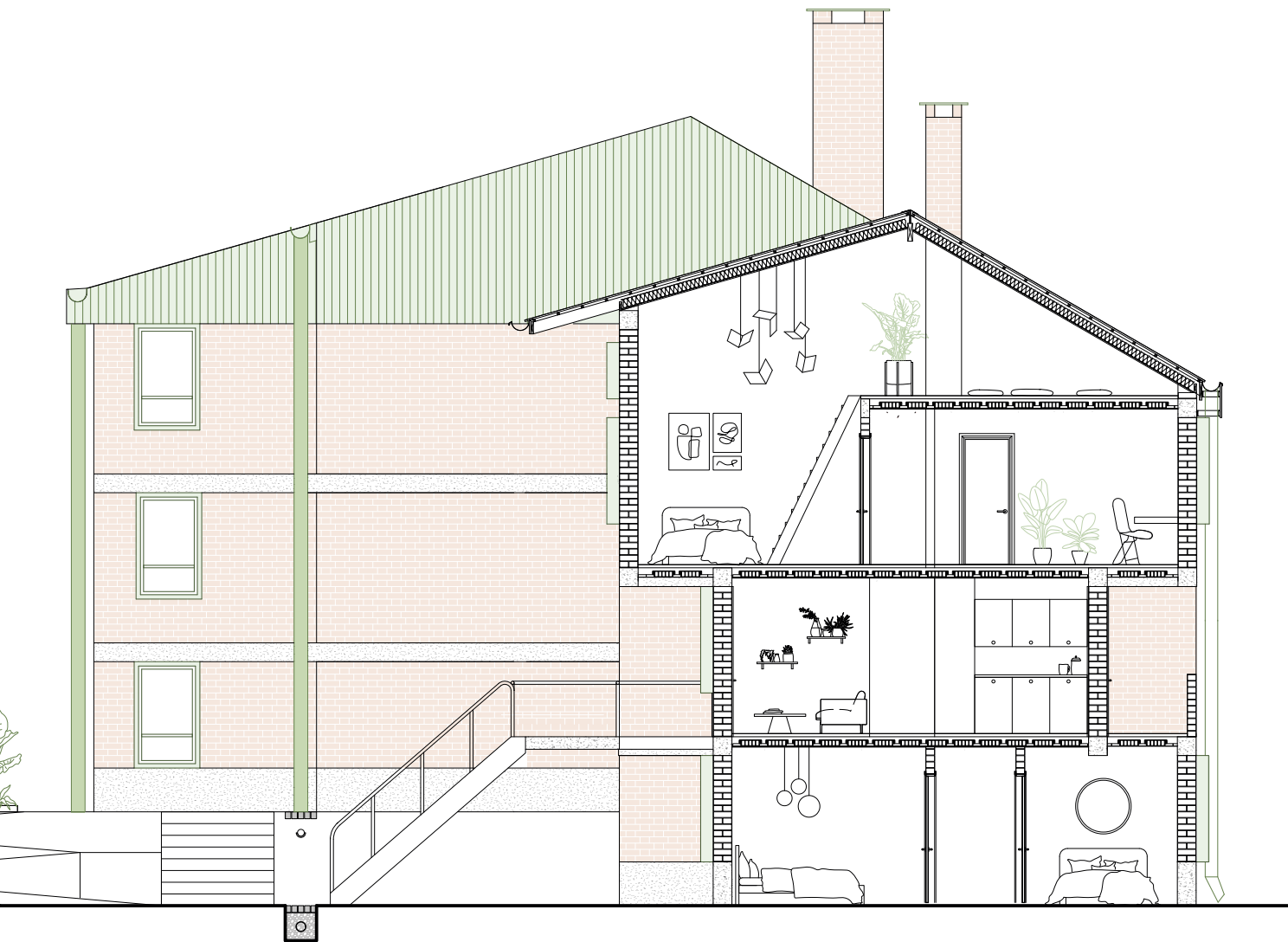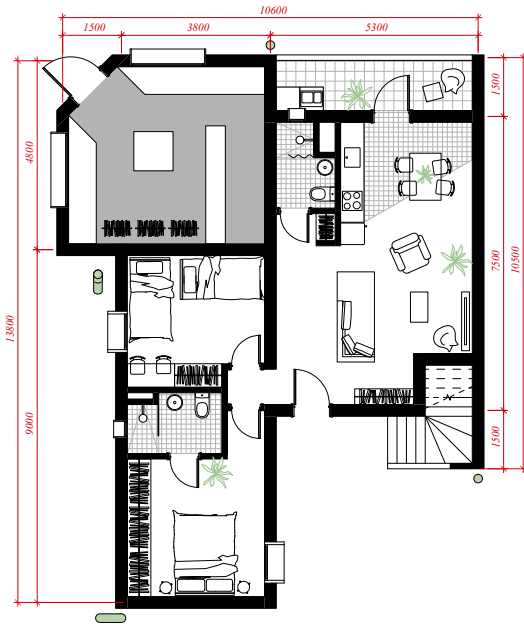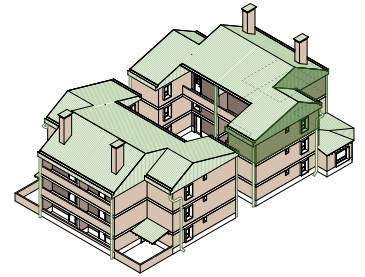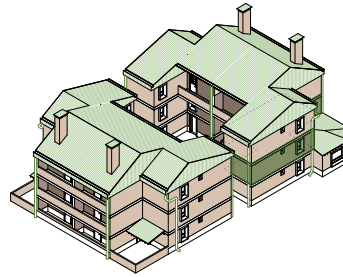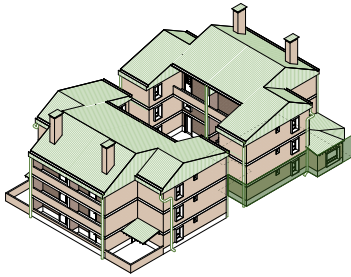
HIS 2

ground level - 68 m2
2 bedrooms
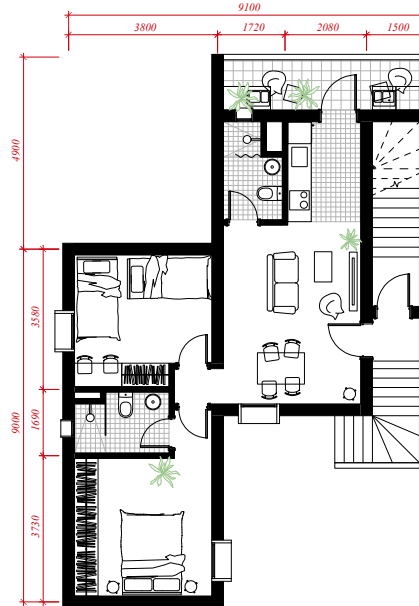
HIS 2

first level - 60 m2
2 bedrooms
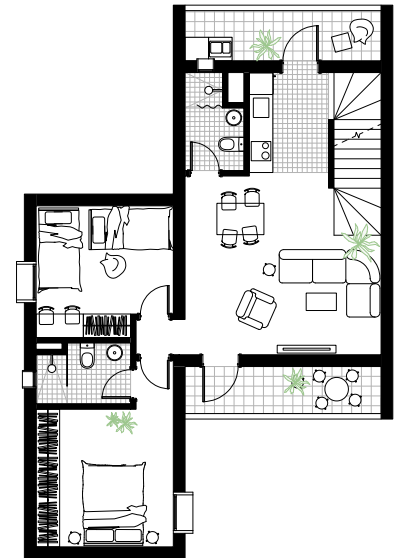
HIS 2

second level - 76 m2
2 bedrooms + mezzanine

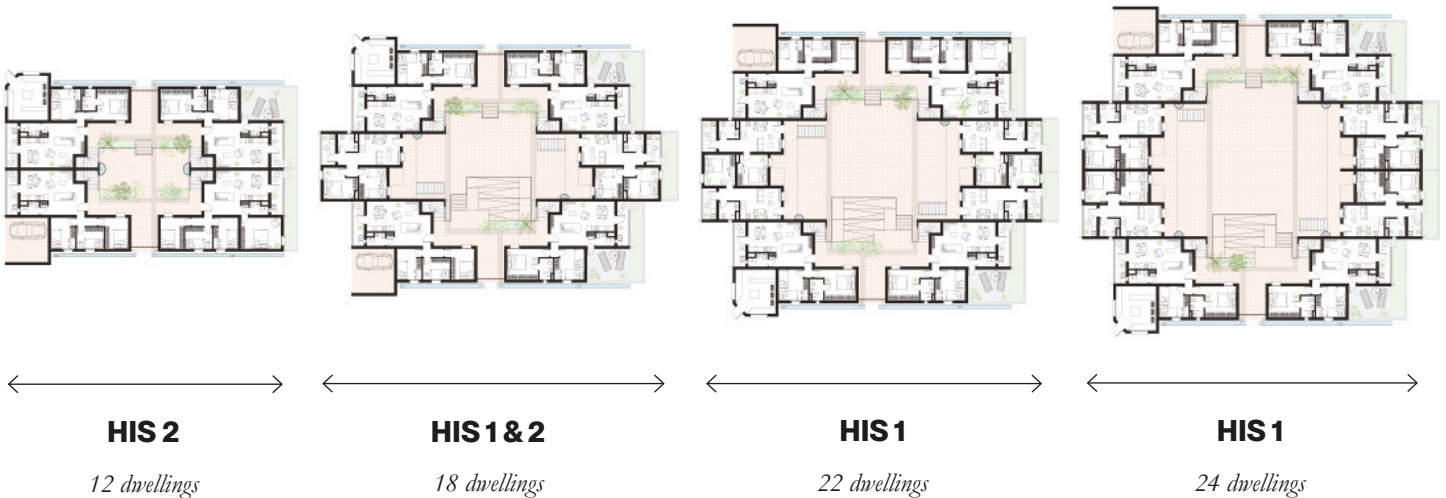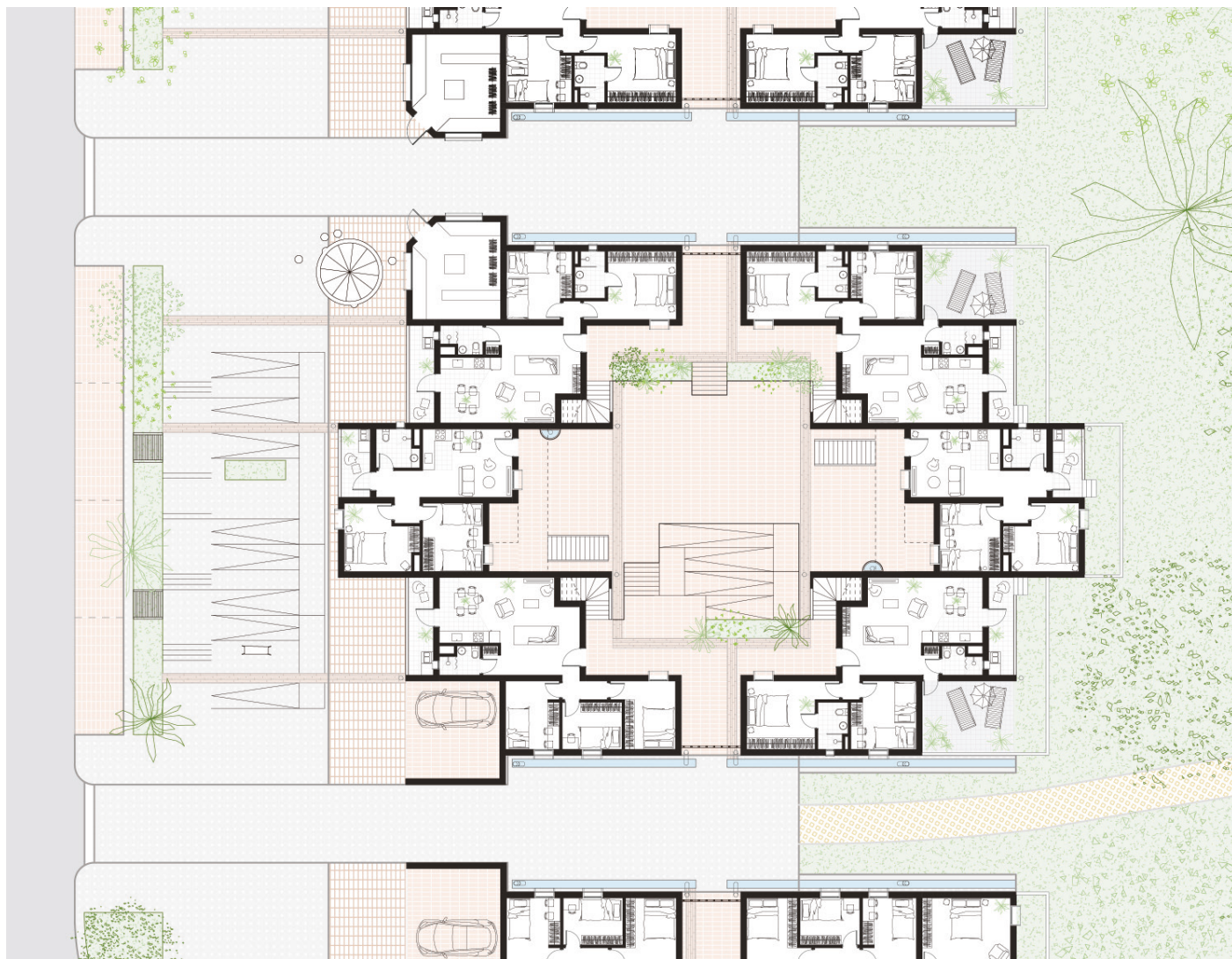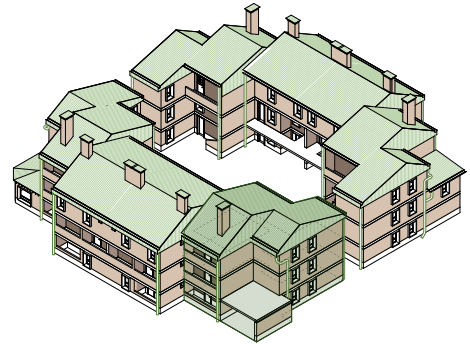The outer edge type has one dwelling unit per level. The upper level dwellings use the Haagse portico stairwell entrance as the method of entry. The clusters with 12 and 18 dwellings have a plan intended for HIS 2 income group, which include two bathrooms.

In the 22 and 24 dwelling clusters, the ensuite bathroom is exchanged for a third bedroom, making these units suitable for larger families. Much like the HIS 2 Courtyard Cluster housing type, the top level unit includes a mezzanine.

The ground floor corner of the outer edge unit plot is an additional space, initially belonging to the entire cluster. It can be adapted over time by any of the residents in the cluster, based on collective cluster decisions.
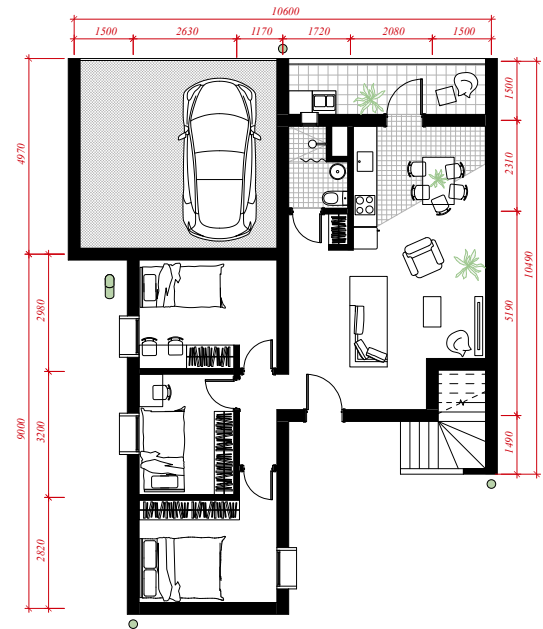
HIS 1

same 3 levels instead
with 3 bedrooms

only in 22 & 24 dwelling clusters

There are 4 types of inner dwelling units of the rowhouse cluster. The ground level dwelling can include either 2 bedrooms, or 1 bedroom with an L configuration depending on the size of the cluster.

On the two upper levels, the dwellings split into duplexes, with communal living spaces on the 1st floor, bedrooms and bathroom on the 2nd, and a mezzanine on the top. The duplexes have entrance access through a shared balcony.
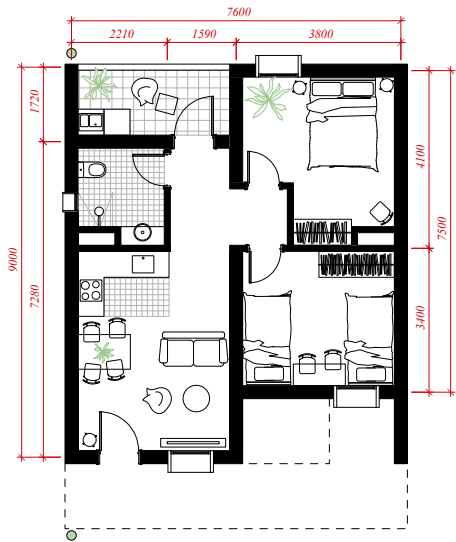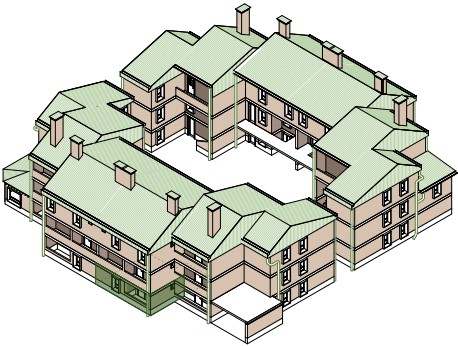
HIS 1

ground level - 58 m2
2 bedrooms

in 18 & 24 dwelling clusters

OR
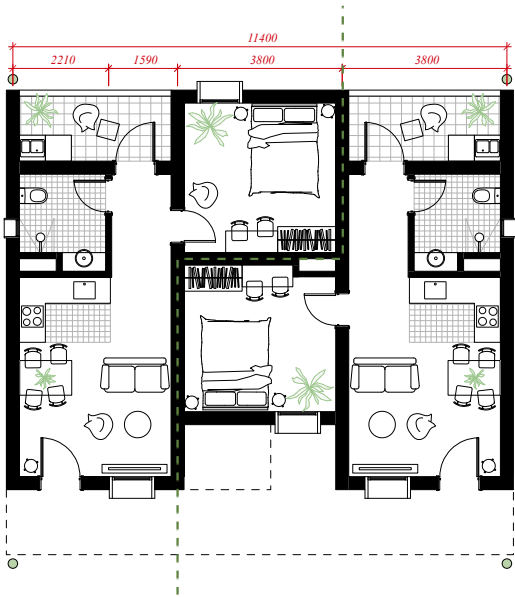
46 m2
1 bedroom

in 22 dwelling clusters
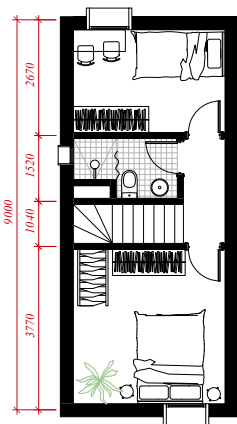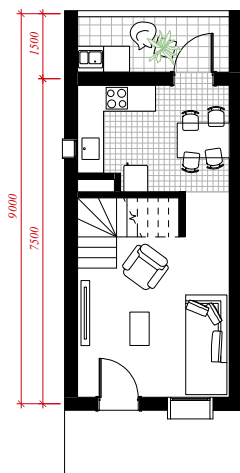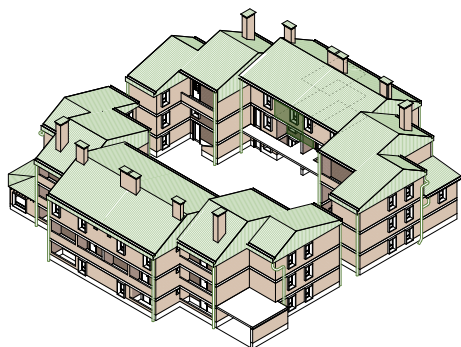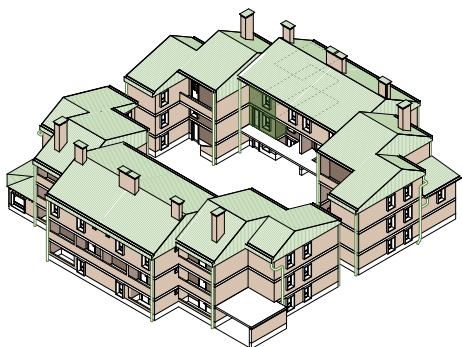
HIS 1

left duplex - 52 m2
2 bedrooms + mezzanine
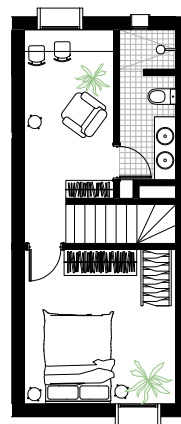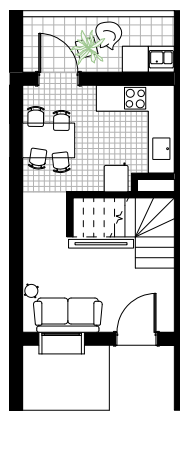
HIS 1

right duplex - 46 m2
1 bedroom + mezzanine

Water drainage in the rowhouse cluster water uses the same gutter and brick paving strip system. Permeable pipes additionally bring water to rain gardens on the public street and inside the clusters. Rain gardens integrate water drainage with the urban landscape, giving vibrance to public street. As a flood control method, rain gardens detain rainwater runoff and filter pollutants. They work best with native species that are flood and drought resistant. The rain gardens provide a variety of native trees, shrubs, grasses, and ornamental flowers which help to liven the public space.

excess runoff directed to raingarden

city water main

underground water collection tank

excess water directed to water reserv

rainwater trench
greenery
sand, 5cm
soil
textile
permeable pipe, Ø15cm
gravel, 45cm
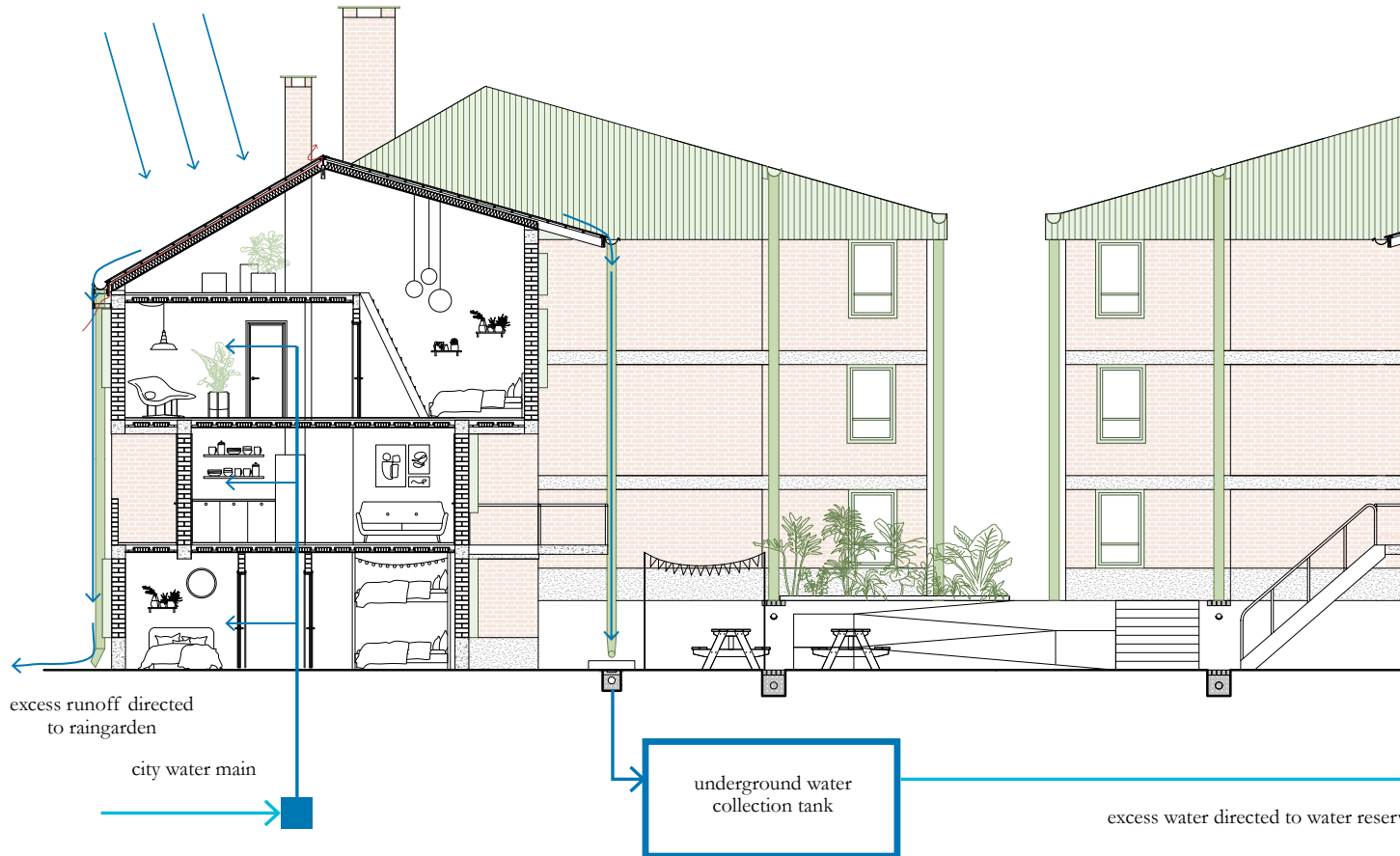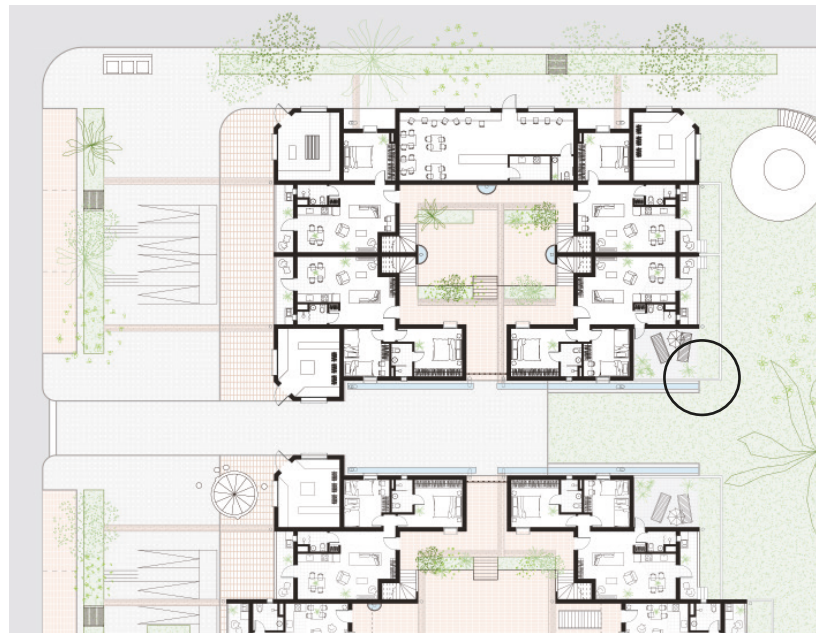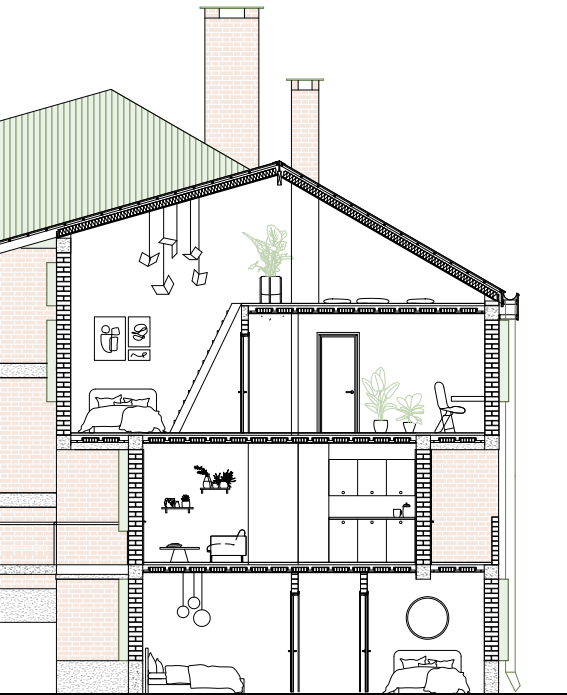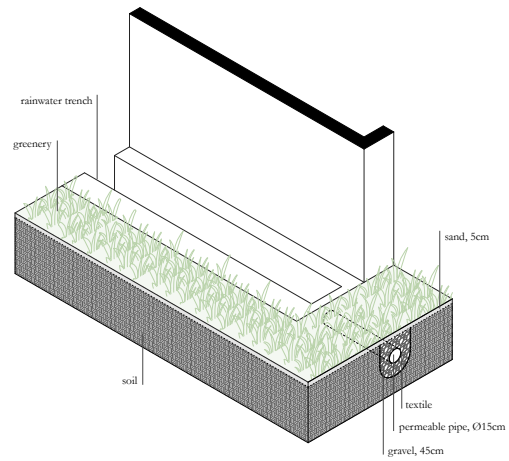
voir

urban conditions

In "The Open City," Richard Sennett defines a border as "an edge where different groups interact"(Sennett, 2006). He explains that borders are the place with the highest intensity of interaction between social groups, due to the joining of different physical conditions. Porous borders encourage an open system, the opportunity for spontaneous action.

The transition between the different streets defined by the Radburn principle represent the borders in the urban plan. The hierarchy of public to private spaces encourage mixing across social groups and different kinds of interaction. First, the existing streets to main boulevard and linear park, which support the connection of the neighborhood's residents to the greater community of Grajau and Sao Paulo.

The presence of the linear park enables social mix through environmental connection, which strengthens the relationship between natural and built environment on the site. The side streets and green streets provide a public connection between the main boulevard and linear park.

public ↑   existing streets

main boulevard

linear park

side streets

green streets

pedestrian local streets

cluster inner shared space

private ↓   dwelling
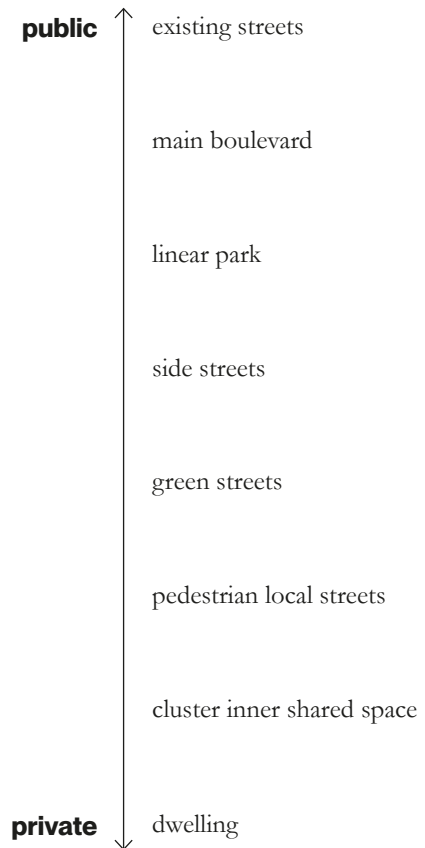
The highest level of social mix occurs in the transition between the local street in the middle of two clusters (semi-public), to the side street (public), when the movement of inhabitants from two different clusters intersect. When local businesses are positioned at the edge conditions, economic opportunity becomes tied to means of community. Shops and services bring people to the community, boosting the local economy and social networks.

Therefore, the clusters along the main boulevard adjust to the condition of a shopping street. The edge unit facing the street on the ground floor alters to create space for a 1-bedroom apartment sandwiched between a corner shop and space for community amenities. The upper-level edge unit dwellings are adjusted to include a balcony to look down on the shopping boulevard.

Finally, the edge between the inner shared courtyard of each cluster (semi-private), which accessible only to the cluster residents, and the dwelling threshold (private) supports the most intimate form social interaction amongst neighbors.
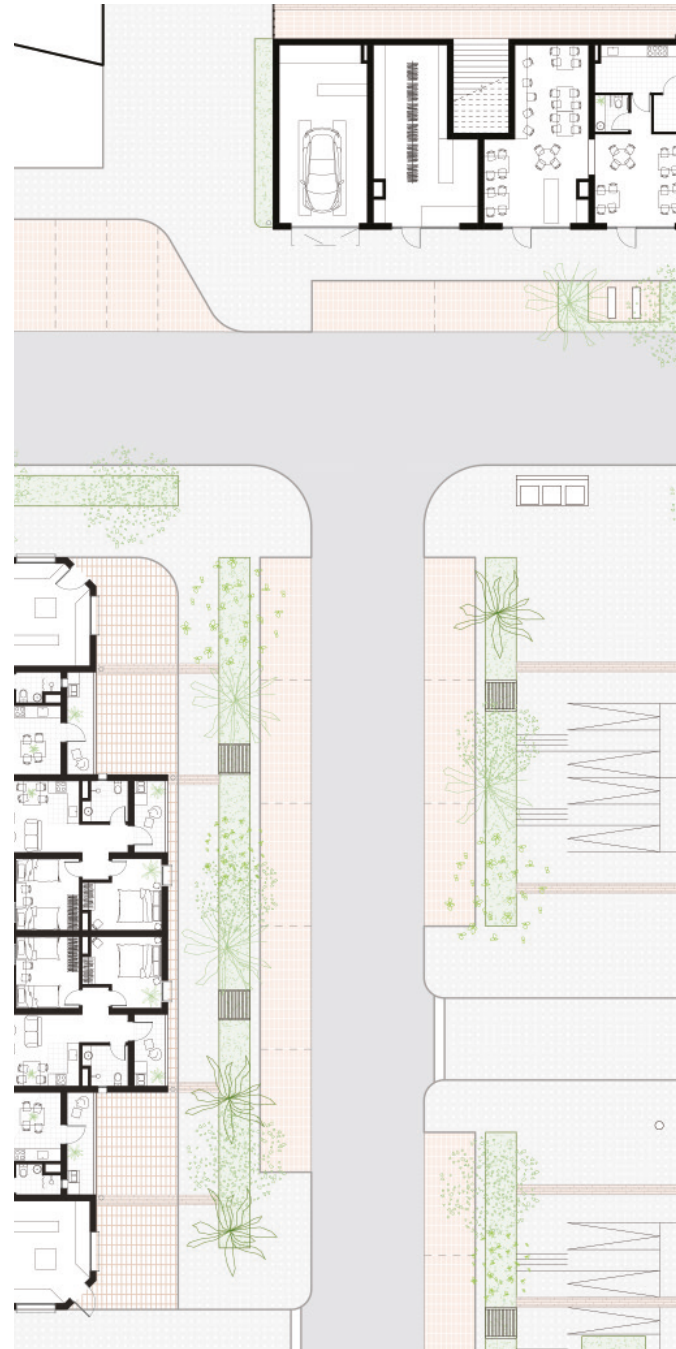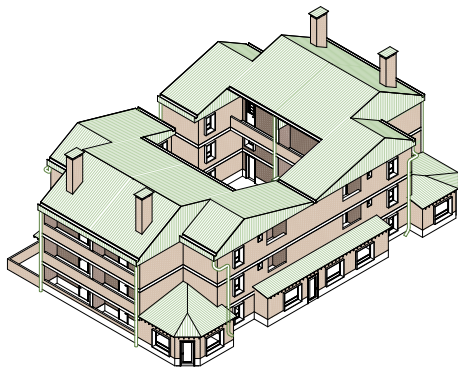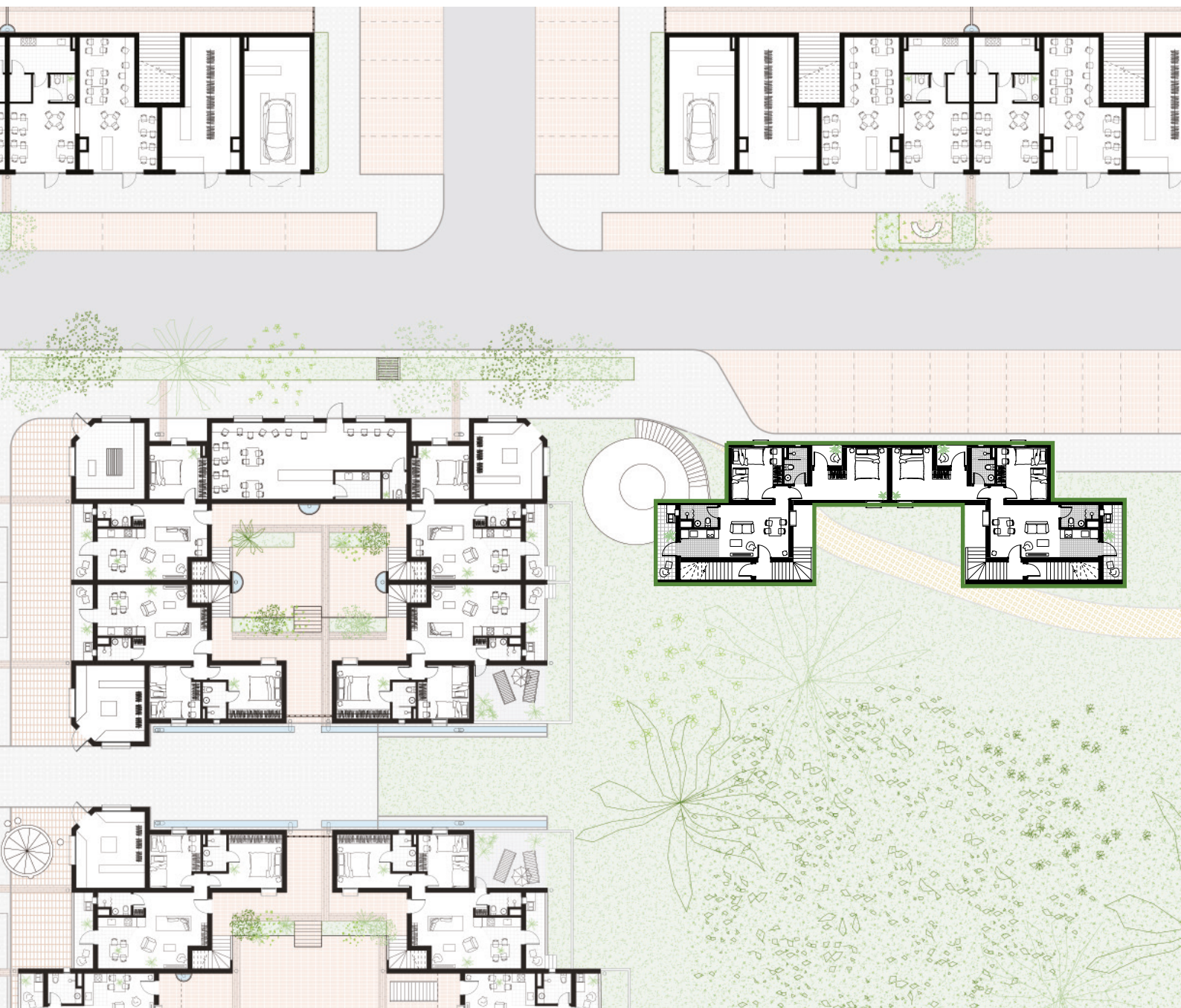
managerial strategy

The spatial organization of the housing is based on clustering, to preserve existing social networks and reinforce the sense of community. The managerial strategy of the community furthers this concept. The development of the neighborhood requires an organizational structure that is based on clusters.

Therefore, the residents in each cluster form an association, akin to an HOA (home-owners association). Under the structure of this association, the residents are responsible for the management of the cluster. Clusters are coordinated based the prior communities of the inhabitants, their relative incomes, and the type of ownership they are interested in.

Each cluster association belongs to a larger neighborhood association which oversees the execution of the neighborhood development, financing, and maintenance.

"Cantinho do Céu"

DIFFERENT COMMUNITIES

"Erundina"

"Cocaia"

ENTIRE COMMUNITIES & INDIVDUAL FAMILIES

One or two families without strong prior community ties

CLUSTER ASSOCIATION

CLUSTER ASSOCIATION

Head of Cluster Association

JARDIM CAMPINAS ASSOCIAÇÃO

Developer
Initial Land Owner
Financial Manager

JARDIM CAMPINAS ASSOCIAÇÃO RESPONSIBILITIES

— Overall site maintenance

— Rent-To-Own financing program

└─ Community labour financing

— Rental management

— Career Opportunity Workshops

CLUSTER ASSOCIATION RESPONSIBILITIES

— Cluster site maintenance

— Individual labour contributions

└─ Choosing Cluster & Unit Types

The stakeholders in the development of the Jardim Campinas urbanisation project follow a similar structure to the existing system used by Chacara do Conde and Residencial Espanha, such that the Brazilian government provides the major funding for the development as a loan under the MCMV program.

However, the Jardim Campinas Association functions as the developer, empowering the decision-making power of the inhabitants through a bottom-up approach (see next page). The JCA allocates the funds given by the Brazilian government towards the necessary actors and provide a financing plan to the cluster residents. The Cluster Associations can choose to contribute to the development of the project through labour by form of sweat equity.

Funding under UAP for
-Water, Sanitation & Sewage
-Infrastructure
-Housing Construction
-Greenery & Environmental Recovery

CAIXA
Federal Savings Bank

Funding under MCMV

MUNICIPALITY

SIURB
São Paulo Municipal Secretariat for Urban Infrastructure

SVMA
São Paulo Municipal Secretariat for Greenery & Environment

SABESP
State of São Paulo Water and Sewage Infrastructure Company

DEVELOPER - SEHAB
São Paulo Municipal Housing Secretariat

R$

R$

Municipality offers **support programs** throughout settlement

Families participate in **unit selection**

RESETTLED RESIDENTS
Displaced by the UAP

R$

Program of requirements

Housing

CONTRACTOR
Architecture firm/Designer/ Project manager

LOCAL CONTRACTORS
Labour

LOCAL MATERIAL SUPPLIERS

—— **Main stakeholders**
—— *Secondary stakeholders*
- - - *Tertiary stakeholders*
→ *Cash flow*
→ *Main activity*

Current Stakeholder Structure

FEDERAL GOVERNMENT
CAIXA

R$ Total Development
Investment Guidance

Investment repayment
with insured interest

R$ UAP Funding

NGOs

R$

Social Support

**DEVELOPER-
JARDIM CAMPINAS
ASSOCIAÇÃO**

R$

R$ for Temporary Housing

Social support programs
(e.g. Career opportunities, house
maintenance guidance)

Program of R...

Technical Assistan...

MUNICIPALITY

SIURB

SABESP

SEHAB
*São Paulo Municipal Housing
Secretariat*

SVMA

R$
Taxpayer/UAP

Program of Requirements for
Infrastructure

Cluster
maintenance

Land & Housing subsidies

R$ Monthly payments

Clusters decide unit selection

CLUSTER ASSOCIATIONS

R$

equirements

ce

Labour support

Sweat Equity

CONTRACTOR
Architecture firm/Designer/
Project manager

Labour

Hiring skilled labourers

**LOCAL
MATERIAL
SUPPLIERS**

**LOCAL
CONTRACTORS**

— *Main stakeholders*

— *Secondary stakeholders*

--- *Tertiary stakeholders*

⟷ *Cash flow*

⟷ *Main activity*

The primary form of tenure for the social housing is home ownership, following a Rent-to-Own financing scheme. While funded by the Brazilian government's MCMV program, the scheme is managed by the JCA. The association operates as a bank, allocating funds for the project development, subsidies for monthly rent based on the MCMV program, and overseeing the sweat equity labor as downpayment towards ownership.

≈1060   TOTAL DWELLINGS

TENURE

75%   RENT-TO-OWN HOUSING & SUBSIDIZED RENTAL
Adaptation of the MCMV Financing run by the Jardim Campinas Associação

Subsidized Rental

Rent-To-Own

23%   RENTAL HOUSING
For migrant workers and families who don't seek home ownership

Rental

2%   TEMPORARY EMERGENCY HOUSING
This short-term housing cluster is reserved for families in emergency cases such as domestic violence, disaster, etc. It is maintaned and financed by SEHAB, and intented to relieve pressure on existing temporary housing assistance measures.

RESIDENTS

Clus

+R$
Rent subsidization

—R$
Monthly rent or mortgage pay-
ments based on income

—R$
Investment Repayment
with Insured Interest

**RENT
MANAGEMENT**

**LABOUR
BANK**

**JARDIM CAMPINAS
ASSOCIAÇÃO**

**FEDERAL
GOVERNMENT**
CAIXA

+R$
Sweat Equity

—R$
Site Maintenance

**SITE
MAINTENANCE**

+R$
Land & Project Development
Investment

—R$
...ter Maintenance

**CLUSTER
ASSOCIATIONS**

─── *Main stakeholders*

─── *Secondary stakeholders*

──▶ *Positive cash flow*

-- ▶ *Negative cash flow*

─── *Main activity*

This financing scheme creates an opportunity and financial incentive for those who cannot afford to enter the rent-to-own scheme immediately, but still want to pursue home ownership. The rent of the lowest income bracket is therefore subsidized by the monthly rent of the other brackets, until those residents move into a higher income bracket and can begin contributing towards their stake in ownership of their dwelling. This financing structure works alongside existing social support programs for employment, provided by the city's Municipal Housing Secretariat.

Seeing as the average income of those evicted from Cantinho do Céu was 2 minimum wages (Franca & Barda, 2012), and the residents chosen to live in Chacara do conde units were in the HIS 1 bracket (1-3 minimum wages), there is no allocation for HMP residents (6-10 minimum wages). This is to ensure that displaced residents have the best chance of access to social housing.

OWNERSHIP

Long rent-to-own terms reinforce sense of responsibility & connection to community

TIME

5 years
maximum time permitted for subsidized rental

10 year minimum before residents can sell or exchange their dwelling unit (verified by JCA)

Moving out before 30 years house can be sold for ownership stake minus interest paid

30 year mortgage

TENURE

75%	**Subsidized Rental**	Only pay maintenance fees
	Rent-To-Own	Mortgage interest & Subsidies set by CAIXA
23%	**Rental**	Monthly rent price set by JCA
2%	**Temporary Housing**	Managed and financed by SEHAB

JARDIM CAMPINAS ASSOCIAÇÃO (JCA) RENTAL FINANCING

resident type	household income	JCA interest	timeframe
Subsidized Rental	HIS 1 - Up to one minimum wage*	N/A	Only site & cluster maintenance fees for up to 60 months (5 years)**
Rent-to-own & Rental	HIS 1 - one to three minimum wages	2%	Up to 360 months (30 years)
Rent-to-own & Rental	HIS 2 - four to six minimum wages	3%	Up to 360 months (30 years)

Subsidized Rental families can switch to Rent-to-own scheme once in higher income bracket

**Expectation of 5 years to rise to next household income bracket, considering neighbourhood economic opportunities & career workshops offered by JCA/SEHAB*

Residents in Cluster associations can collectively or individually decide to offer their own labor as a method of payment towards their home-ownership debt. Therefore, ownership can grow through their sweat equity, based on the value of the labor they put in to build the community. However, this is entirely voluntary, as it is important to give autonomy to cluster associations on how they elect to contribute towards the project development.

JARDIM CAMPINAS ASSOCIAÇÃO CLUSTER HEAD MEMBER

JARDIM CAMPINAS ASSOCIAÇÃO FINANCIAL MANAGEMENT

JARDIM CA

JARDIM CAMPINAS ASSOCIAÇÃO LABOUR BANK MANAGER

JARDIM CAMPINAS ASSOCIAÇÃO SITE MAINTENANCE

CLUSTER

CEB BRICK MAKING & LAYING

FLOOR ASSEMBLY

PLASTERING & PAINTING

PLANTING GREENERY

WATER DR

TRASH REMOVAL

project planning

construction process

resident resettlement

Forms of labor contributions are not limited to manual labor but can also come in the form of management responsibilities. These contributions are tasks which can be easily taught to non-skilled laborers. They are a great opportunity to form community connections and build social capital.

AMPINAS ASSOCIAÇÃO RENTAL MANAGEMENT

MAINTENANCE

CLUSTER SAFETY

} administrative

} construction

GARDENING

AINAGE MAINTENANCE

LAWN MOWING/TREE TRIMMING/WEED REMOVAL

} long-term maintenance

daily neighbourhood life

timeline

public street side

*parking garage
or storage for cluster*

The corner of the edge unit is initially owned and maintained by the cluster. This provides the opportunity to generate income and employment for cluster residents with a local corner shop business. The cluster association can use the space for various applications or elect to sell the plot to an individual resident, who may choose to alter the plot for personal purposes such as a yard or home expansion. Residents of the edge unit on all 3 storeys can collaborate to incrementally expand their home.

corner shop
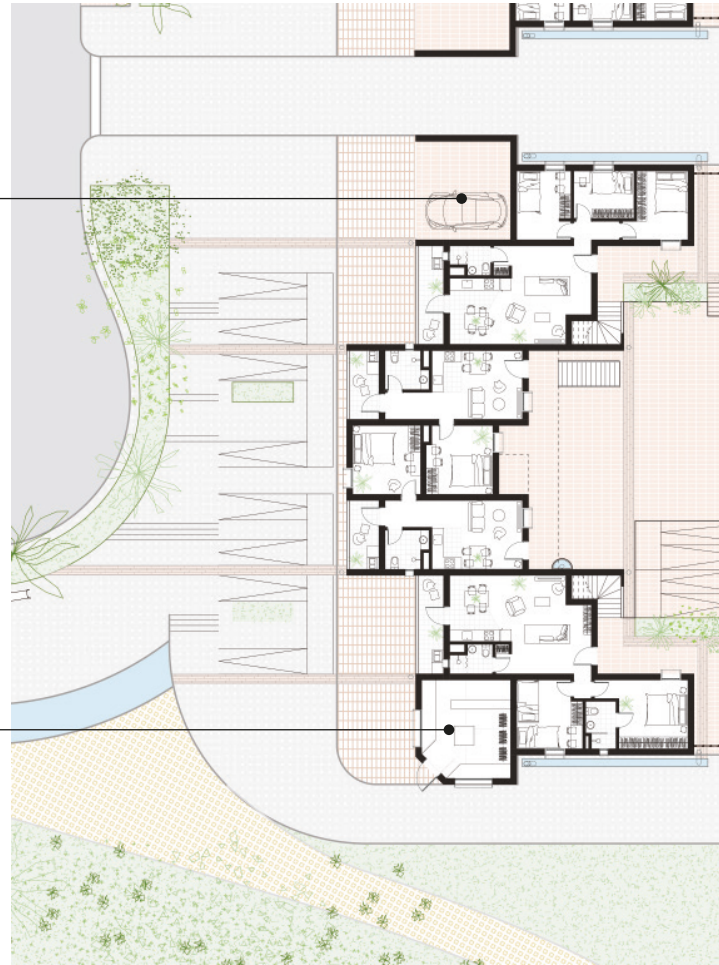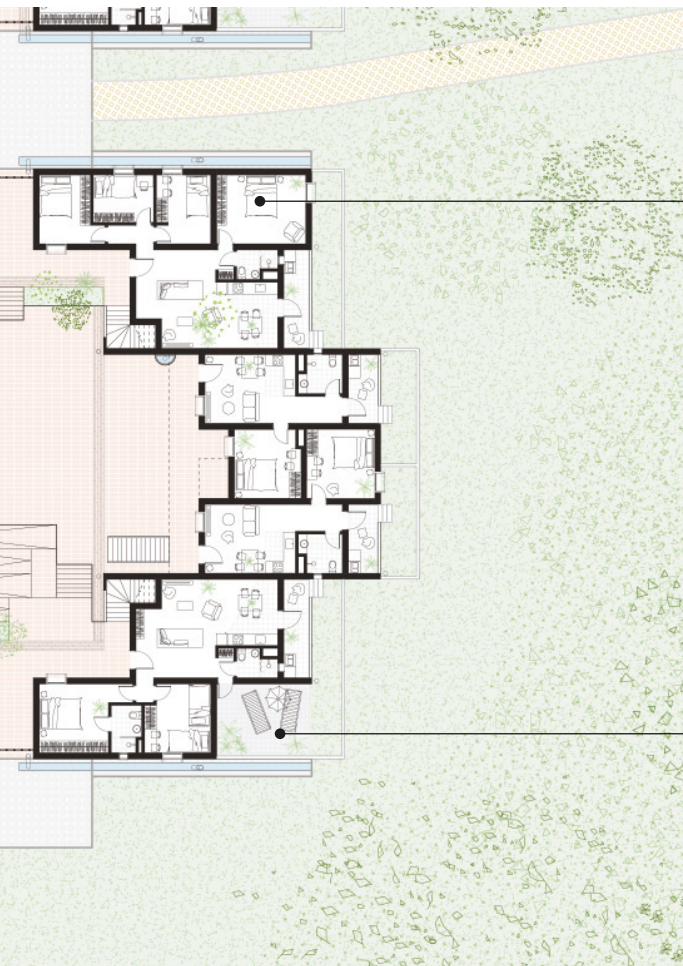
green side

incremental growth

How much each cluster association chooses to contribute towards maintenance fees for their own cluster varies by association's needs and resident's incomes. There is a financial incentive as a group to take care of their dwellings to maintain the property value of their homes, reinforcing the community responsibility within the cluster.

yard

project development

Current State

↓
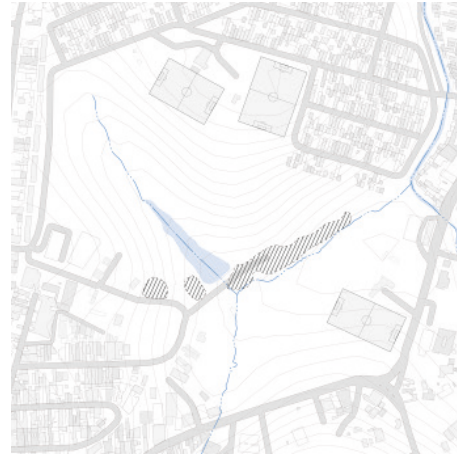
Demolition:
- *illegal waste sheds*
- *illegal dump site*
- *7 settlements*
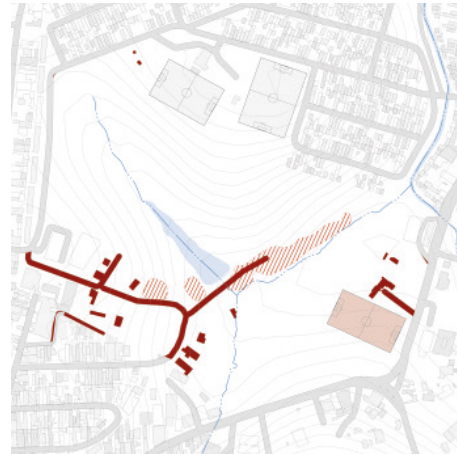
Alteration:
- *rotate soccer field*

↓

Construction:
- *main boulevard*
- *central construction staging site*
- *temporary access road*
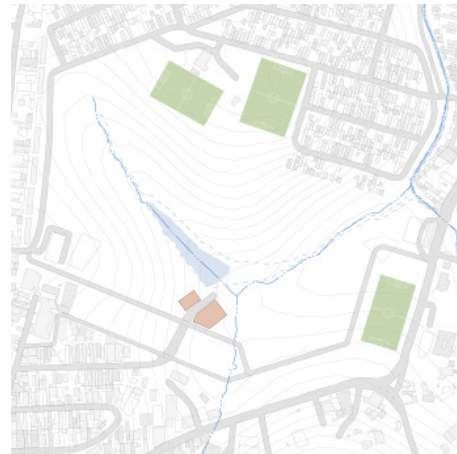
Alteration:
- *reshape water landscape for site drainage/ linear park*

Construction:
- *Site amenities - grocery, bus stop, community space/football club, waste & recycling center*
- *main boulevard in new sector*
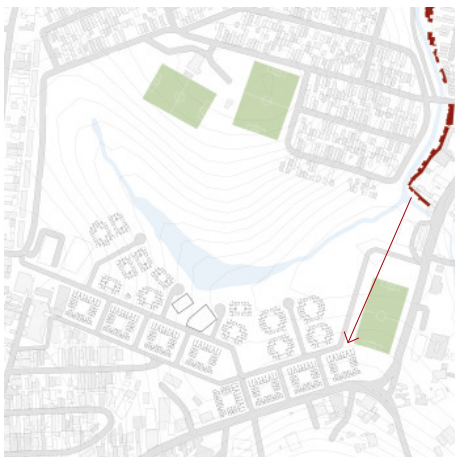
Demolition:
- *38 at-risk favela settlements along creek*

Construction:
- *350 dwellings (Courtyard Cluster Type)*

Rehouse:
- *38 creekside settlements into a Courtyard Cluster*
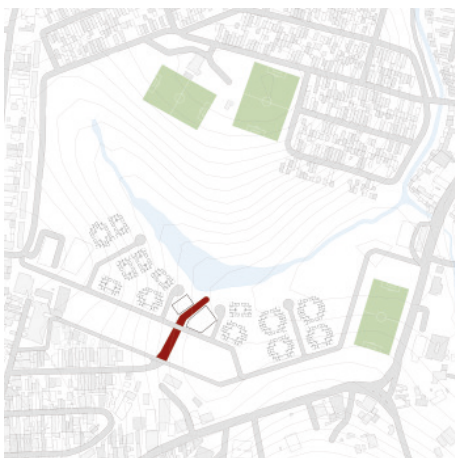
Demolition:
- *temporary access road*

Construction:
- *218 dwellings (Rowhouse Cluster Type)*

Rehouse:
- *7 original site settlements into a Rowhouse Cluster*

Construction:
- *268 dwellings (Rowhouse Cluster Type)*

Construction:
- *244 dwellings (Courtyard Cluster Type)*

Construction:
- *linear park*
- *site amenity - church*

Alteration:
- *turn construction staging site into new community center*

Phasing

The final masterplan produces a dwelling density of 84 dwellings per hectare, for a total of 1062 family dwelling units. This is based on the consideration that the linear park space is shared with the rest of the city, and therefore only counts a portion of the park towards the final calculation.

However, when we look at the individual sectors of the neighborhood, the average density produces roughly 100 dw/ha. This number more accurately represents the density of the project system.

While this density is larger than that of the surrounding area of Jardim Campinas (40-90 dw/ha) or the Cantinho do Céu neighbourhood (70 dw/ha), it falls short of the target density set by Chacara do Conde and Residencial Espanha (roughly 125 dw/ha). The trade off in this lower density is the inclusion of more public & green spaces shared among residents, which elevate the quality of the neighborhood.

≈1060

TOTAL DWELLINGS

3600 estimated dwellers (assuming 3.5 persons per household)

100 dw/ha

SITE AVERAGE

84 dw/ha whole site
      -including 1/3rd of linear park
      -not including unbuildable land

90-110 dw/ha within sectors

FSI: 1.02
GSI: 0.28

70% HIS 1 Dwellings
30% HIS 2 Dwellings

Density

The intent of this project is to create a social housing urban system that can be replicated on any site which features a body of water. In Sao Paulo, many of the ZEIS 4 zones could be used to test the urban system, since they typically have Atlantic Forest vegetation and channels of the Billings Reservoir.

To demonstrate the urban system's ability to adapt to other sites, an example masterplan was created on Hamada Farm, a ZEIS 4 plot north of Jardim Campinas.

This version of the urban plan produces a comparable density, FSI, and GSI to that of Jardim Campinas and enables many of the same urban characteristics. The high traffic street at the top of the plan converts to a main boulevard, which continues south across the site and connects back eventually to an existing street. The rowhouse clusters face downward with the site slope towards the existing water stream, fronting a continuation of the linear park already present on the right side of the site.

≈730

TOTAL DWELLINGS
2500 estimated dwellers

103 dw/ha

FSI: 0.97
GSI: 0.27

78%   HIS 1 Dwellings
22%   HIS 2 Dwellings

Hamada Farm

Jardim Campinas
(Project Site)

building technology

São Paulo is located in a humid, subtropical climate in the southern hemisphere, with high temperatures and substantial rainfall throughout the year. The consideration of climate conditions for social housing is crucial, given that traditional thermal regulation methods such as insulation and mechanical heating and ventilation are expensive. The design must therefore passive and natural methods of cooling and heating. Therefore, local building practices in Brazil often use cross ventilation with higher density materials such as concrete and brick.

The orientation of the dwelling clusters varies according to the site topography, so the dwelling position may not always be fully optimized for shading and ventilation. However, the Tetris shape of the clusters enables different facades to be shaded throughout the day, and more opportunities to create a window opening for ventilation. Additionally, São Paulo's diurnal temperature range of 10 degrees is suitable for thermal mass, which can be used to help with temperature regulation inside the dwelling to ensure thermal comfort.
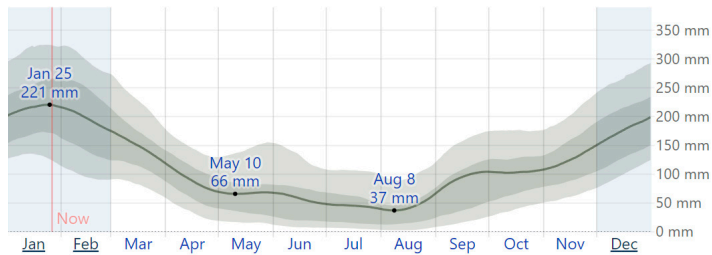
Average Monthly Rainfall in São Paulo
(Weather Spark, 2023)
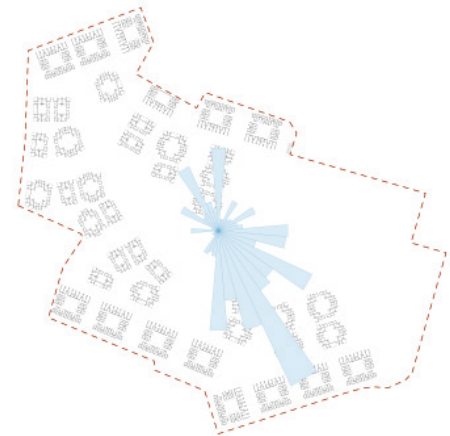
Site Wind Analysis
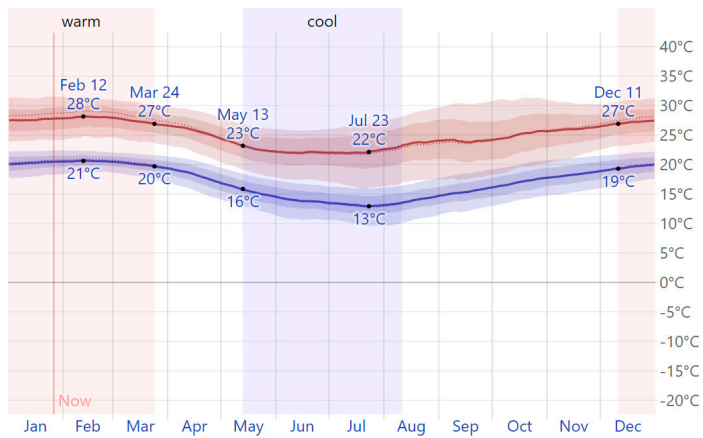
Average High and Low Temperature in São Paulo
(Weather Spark, 2023)
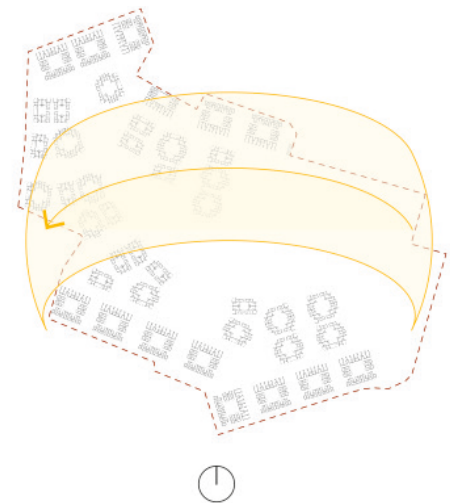
Site Sun Analysis

Climate

Construction of nucleus settlement uisng brick
in Anchieta, São Paulo, image by author, 2022

Building Technology

There are 3 kinds of subsoil common to Sao Paulo and present on the Jardim Campinas site, the most predominant being alluvial and compressible soft soils. These are clayey, silty soils with the capacity to hold lots of water. This soil is suitable for making cement and clay bricks, which are the two most common materials in Sao Paulo's favela construction. In Brazil, the soil is rich in iron, producing the brick's iconic red color.

This soil can also be used to make Compressed Stabilized Earth Bricks (CSEB). CSEBs are made of earth and soil material which is typically locally extracted from the project site. The earth mixture is mixed with cement to stabilize the material and enhance its compressive strength. The material is compressed into brick shapes, either by hand or machine, and then left to air dry, meaning that the manufacturing process of CSEBs require significantly less energy input than fired clay bricks. CSEBs also perform well as thermal mass due to their high-density properties. These qualities make CSEBs a local and sustainable alternative to bricks.

alluvial soil

(Cipriano-Silva, 2020)

granite

(Margramar Granites, 2015)

compressible soft soil

(Almeida, 2011)

The construction practices used in favela housing typically favor labor techniques that use basic manual labor, since it is expensive to employ heavy machinery and skilled craftsmen. Hand-placed bricks and in-situ concrete structures form the structural base. Finishes such as door and window elements, roof materials, fences, and ornaments are procured from a variety of sources. This collage of materials gives the home lots of personality, but can carry the difficult stigma of "slum aesthetics."

bricks or concrete blocks

(Veysseyre, 2014)

plaster

(United Painting, 2022)

beam and block floor

(Monteiro, 2014)

Local Building Practices in Cantinho do Céu (Author, 2022)

corrugated metal roof

concrete columns and ring beams

simple window models

(Author, 2022)

(Ballinger & Wilke, 2015)

(Alive, 2012)

Building Technology
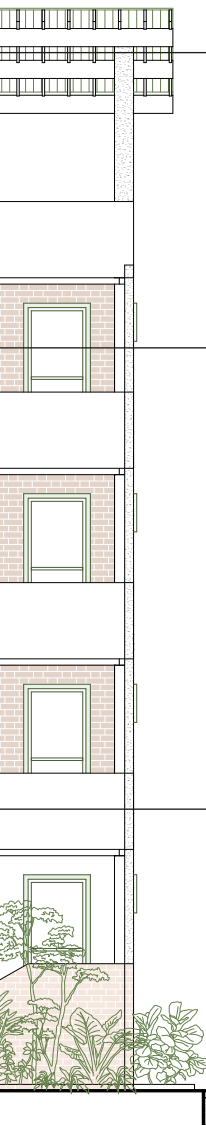
colored corrugated metal roof

- ideal for collecting rainwater
- fun color to give new association to stigmatized material

compressed stabilized earth brick (CSEB)

- structural wall material that functions as thermal mass for passive cooling/heating strategy
- locally sourced from site during construction

plaster

- additional material for courtyard cluster to create visual diversity across the site

The cluster materiality concept is to take the same materials and local building practices of the favela and refine them such that they elevate the building aesthetic while still providing functionality for thermal comfort, strength, and environmental sustainability.

For example, the structural brick is exchanged for the CSEB, a cheap and sustainable alternative, which can stand alone or be easily painted. The corrugated metal roof is most efficient at collecting rainwater, but it is typically stigmatized as a cheap slum roof material. By uniformizing the manufacturing of a brightly colored metal roof which would be used across the site, the material is imbued with new meaning. This color motif is extended to the windows, and gutters, to accentuate these elements in the urban space.

This methodology sustainably uplifts the local building practices while relating to the surrounding context.

deep window frames

- shades the facade
- can be appropriated by resident

concrete ring beam & beam and block floor

- structural floor
- local building practice

colorful gutter and downspout pipe

- highlights the water drainage detail
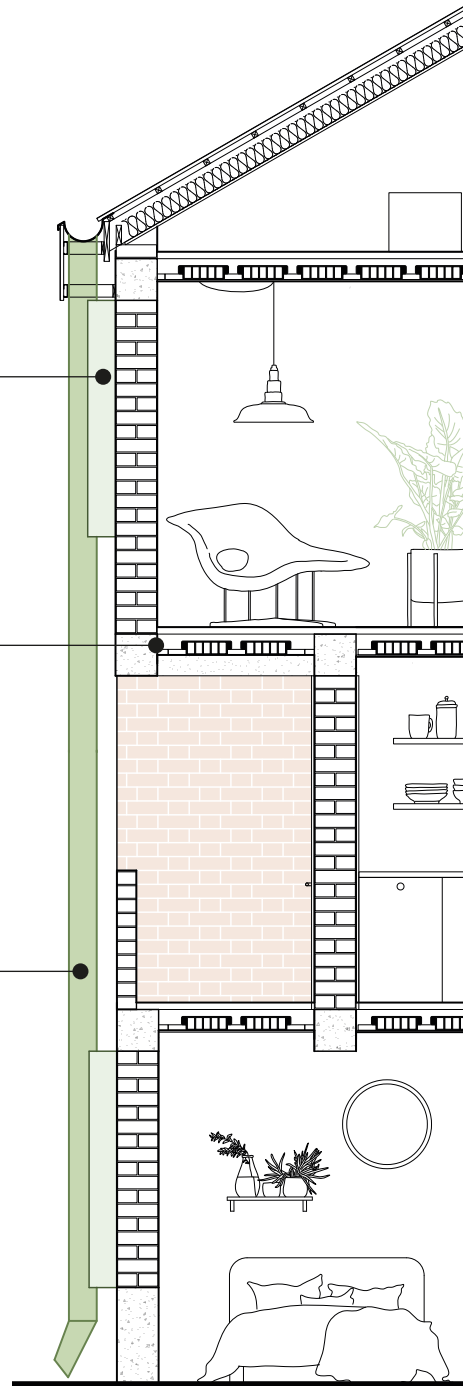
ventilated timber roof

- colored corrugated metal roofing - 26mm
- timber ridge beam - 76x286mm
- timber purlins - 38x38mm
- ventilated cavity - 44mm
- recycled PET insulation - 140mm
  - locally sourced in São Paulo
- timber ceiling rafters - 38x184mm
- gypsum ceiling board - 19mm

hidden gutter

- rounded gutter - 300mm dia.
- colored downspout pipe - 200mm dia.
- fascia board - 38x286mm
  - supports the corrugated
    metal covering "hidden gutter"
- steel C profile - 27x89mm
  - connecting corrugated metal to
    fascia board
  - anchored to wall
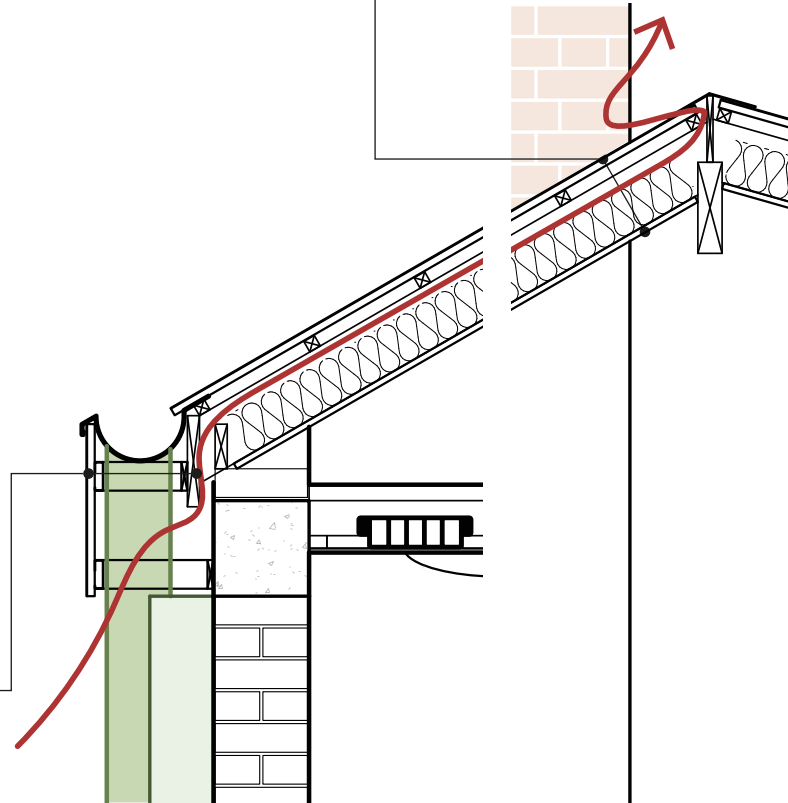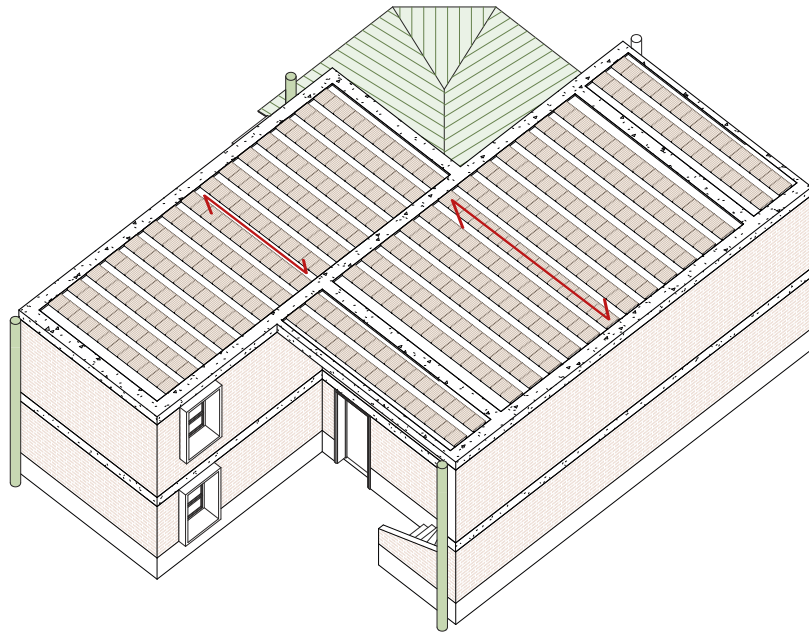
One way spans - 3m to 5.3m

wall

- CSEB
    - 90x140x300mm
    - 10mm mortar
    - double brick layer for acoustical insulation, structural support and thermal massing
- concrete foundation - 300mm thick
    - 1 meter tall to protect CSEB from water
- in situ concrete ringbeam - 300x300mm

beam & block floor

- screed - 50mm
    - smoothing floor finish
- in situ concrete ring beam & pouring over brick blocks - 50mm
- hollow brick blocks 100x350x350m
- reinforced concrete girders - 40x130mm
    - supporting hollow brick blocks
- gypsum ceiling board - 13mm
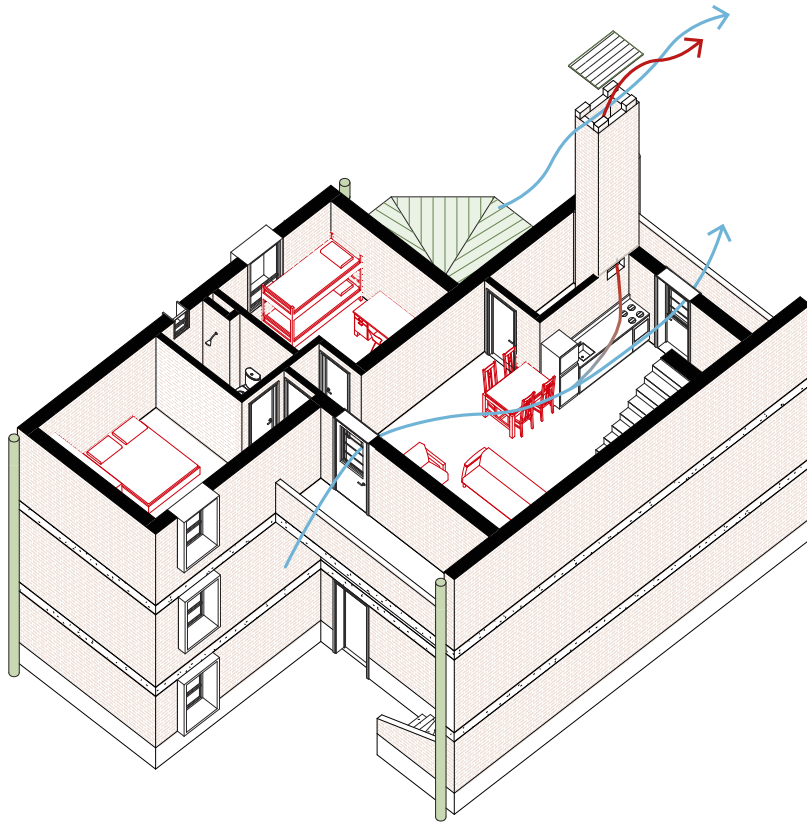
Stack ventilation from the ventilation chimney is improved by cross ventilation in the dwelling unit, ventilated roof design, and the Venturi effect caused by the chimney roof

Chimney Ventilation Calculator

Gravitational constant	g	9.8	-
Height difference	h	2	m
Atmospheric pressure at ground level	P_0	100000	Pa
Gas constant of air	R	287	J/kgK
Outside temperature	T_0	20	°C
Temperature in solar chimney	T_1	25	°C

$$\Delta P(h) = \frac{ghP_0}{R}\left(\frac{1}{T_0} - \frac{1}{T_1}\right)$$

Pressure difference	**DP**	**0.39**	**Pa**

Discharge coefficient	C_d	0.8	-
Inlet opening size	A	0.32	m^2
Density of air	ϱ	1.2	kg/m^3

$$Q = C_d A_{eff}\sqrt{\frac{2\Delta P}{\rho}}$$

Airflow rate	**Q**	**1052.2**	**m^3/h**

Room volume	V	130	m^3
Air change rate per hour	**vv**	**8**	**x / h**

The dwelling unit plans are arranged such that there is always cross ventilation across the kitchen and living spaces, and to the bedrooms when possible. Each dwelling unit has at least one ventilation shaft, typically joining the bathroom and the kitchen, to ventilate the spaces when cross ventilation isn't sufficient. Due to the high temperatures and intense sun in Sao Paulo, the roof is also ventilated and lightly insulated to help keep the interior cool, which helps air flow through the ventilation shaft.

The coupling of thermal mass with ventilation further improves the interior thermal comfort of the dwelling. During the day, the thermal mass captures stores heat from exterior sun, charging up like a battery. Nighttime cross ventilation helps hot interior air to escape, letting the thermal mass discharge its stored heat at a faster rate (Craig, 2019). This balance of ventilation with thermal mass helps to keep the interior temperatures stable for residents.

The ventilation shafts in each dwelling are always a minimum of 2 meters tall past the roof line to generate heat from the sun and stimulate the stack effect. The inlet opening size also has a minimum of 0.3 m2. In this given unit, the ventilation shaft has an air change rate (ACH, or how often the air is replaced in a space) of 8 times an hour, which is in line with the ASHRAE standard recommendations.

The paving materials were carefully selected to create a gradient of permeability across the site. The intention was to maximize site drainage and create distinctions between the different spaces. On most public routes, such as

Street paving
(Author, 2022)

Porous concrete sidewalk
(Roberts, 2023)

Permeable paving for inner courtyard
(Michele & Miquel, 2014)
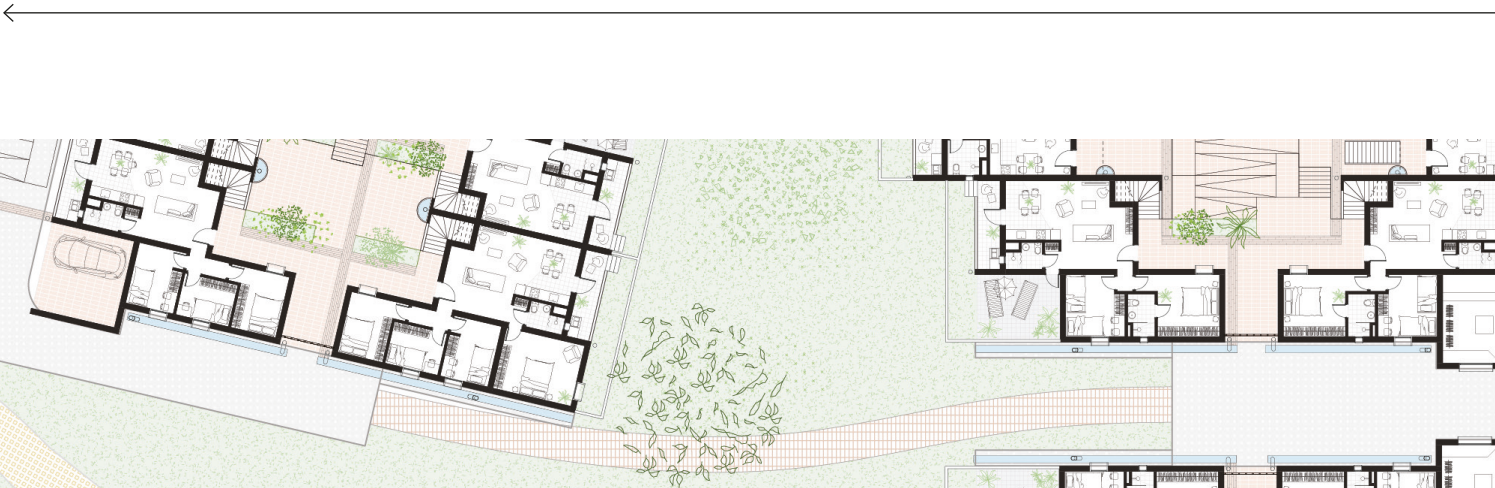
car roads and the main sidewalks, non-permeable or semi-permeable materials are better suited to support heavy traffic. Permeable paving works well with pedestrian-only surfaces, allowing water to drain and grass to grow between the pavers.

Open paving for parking
(Franca & Barda, 2012)

Accessible gravel park pathway
(Hart, 2021)

Parks & rain gardens
(Novas Árvores por Aí, 2023)

7

conclusion

Everyone deserves access to clean water, accessible sanitation, and affordable housing in a safe, healthy living environment. Nevertheless, the endeavor to provide these services to people across the globe will continue to be a challenge. Urbanisation in the Global South is not slowing down. It is estimated that in 2030, 2 billion people will be living in informal settlements and will ramp up to 3 billion by the year 2050 (Mahabir et al., 2016). These projections don't account for the significant repercussions of climate change which will disproportionately affect populations living in tropical and sub-tropical climates. To cope with intense growth, global action that tackles the issues of infrastructure, climate change, affordable housing, and public space is critical. The purpose of this research was to propose a sustainable strategy that addresses these challenges from various lenses and could be applicable to both the context of São Paulo and globally.

Vulnerable populations living in precarious settlements will continue to face displacement in search of better housing conditions. Therefore, it is imperative that urbanization projects that include displaced inhabitants consider the aspects that make a neighborhood desirable

for resettlement, so that inhabitants would want to leave their existing home, rather than leave out of necessity.

In view of the thesis project goals towards urban resilience, it is pertinent to look at the work of REbuildinG AfteR Displacement (REGARD), a research team which looked at the impacts of displacement on vulnerable communities. In "Addressing housing needs of the displaced people promoting resilient and sustainable communities," REGARD identifies eight essential factors for resettlement housing (Jayakody et al., 2022):

1   *adequate provision of standard and quality housing;*

2   *maintain the social equity in housing provision;*

3   *match the location of resettlement housing with social, cultural and economic needs of displaced communities;*

4   *match the size, layout and design of resettlement housing with the social, cultural and economic needs of displaced communities;*

5   *relocate the displaced communities to suitable and welcoming neighbourhoods;*

6   *promote social integration through the housing and the built environment;*

7   *increase the sense of belongingness and social cohesion through housing; and*

8   *promote environmentally sustainable and disaster-resilient housing.*

Upon reflection of the graduation thesis, the final design attempts to target all eight aspects by presenting an interdisciplinary approach, across ecology, urban planning, and architectural design. The project literature review revealed many references that addressed these challenges, although usually with a singular focus. Few references from Brazil that engage in these topics using integrated strategies which propose how to target all issues. For instance, Chácara do Conde addresses the process of resettlement without a cohesive urban strategy, and Cantinho do Céu is an urban revitalisation project without an integrated rehousing proposal.

Therefore, it was valuable for this research to contribute to the discussion by going beyond the present literature. This graduation thesis considered the social practices of residents living in areas ecologically fragile areas without proper infrastructure or in ecologically fragile areas, before and after displacement. The concluding design is a resilient social housing proposal that aims to encourage social mix in an urban plan that embraces natural ecosystems.

Ultimately, this thesis used architectural and urban design research to address the difficult challenges associated with climate and social resilience, through the lens of the socio-spatial relationship between people and environment.

reflection

repair & consolidate & renewal

The 2023 Global Housing Graduation Studio's ambition is the development of affordable and sustainable housing, in response to São Paulo's increasing need for housing, within the city's informal settlements and existing urban fabric.

The studio is called São Paulo: Repair and Consolidate, titled after the urban practices described by Gautam Bhan's in "Notes on a Southern urban practice" (Bhan, 2019). Bhan likens the concept of repair to incremental re-development, rather than upgrade or build. This notion of repair works in tandem with Bhan's definition of consolidate as a process of bringing together and building onto existing networks.

This thesis is aligned with Bhan's definitions of repair and consolidates, assuming the term "renewal." The word, a synonym of repair, is defined as the re-establishment of a practice after an interruption. This term is fitting for the focus of this project, which targets people who are facing displacement, and the need to restore the presence of natural environment in São Paulo's dense urban landscape.

The project proposes a new type of neighborhood that brings social and climate resilience together into a cohesive design, applying the concepts on multiple scales. From the masterplan to the dwelling unit, this thesis aims to tie together themes of collectivity and ecology. This "renewal" of the urban fabric aims to build upon existing social and ecological networks, their strengths, and reinvigorate the connection between natural and built environment.

The definition of renewal in this context is important because as designers, academics, and people, we should not want to fix or correct our environment with design solutions, but rather contribute to architectural discourse by build onto existing precedents. As such, the aim of the TU Delft MSc AUBS program is to consolidate different perspectives from various academic fields and design practice.

This project follows an interdisciplinary structure, encompassing topics which are interrelated with all master tracks within the MSc AUBS:

-Architecture – the morphology of the dwelling types presented in the urban system

-Urbanism – the development of an urban system and the relationships between dwelling types in the urban space

-Building Technology – the construction of the dwellings and design of climate and infrastructural systems, particularly water management and building ventilation

-Landscape Architecture – the integration of an ecological network with the urban system

-Management – the development of a managerial strategy for the housing project which strengthens the urban system

The main methods of research for this studio - literature review, ethnographic research, comparative analysis and contextual analysis – are in accord with this approach. The research explored the vernacular housing traditions, economy, political climate, historical architectural styles, geography, culture, and climate of São Paulo.

The literature review was extensively used to grasp the complex relationships between urban growth, housing deficits, and the process of self-determination by those who live in informal settlements. This was helpful in understanding the balance between the value of public space and ecological inclusion with the need for housing within informal settlements.

The studio relied heavily on the comparative analysis, with case studies from the Netherlands and Brazil. This method was critical for learning why certain design decisions work in some conditions and not others, by analyzing and comparing different case studies through the lens of their contexts.

The case studies informed the layout of the dwellings, local practices for buildings and water management, and overall density. The comparative analysis, alongside the ethnographical research, also underlined the strengths and weaknesses of the project location with regards to cultural practices, infrastructure, and affordability.

These methods were incredibly insightful as they were the foundation for determining the project's aims and objectives. However, using these methods alone proved to be a challenge as there were not many case studies to look to that approached the research topic in the same way. Few of the housing developments that were studied used both clustering and water management together as an organizational tool in designing an urban system. Thus, the design problems throughout the development of the project would lead the research, requiring different sources in and out of Brazil to assist with different design strategies.

This process formed a valuable feedback loop. In essence, this research by design was a valuable way of working because I learned many things which will serve me for the rest of my architectural career. For example, the sloped topography of the project site also forced me to think critically about construction methods, accessibility, and the morphology of the housing clusters.

Finally, the water management system became the integral component driving the masterplan, cluster and dwelling strategies. Subsequently, I learned much about vernacular design solutions to drainage, water harvesting methods and landscape design.

The dialogue between the studio tutors and the students was also vital for the research by design. Beginning with discussions on case studies and literature, we investigated how to incorporate local design practices in a way that

would complement our architectural design while reflecting its context. This pertained to building materials, housing methods, and the hierarchy of public and private in both dwelling unit and masterplan.

Discussions about the meaning of social mix revealed how urban systems can consolidate communities from different lifestyles, income, and backgrounds, at multiple scales of the project. The feedback from the tutors allowed for a critical evaluation on how housing types impact urban quality through their relationship with an urban system, and how they activate different kinds of space.

Together, these research methods enabled this project to take on its current form, a complex housing development that tackles a multitude of ambitions through an interdisciplinary approach. The intent of the design was to create a sustainable and replicable urban system. This thesis presents an approach that can be adapted to any site following these two conditions – a site that features a body of water, and a group of people in immediate need of housing. It pro-

Selection of various masterplan iterations over the course of the project
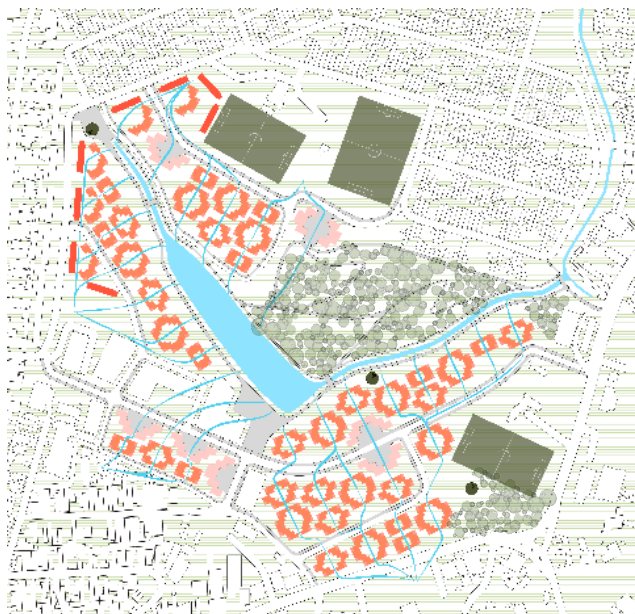
January, 2023

March, 2023

Conclusion
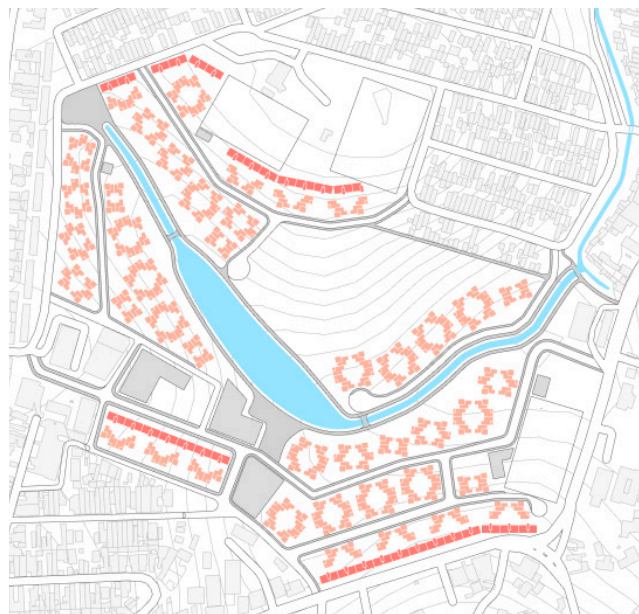
poses an urban system which alternates clusters of housing between greenery and public spaces. The value of the final product can be addressed by first examining some of its challenges and the questions that consequently arise.

Since the target group for the development is displaced people, the clustering scheme responds to the problems associated with displacement by accommodating the continuity of existing communities using its typology and managerial strategy, while reinforcing community networks through the urban plan. However,

this approach only addresses residents in the post-displacement phase. In theory, residents must still wait for housing until the project has been built, which does not address the difficulties residents face prior and during displacement. To what extent is the responsibility of architects towards the residents being accommodated by their design? A solution could require architects to work with residents alongside social workers, urban planners and developers during every stage of displacement.

The adaptability of the system is
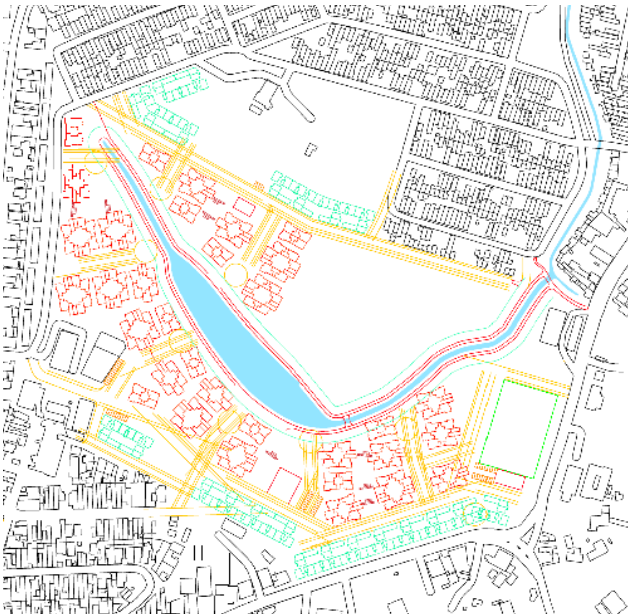
May, 2023

November, 2023

plausible given the minimal required conditions. The site chosen for the project's location was complex – surrounded by several types of urban conditions and odd street patterns. As a result, the final design on the site is less feasible in terms of affordability since it would likely be more complicated to build. Thus, the system would be better suited to a linear site rather than the site that was chosen. Despite this, the implementation of the urban system in a complex plot, demonstrates the design's potential strength in terms of adaptability.

In the light of the staggering housing crises across the globe and increasing need for new housing strategies, a replicable urban system would be beneficial to meet housing needs efficiently and effectively. That said, the adaptability of an urban system in various locations requires careful consideration, since the success of the "transferability" of urban design concepts cannot be easily measured across various physical and social contexts.

Finally, the qualities of the public spaces in the proposal greatly vary across scenarios – conditions facing the main streets, side streets, greenery, and in between housing. Therefore, these areas become primed for social mixing. However, this may be at the expense of housing – the system thus produced a lower density than anticipated- 105 dw/ha instead of the 120 dw/ha benchmark set by the case study analysis.

This result begs the question, what is the right balance between public space and housing, in a city where public space sparsely exists? Would this be greatly valued by residents in this site in comparison to the surrounding area, or lead to another informal pattern of land appropriation as seen in other São Paulo neighborhoods? Would the green areas become fenced off, or become unsafe? The design approach attempts to address these concerns by clearly delineating between public and private spaces, and providing a variety of types of public spaces that would serve the needs of its residents but also attract the rest of the neighborhood. However, there can be no conclusion to the unforeseen impact of a theoretical project.

These examples shed light on the open, ambitious challenge that affects all designers working in foreign contexts. By studying and designing housing patterns in a context that differs from ours, we may find ways to look at the problem differently and give answers to design problems in an innovative way. Learning how to apply strategies from different contexts can also inform how to approach design tasks in our own environments. We must be sensitive to the context, considering our own biases at every stage of the design process by reflecting on why one approach may or may not be suitable. We can hope for our design's success and learn from its failures.

For these reasons, I do believe the topics broached by this thesis bring forward meaningful ideas that touch on many different aspects of Global Housing. The research topic was widely comprehensive, addressing social, economical, environmental, and physical issues relating to housing. The research methods revealed how

Conclusion

case studies and literature often only focuses on one certain aspect, whereas the thesis aimed to use an interdisciplinary approach. The ambition was to create an all-encompassing design that brought together the topics of displacement, water & infrastructure scarcity, and ecological inclusion.

It was difficult to address all these topics with the extent of work that each issue merited. The final approach may not excel at balancing public versus private spaces, giving the best water drainage scheme, or the easiest to build, yet still elegant, design scheme. However, the value of this thesis is in its attempt to bring all these components together, in the hopes that the interrelationships between each issue addressed serves to strengthen the project as a whole. Thus, this thesis stands as a renewal of urban resilience.
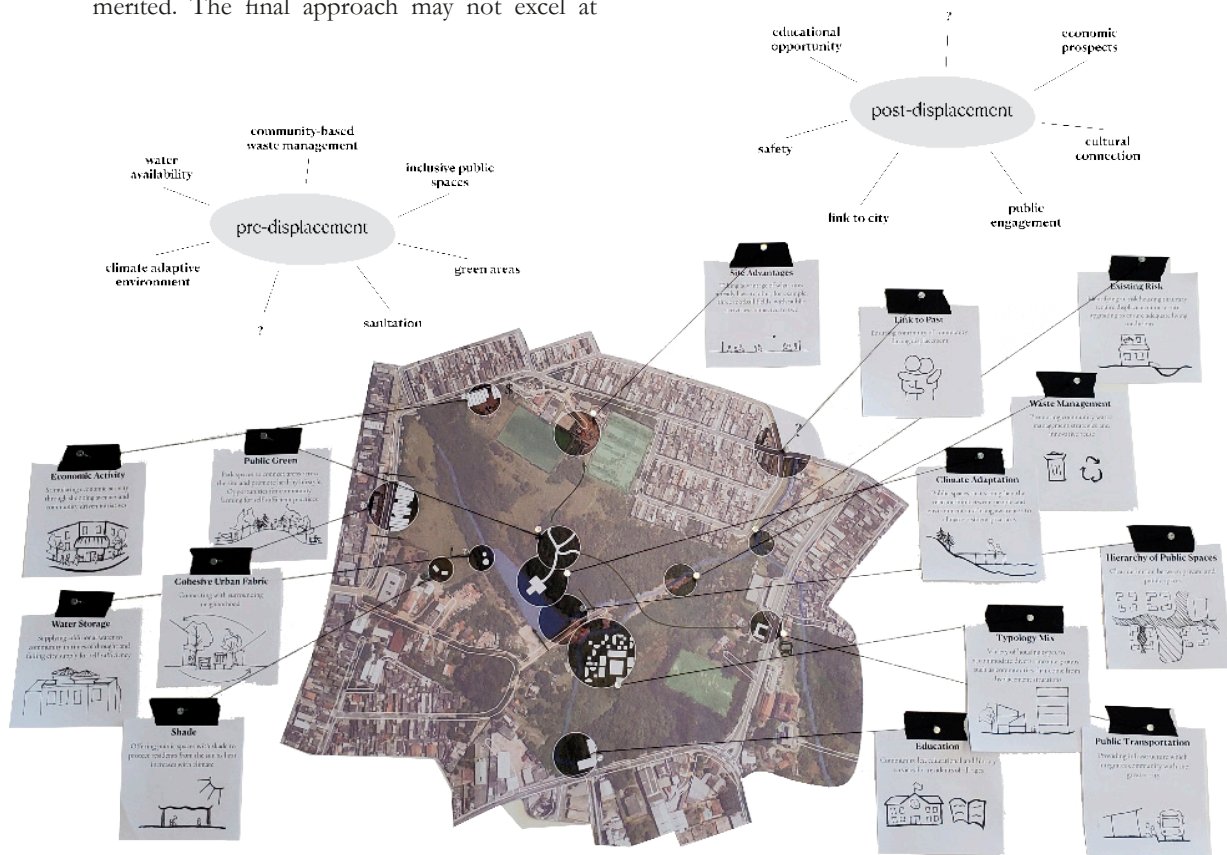
Design Hypothesis, November 2022

bibliography

Alvez, I. (2022, June 27). Novo parque linear esbarra em problema habitacional no Grajaú. Agência Mural. https://agenciamural.org.br/novo-parque-linear-no-grajau-esbarra-em-problema-habitacional/

Ballinger, B., & Wilke, A. (2015). Redefining the Ahwahnee Principles: Challenges from the Favelas of Rio de Janeiro. 4.

Barbosa, L. M., & Coates, R. (2021). Resisting disaster chronopolitics: Favelas and forced displacement in Rio de Janeiro, Brazil. International Journal of Disaster Risk Reduction, 63, 102447. https://doi.org/10.1016/j.ijdrr.2021.102447

Bhan, G. (2019). Notes on a Southern urban practice. Environment and Urbanization, 31(2), 639–654. https://doi.org/10.1177/0956247818815792

Constituição da República Federativa do Brasil, (1988). https://www2.senado.leg.br/bdsf/bitstream/handle/id/518231/CF88_Livro_EC91_2016.pdf

Campello Torres, P. H., Gonçalves, D. A., Mendes de Almeida Collaço, F., Lopes dos Santos, K., Canil, K., Cabral de Sousa Júnior, W., & Jacobi, P. R. (2021). Vulnerability of the São Paulo Macro Metropolis to Droughts and Natural Disasters: Local to Regional Climate Risk Assessments and Policy Responses. Sustainability, 13(1), Article 1. https://doi.org/10.3390/su13010114

Cawood, S., Wahby, N., & Ferrara, L. N. (2022). Hybridity in Practice: Responding to Water Insecurity in São Paulo, Dhaka, and Cairo. 15(3), 21.

Cidade de São Paulo Strategic Master Plan 2014, Pub. L. No. 16.050 (2014).

Cidade de São Paulo. (2018, October 5). My Home My Life | Municipal Secretary of Housing | São Paulo City Hall. Prefeitura da Cidade de São Paulo. https://www.prefeitura.sp.gov.br/cidade/secretarias/habitacao/residencial_espanha/index.php?p=264975

Clarence S. Stein Institute | Works and Legacy | Cornell AAP. (2023). Cornell AAP. https://aap.cornell.edu/academics/crp/stein-institute/works-and-legacy

Cox, A. (2019, October 19). CREB® | Community Profile: Varsity Village. https://www.creb.com/News/CREB-Now/2019/October/community_profile_varsity_2/

Craig, S. (2019). The optimal tuning, within carbon limits, of thermal mass in naturally ventilated buildings. Building and Environment, 165, 106373. https://doi.org/10.1016/j.buildenv.2019.106373

Dickson, E. (2012). Urban risk assessments: Understanding disaster and climate risk in cities. World Bank. http://site.ebrary.com/id/10583938

ETW: Building Profile: New - Louisville. (n.d.). Building Science Corporation. Retrieved November 21, 2022, from https://www.buildingscience.com/documents/profiles/etw-louisville-profile

Famiglietti, J. (2019, March 3). A Map of the Future of Water. Pew Trusts. https://pew.org/37s1hrx

Franca, E., & Barda, M. (2012). Entre O Céu E A Água. Prefeitura de São Paulo.

Gerberg, J. (2015, October 13). See how Brazil's biggest city is fighting a historic drought. Time. https://time.com/4054262/drought-brazil-video/

Gestão Urbana SP. (n.d.). Gestão Urbana SP | Prefeitura da Cidade de São Paulo. Retrieved November 15, 2022, from https://gestaourbana.prefeitura.sp.gov.br/marco-regulatorio/plano-diretor/arquivos/

Guerreiro, I. (2012). USINA_ctah/ Comuna Urbana D. Helder Câmara. USINA_ctah. http://www.usina-ctah.org.br/domhelder.html

Hillside communities learn to mitigate landslide risks. (n.d.). Flood Resilience Portal. Retrieved January 18, 2023, from https://floodresilience.net/blogs/hillside-communities-learn-to-mitigate-landslide-risks/

Human Rights to Water and Sanitation. (2022). UN-Water. https://www.unwater.org/water-facts/human-rights-water-and-sanitation

Jayakody, C., Malalgoda, C. I., Amaratunga, D., Haigh, R., Liyanage, C., Hamza, M., Witt, E., & Fernando, N. (2022). Addressing housing needs of the displaced

people promoting resilient and sustainable communities. International Journal of Disaster Resilience in the Built Environment, 13(3), 368–385. https://doi.org/10.1108/IJDRBE-09-2021-0124

Kaipper Ceratti, M. (2018, May 7). Recovering Water: A Results-Based Approach to Water Supply and Sanitation in Brazil's São Paulo State [Text/HTML]. World Bank. https://www.worldbank.org/en/results/2018/05/07/approach-to-water-supply-and-sanitation-brazil-sao-paulo-state

Lejano, R. P., & Del Bianco, C. (2018). The logic of informality: Pattern and process in a São Paulo favela. Geoforum, 91, 195–205. https://doi.org/10.1016/j.geoforum.2018.03.005

Mahabir, R., Crooks, A., Croitoru, A., & Agouris, P. (2016). The study of slums as social and physical constructs: Challenges and emerging research opportunities. Regional Studies, Regional Science, 3(1), 399–419. https://doi.org/10.1080/21681376.2016.1229130

Mais um corpo é encontrado em área de deslizamento em Santos. (2020, March 6). G1. https://g1.globo.com/sp/santos-regiao/noticia/2020/03/06/mais-um-corpo-e-encon-trado-em-area-de-deslizamento-em-santos.ghtml

Mathur, A., & Cunha, D. da. (2014). Design in the Terrain of Water. Applied Research & Design.

McCarthy, J. (2020, February 9). Why Climate Change and Poverty Are Inextricably Linked. Global Citizen. https://www.globalcitizen.org/en/content/climate-change-is-con-nected-to-poverty/

Millington, N. (2018). Linear Parks and the Political Ecologies of Permeability: Environmental displacement in São Paulo, Brazil. International Journal of Urban and Regional Research, 42(5), 864–881. https://doi.org/10.1111/1468-2427.12657

Muggah, R. (2014). Os deslocados: Conceptualizing internal displacement in Brazil. HASOW Humanitarian Action in Situations Other Tham War, July.

Pimentel Walker, A. P., & Arquero de Alarcón, M. (2018).

The Competing Social and Environmental Functions of Private Urban Land: The Case of an Informal Land Occupation in São Paulo's South Periphery. Sustainability, 10(11), Article 11. https://doi.org/10.3390/su10114160

Prefeitura da Cidade de São Paulo. (2022, July 26). Urban-ization of Precarious Settlements | Secretaria Municipal de Habitação. Prefeitura da Cidade de São Paulo. https://www.prefeitura.sp.gov.br/cidade/secretarias/habitacao/secretaria_executiva_do_programa_mananciais/noticias/index.php?p=332564

Refresca São Paulo—Adapting Slums to Heat Islands Stresses and Water Insecurity—Brazil | UNFCCC. (n.d.). Retrieved November 4, 2022, from https://unfccc.int/climate-action/un-global-climate-action-awards/winning-projects/activity-database/refresca-sao-paulo-adapt-ing-slums-to-heat-islands-stresses-and-water-insecurity-brazil

Robinson, W. C. (2003). Risks and Rights: The Causes, Consequences, and Challenges of Development-Induced Displacement. 102.

Samper, J., Shelby, J. A., & Behary, D. (2020). The Paradox of Informal Settlements Revealed in an ATLAS of Informality: Findings from Mapping Growth in the Most Common Yet Unmapped Forms of Urbanization. Sustainability, 12(22), Article 22. https://doi.org/10.3390/su12229510

Santoro, P. F. (2015). Urban planning instruments for promoting social interest housing: From zoning to obligatory percentages in São Paulo, Brazil, in dialog with Bogotá, Colombia. Revista Brasileira de Estudos Urbanos e Regionais (RBEUR), 17(2), 99–117.

Satterthwaite, D., Archer, D., Colenbrander, S., Dodman, D., Hardoy, J., Mitlin, D., & Patel, S. (2020). Building Resilience to Climate Change in Informal Settlements. One Earth, 2(2), 143–156. https://doi.org/10.1016/j.oneear.2020.02.002

São Paulo: A Tale of Two Cities. (2010). UN-Habitat.

Secretaria Municipal de Habitação. (2022, July 26). Programa Mananciais. PROGRAMA MANANCIAIS | Secretaria

Municipal de Habitação | Prefeitura Da Cidade de São Paulo. https://www.prefeitura.sp.gov.br/cidade/secretarias/habitacao/secretaria_executivo_do_programa_mananciais/noticias/index.php?p=332560

Secretaria Municipal de Habitação, & Secretaria Especial de Comunicação. (2022, May 5). Prefeitura e CDHU entregam mais 316 unidades no Conjunto Habitacional Chácara do Conde—Prefeito Bruno Covas. Prefeitura de Sao Paulo. https://www.capital.sp.gov.br/noticia/prefeitura-e-cdhu-entregam-mais-316-unidades-no-conjunto-habitacional-chacara-do-conde-prefeito-bruno-covas

Secretaria Municipal de Habitação. (2016, June 17). Habitação. habitaSAMPA. http://www.habitasampa.inf.br:80/habitacao/

Secretaria Municipal de Habitação. (2018, October 5). Atendimento Habitacional Residencial Espanha. Secretaria Municipal de Habitação | Prefeitura da Cidade de São Paulo; Prefeitura da Cidade de São Paulo. https://www.prefeitura.sp.gov.br/cidade/secretarias/habitacao/residencial_espanha/index.php?p=264981

Secretaria Municipal de Habitação. (2022, October 20). Visit to Cantinho do Céu Neighborhood & Chacara do Conde Housing Complex with SEHAB Member [Personal communication].

Sennett, R. (2018). Building and dwelling: Ethics for the city. Allen Lane, Penguin Books.

Sennett, R. (2006). The Open City. Urban Age.

Silva, F. P. da. (2020). Perpetuating the temporary: Considerations on the use of Rental Assistance in the city of São Paulo. Revista Brasileira de Estudos Urbanos e Regionais, 1–25. https://doi.org/10.22296/2317-1529.rbeur.202030en

Soares, M. C. (2014). Parques lineares em São Paulo: Uma rede de rios e áreas verdes que conecta lugares e pessoas [Text, Universidade de São Paulo]. https://doi.org/10.11606/D.16.2014.tde-23062015-162603

Sonho frustrado: Casa própria foi o começo, mas sem estrutura vida segue dura no maior Minha Casa, Minha Vida de SP. (n.d.). Retrieved March 21, 2023, from https://noticias.uol.com.br/reportagens-especiais/a-falta-de-estrutura-no-maior-minha-casa-minha-vida-de-sao-paulo/

Souza-Lopes, A. V. de, & Saab, T. B. (2021). An analysis of public policy for urban housing in the state of São Paulo. GEOUSP, 25, e.
SP: Com dez vezes mais água que Cantareira, Billings pode ser alternativa. (2015, January 20). Agência Brasil. https://agenciabrasil.ebc.com.br/geral/noticia/2015-01/com-dez-vezes-mais-agua-que-o-cantareira-billings-pode-ser-alternativa

Stein, C. S. (1989). Toward new towns for America. M.I.T. Press.

Tomás, L. R., Soares, G. G., Jorge, A. A. S., Mendes, J. F., Freitas, V. L. S., & Santos, L. B. L. (2022). Flood risk map from hydrological and mobility data: A case study in São Paulo (Brazil). Transactions in GIS, 26(5), 2341–2365. https://doi.org/10.1111/tgis.12962

Urbanização de Heliópolis: Os desafios da intervenção na cidade informal. (2022, October 5). ArchDaily Brasil. https://www.archdaily.com.br/br/989815/urbanizacao-de-heliopolis-os-desafios-da-intervencao-na-cidade-informal

USINA 25 anos—Comuna Urbana D. Hélder Câmara. (2015, June 7). ArchDaily Brasil. https://www.archdaily.com.br/br/767961/usina-25-anos-comuna-urbana-d-helder-camara

VIGLIECCA & ASSOCIADOS. (n.d.). Retrieved October 20, 2023, from http://www.vigliecca.com.br/en/projects/heliopolis-urbanization-glebe-a

World Bank Group. (2022). Sao Paulo, Brazil's Water Challenges. 2030 Water Resources Group. https://2030wrg.org/where-we-work/sao-paulo-brazil/

Young, A. (2013). Urban expansion and environmental risk in the São Paulo Metropolitan Area. Climate Research, 57, 73–80. https://doi.org/10.3354/cr01161

ZEIS maps: Comparing areas to be earmarked exclusively for social housing in São Paulo city. (2016). Land Use Policy, 58, 445–455. https://doi.org/10.1016/j.landusepol.2016.08.010

Geneviève Mae Shymanski
5466067
Global Housing Graduation Studio 2022-2023
São Paulo: Repair and Consolidate
TU Delft MSc AUBS Thesis

Design Mentor | *Ir. Harald Mooij*
Research Mentor | *Dr. Nelson Mota*
Building Technology Mentor | *Ir. Stephan Verkuijlen*

TUDelft Department of Architecture
BK Bouwkunde

Architecture & Dwelling