



# water urban infrastructure

a disaster housing strategie response for Beira

Universidad Politecnico di Torino

Andrea Orellana Lliguaipuma  
Tuthor: Prof\_Arq. Francesca De Filippi  
Co-Tuthor: Prof\_Arq. Matteo Robiglio







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Universidad Politecnico di Torino  
Architettura per il progetto sostenibile

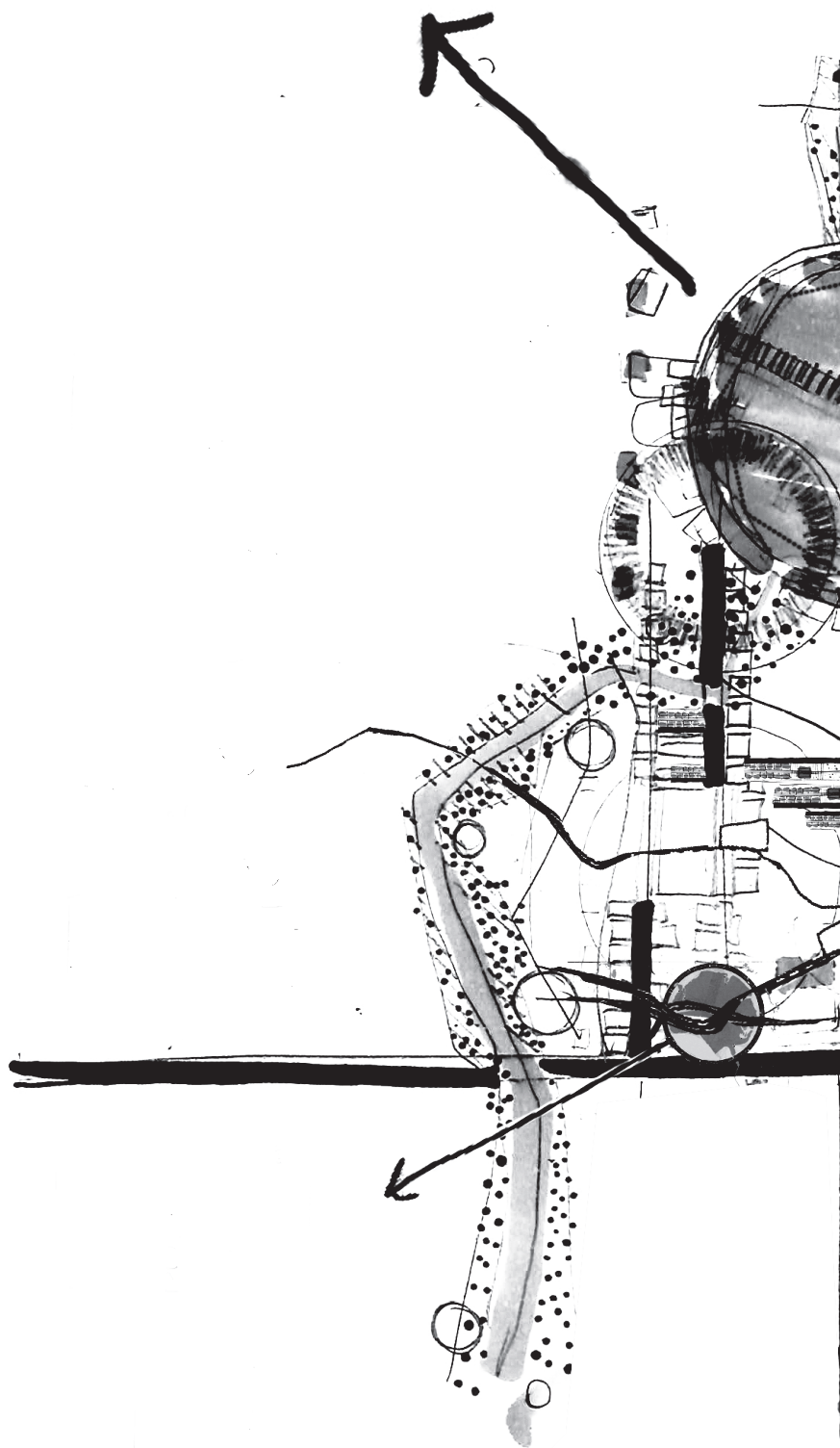
ANDREA FRANCISCA ORELLANA LLIGUAIPUMA  
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TUTOR: Prof\_Arq. Francesca De Filippi

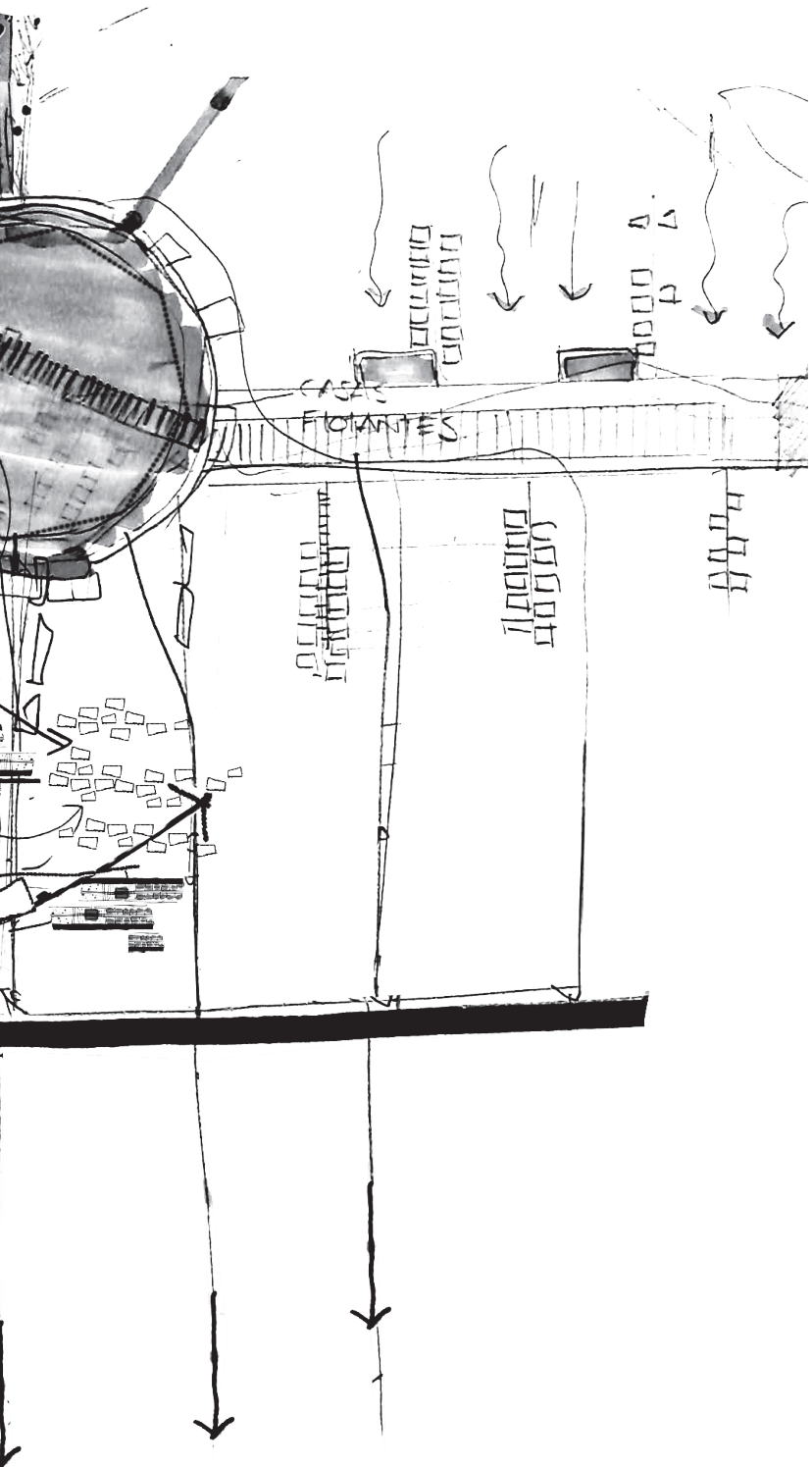
CO-TUTOR: Prof\_Arq. Matteo Robiglio

Torino, 22 February 2021









Dedicata alla città.  
Alla dimensione complessa e incontenibile di cui siamo  
parte, allo spazio che ci permette di avvicinarci o  
allontanarci, allo spazio che costruisce infinite possibilità  
di scambiare, connetterci, inventarci, fluire, proteggerci.  
Allo spazio che ci permette di viverlo.

andrea orellana



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## ABSTRACT \_

key words | urban infrastructure ; fragile city ; social housing ; water infrastructure ; flooding cities;

*“Il movimento della vita è caratterizzato dall’aver un ordine. Il problema è il rapporto tra ordine e libertà, ma il fatto importante è che solo riunendo gli estremi possiamo ottenere il quadro completo. Un approccio da solo, non è sufficiente. Il compito consiste nel creare un ordine in quello che sembra essere incompatibile ”*  
Manfredo Tafuri

*“Il movimento della vita è caratterizzato dall’aver un ordine. Il problema è il rapporto tra ordine e libertà, ma il fatto importante è che solo riunendo gli estremi possiamo ottenere il quadro completo. Un approccio da solo, non è sufficiente. Il compito consiste nel creare un ordine in quello che sembra essere incompatibile ”*  
Manfredo Tafuri

The different forms of construction and recovery of Beira and its consolidated scenarios converge in an unplanned city. It have been generated many not articulated urban areas, spaces inhabited by population in a poverty state, physically and socially segregated, denoting the lack of urban facilities, and a precarious infrastructure, adding to this, the extreme vulnerability to natural disasters.

The approach this thesis proposes is to consider the term “infrastructure” as a whole concept that join the services and facilities of a city and the housing issue. A proposal that attempt to be a point of departure that create conditions and provides possibilities to simultaneously manage urban water problems and improve social housing. In other words, consider the concept of “Urban Infrastructure” as being the main responsible for a disaster response and the one who sets the path for recovery and reconstruction of the city. An element that redefines the space and respond to new demands that the traditional approach does not conceive.

Le diverse forme di costruzione e recupero di Beira e dei suoi scenari consolidati convergono in una città non pianificata. Sono state generate molte aree urbane non articolate, spazi abitati da popolazione in stato di povertà, fisica e socialmente segregata, denotando la mancanza di strutture urbane, e una precaria infrastruttura, aggiungendo a questo l'estrema vulnerabilità all clima.

L'approccio che questa tesi propone è quello di considerare il termine “infrastruttura” come un concetto che unisce i servizi e le strutture di una città e social housing. Una proposta che cerca di essere un punto di partenza, che crea le condizioni e offre possibilità per gestire contemporaneamente i problemi urbani di acqua e migliorare l'edilizia sociale. In altre parole, si consideri il concetto di “Infrastruttura urbana” come il principale responsabile di una risposta al disastro e colui che stabilisce la strada per il recupero e la ricostruzione della città.

Un elemento che ridefinisce lo spazio e risponde a nuove esigenze che l'approccio tradizionale non concepisce.



Tel Aviv

Addis Ababa

Beira



## THEORETICAL FRAME WORK \_

As it happened in many African cities, in Beira, has been evident the aftermath of an unplanned city, a consequence of a disorderly territorial expansion, which has had a significant impact even more after having faced a rapid population growth, natural disasters, a 15-year of civil war, etc"; that enables the growth of poverty, and inequality because of its vulnerable economy. Today, Beira is one of the poorest countries in the world and ranked third among the African countries most exposed to climate-related risks (World Bank, GFDRR).

Currently, in African cities, there is a new wave of global interventionism, whose vision of urban space is still unexplored, many scenarios arise around this phenomenon with massive emergency housing, forced displacement, resettlement; non-existent, unfinished or underutilized infrastructure, urban plans awaiting execution, an increasingly evident complex reality, thus generating an open discussion on the development of different forms of structuring, organizing and recovering the city of Beira.

To support the city several recent international interests have been implemented under these conditions. For example, The Dutch government has significantly invested in the city, operating the port, and donating money for infrastructure improvements. Germany's Development Bank recently constructed a parkway along the Chiveve River; World Bank-financed other major water infrastructure projects ; international donors, such as the Sustai-

nable Development Goals (SDGs) and New Urban Agenda (NUA) are interested also in collaborate with the city recovery.

In this context it can be observed that the development of African urbanism is under the international and local interest of many stakeholders who aim to recover fragile cities like Beira, often considering the rhetoric of a "modernize" plan that promise "smart cities" a "eco-city", "future city", however, as Murath Shannon has noted in her article: (Who Controls the City in the Global Urban Era?) these actors have been pursuing highly exclusionary 'urban fantasy' as seen in the new city developments, these initiatives span various scales and developments, ranging from satellite towns, gated communities and entire capital cities. Based on utopian visions of high modernity and market-based governance models, these developments have been hailed as a coming-to-Africa of 'speculative urbanism' it has given rise to new disagreements and complexities which have served to understand that urban development has to be seen with a different perspective to rethink the city.

Most international, local, and academic urban visions and plans, conclude materializing their contribution in "infrastructures" being considered one of the tools to address the solution to this problem-This is why I consider it necessary to clarify the concept of infrastructure. Infrastructure in very broad terms is generally defined as the "set of elements or services deemed necessary for the creation and operation of an organization



organization such as roads, supply networks, cables, pipelines, energy networks, flood management systems, telecommunications, engineering works, etc. Edward Soja considers infrastructure as “the system capable of articulating the territory and capable of responding to diverse speeds and varied scales”.

On the other hand, from sociology and thanks to the contributions of Karl Marx, infrastructure is taken as the basis of society. Marx takes the concept of infrastructure as the founding structure of a society.

Instead, Alvar Aalto in 1932, considered the telephone and the radio as an infrastructure of the city, reflecting that these could come to determine the form of settlement of a group of houses, compared the telephone infrastructure to other forms of communication: the streets of a city, the national railway network, the telegraph or post office, attributing to the infrastructures the capacity to generate an organic, decentralized, but not dispersed city model.

**“The validity that holds Aalto’s thoughts dwells in the infrastructures as part of the geographic and territorial nature on which it is sustained; a clear intention to create with infrastructures, spatial and functional structures in which housing, streets, squares, buildings and above all, the people participate. A system is not imposed but rather the system rises as a necessity of the project itself. “ (PROYECTO, PROGRESO, ARQUITECTURA. N13, NOVIEMBRE 2015 (AÑO VI) arquitectura e infraestructura)**

Also, nowadays we talk about the resilience of infrastructure concept that is the ability to reduce the magnitude, impact, or duration of disruption events defining its effectiveness on its ability to anticipate, absorb, adapt and/or recover rapidly from a potentially disruptive event. (Guidelines for Critical Infrastructures Resilience Evaluation ) pdf

Here comes the importance of a whole rethinking around the concept of INFRASTRUCTURE, and question us about whether there is then a correct place, function, or definition of infrastructure, especially when its concepts are intensely confronted? Therefore I consider that there is a need to reappraise the infrastructure concept, looking for new threads that give a new meaning to the way of making the city, because this is essential for the role that architecture plays in the current and future circumstances of the African environment and, even more so, in fragile cities such as Beira. It is within this context that the thesis explores new strategies and with a guide supported in history, I take as an example and starting point several ideologies between infrastructure and architecture amalgamation.

For example, through the ideologies of Kenzo Tange we could stress the importance of a whole rethinking around the concept of infrastructure, he has shown how likely it may be, to think about the development of a city on the sea as it develops in the plan of territorial scale on the bay of Tokyo. The interest of the proposal is focused on its ideological contribution because everything lies and is

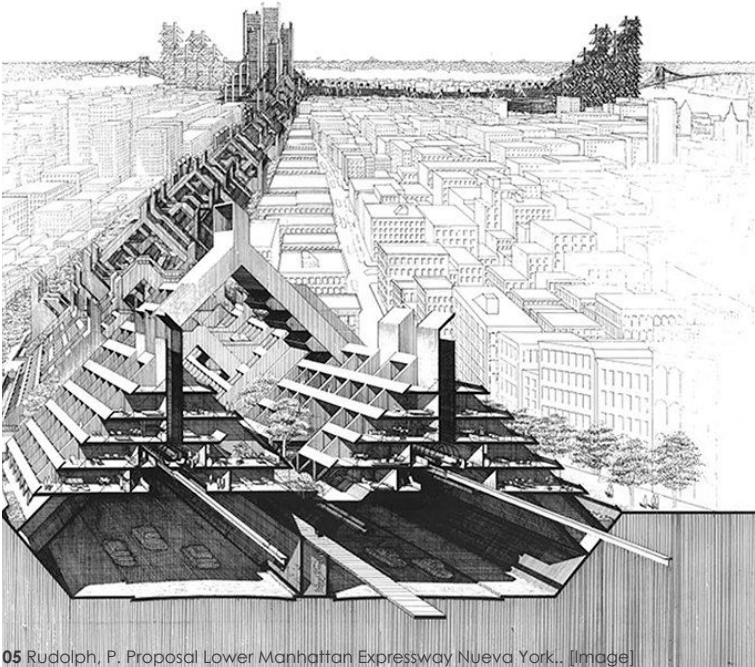












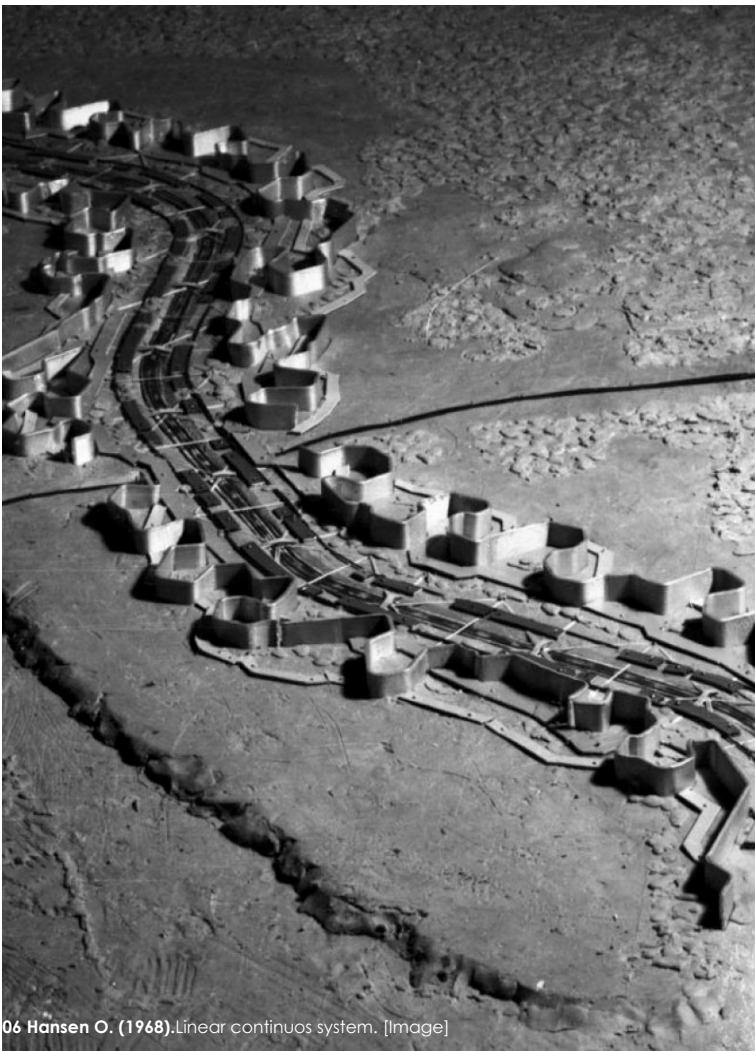
05 Rudolph, P. Proposal Lower Manhattan Expressway Nueva York.. [Image]

based on the “movement”,; Tange considers :

**“We live in a world where there are big incompatibilities: human and superhuman scale, stability and mobility, permanence and change, identity and anonymity, comprehensibility and universality. The movement of life is characterized by having an order. The problem is the relationship between order and freedom, but the important fact is that only by approaching the extremes can we get the full picture. An approach alone is not sufficient. The task is to create an order in what appears to be incompatible” (Tafuri, Manfred. “Un piano per Tokyo e le nuove problematiche dell’urbanistica contemporanea-Panorama”)**

We can then understand the intention to merge the different orders that make up a city. Orders that require a system capable of organizing the new interpretation of the actual city where communications, growth and constant change creates new relationships and identity.

In the same way through the ideas and vision of Oscar Hansen and his continuous linear system, in which he proposed “the open form theory” as his architectural vision. He put particular attention to the socio-spatial problematic, understanding the government as a “space-producing agent”, and people as an important part of a collective. He focused on the social and political dimension, since for him was fundamental a project whose aim was not only to provide to the territory a functional urban system, but also to offer leisure spaces to collective and community, also the model stimulates the individual initiative. After all, it represents the combination of infrastructure and architecture, a laboratory where ways of life could be assessment, In any case, the most outstanding contribution is precisely to generate an architecture as support, which response to the growing and unknown contemporary demand.



06 Hansen O. (1968).Linear continuous system. [Image]



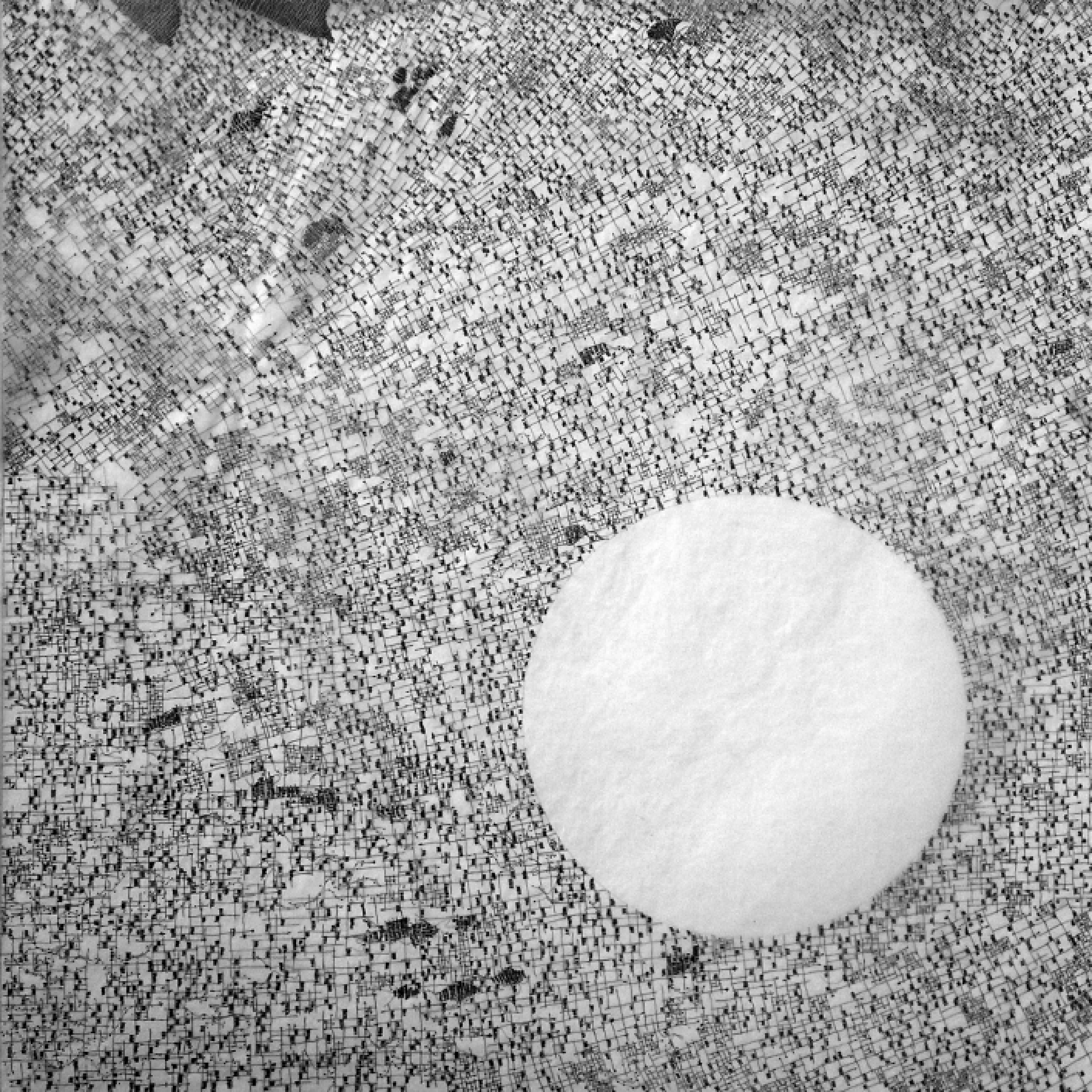
## RESEARCH QUESTION

It is interesting to compare past premises with the current approaches, since it makes us question if: In the current conditions, the union between architecture and infrastructures can prepare the ground for future constructions and propitiate the suitable conditions to face any event. Therefore, within the described scope I wonder if:

**Can the urban water infrastructure implementation in Beira city generate a supporting architecture that responds to constant changes and at the same time be the responsible for anticipate, absorb, adapt and recover rapidly from a potentially disruptive event?**

It makes sense that any infrastructure is part of a big system and that, infrastructures are essential structures in any spatial and functional organization, always present in creation, management and organization of an idea that aimed to make architecture. If something we have to question is the value of the infrastructures in the city, because it is necessary to reflect that “in the past the architecture provided security, in these moments we must care, mitigate and repair.”.











## OBJECTIVES\_

### SPECIFICS

- Contribute to current discussions about 'making cities inclusive, safe, resilient and sustainable.
- Contribute to the thinking of sustainable urban infrastructure development in African cities.
- Provide an empirical analysis of forced displacement and resettlement associated with infrastructure development in Beira city.
- Generate an assessment of the current state of water treatment infrastructure facilities in Beira.
- A clear strategy for climate change adaptation for water issues, and resettlement.
- Generate an urban facilities that merges housing and an urban infrastructure capable of enable adequate conditions to face any climatic, social event.
- Generate principles and strategies that can later be used as a basis for the development of houses that coexist with water.

### GENERAL

Explore "A new urban spatial order", structuring Beira through an urban infrastructure capable of organizing the interpretation of the current city, in which urban growth and constant change allow living with the need to co-inhabit with water and climate changes.

"Only if we are able to inhabit, we can build"  
Heidegger







## METHODOLOGY \_

A systematic approach has been chosen to provide an answer to this research question, dividing the research into four parts in which I will describe a general literature overview of Africa specifically on Beira, in addition to this, the assortment of case studies focusing on the "Arquitectura + Infrastructure combination", its principles, concept, and viability over time.

I will explore according to the following Guide Line:

**1)** The first section of the report covers background information of the new urban approach in the world specifically in Africa's infrastructure + architecture. As well as its plans, development, progress, and causes in order to have a general overview of what is happening worldwide but always linking to African background.

**2)** The second part provides general data about the city, including the historical trajectory of Beira city, its's geography, climate issues, and a brief outline of the urban development infrastructure. The research will focus on the future vision of Beira, highlighting the water problem. The purpose of this section is to provide a general context for the most common scenarios that would call for an urban infrastructure intervention.

**3) Then** provides a general description of of architecture and city infrastructure concept, with the aim of seeking past and current approaches, obtaining a clear conclusion of principles, concepts, and strategies as a solution to face Beira issues.

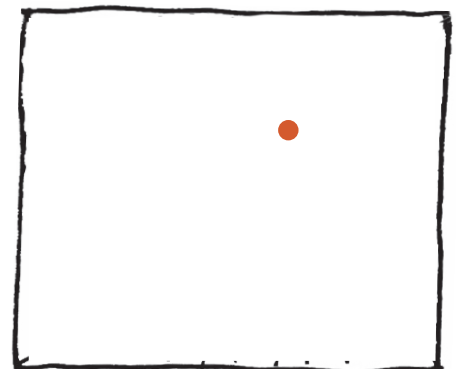
**4)** While the last part will provide general concepts and hints of infrastructure + architecture, in this moment i will conclude and explain a possible "concept" regarding specific strategies to be taken into account in the definition of our proposal (water machine + housing).



01.



**b e t w e e n**  
**architecture &**  
**infrastructure**  
general background







08 Getty Images. (2019). u=Urban city view . [Image]



## URBAN APPROACH \_

Africa is urbanizing rapidly and is facing enormous urban challenges; such as the growth of slums, increase inequality, and significant transformations in cities and towns. This brings into perspective a chance to assess and explore African cities tackling different issues that overwhelm societies. These include social structures, economic pathways, and governance systems that increase even more and shape the path to a confused urban development.

Understand what “urbanize” means in Africa is ambiguous because we could realize dissimilar scenarios that are not just a matter of delayed history. Apart from all the historical and cultural complex mix of factors that affected how cities grew in Africa. Nowadays, we can observe that urban areas are characterized according to the function of the area, population, adaptive capacity to face climatic disasters, dynamic of place resettlement, and lack of solid government policies. Which varies widely in the continent without making evident the logic of an Africa urbanization trend.

Forexample, “urban” areas are characterized by the dominance of non-agricultural land and a formal and modernized built environment. Demonstrating that agricultural activities are not considered an integral part of an urban area. In the same way, the invasion of urban development on rural areas and their conflicts between land use, do not clearly define this African urban dynamic. (Abraham r. Matamanda. 2019).

Instead of that, the unknown scenario of environmental impacts such as floods, landslides, cyclones, storms, sea-level rise, that force many people to leave their homes and re-establish themselves in new spaces, causing a chaotic growth of the cities thus increasing the number of people exposed to problems of overpopulation, resettlement, and lack of housing. Add to this, there is an unplanned strategy answer to the African problems due to the mass production of emergency housing financed with international aid, investments, and numerous assets flow.

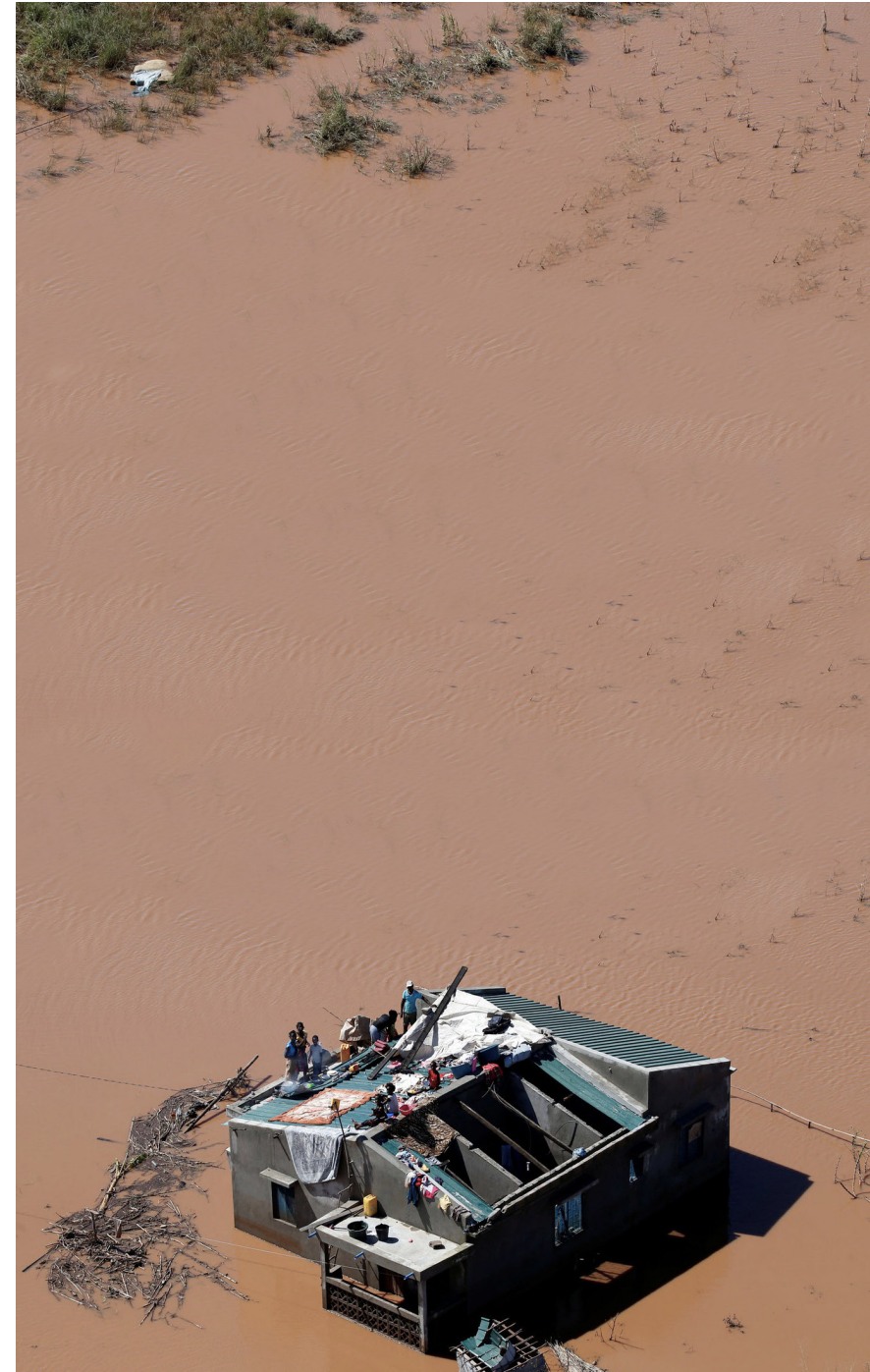
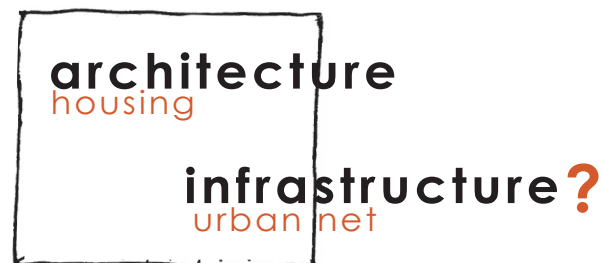
Besides this, it has become even more difficult to define “urbanization in Africa.” Due to the uncertainty on how all these problems are attempted, it’s clear that the land use management, the provision of basic infrastructures and services are in hands of a government that as smit w. Described: “governance appears to lack any semblance of coherence and to be fragmented, disjointed and divided by deep antagonisms. Key actors continually challenge each other’s legitimacy to “rule”(2018). This means that these actors cannot address the problem of the rapid growth of African cities.

Furthermore, given the sorts of challenges that African cities are facing, I believe that to create a solid basis for the current generation and think about a future resilient Africa, it’s crucial to ask ourselves: what is the path to move towards sustainability?.



However, it becomes critical to talk about “sustainability” since unplanned urban growth is the main threat when the necessary infrastructure is not developed. How can the concept(s) of sustainability be applied? Due to the fragility nature of African cities, some methods of “resistance” against unexpected events are required. Therefore, rather than think of immediate responses as “massive emergency housing” or “basis facilities”.

We should think about solutions as a city-level infrastructure whose aim is not only to provide to the territory an urban system but also generate an architecture as support, creating a space that responds to the unknown climate disasters, to the creation of community. A space that shows how to lead and co-live with water problems, and will be ready for any emergency event.



09 Barbier A. (2019). Weather cyclone disaster . [Image]





10 Barbier A. (2019).Infrastructure after cyclone Idai. [Image]



## BETWEEN ARCHITECTURE AND CITY INFRASTRUCTURE \_

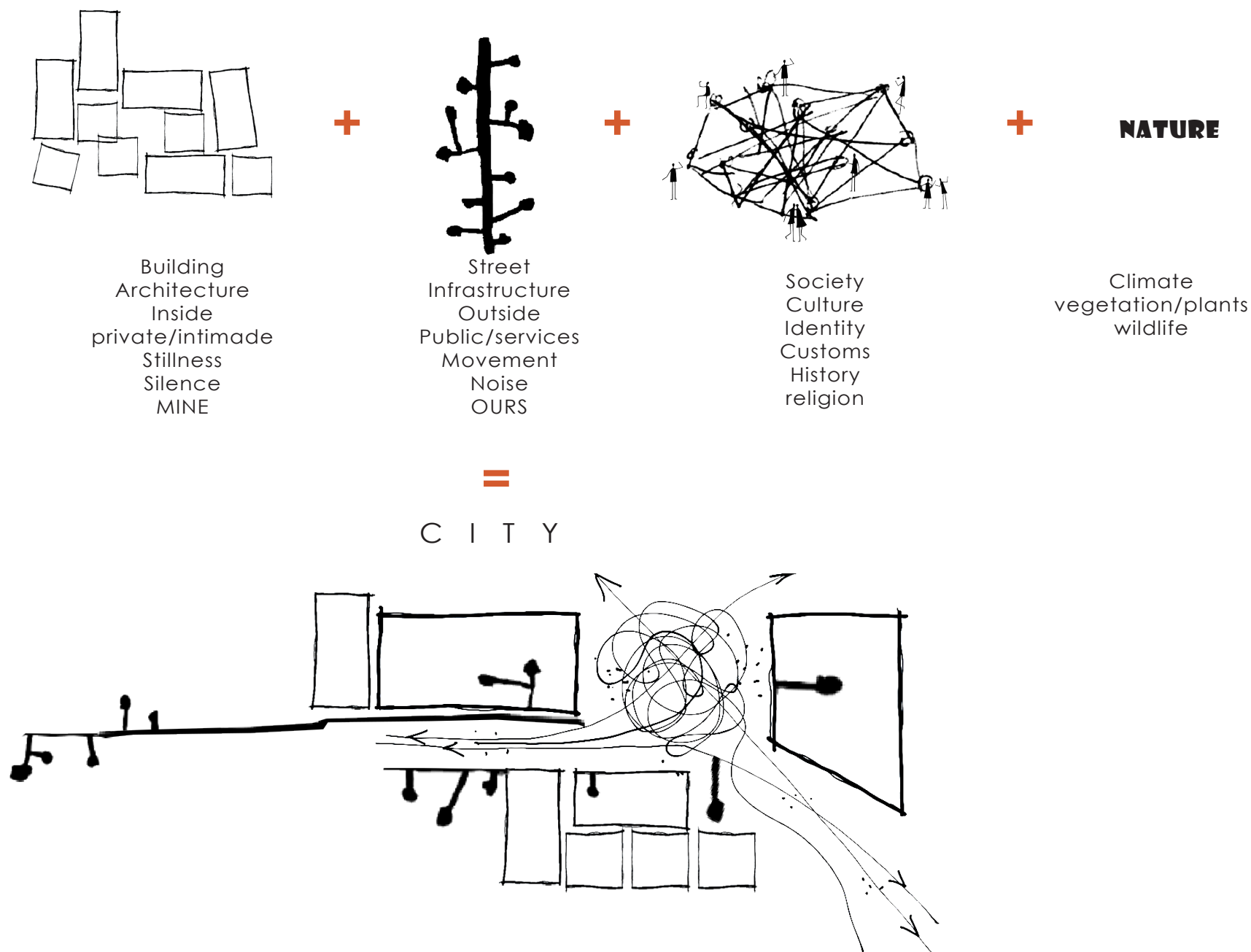
How to consider the design of the infrastructures of a city as an architectural issue? Since the late '60s, housing begins to have equal importance as all the systems that support them. Understanding private spaces (the housing) and public spaces (park, squares, hospitals, light network, water, sewage) as protagonists of the project, no longer as isolated functions but inside a paradigm, based in a networks and connections system. (Ramos, 2015, pg.17).

However, half a century has passed since these ideas about "architecture + infrastructure" appeared. We can observe that cities continue to make their infrastructures based on isolated technical arguments, and very few cases thought from the architectural field and the city's reality. The present work proposes an approach to Beira by extrapolating the meaning of "infrastructure" and "architecture" since I think that it is necessary to consider them as a whole and not each one as isolated elements, analyzing the complexity of the dynamics of Beira itself and the particularities of its citizens.

This analysis must start from the idea of the city established by four protagonists: infrastructure / architecture / society / nature. (public / private / social / climate).

These will be developed theoretically in the first section and incorporated into the discourse throughout the investigation. Although each term has its concept itself, there is an evident synergistic relationship between each one.







## General Concepts and Vision

Cities are immersed in a constant transformation process, expanding and renewing through the conservation, replacement, addition, reconstruction, or elimination of their architecture and infrastructure. Search to satisfy the needs of the systems and infrastructures of the city by updating them, to not only to improve the inhabitants' life quality but also to be more respectful with the environment. But how do you differentiate architecture from infrastructure? Where does one end and the other begin?

According to Mangada, E. (2015) in his article "Calles y edificios " understands "as infrastructure: the street. And as architecture: the building. Contemplating both, inseparably. The street, as a synthesis of urban infrastructures, including (cables, streetlights, or catenaries) and the underground (sewers, water, or metro). The infrastructure is the outside, the public, the services. Architecture is what is inside, what is intimate. The infrastructure is the movement, the noise. The architecture is the stillness, the silence. Architecture encloses and protects what is mine, infrastructure houses and moves what is ours, the plural. But the city and the infrastructures are not born simultaneously. As urban and social development became more complex, the different elements appeared in response to the city's needs.

According to Perre Bellanger, cities are supported by their infrastructures. Although

the arguments that initially drove its creation were only functional. Today it has different and forceful importance, which goes beyond its practical use.

But, what is infrastructure anyway? Infrastructure, in a very broad terms, is generally defined as the "set of elements or services deemed necessary for the creation and operation of an organization such as roads, supply networks, cables, pipelines, energy networks, flood management systems, telecommunications, engineering works, etc. Edward Soja considers infrastructure as "the system capable of articulating the territory and capable of responding to diverse speeds and varied scales"

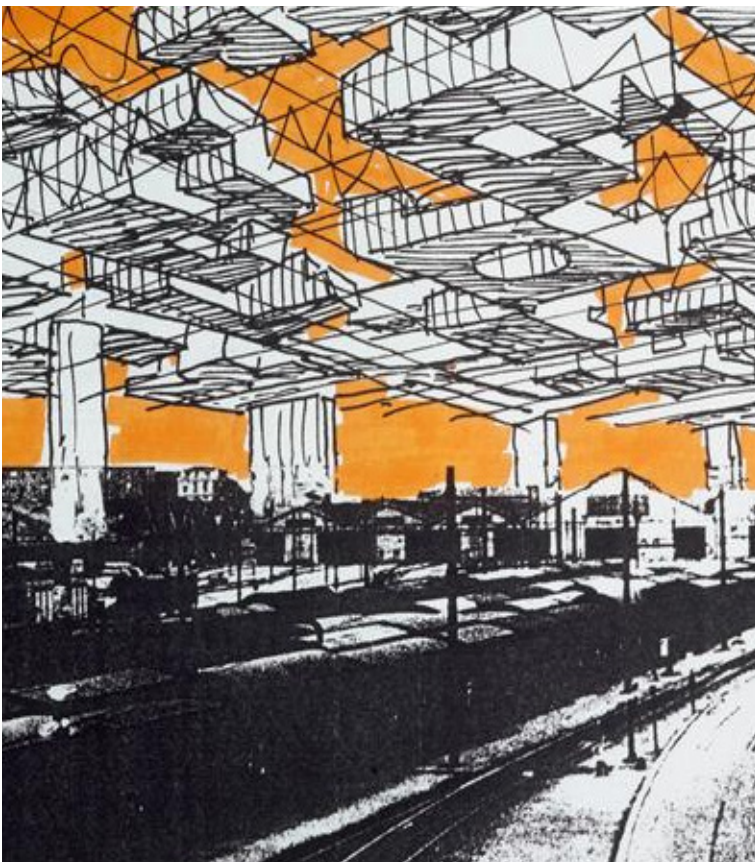
We can then deduce that modern cities' infrastructures are four: sanitation, transport, energy, and communication. The first is motivated by hygienic needs, the second by the machines apparition, (railway-plane-car, etc) the third by the advance in living conditions, and the last arising from technological advances and social transformations.

While this definition is purely functional, other sources broaden its definition to include parameters such as telecommunications, waste disposal, water treatment, power grids, ecological infrastructures, and mega structures. Furthermore, today we talk about the concept of infrastructure resilience, which is the ability to reduce the magnitude, impact, or duration of disruptive events, defining their effectiveness in their ability to anticipate, absorb, adapt and recover quickly from a potentially disruptive event. (Guidelines for the assessment of the resilience of critical infrastructure) pdf.event.

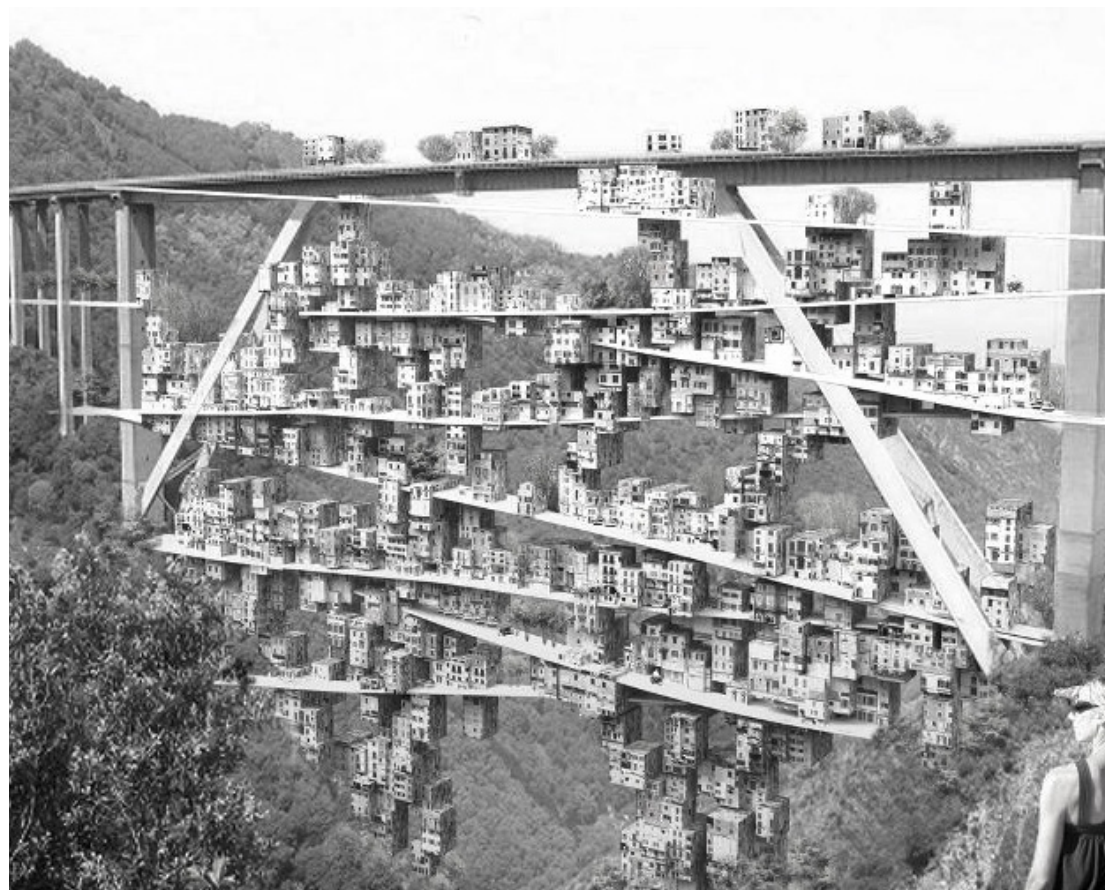


In this city's transformation process, with a new position of the architect, in which infrastructure (street) and architecture (building) are inseparable in their conception and their hypothetical realization. It is interesting to observe the first images that appear in projects such as Kenzo Tange's for Tokyo Bay; with Yona Friedman's *Ville Spatiale* or even Archigram. And just a few years ago, Zaera's Yokohama terminal should be added. Taking us to a completely different concept, however in the case of Beira we find ourselves in a different reality.

As a result, for each new instance, the architecture has indicated and designed infrastructure places. The context has been modified and new situations have been generated. This has a direct impact on the organization of urban and territorial structures, on the internal cities' mobility, and also in people's interaction. In other words, faced with a scenario full of infrastructures with different connotations, each one going through a different moment in its life cycle, it is worth asking: **(architecture or infrastructure)?**



12 Friedman, Y. *Ville Spatiale*, (1959-60). Courtesy Studio Friedman [Image]



13 Ja Studio. (2018). The Habitable Bridge. [Image]

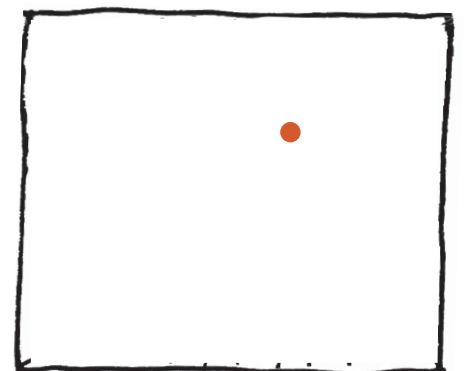


02.



# BEIRA

general overview







14 Google Earth. (2020).Beira City. [Image]



15 Google Earth. (2020).Beira City. [Image]



16 Getty Images. (2019).Beira Neighborhood. [Image]



# Beira

## Synthesis

Beira is a city located in the lowlands of central Mozambique, at the end of the Great Rift valley, in the delta of the Pungwe River, where it meets the Indian Ocean. After facing increasing of the population in the last years, Beira nowadays has a population of around 540,000, becoming the fourth-largest city in population in Mozambique. Despite Mozambique ranks among the lowest nations on the UN's Human Development index, it is a nation plenty of natural resources. So the World Wildlife Fund for Nature has developed a Natural Capital Program to help protecting coral reefs, seagrass beds, mangrove forests, and other ecologies along Mozambique's coastline.

Beira was founded in 1887 as a port city, only a few meters above the sea level. Currently it is the second largest seaport in Mozambique, after Maputo. The port of Beira has a significant importance in the region, because it acts as gateway for the country and the land-locked nations of Zimbabwe, Zambia and Malawi, providing food and other basic products to countries in East Africa. In the early 20th century, the Portuguese created the main seaport in Beira and a railway to Rhodesia. This infrastructure was developed on top of Beira's sandbar, denying its natural capital.

The city was a major hub in East Africa that included tourism, fishing, and trading activities. Beira's independence in 1975 was followed by a 15-year civil war (1977-1992) that contributed to the growth of poverty and inequality. Since then, multiple social, economic, and climate threats have evolved in Beira's already vulnerable economy. The few infrastructure the Portuguese built is concentrated near the coast, and much of it has not been improved since their 1974 departure following Mozambique's independence.

Today, Mozambique is one of the poorest countries in the world and ranked third among the African countries most exposed to climate-related risks (World Bank, GFDRR).

Since the lack of awareness of African geography can be seen as changing and confusing due to the multiple relationships of union and rupture that it has suffered over the years, even it turns out to be an area in permanent resilience. Beira is being a city that is drastically devastated by the climatic situation, this not only leads to the desire to build bridges, schools, and hospitals, but also to the need to reinforce the different identities of the territory fragmented.

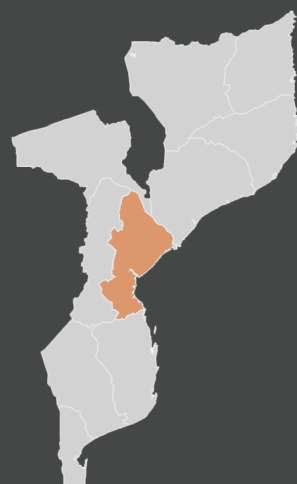
Climate change effects are a main issue in Beira due to the city's low elevation and proximity to the Indian ocean and nearby Pungwe river delta. Large parts of the city centre are at risk from rising sea levels, and severe rainfall and frequent high tides cause regular flooding. Beira is also known for its extreme vulnerability to flooding and tropical storms, earning the title of Mozambique's most climate vulnerable city. On average, the 75% of the population in Mozambique live in informal settlements (slums) and have limited access to basic services; Beira doesn't make an exception and follow the same pattern even if official figures on the phenomenon are not available. According to the United Nations 'slum household' corresponds to the one in which the inhabitants suffer one or more of the following 'household deprivations': 1) Lack of access to improved water source, 2) Lack of access to improved sanitation facilities, 3) Lack of sufficient living area, 4) Lack of housing durability and, 5) Lack of security of tenure. By extension, the term 'slum dweller' refers to a person living in a household that lacks any of the above attributes.



A F R I C A

M O N Z A M B I Q U E

S O F A L A



**TEMPERATURE AVERAGE :** 25.1 °C MAX 40.1 - MIN 12.9



**SURFACE:** 631 KM2



**LANGUAGE :** Portuguese



**POPULATION:**  
456,005 Inhabitants

**DENSITY:** 723 h/km2

#### RESILIENT COMMUNITY

Beira is not ready for an immediate recovery process due to limited resources, and its high vulnerability to environmental issues. International intervention is necessary for a fast and correct recovery of the city .

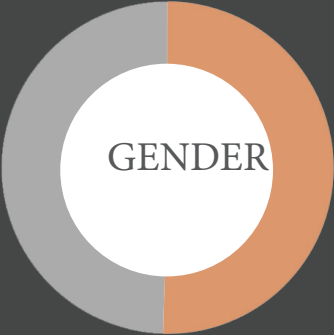
It is important to emphasize that Beira community has a basic knowledge of how react to increase its resilience. Beira community has been able to recover in an empirical way, creating practical adaptation strategies and creating a certain social resilience; they have learned how being self-sufficient and to resist climatic challenges, however, a technical guide of how withstand, adapt to, and recover from adversity, identify actions and guide them in their implementation for increasing the resilience at settlement level.

Also its necessary a correct infrastructure system that depends on local authorities vision. For this reason, the different project recovery proposals should be redirected on how promote and encourage this innate ability of resilience.

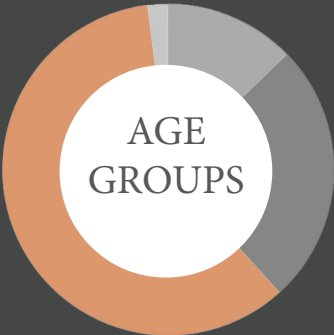


# Beira

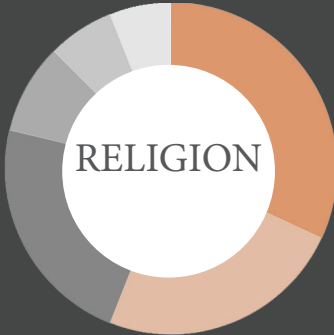
## General Data



Male (50.43%)  
Female (49.57%)

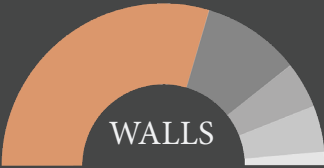


0-4 years (12.75%)  
5-14 years (25.54%)  
15-65 years (59.71%)  
+65 years (2%)

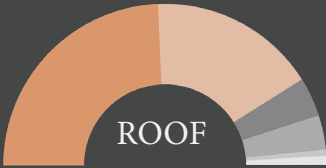


Catholic (31.9%)  
No religion (24.1%)  
Evangelic (22.7%)  
Zion (8.8%)  
Islamic (6.5%)  
Others (6%)

### CONSTRUCTION MATERIALS

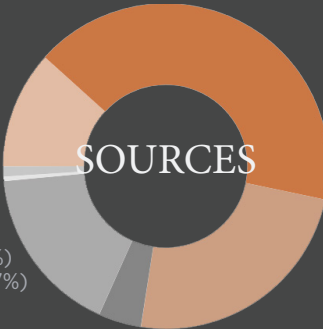


Zinc sheet (59.14%)  
Fiber cement sheets (19.63%)  
Concrete slab (9.27%)  
Straw or palms (9.21%)  
Others (2.75%)



Concrete block (48.68%)  
Sticks and earth (33.43%) (25.54%)  
Sticks/bamboo/palms/canes (7.97%)  
Bricks (6.87%)  
Adobe (1.21%)  
Others (1.84%)

### WATER



Piped water outside the house (41.61%)  
Piped water inside the house (11.7%)  
Fountain (24.15%)  
Protected well (4.26%)  
Open well (16.83%)  
River (0.42%)  
Others (1.02%)

17 Orellana a. (2021).Beira General Data . [Table]



18 Gokhan B. (2019).Aftermath of Cyclone Idai in Mozambique . [Image]



19 Trutschel T. (2015).A man sews a pair of pants with an old sewing machine in a slum in the city area of Beira on September 28 . [Image]



20 Chiba Y. (2019).Social Dynamics of Beira After cyclone Idai. [Image]





21 Barbier A. (2019). Flooded area of Buzi, central Mozambique after Cyclone Idai. . [Image]



# Cyclone

## IDAI

Africa was hit by one of the worst tropical cyclones: Cyclone Idai. On March 14, 2019, in the afternoon idai made landfall near in beria leaving heavy rains and strong winds of 185 km / h to 200 km / h until the early morning of March 15 , this caused extreme weather conditions, flash floods, hundreds of deaths and massive destruction of houses and crops. As a result, the cyclone unleashed a humanitarian crisis and thousands of people were displaced, Beira became in a big lake.

The city was isolated due to the winds and rains that continued during the hole week, this event was reportedly extremely tragic and caused the following damage:

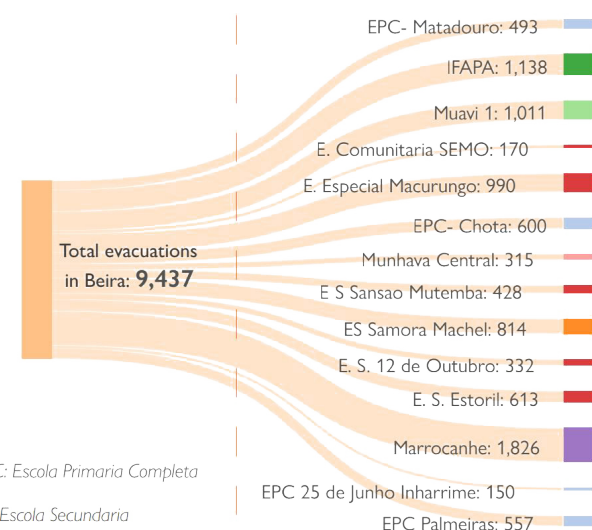
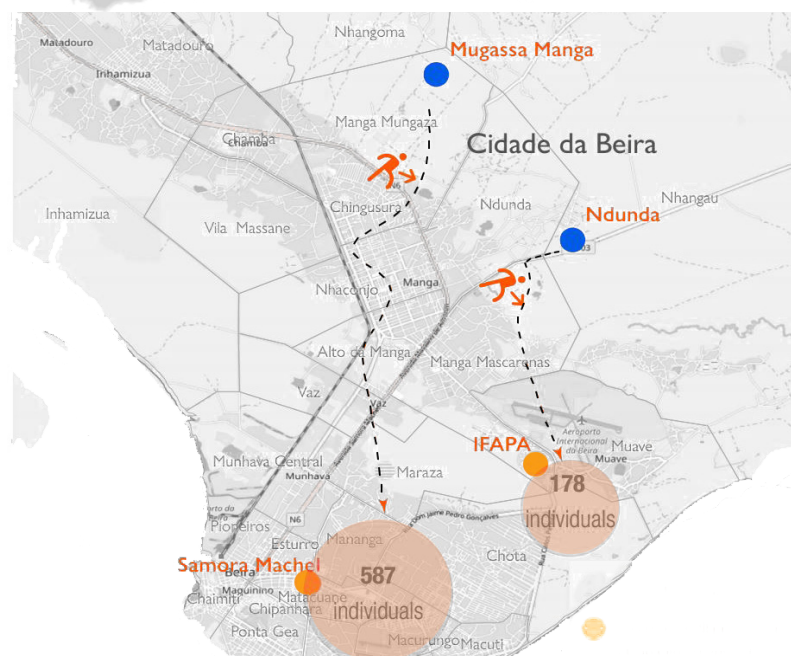
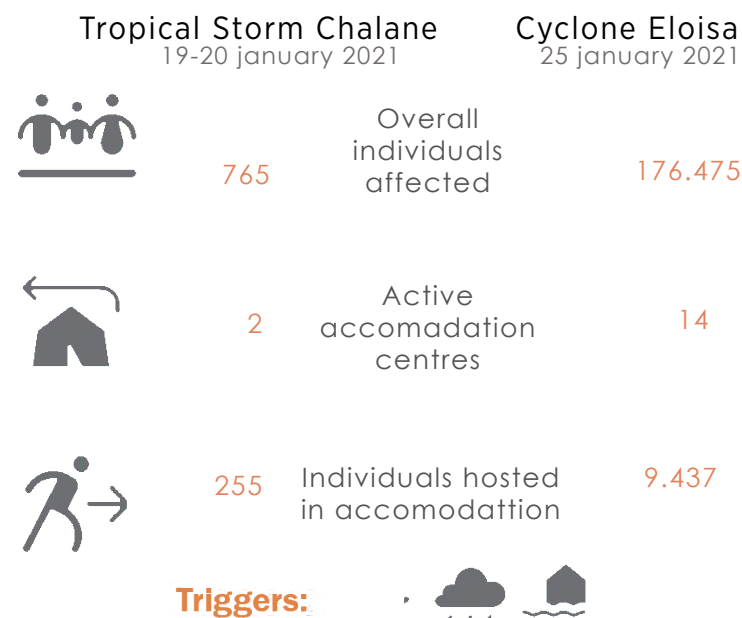
- “An estimated 3,000 sq. km of land and 715,378 hectares of cultivated land were flooded by IDAI. As of the end of April, 400,000 had been displaced, of which 160,927 were sheltering in 164 temporary accommodation centers across the four provinces.” Pereira, Francisco. (2019). *Mozambique Cyclone Idai : Post Disaster Needs Assessment* (Conference Version). [https://www.ilo.org/wcmsp5/groups/public/---ed\\_emp/documents/publication/wcms\\_704473.pdf](https://www.ilo.org/wcmsp5/groups/public/---ed_emp/documents/publication/wcms_704473.pdf)
- The coastal protection system was totally collapsed also the roads, the drainage system and the sewage system suffered the effects of the cyclone. As a consequence of this long storm tide, inundations and rivers overflowing with flood waters, apparently rising above 10 meters.
- The storm complicates even more the drinking water and sanitation situation, arising an outbreak of cholera, people have reduced access to basic health services and food, it should also be

mentioned that before cyclone Idai, food security and livelihoods were threatened by the “gusano cogollero” that had already damaged food and agricultural production.

- Early indications state that 63,506 houses lost their roofing and 23,822 houses were destroyed completely. According to the reports, 70 % of all buildings were severely damaged and many lost their roofs partially or totally. Vulnerable buildings collapsed, 3,000 trees were overgrown and a huge number of posts and street lamps collapsed. The critical infrastructure of the municipality has also been severely damaged. Many inhabitants of Beira lost their homes and belongings and had to go through a very difficult period of time. Dozens of people died in Beira as a direct effect of the storm. (CARE ,2019, p. 10).
- Permanent resettlement sites for displaced persons have been established. Many of these sites lack of basic services, including latrines and water supplies.

After the cyclone, there have been many international and local interventions to reinforce the reconstruction of the city and its citizens , however we must take into account that the neighborhoods of Beira are completely vulnerable to environmental risks that are intensity and frequency variable, ranging from seasonal flooding to high tides. Today, households has to tackle a new situation that slowdown the reconstruction and recovery process of Beira . They have had to deal with Tropical Storm Chalane, which occurred on 30 December and Cyclone Eloisa on 23 January.





Reference:  
Information obtained from:  
Displacement Tracking Matrix **DTM** - Evacuation to accomodation centers.  
<https://displacement.iom.int/reports/mozambique-%E2%80%93-flash-report-13-evacuations-accommodation-centres-19-20-january-2021>

Rapid Assessment , Sofala province IOM/INGC (Beira district) (As of 25 January 2021)

22 Orellana A. (2021). Data Beira after Tropical Storm Chalene and Cyclone Eloisa. [Figure]



# Tropical Storm Chalane

## Cyclone Eloisa

After Cyclone Idai, a strong tropical storm called **Chalene** was registered on December 30, 2020, causing the relocation of some residents of the Mugassa Manga and Ndundaz neighborhoods in the center of Beira. All Beira was experiencing significant flooding as a result of heavy rainfall since 15 January, more than 21,500 people have been affected, 3 people have died, and more than 3,900 hectares of farmland have been impacted, according to data from Mozambique's National Institute for Disaster Management and Risk Reduction, INGD).

According to the 13 report of DTM (Displacement Tracking Matrix) the results estimate that "765 individuals (255 households) were relocated from the neighbourhoods. A total of 2 accommodation centres have been activated, Samora Machel in Esturro neighbourhood (hosting 587 individuals) and IFAPA in Aeroporto neighbourhood (hosting 178 individuals)". All the relocated individuals are living in tents. (Figure 2)

Added to this, on January 23, category 1 strength Cyclone Eloise made landfall in Mozambique, bringing strong winds, torrential rains and severe flooding. It impacted and destroyed farm lands, rural areas, infrastructure and many homes, and once again affected families that live just below the poverty line are still trying to rebuild their lives after Cyclone Idai. It also affected the coastal zone that extended north and south of Beira, since the shape of the coast and Eloise's movement were almost parallel. Beira received 250mm (10 inches) of rain in 24 hours, according to Mozambique's National Institute of Meteorology (INAM).

The principal consequences are:

### Infrastructure:

- Many roads in central Mozambique are now impassable, hindering access to some places and obstructing labors to bring assistance.
- Basic services have been interrupted and many affected families are in need of shelter, food, contact to health places, medical supplies and access to safe drinking water.

### Displaced people:

Preliminary information from the National Institute for Disaster Management and Risk Reduction (INGD) shows that an estimate of 176,475 individuals (35,684 households) had been affected. So far, 32 accommodation centres have been activated in Sofala province: In Beira specific (14 centres, for 9,437 individuals). Of which (82%) of families who are in accommodation centers have left their place of origin after tropical cyclone Eloise and 18 percent left after tropical storm Chalane. (Figure 3)

Local officials and aid agencies were assessing the scale of the damage so they could help affected people, however people feel tired because of the situation, actually the resettlement sites had their tents and shelters also destroyed/partially as a result of Tropical Cyclone Eloise.





23 BBC. (2021).Family after cyclone Elosia.[Image]



24 BBC. (2021).Flooded home after Cyclone Eloisa.[Image]





25 BBC. (2021).Flooded home after Cyclone Eloisa.[Image]



26 Zuñiga A. (2021).Dondo district of the city of Beira after the passage of cyclone Eloise on January 28.[Image]

### Ongoing inundations

-Tens of thousands of hectares of crops have been flooded, which could impact the next harvest in April.

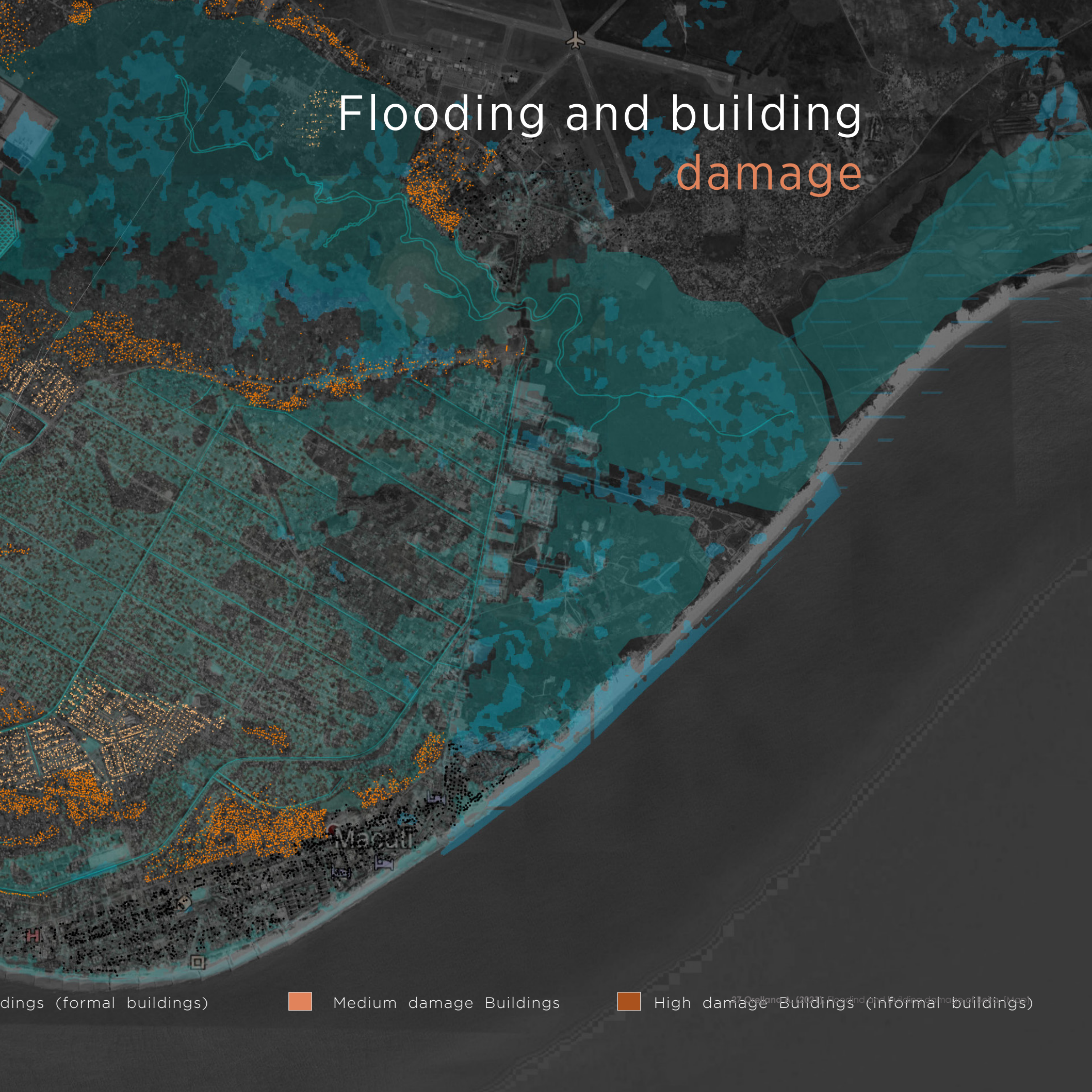
-There is an outbreak of water-borne diseases such as diarrhea and cholera in flooded areas.

-On the reported survey on February 2021 realized by DTM Y CCCM CLUSTER to a total of 593 heads of households (accounting for 2,762 family members) in accommodation centers located in Beira, provided the following results of their intentions and concerns. "The majority (95%) of the house-holds reported having their houses affected - destroyed, severely or partially damaged, while three per cent still have their house flooded and two per cent of the houses had been looted". "The majority (66%) of households indicated their intention to return to their place of origin. While another 13 per cent had not decided yet, pending information and support."More rainstorms are also expected in the coming days.









# Flooding and building damage

Buildings (formal buildings)



Medium damage Buildings



High damage Buildings (informal buildings)

27 Osellanda, (2021), Flooding and building damage in India





Beira Port Formal Settlement Informal Settlement Green space /Agriculture Planned Implementation phase Completed

28 Orellana A. (2021). Land use patterns and the spatial implications of interventions in the built environment in Beira from international donors. [Map]



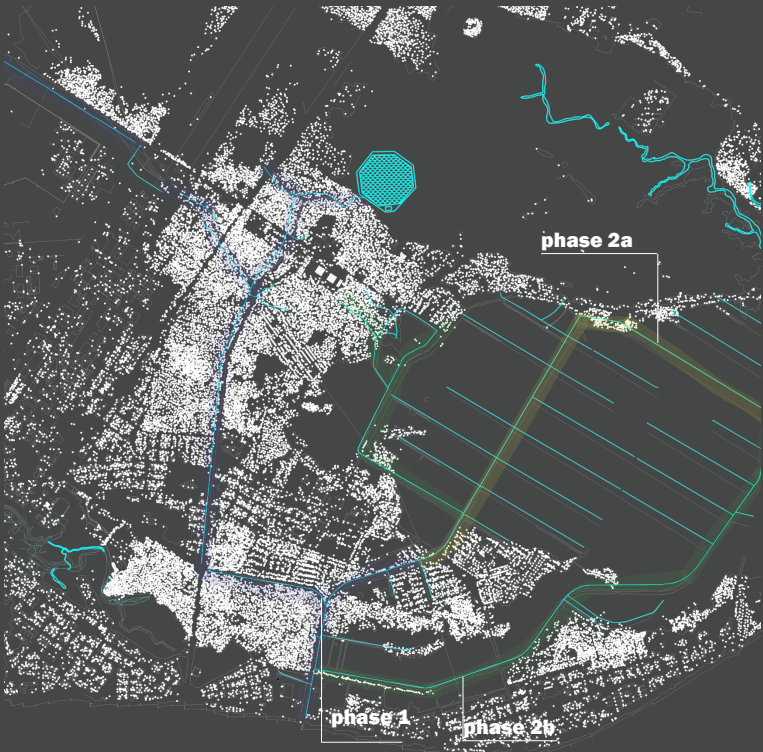
# URBAN ANALYSIS

Donors in Beira have amounted to 100's of millions of USD which have predominantly targeted the built environment. These have included several high-profile infrastructure interventions, such as, urban drainage and river rehabilitation, and public green space development, costing. Figure x provides a tentative overview of the spatial implications of these interventions that encompass a range of urban planning, land management and infrastructural interventions in various stages of implementation, all of which are premised on land use change and (often) forced displacement.

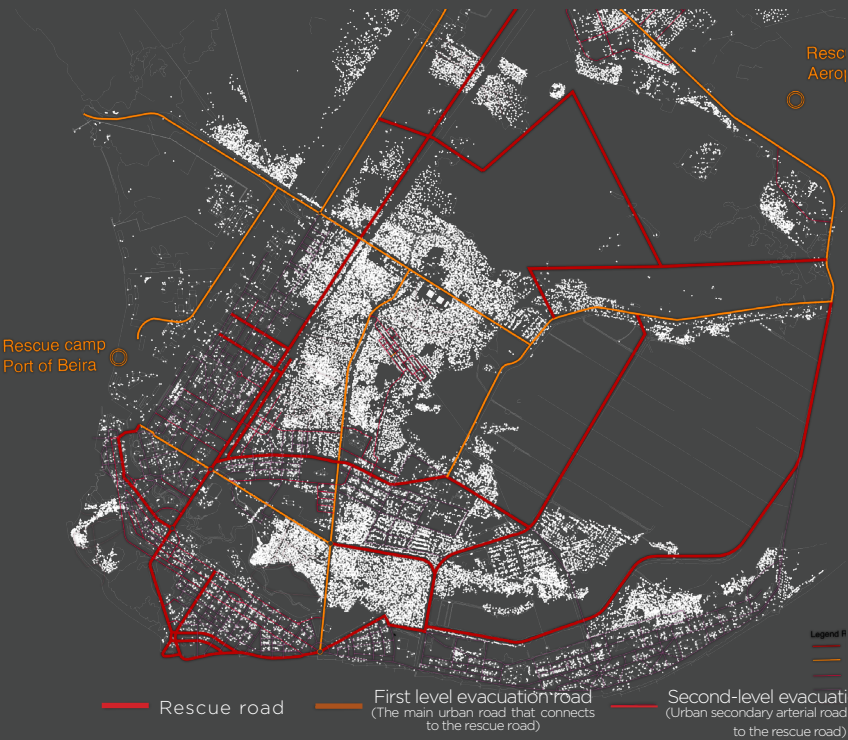
The city of Beira has ongoing works for maintenance and improvements of the drainage system. The figure x shows Beira's drainage network reconstructed under the project "Rehabilitation of the Storm Water Drainage System in the City of Beira" . Beira Municipal Recovery and Resilience Plan, ( "A Roadmap to Building Beira Back Better", Volume 1 - Main Report )

The rehabilitation of the primary drainage system is split up in three phases. The first phase has been completed. The other phases are still on pre-feasibility level.

However the rainfall in Beira can be intense. The drainage system should be designed for frequencies of retention and discharge according to these intense rainfall events. Norms for testing and design of drainage systems should be developed according to actual (or expected) frequencies and return periods.



29 Orellana A. (2021). Beira Channels. [Map]



30 Orellana A. (2021). Beira Accessibility. [Map]



CHALLENGES  
Beira's main  
challenges include:

Flood From:  
Precipitation  
Storm Water  
Surge Coastal Erosion  
Rapid Urbanization  
Job Insecurity  
Environment  
Land Use  
Natural Habitat  
Destruction



31 "Beira Municipal Recovery" (2019). Drainage. [IMAGE]

## 01 WATER

**Sewage** is a sector that requires urgent attention, its necessary to rehabilitate the existing system and also expand it into unserved areas of the city. Its necessary to address recurrent flooding issues by providing adequate sewage.

### Chanel's

- Build and improve existing primary, secondary and tertiary drainage network for climate calamities and flood situations, but also because Beira needs this upgrade for support people in a normal situation for its daily life.

- Drainage in low swampy areas, reducing health problems and improve the life quality for people.

- Robust waste water collection and treatment system. Immediate action needed: recover the sanitation system.



32 Bloomberg. (2020). Beira district after Cyclone Idai. [Image]

## 02 INFRASTRUCTURE

### Roads

The cyclone has caused extensive damage to roads, particularly along the coast, where the road has been destroyed by sea water. Similarly, with the aim of rebuilding the city, many fallen trees and houses rubble have damaged the roads due to the use of heavy machinery.

Apart from rebuilding lost roads, there is an urgent need to build new resilient roads that can withstand heavy rains without deterioration and that can be used as evacuation routes during future floods, also resist cyclone conditions avoiding the high level of damage in the future.

### Buildings and services

176 buildings owned by the municipality are damaged or severely damaged by cyclone Idai, and most of them are critical infrastructures. Due to rainfall, lots of equipment and municipal furniture suffered damage, and much had to be discarded.



# Rebuilding Beira CHALLENGES



33 Chiba Y. (2020). A woman with children stand on a muddy street. [Image]

## 03 HOUSING

### Housing and settlements

Beira's existing housing was badly affected by cyclone Idai with approximately 70% of houses destroyed partially (63.506 units) or totally (23.833 units). The biggest destruction occurred in the poorest neighborhoods with low quality construction increasing an already critical social, economic and environmental vulnerability. Pereira, Francisco. (2019). *Mozambique Cyclone Idai : Post Disaster Needs Assessment* (Conference Version). [https://www.ilo.org/wcmsp5/groups/public/---ed\\_emp/documents/publication/wcms\\_704473.pdf](https://www.ilo.org/wcmsp5/groups/public/---ed_emp/documents/publication/wcms_704473.pdf)

The characteristics of the settlements have been decisive in the damage. There is a need for an integrated approach for resilient housing in an urban context which includes:

- Access to basic services including to water, sanitation, lighting, electricity, and waste.
- Secure land tenure including compliance with a continuum of land rights, promotion of gender-equality, and prohibition of housing discrimination and forced evictions), (Habitat III Policy Paper Housing Policies, UN-Habitat).



34 Barbier A. (2020). People gather on the roof of a house submerged by floods. [Image]

## 04 COMMUNITY

According to the United Nations 'slum household' corresponds to the one in which the inhabitants suffer one or more of the following 'household deprivations':

- 1) Lack of access to improved water source,
- 2) Lack of access to improved sanitation facilities,
- 3) Lack of sufficient living area,
- 4) Lack of housing durability and,
- 5) Lack of security of land tenure.

Beira's recovery should not simply replace assets or identify the gaps that contributed to disasters' climate vulnerability, it should aim at institutional and social changes.

Sustainable recovery is a process that balances community, economic, and governance needs without compromising the well-being of future generations. (Municipality of Beira, *A Roadmap to Building Beira Back Better* (Volume 2), 2019, pg.12)





35 Orellana A. (2021) Strategies for Beira. [Map]



# Rebuilding Beira STRATEGIES

## 1 WATER MACHINE

Beira has a natural capital "water" due its location at the confluence of rivers and the sea and the continuous rainfall, it can be the basis on which resilient communities grow; i propose two environmental axis directly related with water to facilitate urban transformation according to social context:

- Environmental axis GREEN BAND Activities belt (leisure uses). Its a longitudinal belt articulated by a pedestrian (cords) and sponge water nodes, that link social infrastructures with housing, a system composed of local trade, leisure, rest, sports activities, forest / urban agriculture i.

- Drainage axis WATER RING A storm water management infrastructure, it reroutes and collects water and serves as a buffer between the channel and the city during flooding seasons.

## 2 INFRASTRUCTURE \_link services

Develop a strong resilient social infrastructure net with different NODES inserted in the city that behaves as a connection between the social dynamics of people and at same time face the water problem.

- Pemeable nodes with specific behavior recreational activities, storage water tanks, creating more water holding areas.

- Redesign of roads with multiple functions, a platform for sewage and drainage system and connection of houses to the system, increase height difference between street level and ground floor level. considering resilience, safety, calamities including flooding, as well as economical impact.

## 3 COAST DOOR

Introducing a resilient coastNODE introduction of aquaculture and agriculture. A node like a door that reroutes and collects water and serves as a buffer between the channel and the sea.

## 4 URBAN BORDERS

Cords with specific behaviors but transversal shared activities. New conception of edges and limits. The proposal creates integral new relationships that involve the built environment and the project in order to sew the urban pattern.

## 5 HOUSING+ COMMUNITY

The proposal is a building-structure, flexible and open. Its ability to replicate as a form of action is possible throughout the neighborhood, it does not imply technological solutions but it becomes a base of citizen dialogue that experiments the identification of vertical public space in front of private space.

-It has a elevational programming for future cyclones and urban growth.

-Objective of continuity between the existing net with our site through the use of an infrastructure element.

-Fragmentation idea of the block, the objective is to generate free spaces, fluid elevated paths without a perpendicular frame

-Housing on partially elevated areas raising the ground floor level..

Resettlement inside the city

-adaptation houses

-floating houses

-elevated houses

-mobile houses







# WATER-Network

## GOALS

The general design of this project focused on the relationship between people and water. By studying reports about people's perception, issues and their needs of water, i conclude that its necessary to learn how to live with water, and become this problem a benefit for the city

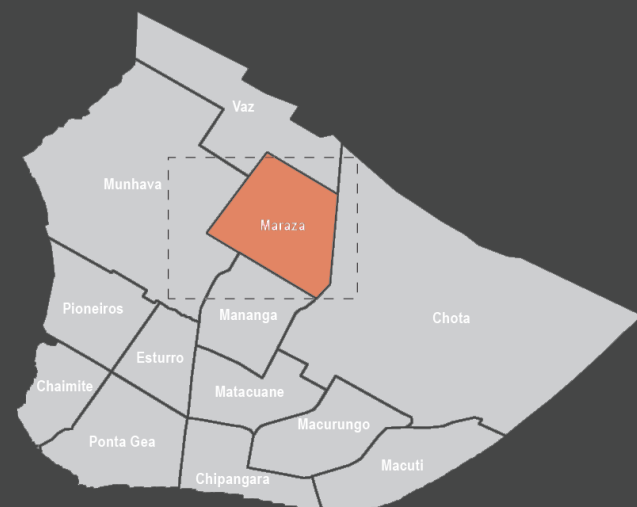
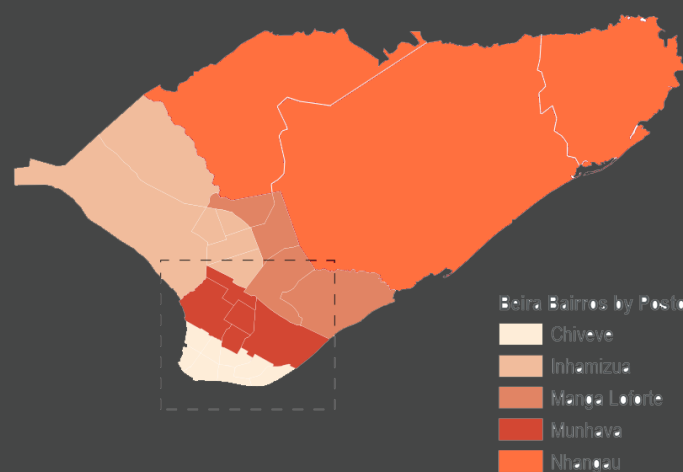
A new vision of water management infrastructure its totally necessary , an element that behaves as a link between water and people that reroutes and collects water and serves as a buffer zone during flooding seasons. It also creates a platform for water related recreational actives. In this way, people have the opportunity to change their perspective about the flooding problem.

The integration of the cement city into the center of Beira its the main goal of the water network system. It is proposed to use the water reservoir as the main core (head) and generator of a water purification system, through its development over time, appropriating each neighborhood, connecting it with the city center and transforming the urban pattern without losing the social dynamics of Beira.

The urban development process begins with the connection and activation of some programmatic nodes. Starting from a strong investment, staking and initial change in the current water reservoir of Maraza. From this, a series of reactions will be unleashed over time, which will gradually colonize the territory, and which will develop a programmatic network and tissues associated with these nodes.







## MARAZA SITE

"Maraza has historically been a major agricultural zone used primarily for rice cultivation by poor households, which had historically been the recipient of support from the Mozambican central government and international donors (Sheldon, 1999).

Under the auspices of the BP however, agricultural land has been recast as a raw resource for the LDC expansion. In fact, no mention was made of urban agriculture in the masterplan's vision for Beira's future, meaning that all agriculture was assumed to be erased from the city by 2035".

(United Nations Institute of Training and Research [UNITAR], 2019)

**3.788** Total buildings

**3763** buildings damaged

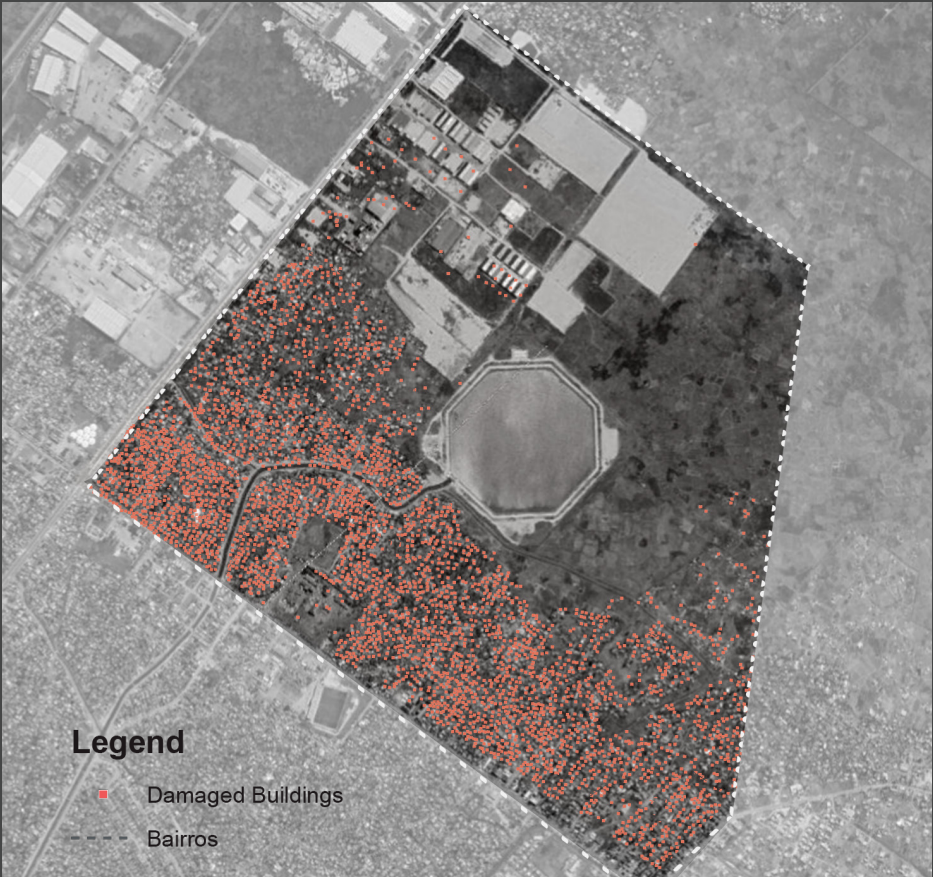
**99%** of neighbourhood damaged

\*according to UNOSAT-REACH analyst building count  
 \*\*\*construction typologies by zone were gathered by REACH through participatory mapping with neighbourhood leaders. % of buildings in the area with each type of wall/roof were collected, and the remote sensing damage figures were used to estimate total damaged buildings by type.



# Maraza Site

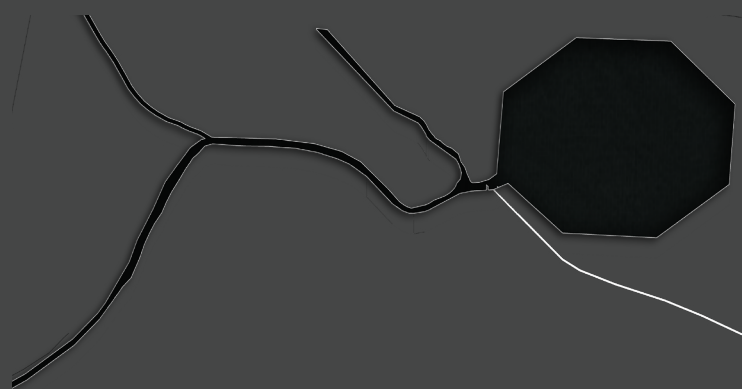
URBAN ANALYSIS



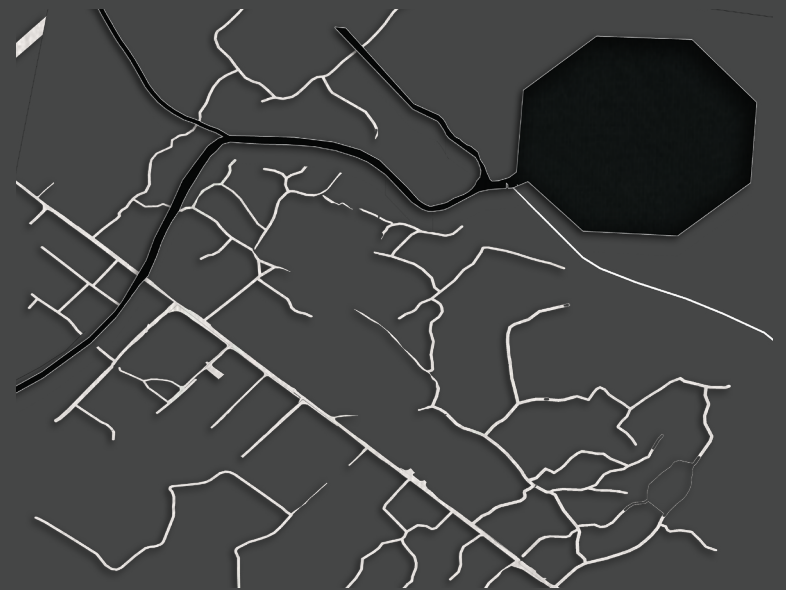
38 Unifar . (2019). Maraza - Structural Damage by Construction Typology. [MAP]

39 Google Earth . (-). Maraza Urban Basin from 2016 to 2020. [Image]





Maraza water basin and phase 1 channel



Maraza high road "Krusse Gomes" and dirt roads

### MARAZA- Unimproved water sources

\*According to UNOSAT-REACH analyst building count

\*\*Unimproved water sources are open wells, open water catchments and other unprotected water sources identified through a rapid infrastructure assessment of Beira by REACH.

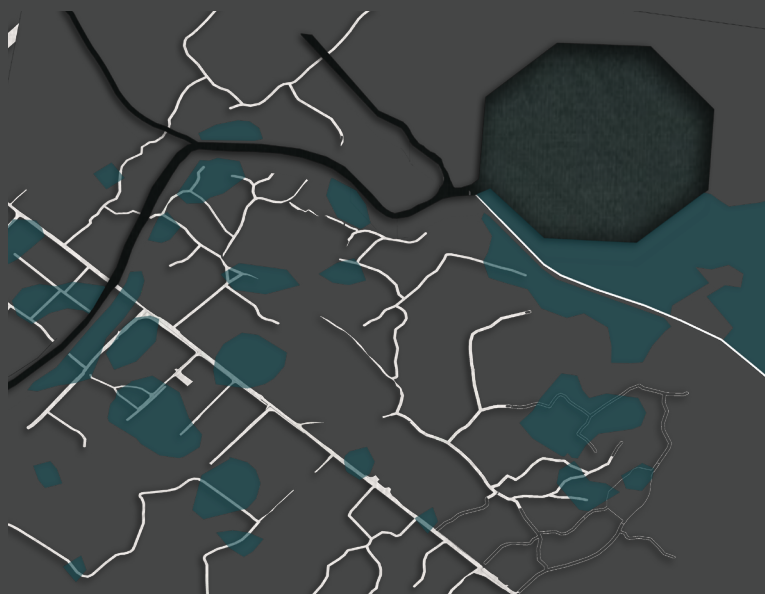
Other water sources are protected wells, motorized/hand pumped boreholes, tapstands, and municipal piped water. REACH was unable to map the piped water system due to its extent, so water analysis is focused on highlighting areas with unimproved sources. unknown contemporary demand.

Reference:  
United Nations Institute of Training and Research [UNITAR] (2019)  
Muave - Unimproved Water Sources. [https://reliefweb.int/sites/reliefweb.int/files/resources/moz\\_map\\_cycloneida\\_wateranalysis\\_muave\\_25apr2019.pdf](https://reliefweb.int/sites/reliefweb.int/files/resources/moz_map_cycloneida_wateranalysis_muave_25apr2019.pdf)



# Maraza

WATER SOURCES



Maraza water ponds



Maraza neighborhood

**3.788** Total buildings

**644** buildings within 50m of an improved water source

**17%** of neighbourhood within 50m of improved water sources



40 Google Earth . (-). After rain. [Image]

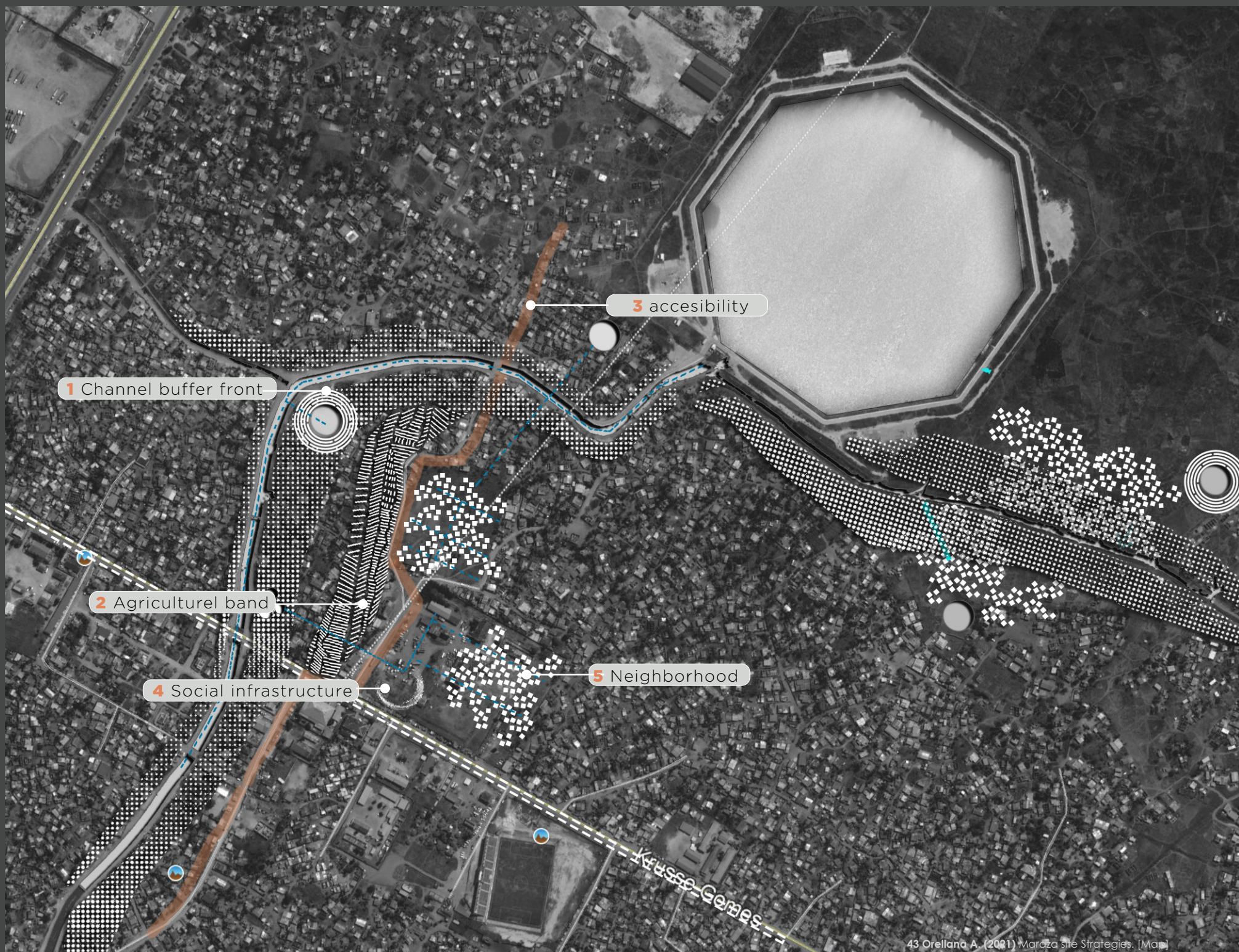


41 Google Earth . (-). Public space. [Image]



42 Google Earth . (-). Public space. [Image]





43 Orellana A. (2021) Maraza site Strategies. [Map]



# Maraza

## SITE STRATEGIES

### 1 CHANNEL BUFFER FRONT

Water management infrastructure:

- Creating more water holding areas
  - Water transportation
  - Treat stormwater for agriculture (reuse for irrigation);improvement of water quality
  - Revive channels fronts
- Introducing aquaculture ponds and filtration ponds. Aerobic, maturation and facultative ponds to treat water, and agriculture

A "storm water management infrastructure", it reroutes and collects water and serves as a buffer between the channel and the city during flooding seasons.

### 2 AGRICULTURE BAND

Push up the agriculture and aquaculture (permaculture) Create habitat, nature and biodiversity protection, design agricultural settlements similar to natural ecosystems, and therefore able to maintain themselves autonomously and renew themselves with a low use of energy.

### 3 ACCESSIBILITY

- (streets)
- pedestrian paths
- elevated bridge
- emergency area for flood scaping

### 4 SOCIAL INFRASTRUCTURE

Productive and preventive flood infrastructure like:

- Introducing channel line park that creates
- public nodes for community
- social infrastructure leisure that also fulfill more functions as:

Movable market and playground

### 5 NEIGHBORHOOD

- Housing
- Densify housing
- Double ground floor

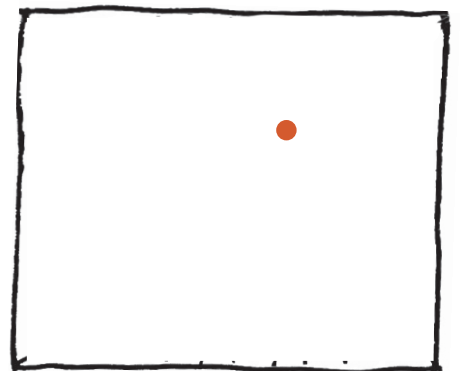


03.

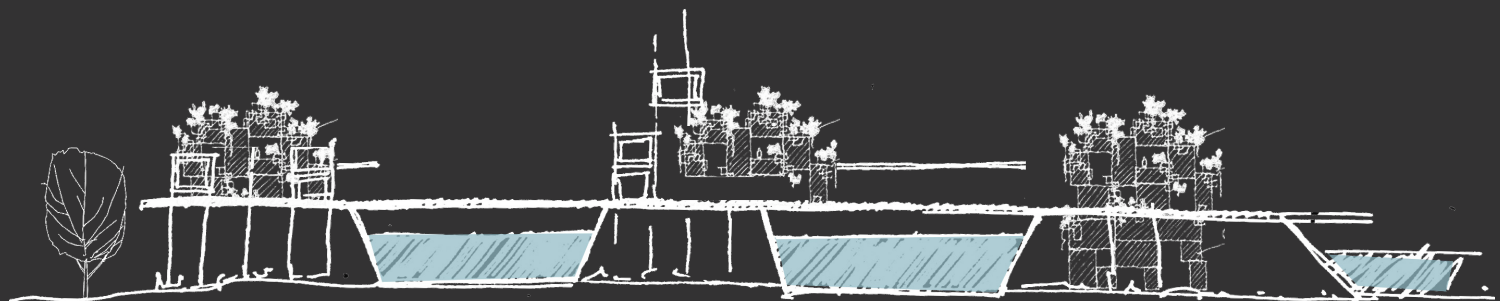


# WATER

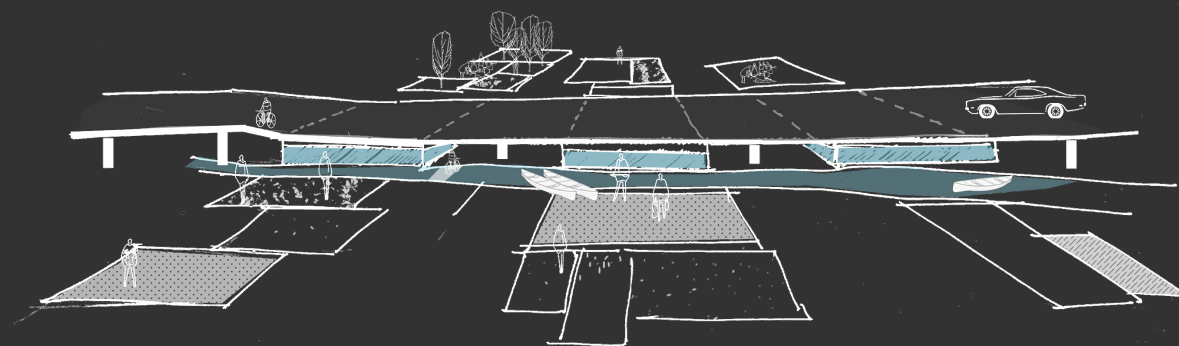
urban infrastructure  
proposal







- from path to connection



- from edges to limits



- an habitable border

44 Orellana A. (2021) Concept Exploration. [Sketch]



# Beira

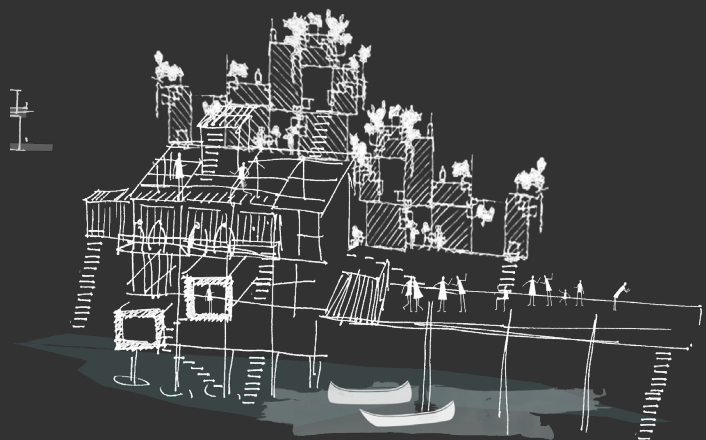
## CONCEPT

The project proposal seeks to find a middle point between infrastructure and architecture; (dimensions that have historically been considered separately); Through the integration of urban elements in the urban pattern of the city, capable of address social, urban and climatic transformations; Integrating the community, and articulating the informal heterogeneous borders with the rest of the city.

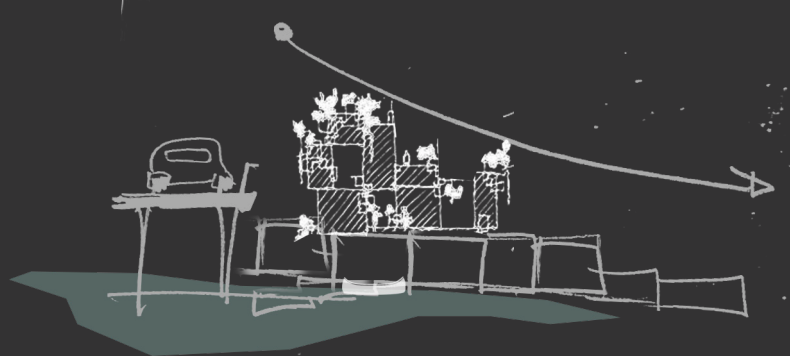
To achieve this, I have explored a variety of new interpretations of making city, interpretations capable of guiding inclusive, sustainable and resilient policies. In search of these new threads, I have defined 6 scenarios that express the concept of the project, each one have an approach different than the known one, because it seeks to break with the pre-concept which they were conceived, in other words, examine other infrastructure dimensions that release different meanings, shapes, and uses. For this reason, I have reformulated the 5 urban image elements of Kevin Lynch and update them to the following connotation:

From path to connection/link  
 From edges to limits  
 From neighborhoods to insieme  
 From nodes to interchange  
 From landmarks to contenitore

With the expectative that this introduced elements , allows the opportunity of exchange on the space. Through which could transit resources, goods, ideas, plans, energy, people and finances.

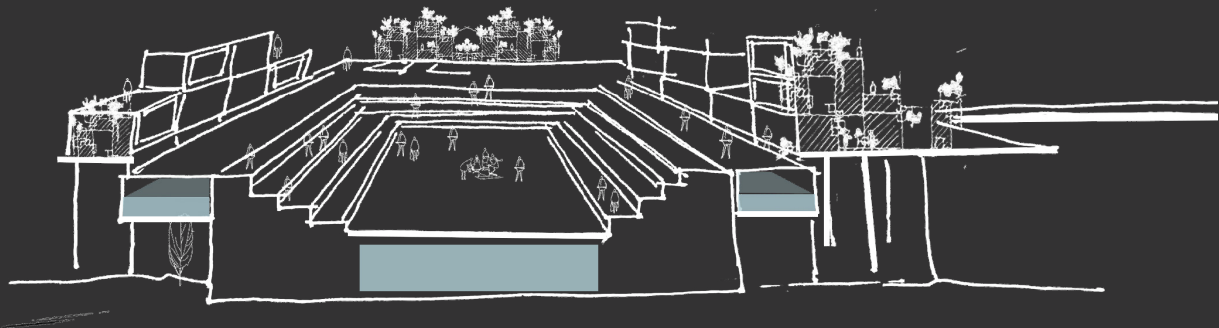
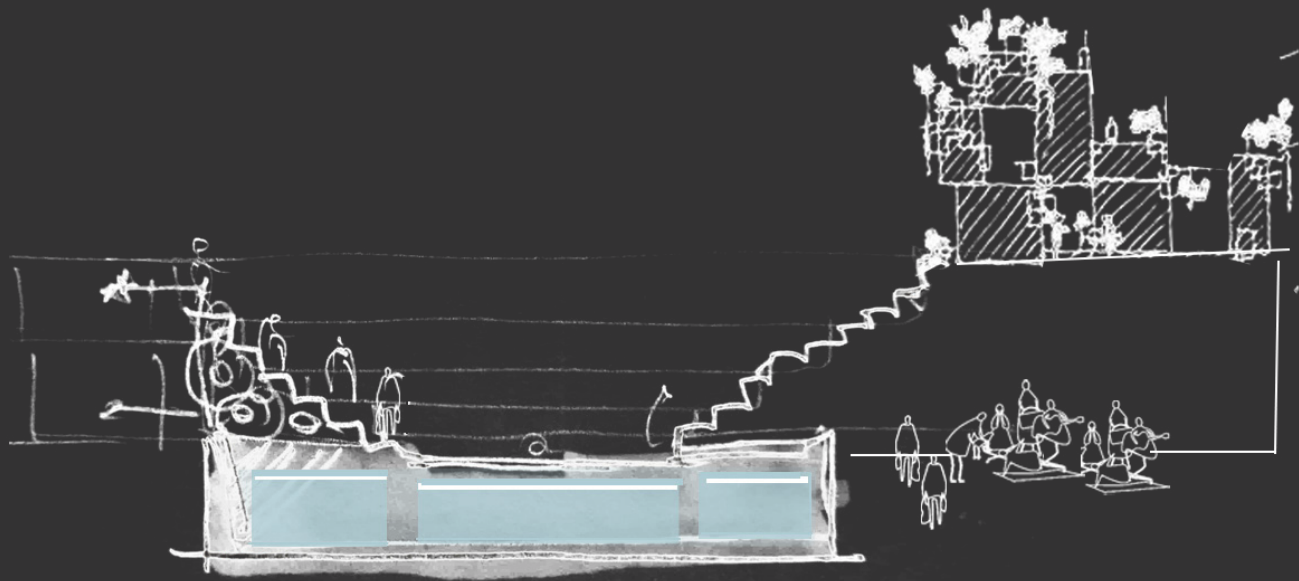


- adaptable changing open landscape system





connection

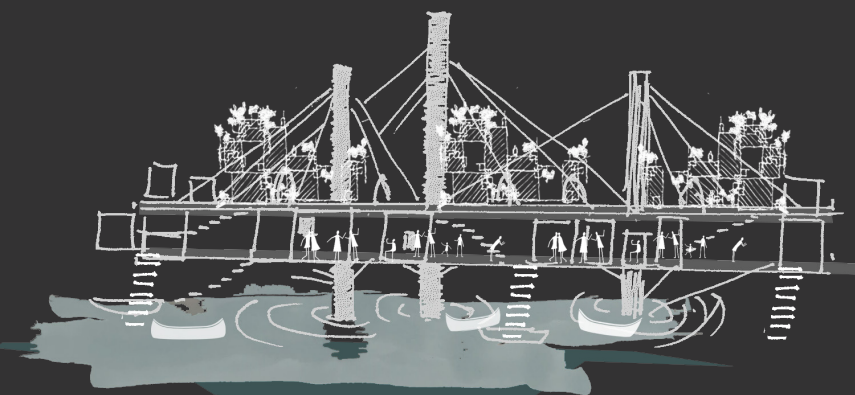


45 Orellana A. (2021) Concept Exploration. [Sketch]

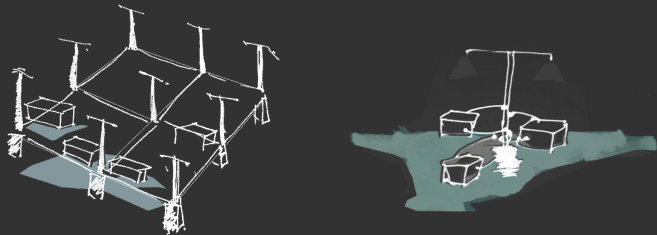


# Beira

## VISION



- adaptable changing open landscape system



The proposal seeks to answer to daily circuits and spaces where we can find different social and environmental dynamics of Beira, places full of meanings, narrative experiences, social and cultural mixes, open system thinking, changing and adaptive: A circuit made by different elements that make up the city (paths, borders, neighborhoods, nodes, landmarks) as a narrative experience, a tour of situations that are responsables of linking the city, especially giving the opportunities to mitigate the environmental changing that Beira suffers.

But how it should be achieved a strategy that understands the value of a fragil city as Beira ?

The answer consists to understand how to approach, understanding how to handle and taking advantages of a valuable resource, as WATER. For Beira, the problem of the water is real, however is on this weakness of the city, that the project born. The water has to be the element of union for the different infrastructures that should be implemented in the city.

The presented masterplan is a narrative of this tour, it presents different elements inserted in the city that will be explained in 6 scenes of the project.





1

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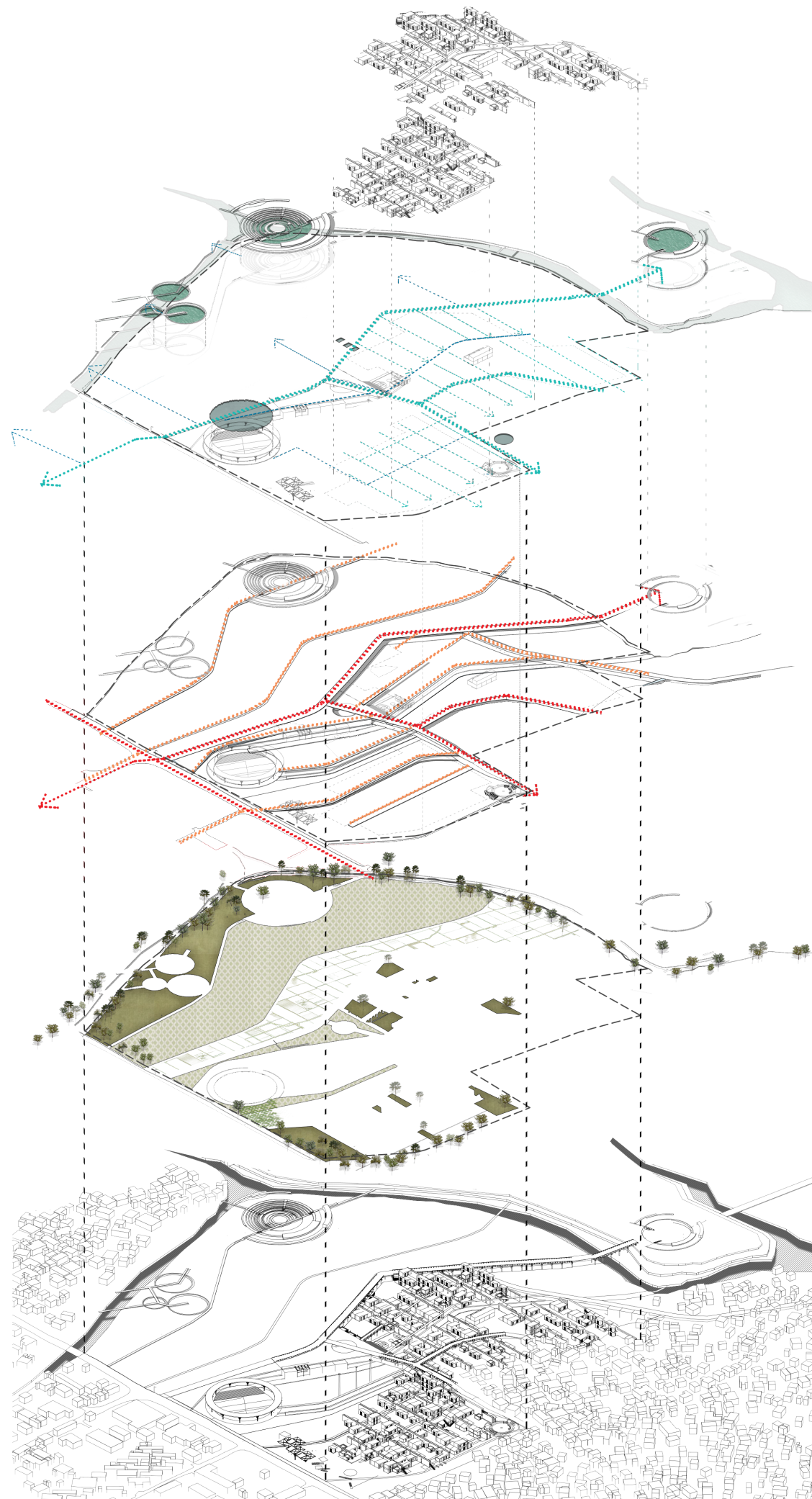




# PROGRAM:

- 1 Channel buffer front\*[-]
- 2 Community center
- 3 Agricultural fields/ crop lands
- 5 Water storage point
- 6 Local sporadic market place
- 7 Emergency shelter point
- 8 Water plant Purification
- 9 Water park
- 10 Housing Unit





47 Orellana A. (2021) Space Components Proposal.



## WATER URBAN INFRASTRUCTURE

### Space components

#### Ambiental

The architectural program and its edges were designed to act as a large piece of urban furniture, in which the core of the system is the water storage plant currently under construction. This would be the principal component that collects and distributes the water for its subsequent purification, also the objective is to design green bands to create habitat, allow biodiversity protection, and natural ecosystems, able to maintain themselves autonomously and renew it with a low use of energy. Also push up the agriculture and acuiculture

#### Urban

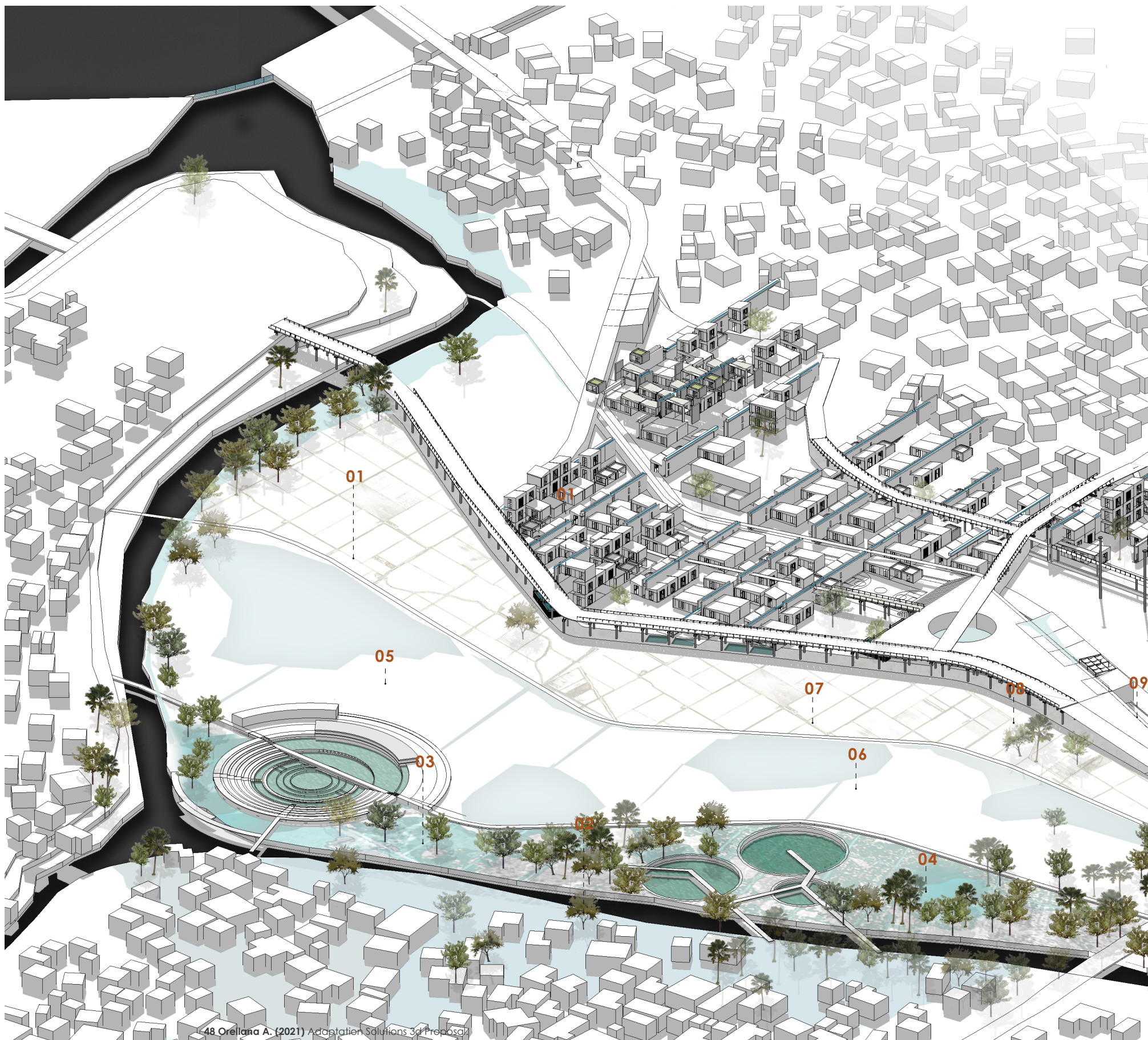
The objective is achieve flexibility and continuity on neighborhood, and city scale, through a public infrastructure system (streets, lighth or water network, sewage, etc) that fulfill double function (street-park; street-water plant etc). Intended as a public accesibility circuit responsible for articulating and being the transition axis between architecture and the city, generating new dynamics and neighborhood activities.

The project is emplaced by understanding urban vacuums and recognizing risk floodeable areas.

#### Landscape

Improve the resilience of the city by restoring and reinforcing greening on the city with adequate trees along the urban infrastructure circuits (channels, streets) as important element of building back Beira. Create littles ecosystem that will expand with time, a spatially heterogeneous zone where people and natural processes interact.





48 Orellana A. (2021) Adaptation Solutions 3d Proposal



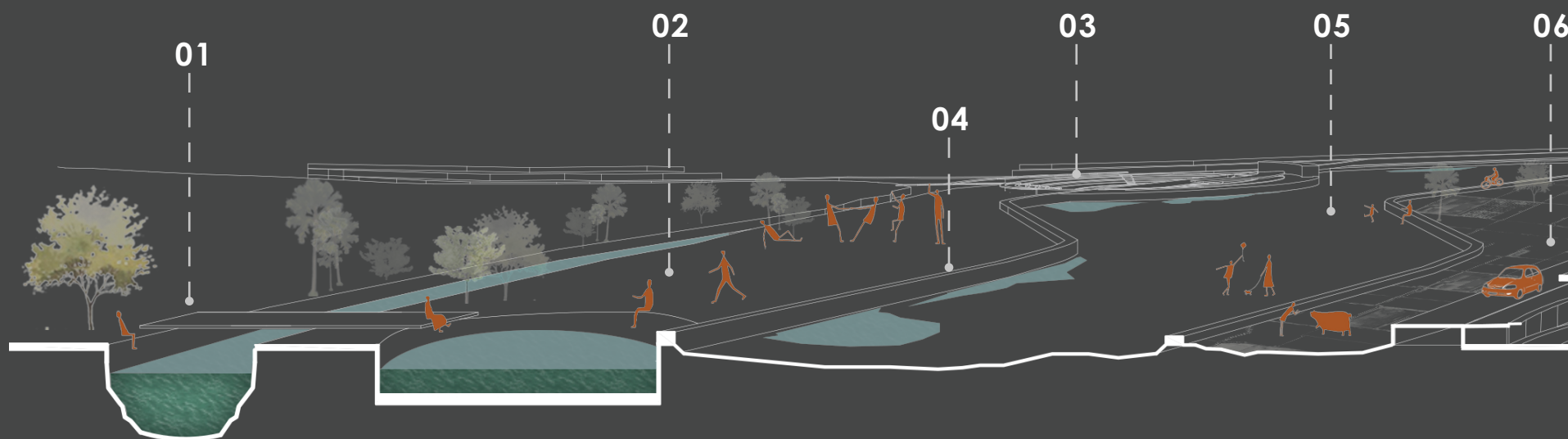
# Adaptation Solutions

## Fluvial flooding



- 01 Green buffer zone
- 02 Floodable buffer zone
- 03 Urban sponge point
- 04 Floodable dike
- 05 Emergency overflow zone
- 06 Agriculture camps
- 07 Increase storage or discharge capacity of surface water
- 08 Increase height difference between street level and ground floor level
- 09 Emergency shelters place
- 10 Evacuation Routes at elevated levels
- 11 Safe house
  - Building on partially elevated areas
  - Buildings (partly) situated in the water
  - floating buildings
- 12 Multifunctional infrastructure





### 01 Green buffer zone

Implement green cords in the city . it will provide shade and also absorb water. This greening can be done by tree lines along the chanel and in the proposed urban band, creating parks and green infrastructure . It will provide recreational possibilities and increase the livability of the city.

### 02 Floodable buffer zone

A artificial band parallel to the channel, that will protect the lower housing zones of overflow water, in addition it is a place where rainwater can accumulate, storage and then redirect it to be able to be treat.

It is a landscape oportinuty and also a recreational and infrastructural place for the city.

- control and use of water
- recreation activities
- aquatic transport

### 03 Urban sponge point

It is a leisure infrastructure that integrates floodable buffer zone and the city neighborhoods, this serves as a water retention area used to manage rainwater runoff to prevent flooding and improve the quality of water in the chanel.

### 04 Floodable dike

It is an element placed after the floodable buffer belt , it is designed to protect from f frequent flooding.

This element also serves as a pedestrian path, and protects the vulnerable neighborhood interior from high levels of extreme clima.

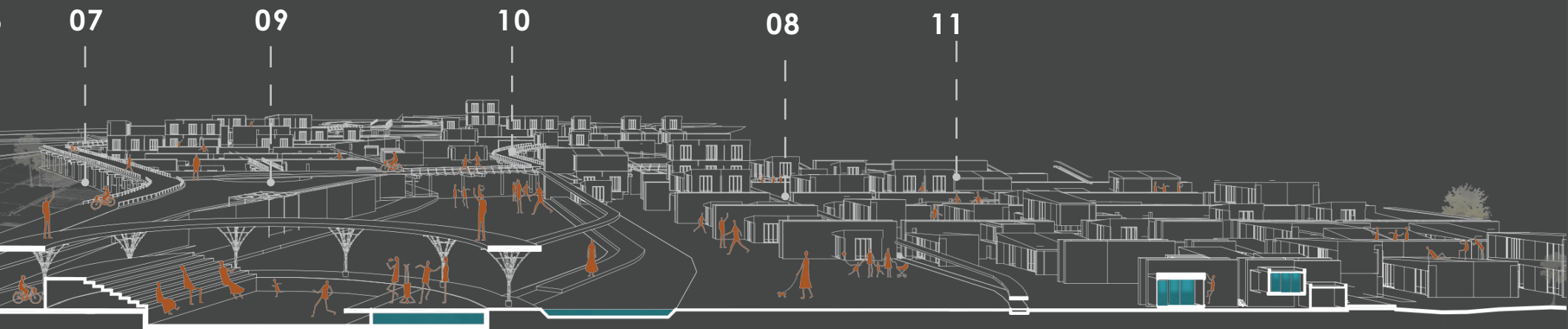
49 Orellana A. (2021) Adaptation Solutions Urban Section.

Reference:

Information obtained from the application made by:  
Bosch Slabber Landscape + Urban Design; Deltares; Sweco;  
KNMI Witteveen+Bos ( 2019) Muave - Unimproved Water Sources.  
<https://www.climateapp.org/>



# Adaptation Solutions



## 05 Emergency overflow zone

Is a big artificial urban wet land retention basin that is able to handle rain water overflow to avoid flooding, and recover water quality in the chanel. Also this zone helps to redirect part of the water flow into agricultural camps.

This area can be used for example, leisure under normal conditions and water storage under extremely humid conditions

## 06 Agriculture camps

The agricultural fields are located between the protected areas near the canal and the neighborhood, it helps to preserve crops and not affected by flooding.

## 09 Emergency shelters place

Elevated emergency shelters zone is designed in the center of the neighborhood because it is easily accessible and has the capacity to accommodate all people in the vicinity. its is a open common space that has the possibility ti change use.

## 07 Increase storage or discharge capacity of surface water

To reduce floodrisk and improve the ability to manage the water. The area down the the streets will help as an storage and purification place for water. its a water purification cord.

## 10 Evacuation Routes at elevated levels

Design routes for safe evacuation in flood events, but also it serves in daily life. They are designed in a upper level. People affected by the floods can use the routes to reach safe (higher) ground.

## 08 Increase height difference between street level and ground floor level

To reduce the probability of flood water entering in homes, it is proposed to make elevated streets that directly lead to a second level of the house, with the difference between street level and house entrance level we avoid rainwater entering.

Water can be stored under the streets in storage tanks that are designed to store runoff

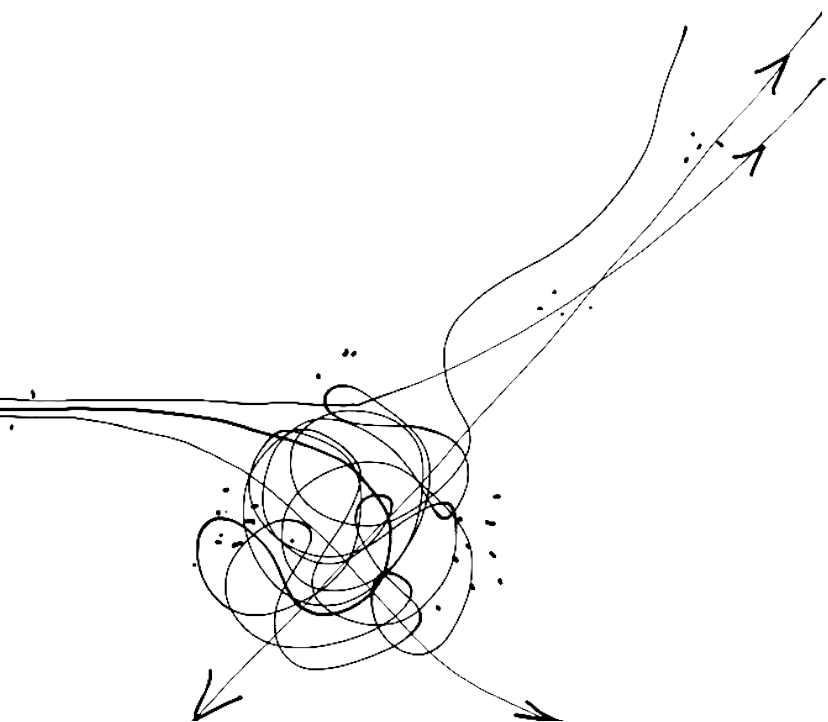
## 11 Safe house

3-4 floor housing buildings  
-adaptation houses  
-floating houses  
-elevated houses  
-mobile houses









[from]

**01** EDGES

**02** PATHS

**03** NODE

**04** LANDMARK

**05** LANDMARK

**06** DISTRICT

[to]

**LIMIT** [Water ponds /  
let it flood]

**CONNECTION** [street]

**INTERCHANGE** [Communal  
vertical zone]

**STORAGE** [Water  
land park]

**STORAGE** [Water  
treatmemt ring]

**NEIGHBORHOOD** [Together]



# Water

## let it flood

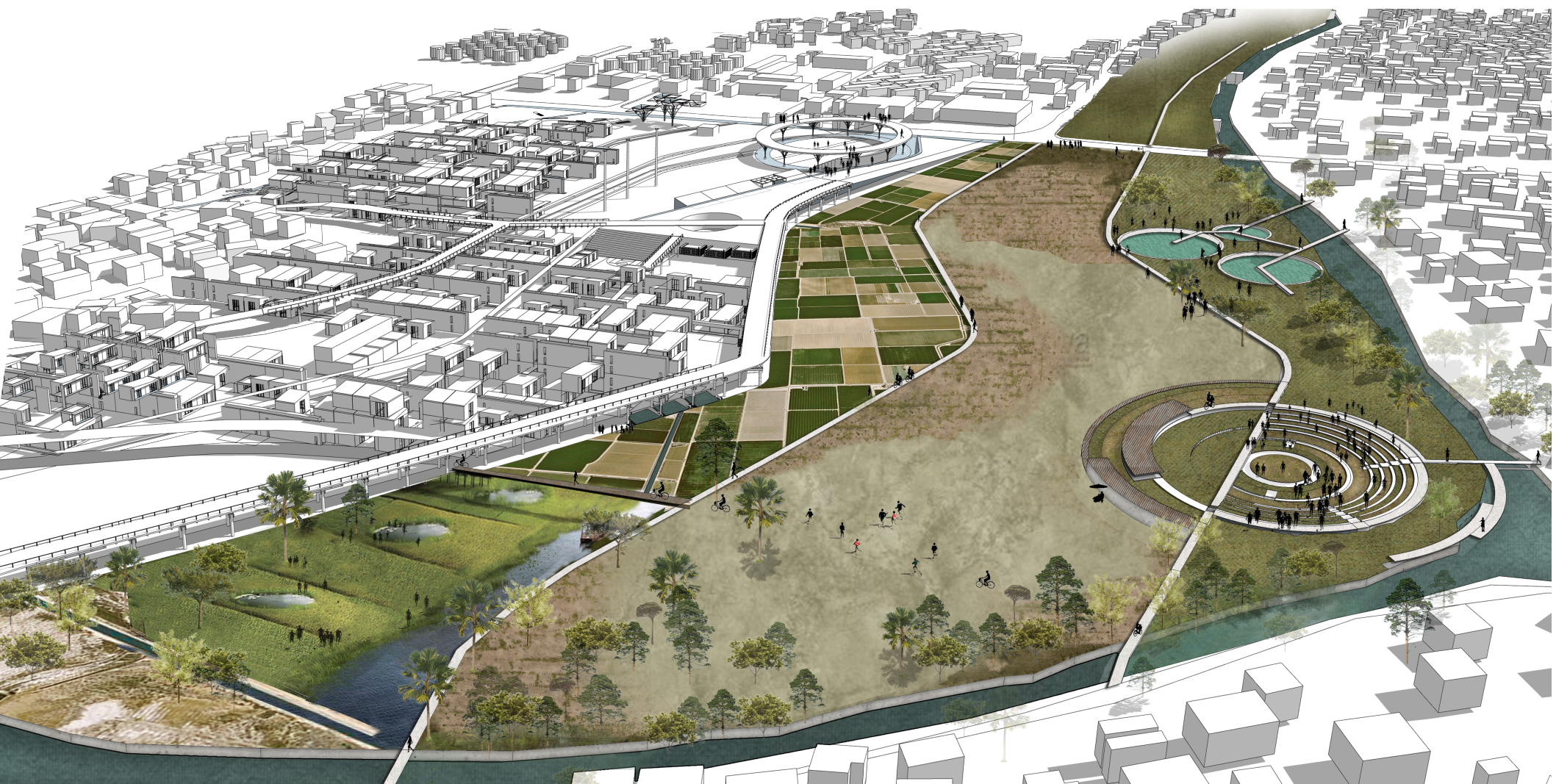
01



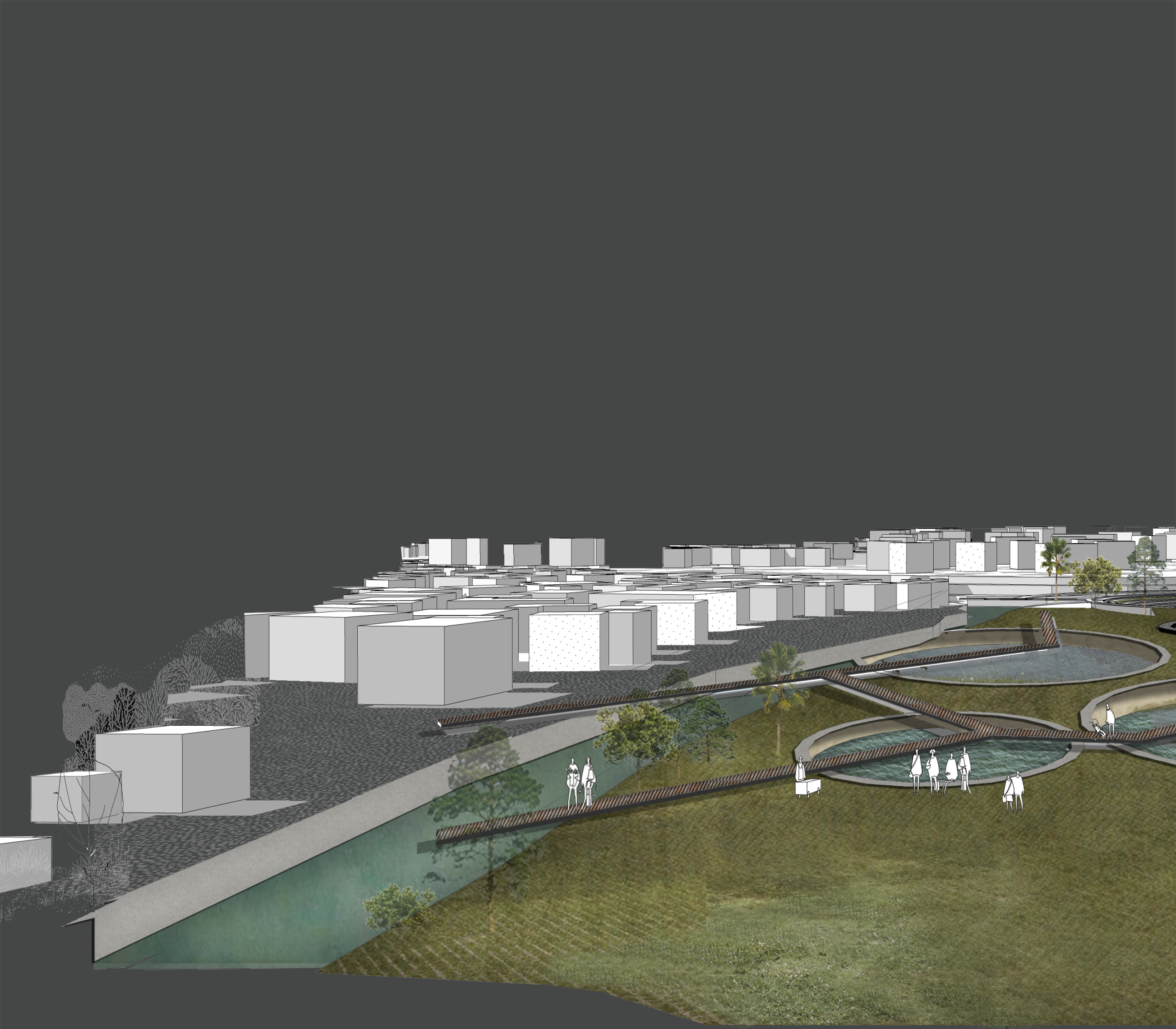
Improve the existing urban edge (channel), an element that define the neighborhood limits but also serves as link, union and continuation between zones, generate a malleable, permeable edge, that does not delimit or separate, it should establishes differences, but at the same time emphasize and persist on city continuity.

A big floodable corredior is proposed, capable of mitigating climate inclemences, as well offering recreational possibilities that improve life quality of Beira citizens. It should be a place capable of coordinating communities, organizing the city and being the possible key to a continue and permanent resilience. Its also necessary to promote agricultural activity in this band, because it was an traditional practice carried out specifically by women and were embedded in the livelihoods of the people from Beira. Due to land demand this labour is in danger.

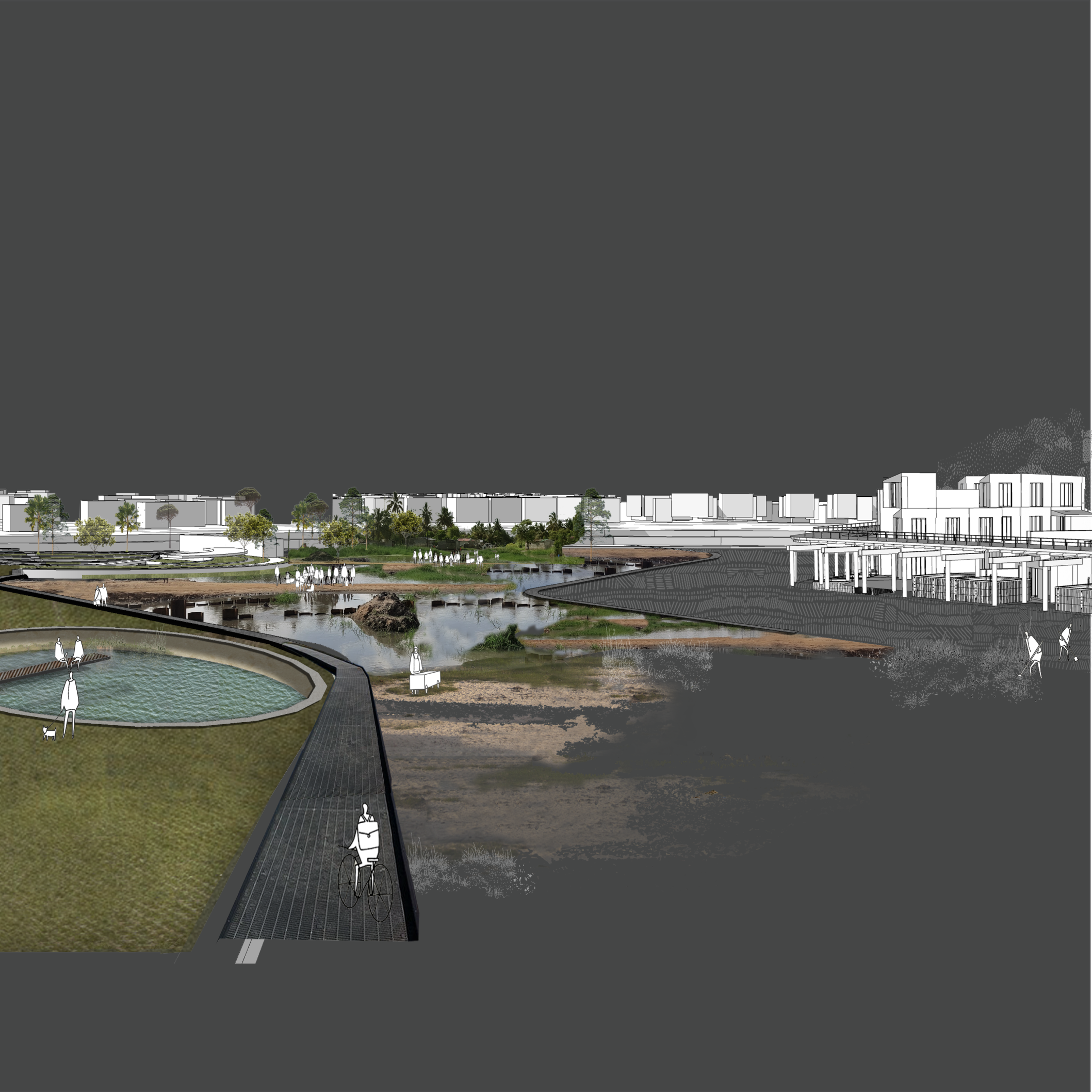








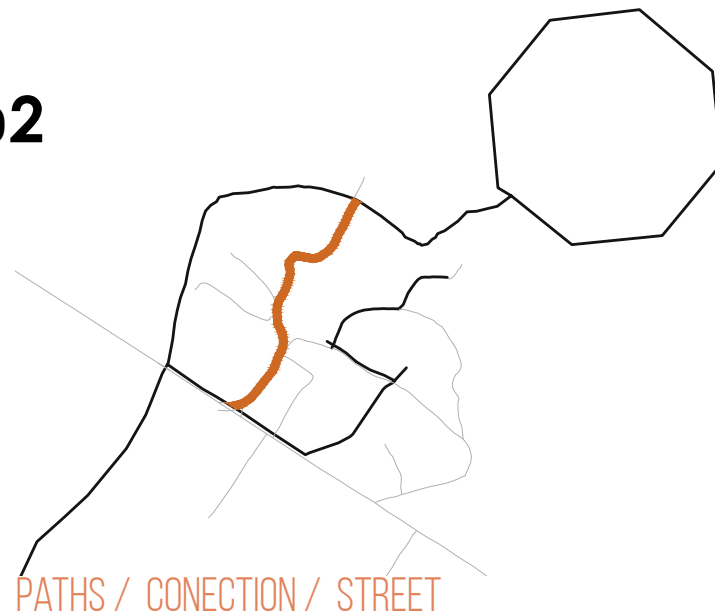




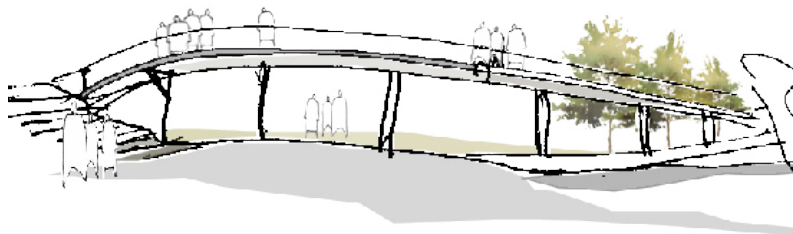


# Streets

02



**From Street to Conection \_A urban cord that allows flow / mobility , accessibility of people and sources.**



An infrastructure capable to allow people and sources flow, following the organic shape of existing dirt roads.

Generate an articulate urban piece between the pre-existing city architecture and infrastructure, guaranteeing public shared spaces. Dynamic and static spaces at the same time. Design routes for safe evacuation in a upper level zones for flood events, but also could serves in daily life. People affected by floods can use this routes to reach safe (higher) ground.

To reduce the probability of floodwater entering in homes, it is proposed to make elevated streets that directly lead to a second level of the house, with the difference between street level and house entrance level to avoid rainwater entering. Water can be stored under the streets in storage tanks that are designed to accumulate runoff excess in urban drainage systems during wet periods.

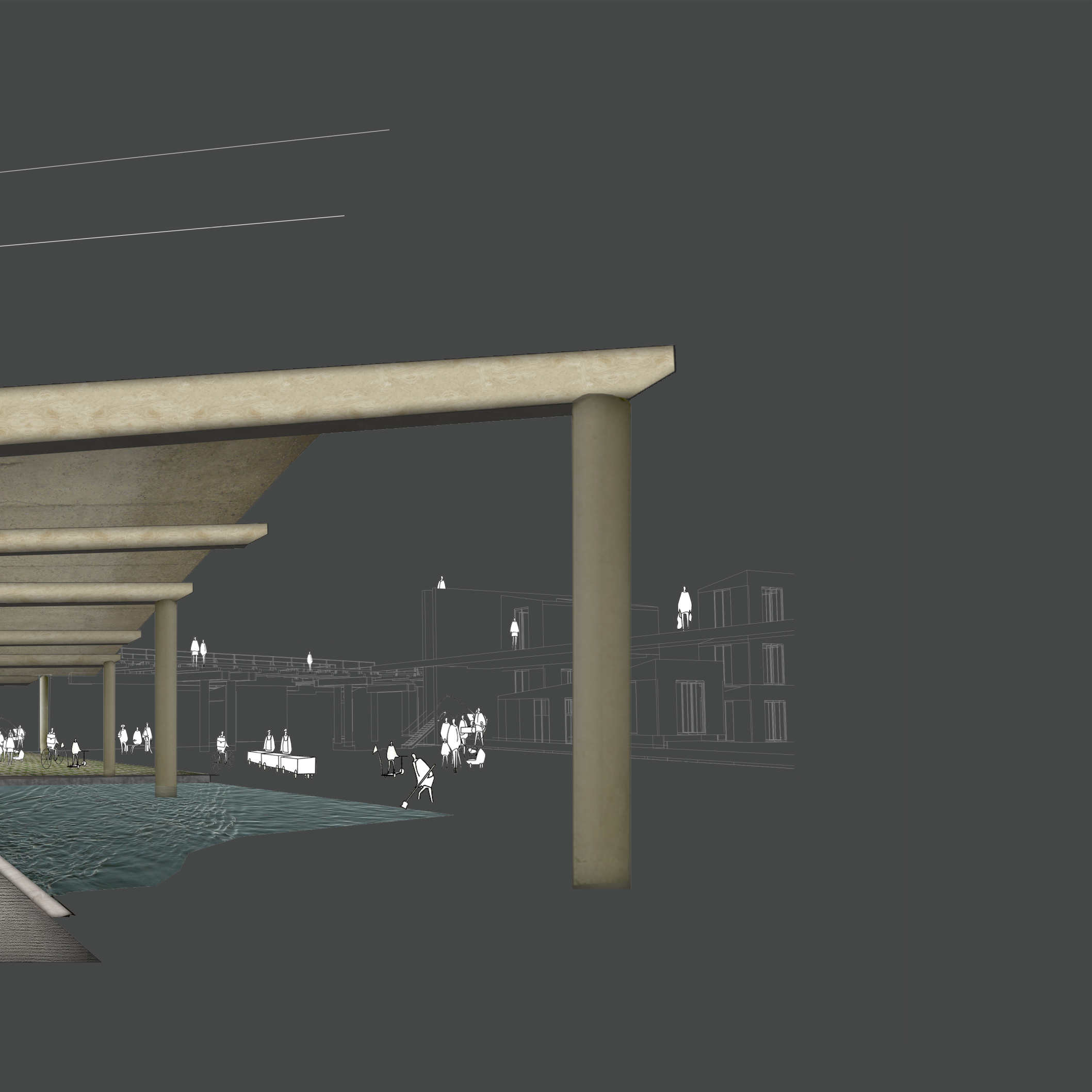








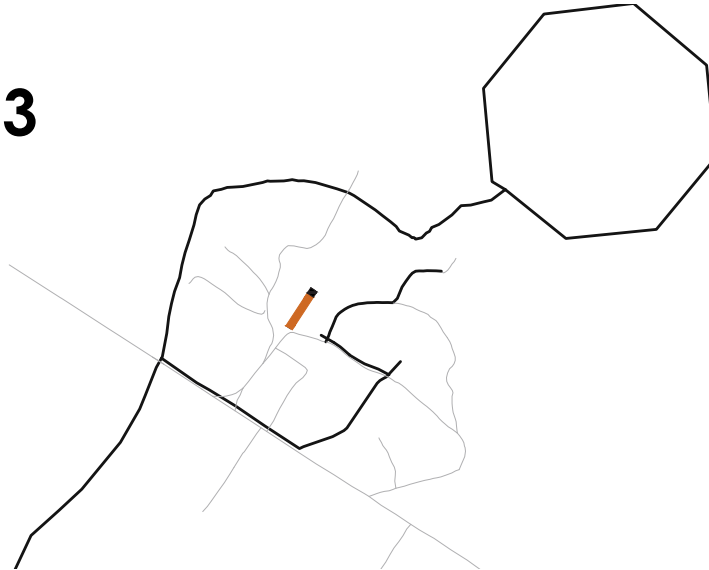






# Community Spaces

03

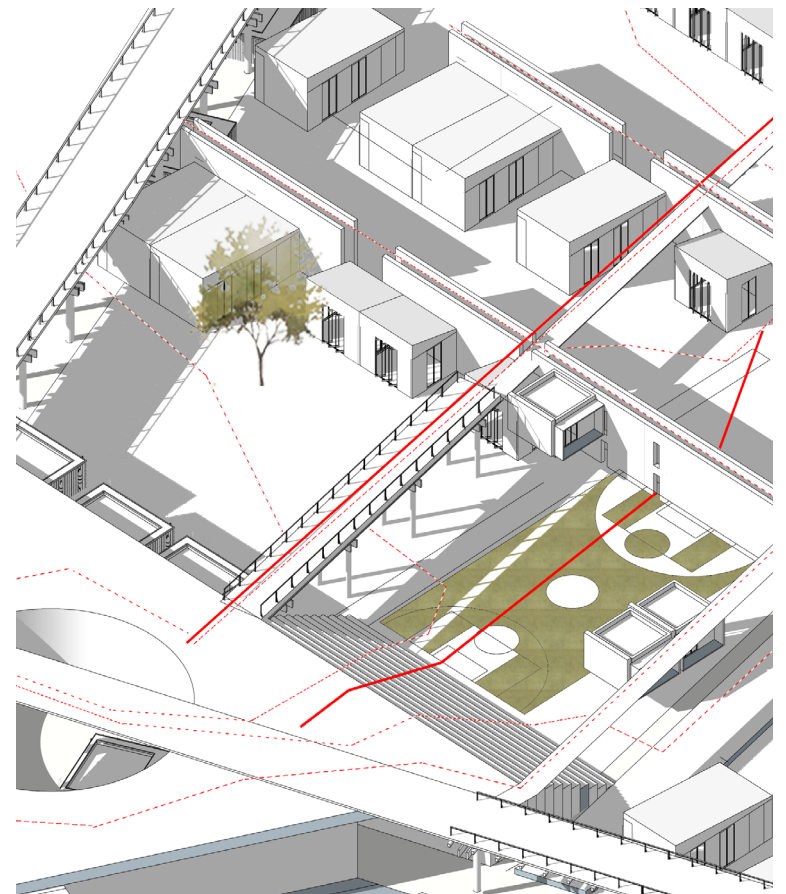


## NODE / INTERCHANGE / COMMUNAL VERTICAL PARK

This proposal is a communal space node , flexible and open but at the same time it has the ability to storage water as a form of action is possible throughout the neighborhood paths that help water recolection, it does not imply technological solutions but it becomes a base of citizen dialogue between the identification of different-public infrastructure element in front of common space.

An communal infrastructure space, though as an exchange node that allows community be safe when an extreme climate event occurs. It is an emergency zone , where food kits, medical care, water can be distributed.

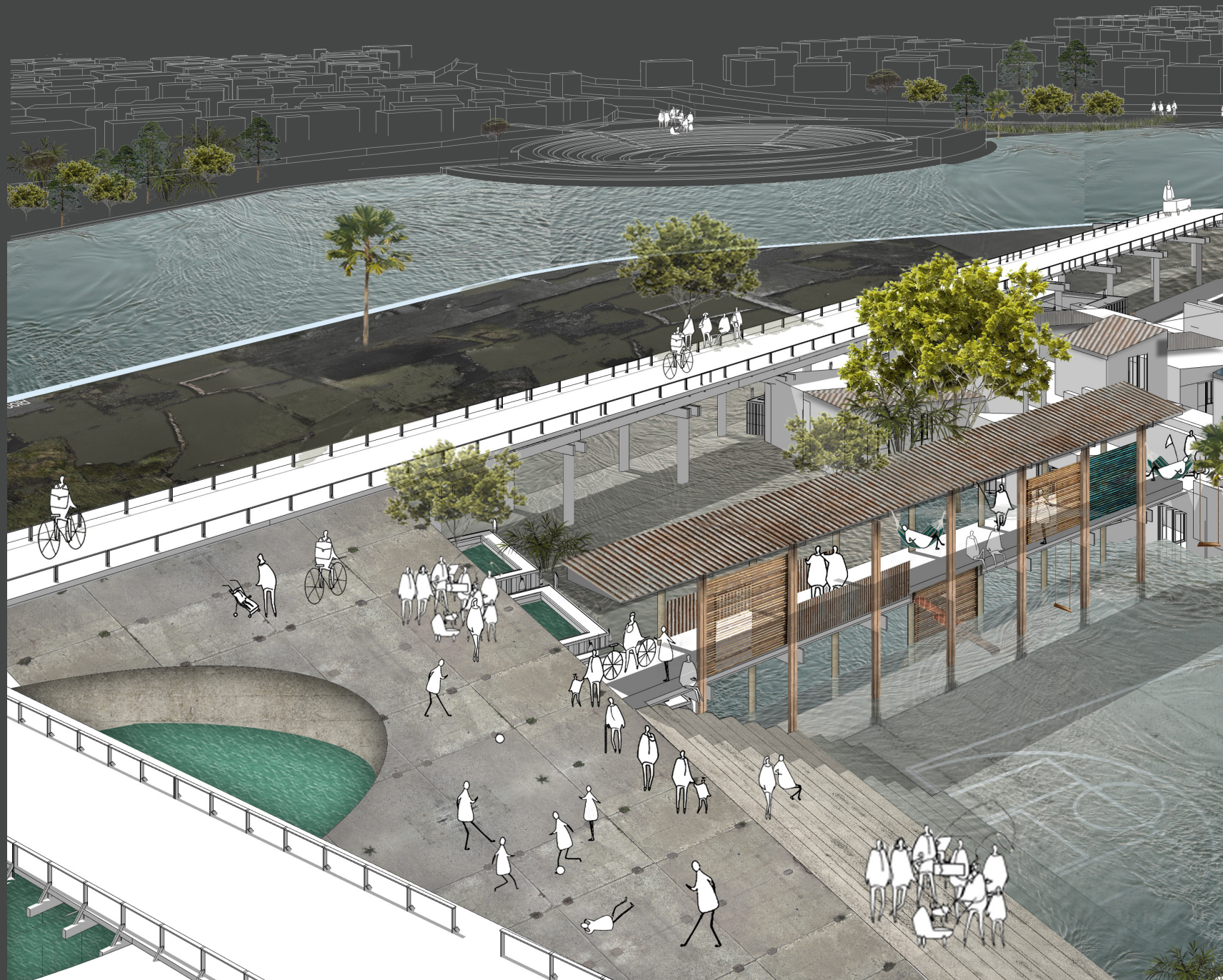
It is confluence point of many paths to an elevated emergency point that allows community continue their daily life even if they are flooded.











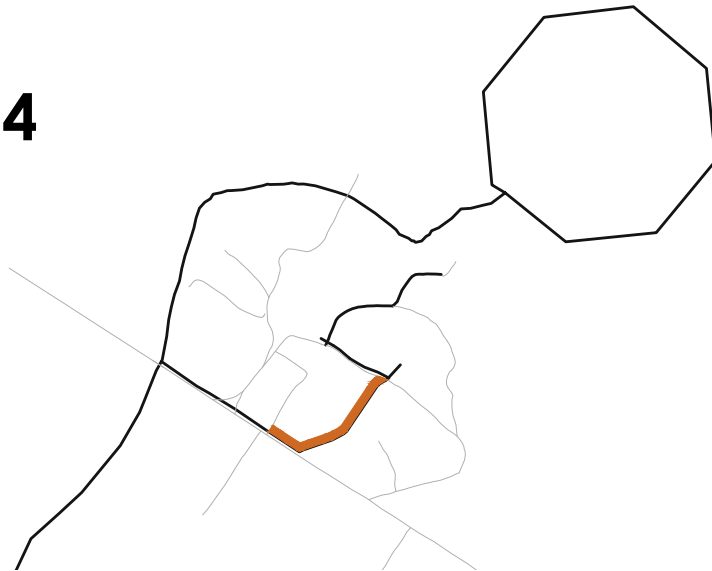






# Water-Purification cord

04



LAND MARK /CORD CONTAINER/ WATER LAND PARK

**A cordon or water purification circuit designed through urban sponge lagoons, a storage point of the city that becomes a city reference and at the same time comprehends a new social community dynamic: learn to manage water for its own benefit.**

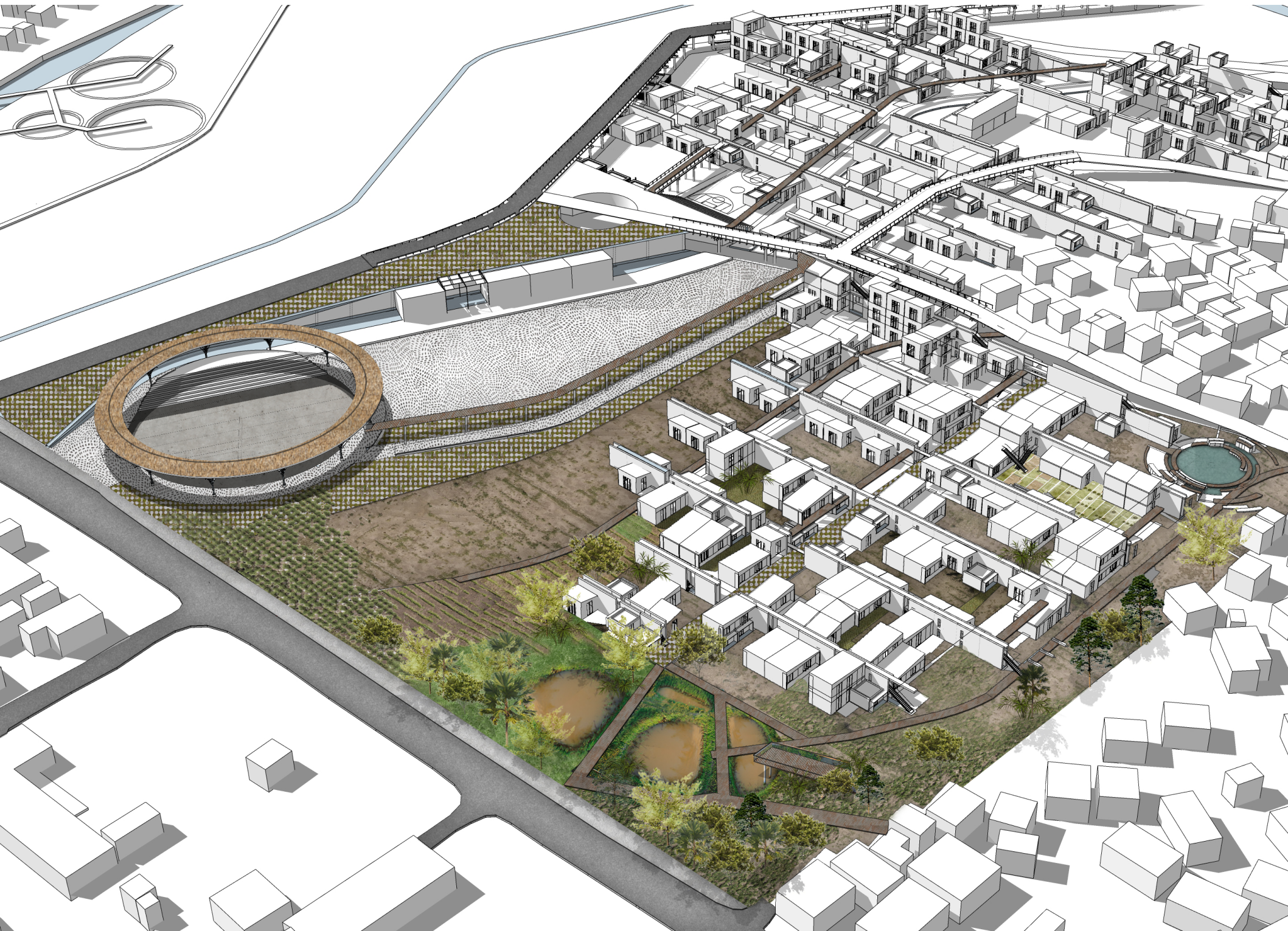
The urban infrastructure proposal, seeks to solve climate problems from a position in which water problems are not rejected, but not accepted at all, use the resilience behavior from Beira community to coexist with water and raise a social infrastructure that allows a tactic approximation to manage water recollection and purification.



49 "Google Earth" . (n.d). After rain. [Image]

Realize a lagoons collection and purification water circuit, placed in the main neighborhood entrance, in order to introduce community into a direct exploration of a new daily life dynamic , modifying leisure zones and turns them into a multifunction space (A space that allows recreation but at the same time comprehend the importance of water maintenance). We cannot expect an already set, still, blocked architecture when the city changes constantly for climatic, social or urban reasons, we should think in a dynamic , flexible, malleable spaces.

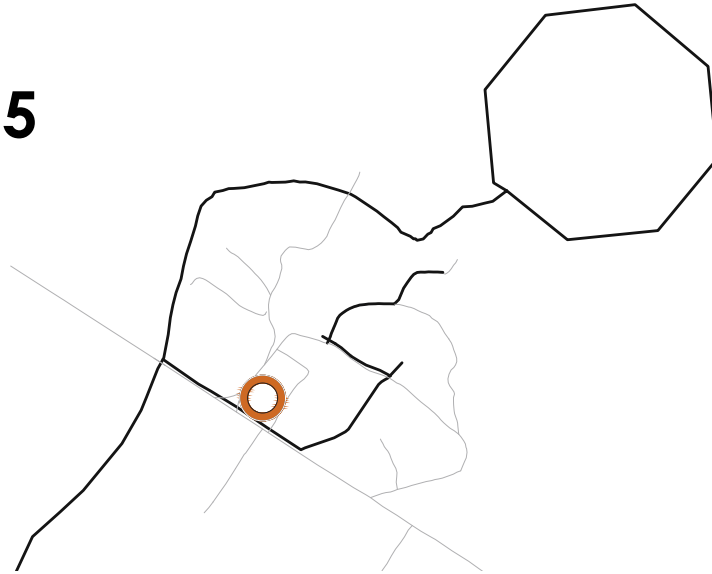






# Water-urban Collector Ring

o5

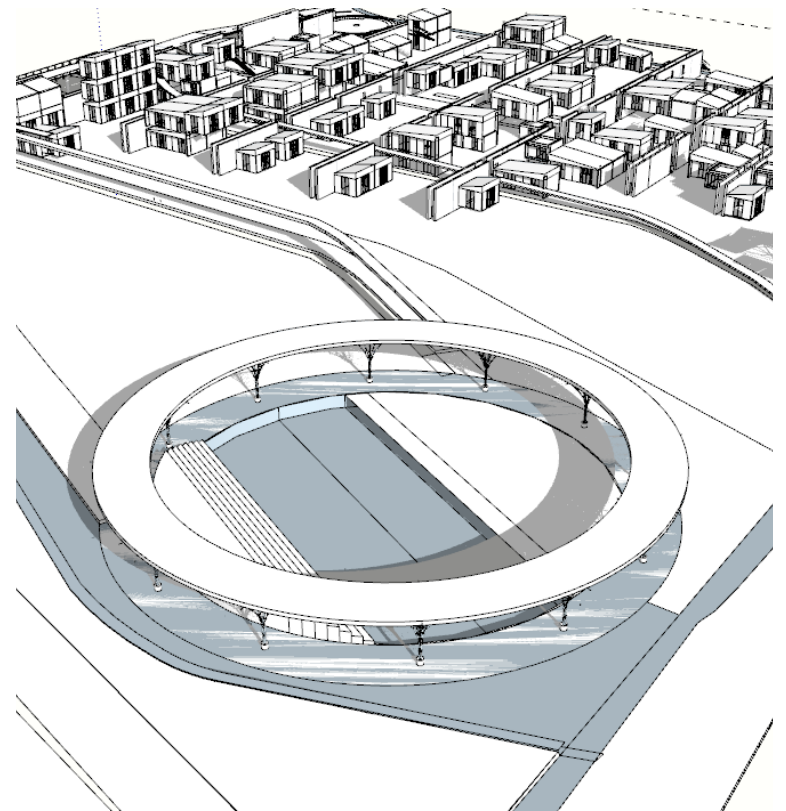


LAND MARK / CONTENITORE /

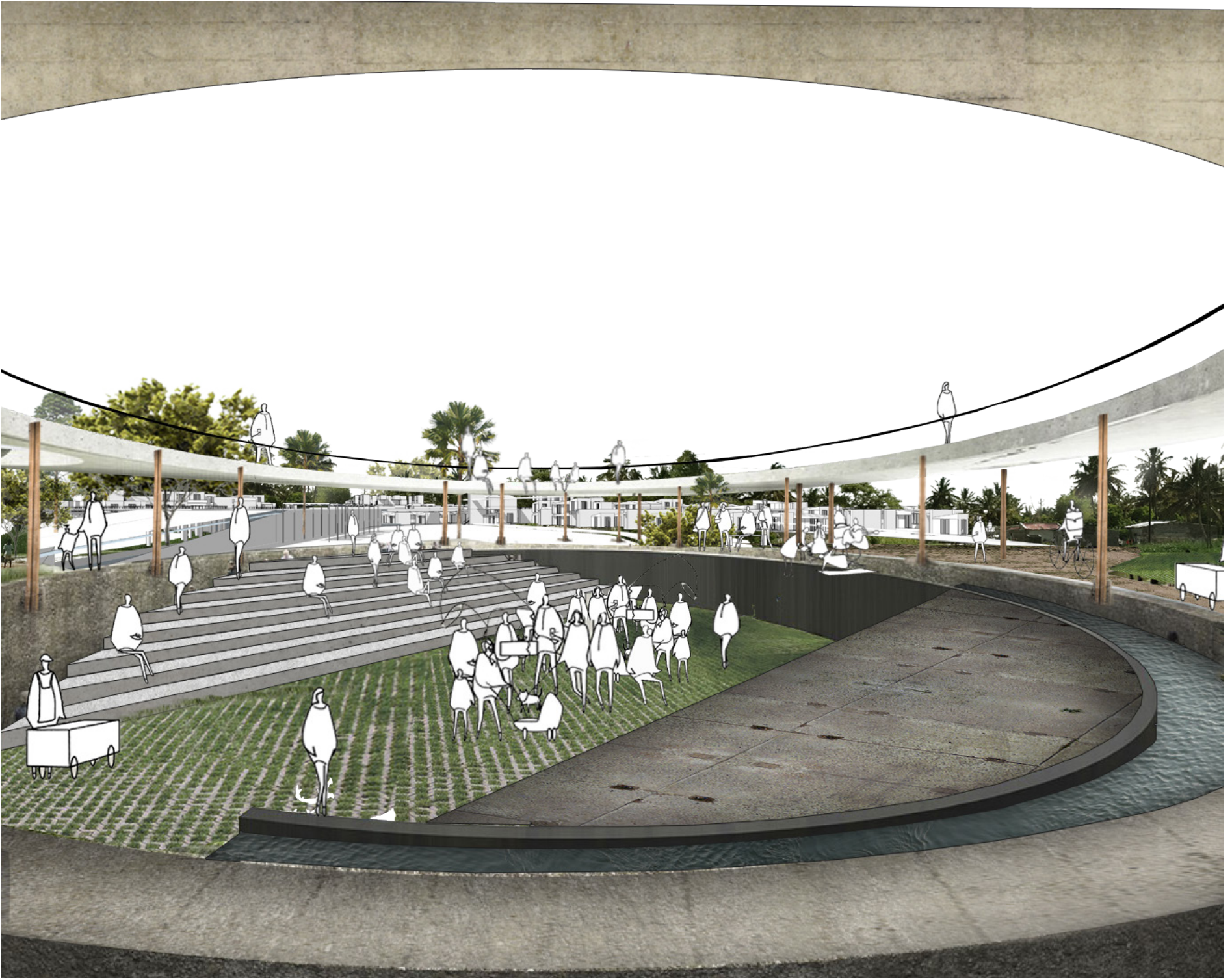
The proposed element inserted in Beira urban pattern aims to be a reference point for the neighborhood and the city, besides guaranteeing freedom community movements that are constantly changing, in other words be concern of the continuous metamorphosis city process, seeking for new architectural senses without forgetting Beira identity that must be maintained despite its persistent permutation due to climatic changes.



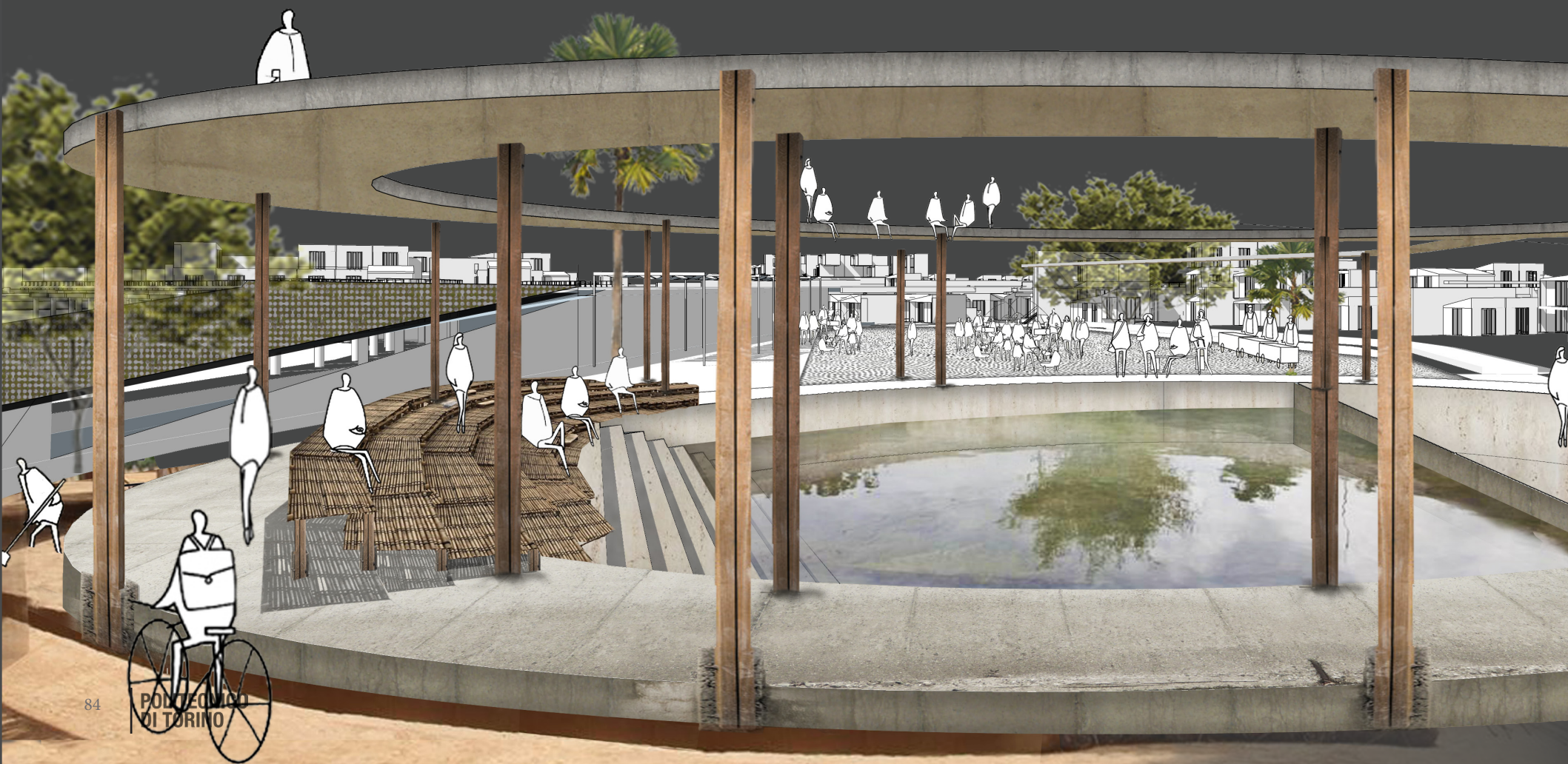
50 Google Earth . (n.d). Public space. [Image]



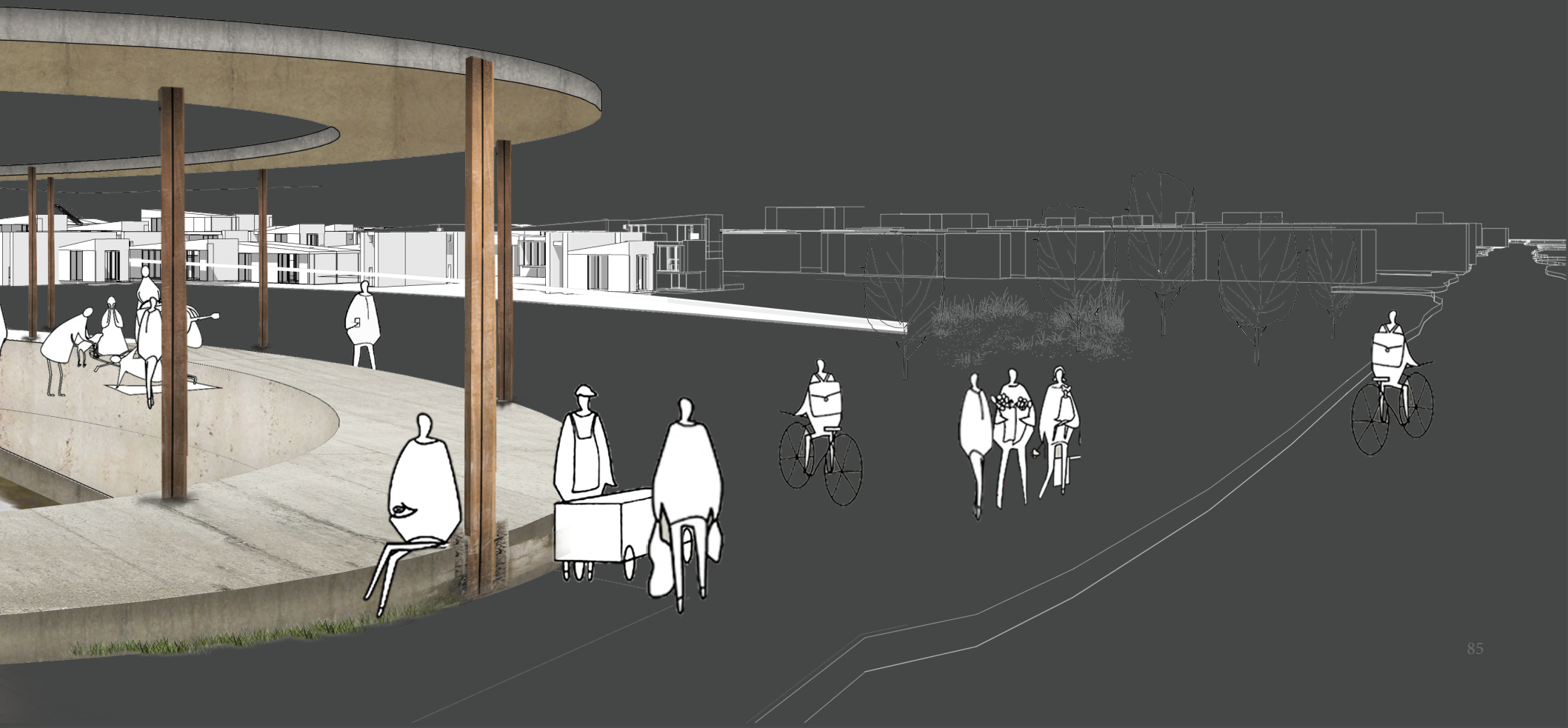








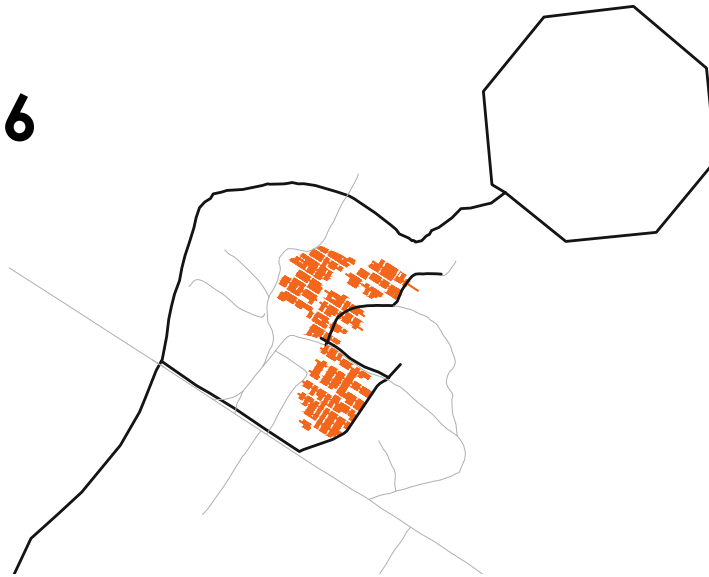






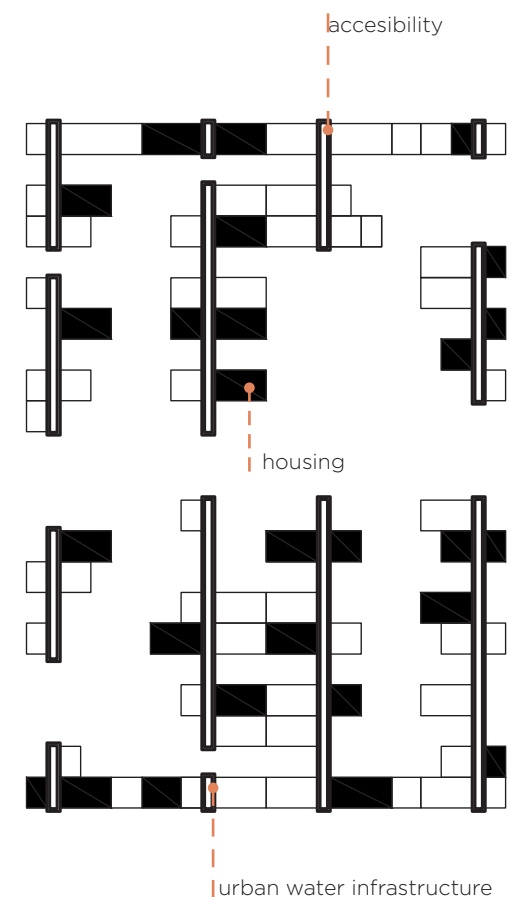
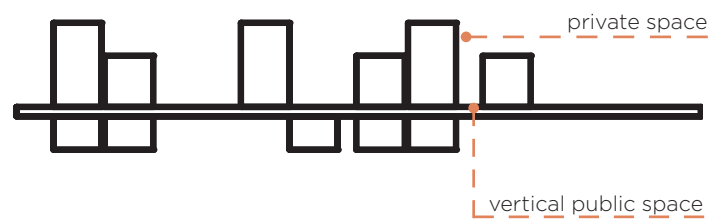
# Neighborhood Metabolism

06

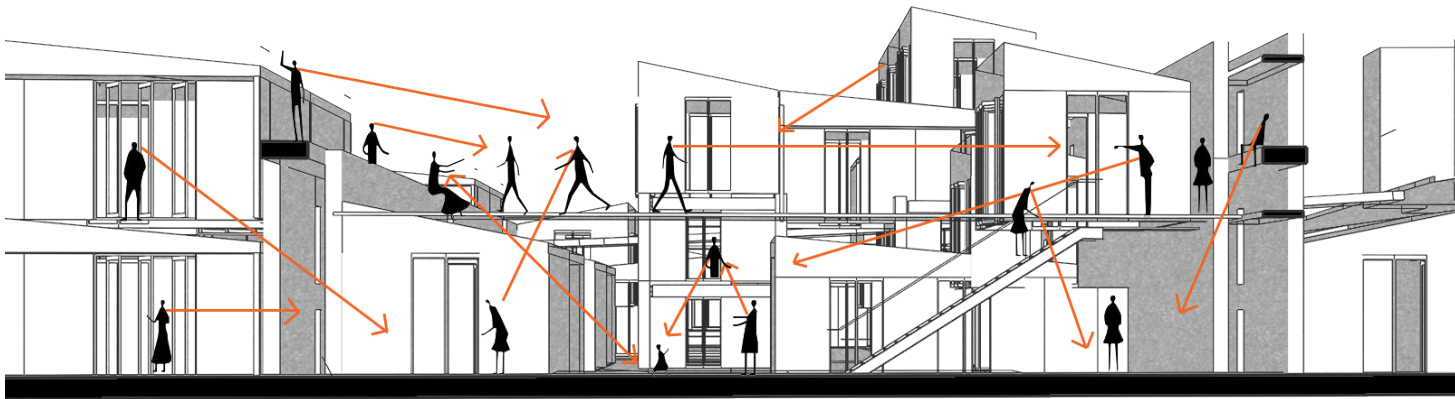


## DISTRICT / NEIGHBORHOOD / TOGETHER

The proposal is a building-structure, flexible and open. Its ability to replicate as a form of action is possible throughout the neighborhood, it does not imply technological solutions but it becomes a base of citizen dialogue that experiments the identification of vertical public space in front of private space.







## Formal design\_premises

- 01 Scale / • 3-4 floor housing buildings
- 02 visual and physical connections (shelter points/nodes / water boundary)
- 03 accessibility / not just ground floor / spatial experience using roofs and urban infrastructure, emergency paths in upper levels
- 04 Mobility/ different ways of transportation
- 05 Urban life carpet/ open permeable space.
- 06 Construction/ low technology / self construction
- 07 Replicable vs Flexibility vs. control  
Emotional belonging
- 08 Green corridors/ social shading space
- 09 Housing : mixed uses / mixed social status  
density compact city / high density  
progressive housing

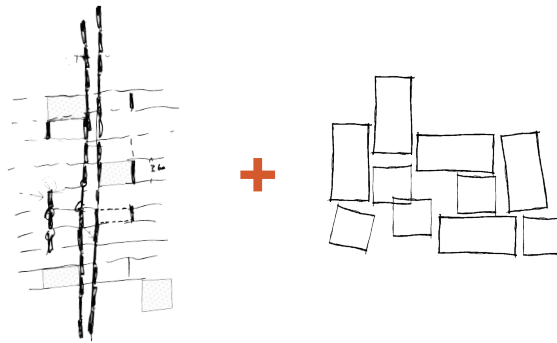


- 10 public & private space  
no limits/ space for everyone and anyone
- 11 freeing up space for diversity and agriculture
- 12 Rainwater connection system  
Energy collector circuit
- 13 Green corridors and interior yards that allows  
the interaction between inhabitants .

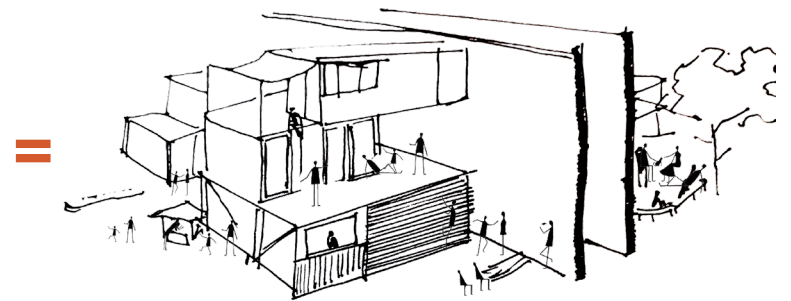
A neighborhood scenario in which pre-existing homes can be recovered and improved and new homes allow flooding at ground level. I understand that many settlements are critically damaged without access to basic services (including water, roads, sanitation, lighting, electricity, and waste), I propose an integrated cohesive approach for resilient housing in an urban context which includes: water infrastructure+ housing.



# Housing-Unit Metabolism



urban infrastructure + residential housing



The reconstruction process represents an opportunity for Beira, a particular approach to the socio-spatial problematic, understanding the government as a "urban-water infrastructure producing agent", and citizens as an important part of creating neighborhood collective.



Its fundamental to clarify the responsibilities of the social and political dimension, in which the "urban water infrastructure proposal" is responsibility of the governance and the "housing" concerns to community. The aim its no only provide to the city a functional water infrastructure', but also to offer the opportunity to become autonomous and self-sustainable, access to clean water, and also stimulates the individual initiative. After all, it represents the combination between infrastructure and architecture, a dimension as a support where different ways of life could coexist and also response or adapt to the constant climate change.







# Bioclimatic strategies

## 01 water

- 1a| **rain water collection- h2o wall**
- 1b| garden/crops irrigation
- 1c| water retention / sponge city
- 1d| clean water to river ●●●●●

## 02 energy

**roof** solar panels collection-  
energy produce (6.43kwh)

## 03 waste

urban **waste** points- (15 l)  
**biodigester tanks** ○

## 04 wind

- 4a| **natural** ventilation/ cross ventilation
- 4b| natural ventilation / chimney effect
- 4c| **patios** create micro climas / ■ shading social spaces

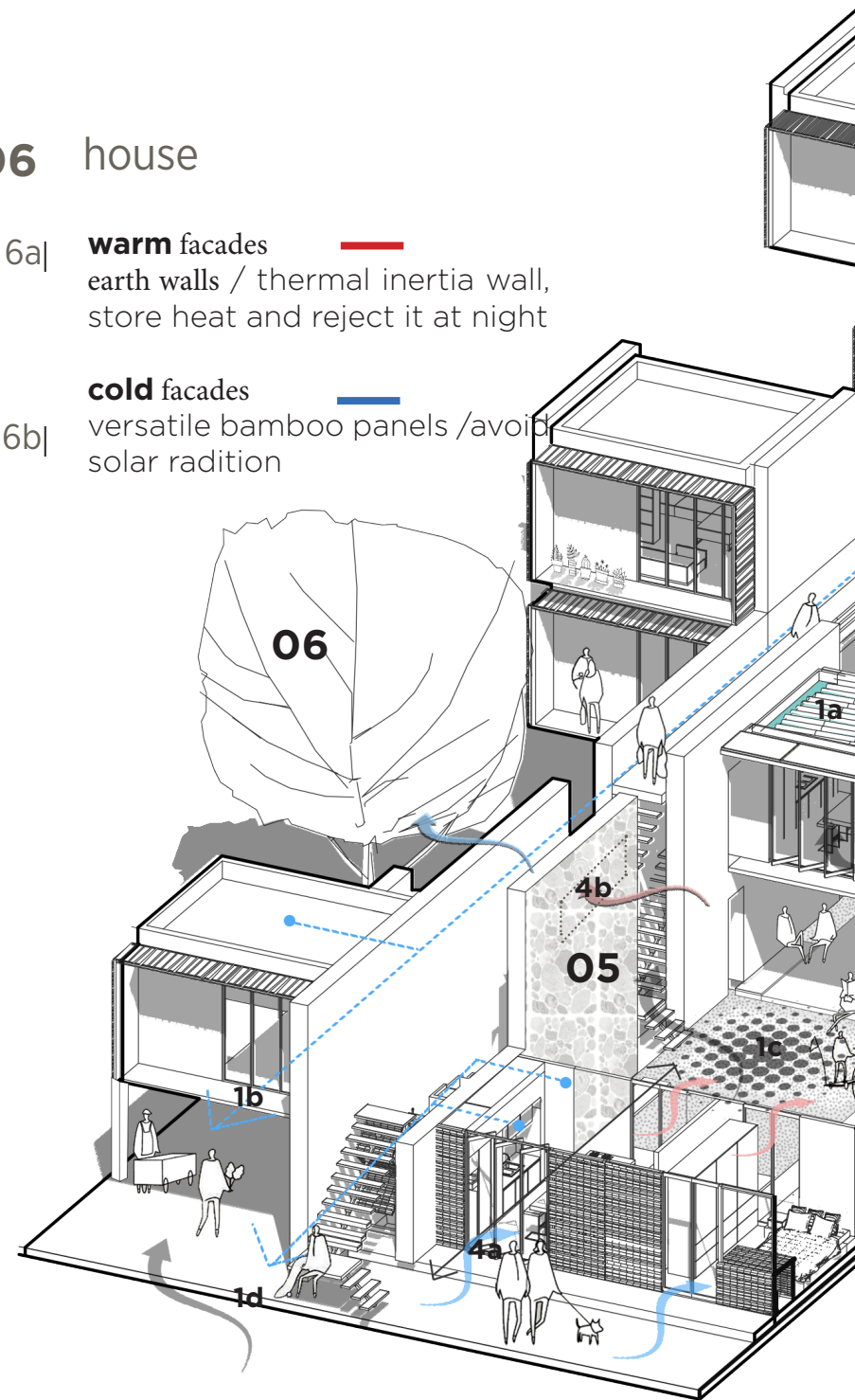
## 05 vegetation

vegetable **green** screen

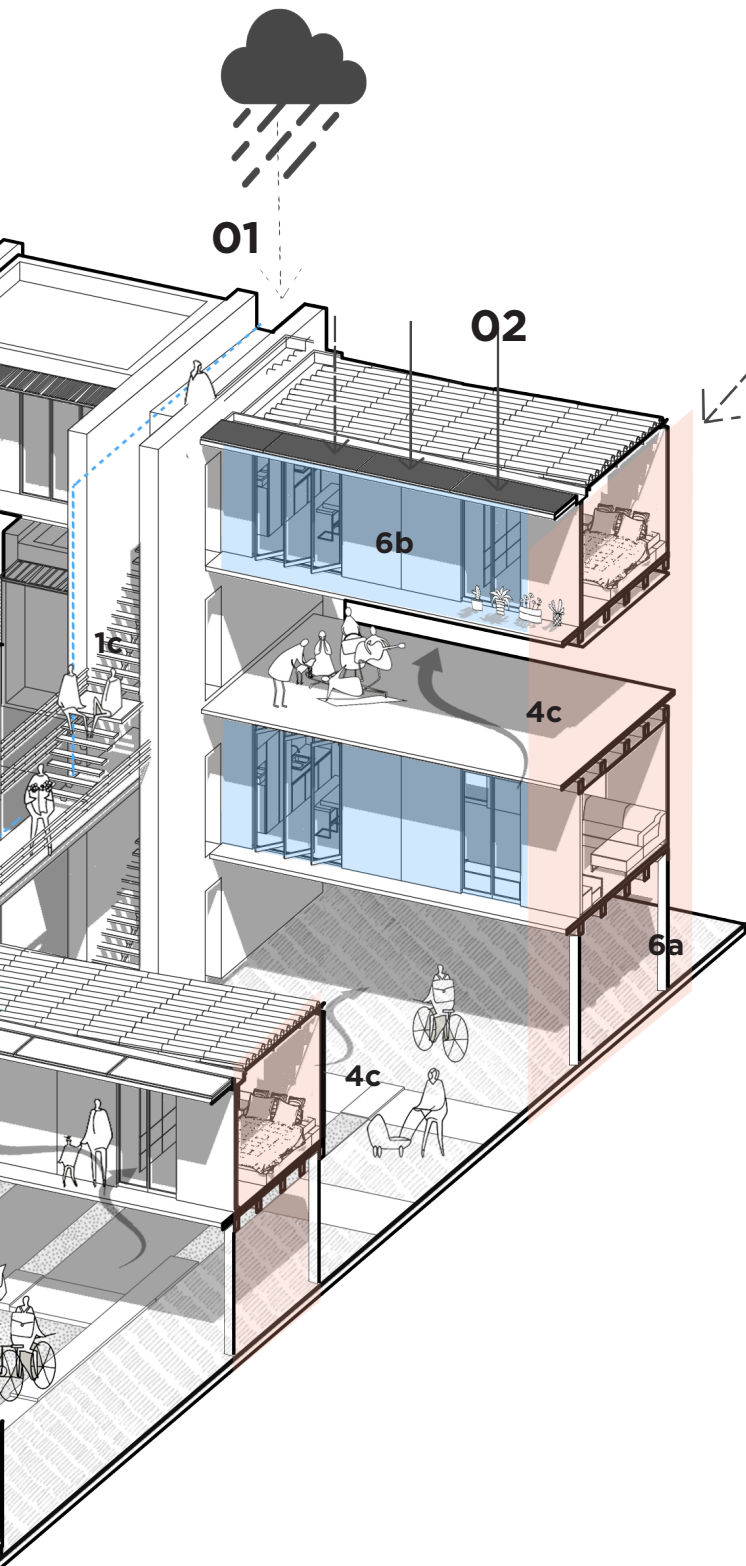
## 06 house

6a| **warm** facades —  
earth walls / thermal inertia wall,  
store heat and reject it at night

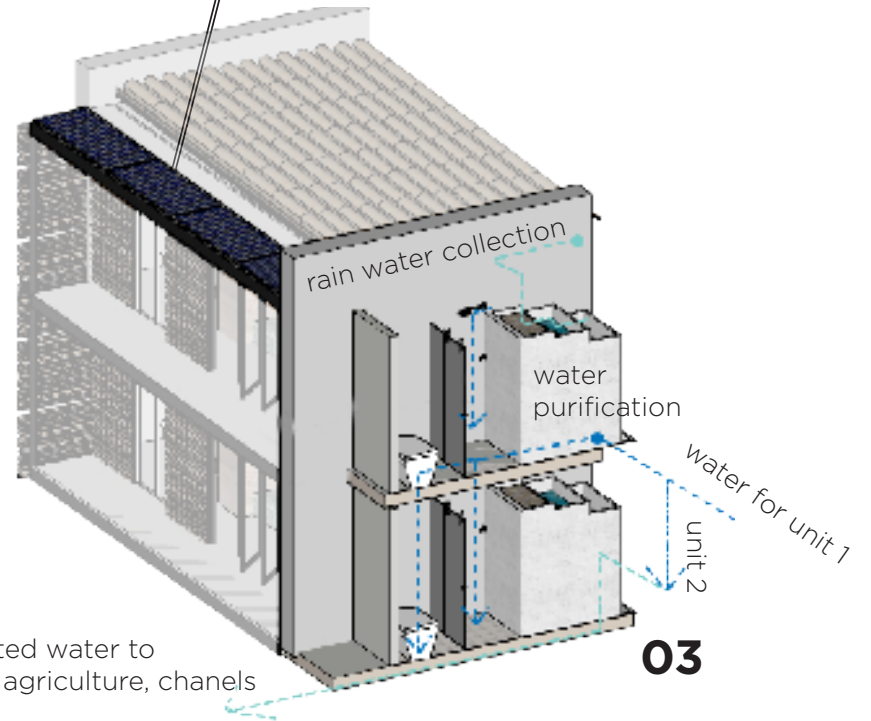
6b| **cold** facades —  
versatile bamboo panels /avoid  
solar radition







photovoltaic CELL 270 W



purificated water to  
garden, agriculture, channels

## wall tanks

water wall cistern

Dimensions cistern per unit:  
 $1.50\text{m} \times 2.80\text{m} \times 1.50\text{m} = 6.30 \text{ m}^3$

Capacity per unit **6300L**

Number of people in 1 unit = 10p  
Water demand per person  $V = 25\text{L}$

250lts daily general collection of water

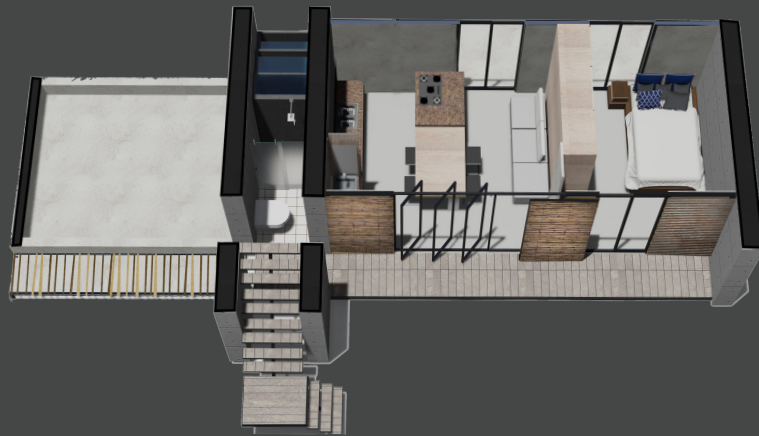
**water machine/ harvesting system**  
city infrastructure part of residen-  
tial housing

# Water

**tank as a** city infrastructure part of residential housing



# Housing + urban infrastructure



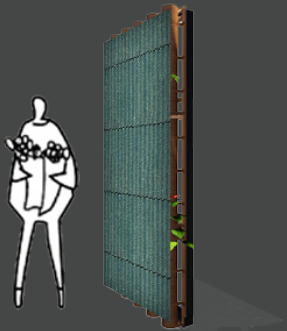
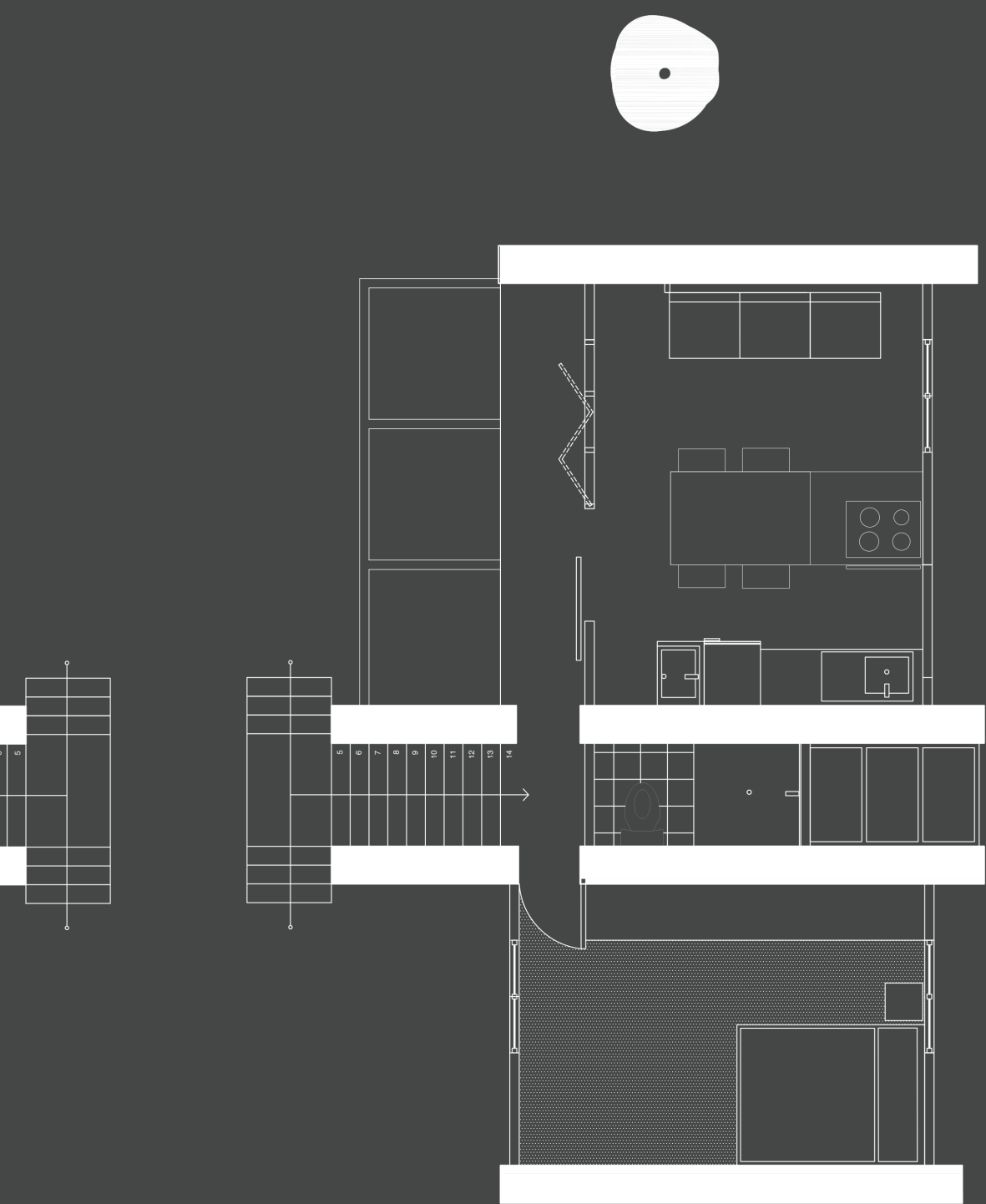
## block | typology

The basic modules can be arranged in various ways , by adding the facade different elements solutions can be created..

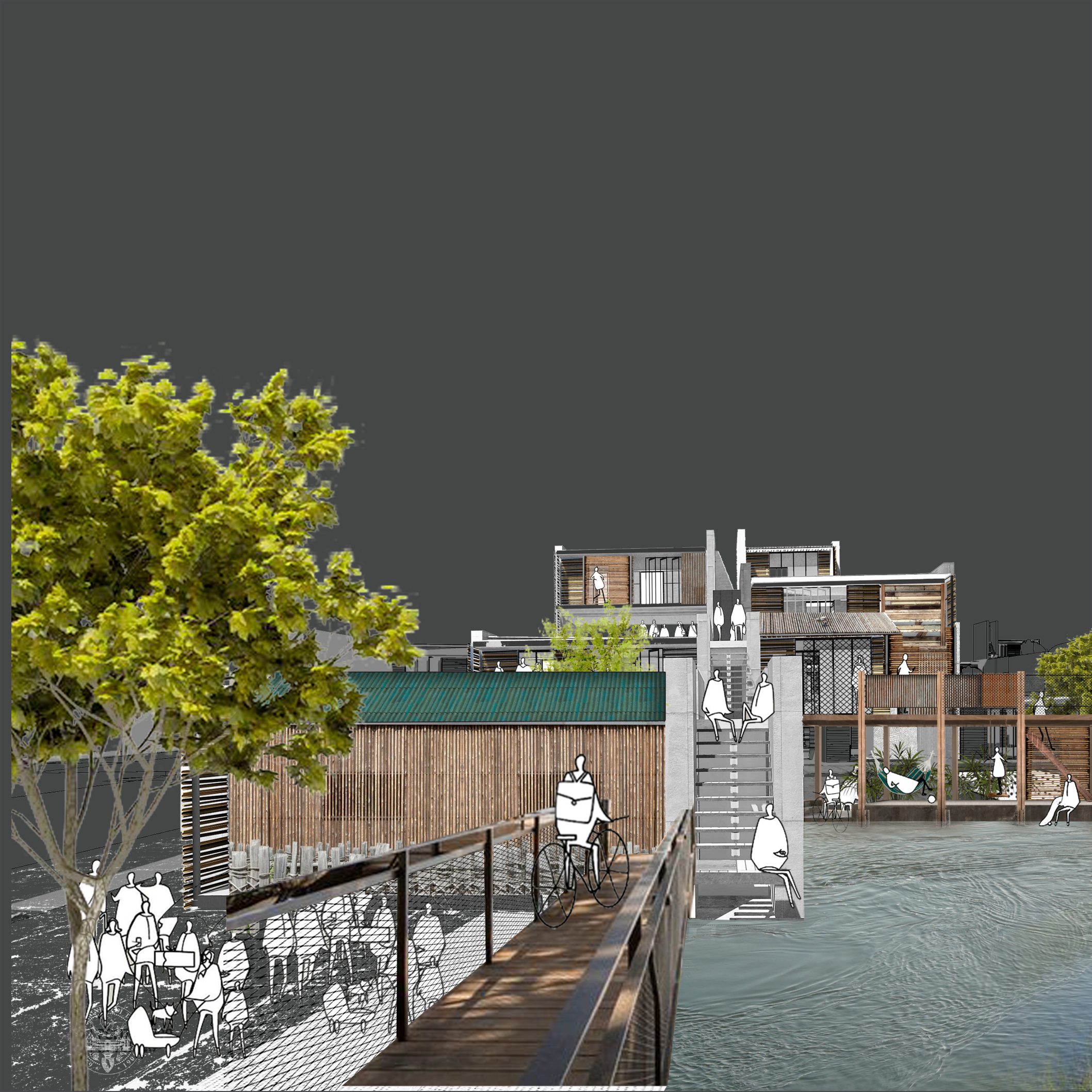




01 | exterior envolment(panels)













**WATER** URBAN  
INFRASTRUCTURE



## CONCLUSIONS

- In order to be able to do this proposal is important to understand actual urban governance processes, which are essentially about how different actors interact to make real decisions in making the city, is vitally important.

Its important highlights the diversity of actors involved in urban governance and its complexity processes. Its necessary identify key actors to rebuild a resilient Beira. Question ourselves about what are the government roll or limitations, the importance of political parties, traditional leaders, private sector trades, international helps and civil society. Lack of society responsibilities complicates address the problematic of the city but can also be seen as an opportunity for leveraging additional skills and resources through collaborative processes that bring different stakeholders together to develop and implement inclusive strategies.

**Fragility occurs when city authorities are unable or unwilling to deliver basic services to citizens.**

- The reconstruction process represents an opportunity for Beira. The aim its no only provide to the city a social functional infrastructure', but also offer the opportunity to become autonomous, responsible, self-sustainable, and also stimulates the individual initiative.
- To think about city and house , should investigate differents urban components of the city , elements that intervenes from block scale, neighborhood scale ,to city level scale, it would allow us to analyze city with different perspectives and have an integral approach capable to face city changes.



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**WATER** URBAN  
INFRASTRUCTURE

a disaster housing strategie response for Beira

ANDREA FRANCISCA ORELLANA LLIGUAIPUMA

Torino, 22 February 2021