Graduation Thesis

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ALTAMIRA BEYOND BELO MONTE

Gaps and opportunities for promoting sustainable development in a new energy landscape

COLOPHON

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Gaps and opportunities for promoting sustainable development in a new energy landscape

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(cover) **Altamira and the Xingu river**
image by the author

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figure 0.1 | **Boys playing in a flooded tree**
image by Aaron Vincent Elkaim
source: http://www.aaronvincentelkaim.com/where-the-river-runs-through

PREFACE

"An energy landscape is a landscape whose images and functions (be they natural, productive, residential, recreational, cultural, etc.) **have been significantly affected by energy development."** (Frantál et al., 2014)

The research focuses in the city of **Altamira**, in Brazil. The municipality is located in the margins of the Xingu river, affluent of the Amazon river, and has been facing intense socio economic transformations, mainly through the construction of the **Belo Monte** hydroelectric power plant - third biggest in the world, in generation capacity. Over the last 10 years, the local municipality estimates that the population inflated from 100.000 to 140.000 inhabitants (FOLHA, 2013), as a consequence of the jobs related to the dam and its construction. On the one hand, the implementation of the project has brought heavy investments in public infrastructure, following the compensation and mitigation guidelines established by the national environmental agency, providing the inhabitants with public amenities completely nonexistent before the dam. On the other hand, the intense transformation of the built environment resulted in new social challenges, including increased violence, prostitution and drug consumption, adding pressure on the limited infrastructure and public equipments. The project - heavily criticized by local and international media - is almost concluded and is already in partial operation. This research aims to investigate the next steps following the conclusion of the construction, searching for strategies capable of promoting sustainable development in the region. The focus is not only to look into the urban transformations triggered by the installation of the dam but also to explore possible future scenarios once Belo Monte is concluded.

figure 0.2 | **Boy playing in the Xingu river**
image by Dario Bosio
source: https://dariobosio.com/at-the-end-of-the-river/

ACKNOWLEDGMENTS

The following research was developed as the graduation thesis for the Masters of Urbanism at the faculty of Architecture and the Built Environment, at TU Delft. The one-year process was far from 'individual' and only became feasible because of constant collaboration and support from my mentors, peers, friends, and family. I would hereby like to express my deepest gratitude to all who contributed:

First of all, to my mentors Arie Romein and Leo van den Burg. Thanks to Arie for his genuine enthusiasm regarding the research, its methods and the solutions for the city of Altamira. Throughout our meetings, your comments and expertise offered me not only guidance but also the motivation to keep moving forward. Thanks to Leo for your dedication and for always asking the right questions. Your sensible input consistently challenged not only my work but also myself, encouraging me to further explore the research, the design, and to go beyond my 'comfort zone'.

To the Urbanism department's academic, research and professional staff for their constant advice and support.

To all students and professionals who contributed to the research during the site visit, sharing their expertise and opinions throughout a series of insightful interviews. I hope this document offers a useful and new perspective on the possible development outcomes for the city of Altamira.

To all photographers who registered the recent development of Altamira, beautifully highlighting and emphasizing the main issues to be tackled.

To the EFL Stichting, for their interest and for supporting the graduation thesis.

Finally, to my family and friends, for their endless support, for their partnership and for guiding me not only now, but in every moment of my life.

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figure 1.1 | **View over Altamira**
image by the author

chapter **1.**

INTRODUCTION

ALTAMIRA, NATURAL LANDSCAPE, TRANSAMAZONICA HIGHWAY AND THE BELO MONTE DAM

Altamira, focus of this research project, is the biggest municipality in the state of Para, in Brazil. Located in the margins of the Xingu river, the city has been experiencing significant transformations in its urban structure, encouraged by the variation of its population figures, especially since the year of 2010, when Belo Monte hydroelectric plant got its installation license approved. The presence of the enormous construction site attracted workers and migrants from different parts of the country to the region, settling in construction allotments and surrounding urban areas. This intensive migration is described as 'chaos' by local population (FOLHA, 2013), mainly due to difficult traffic conditions and poor public security. This chaos is expected to be temporary, according to the construction consortium, which has been intensively investing in public infrastructure, supplying the population of Altamira with public equipment and amenities inexistent before the conception of the dam.

1.1 MOTIVATION

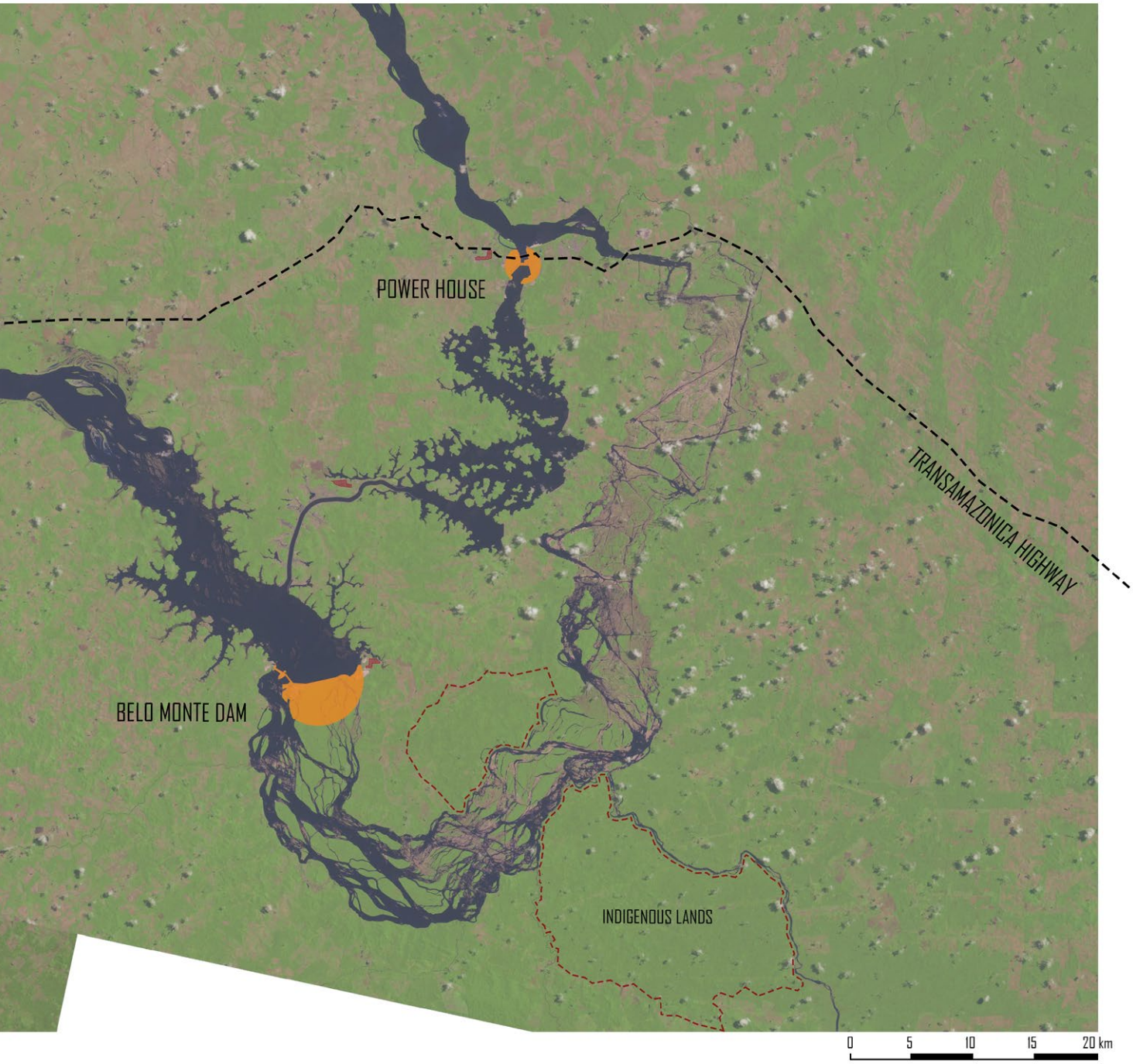
The construction of big infrastructure projects in remote regions is very frequent in many countries around the globe and the discussion of its impacts in fragile urban ecologies is fundamental for the assurance of the quality of life of the affected communities and preservation of the natural landscape. Within the discipline of Regional and Urban Planning, topics such as workforce migration, resettlement of affected population, population growth, city expansion, social and spatial justice amongst others, have a vital importance for promoting a sustainable development in the selected and similar sites.

The symbiosis between Altamira and the Belo Monte dam offers a unique opportunity to study how interventions and transformations associated with the construction big infrastructure projects, government policies and the resulting development can impact the daily life of neglected communities, affecting their households, jobs and social structures.

Also, despite the main interest in exploring city development is through regional planning, the research scrutinizes different analysis methodologies, introducing design as part of the process. This approach might contribute to a different perspective within the disciplinary body of knowledge.

The expected outcome is a set of guidelines able to help to detect and diagnosis the fragilities and opportunities of the process and contribute to future urban planning and policies. Besides that, the project deals with a protected landscape, currently under pressure for its natural resources. If not planned, the socio-spatial impacts described might increase this pressure by stimulating unorganized urban growth and territorial occupation. The development in such region must be very cautious, aligned with activities and policies capable of protecting the natural habitat and its local communities.

figure 1.2 | **Xingu river, Altamira and Belo Monte**
base map: Landsat 8 | Sep. 2017


POWER HOUSE
TRANSAMAZONICA HIGHWAY
BELO MONTE DAM
INDIGENOUS LANDS
0
5
10
15
20 km

1.2 ALTAMIRA & THE LANDSCAPE

> "A very green valley, where it rains a lot, where the trees are very long and rivers are as big as the ocean. There is so much richness there that nobody needs to work. A place where elderly never die and the young never loose their strength. It is a land so green. ALTAMIRA!"
>
> **Lorde Cigano (gipsy lord)** in a speech to a small community affected by the drought in the Brazilian northeastern region, right before taking the decision of leading his caravan towards the city. The speech illustrates the perspective of a group of Brazilians, during the 80's, envisioning Altamira as a promised land.
>
> *scene from the movie **Bye Bye Brazil, 1980**

Located within the Amazonian forest, in a tropical climate, Altamira and the surrounding region is characterized by the abundance of nature and diversity of cultures. Even with recent occupation and development of the territory, nature is still very much present in the daily life of the local communities. Familiar agriculture, extractivism and fishery are important economic practices of the population, exploring the vastness of natural resources. In a social perspective, the population consists of a mixture of ethnicities, product of different periods of colonization and migratory processes.

The firsts evidence of the city of Altamira origin from the colonization of the country, when the territory was occupied by different indigenous tribes. Similar to many other cities in the Amazon, its development was accelerated during the 19th century by the extraction and production of latex. It was the first step in colonizing the enormous green world of the Amazonian region. Even with the later decline of the rubber market, the region was shaped, in the first half of the 20th century, by many of federal programs and attempts of occupation. Programs elaborated by organs such as SEMAT and INCRA promoted the colonization of the amazon, advertising its prosperity to attract inhabitants of the northeastern part of the country, affected by serious droughts and social conflicts. I was the beginning of a migratory process, trying to explore the vast and virgin lands by promoting latex extraction and familiar agriculture.

figure 1.3 | **The city of Altamira, in 2016**
source: GOOGLE EARTH 2016

1.3 ALTAMIRA & TRANSAMAZONICA

> **trucker:** Altamira! Altamira is the center of the Transamazonica Highway. There are people from the whole Brazil going there, to work in the highway construction and to buy some land. Pineapples have the size of a jackfruit over there. Threes are the size of skyscrapers. Amazonic forest!
>
> **gipsy lord:** And are there many indigenous people living there?
>
> **trucker:** There was. But after they built the highway it has become a place for the whites. Everybody is rich now
>
> *scene from the movie **Bye Bye Brazil, 1980**

As described before, during the 70s, the opening of the Transamazonica Highway connecting the Amazon to the rest of the country promoted a new dynamic for Altamira, resulting in intense transformation of its urban structure over the following decades (NETO & HERRERA, 2016). The Transamazonica, idealized as one of the main strategies for occupation of the region, was the trigger for a strong migratory process, attracting workers and new inhabitants from multiple states of the country, settling in small cities and villages along the highway.

But in a short term, this intense migratory flow has shown to be problematic, mainly due to incapacity of local municipalities to absorb the increasing population. In Altamira, the number of inhabitants jumped from 15.000 in 1970 to 46.500 in ten years (IBGE, 2010). With this rapid growth many families settled in risk and flooded areas, resulting in the unorganized development without the provision of proper infrastructure (NETO & HERRERA, 2016). Furthermore, the region was experiencing a strong process of urbanization, between the 70's and the 90's, were the urban population in Altamira increased from 37% to 69% (IBGE, 2010), increasing the pressure in the delicate and limited urban infrastructure.

As a result of the intensity of population influx, the growth promoted an unplanned occupation of the territory. The census of 2010, before the start of the construction of the Belo Monte dam, indicated the presence of more than 9.000 people living in irregular settlements in Altamira, without access to basic infrastructure such as waste collection and treatment, water network, energy or public lightning (NETO, 2014).

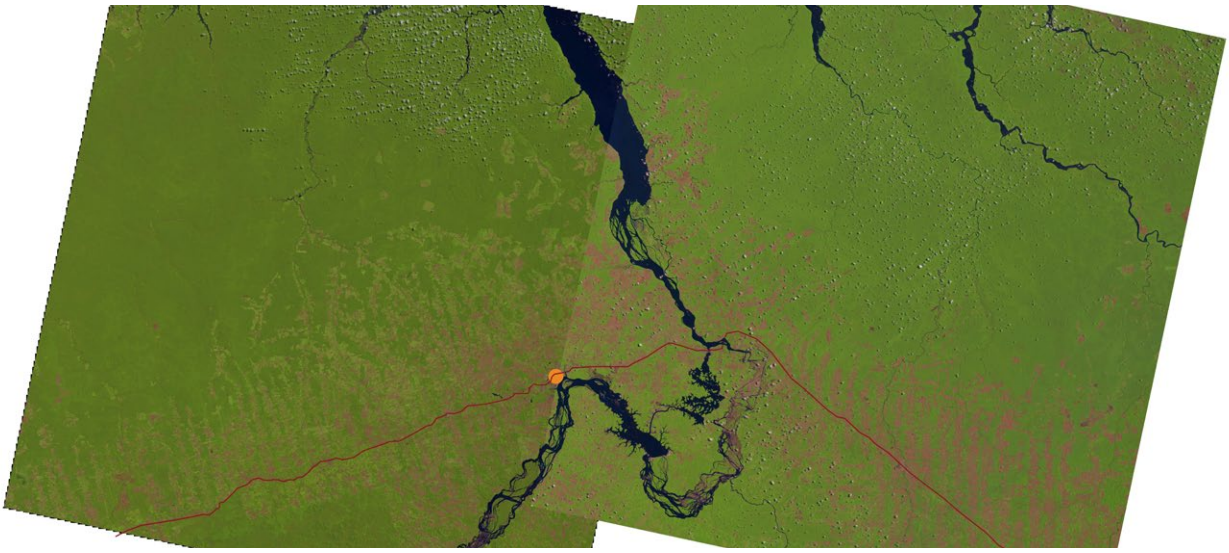


figure 1.4 | **Transamazonica and the landscape patterns**
base map: Landsat 8 | Sep. 2017

figure 1.5 | **View of the Transamazonica highway, next to Altamira**
image by the author

1.4 ALTAMIRA & BELO MONTE

Belo Monte is one of the key projects for the national plan for accelerating growth (PAC) in Brazil. The construction license for the dam was conceived in 2010, but its implementation has been discussed and negotiated since the 70's. When fully concluded, the hydroelectric plant is expected to generate up to 11.233 MW, capable of providing energy for 18 million households throughout the country (NORTE ENERGIA, 2010). Besides that, the dam is also envisioned to promote economic development of the region, by creating new jobs and providing resources and investments to surrounding cities. In a national perspective, Belo Monte and the energy generated is a necessity. However, considering its proportions and the history of development in the region, it might also become a challenge.

Nearly concluded, the construction of the dam, derivation canal and powerhouse of the Belo Monte hydroelectric plant have colossal dimensions. Associated to its erection, the manpower reached a peak of 25.000 laborers in 2013, working in the multiple construction sites. Out of all these workers, 87% were men and over two thirds migrated from outside the municipality of Altamira (FOLHA, 2013). To accommodate this army of workers, the construction consortium built different housing allotments near the sites, almost in the size of small cities. But even though Belo Monte is located around 50km away from Altamira, the city is the main urban center surrounding the project, becoming the focal point of migrants traveling in the search for jobs or new opportunities. This population influx, triggered by the conception of new energy infrastructure, determined a new dynamic of development in the municipality.

Since before the beginning of its construction, the project of the Belo Monte dam has been shaping the development of city of Altamira. Many of the changes were - and still are - determined by the PBA (Basic Environmental Project) guidelines established by the social environmental assessment of the project alongside with the national environmental agency (IBAMA). The PBA was designed in order to mitigate and compensate socio environmental impacts associated with the construction, assuring that the affected population would be properly restitute and the surrounding cities could explore the potential development in a sustainable way. These guidelines focus not only on mitigating the impacts caused by the installation and operation of the dam, but also in integrating the projected population growth and their influence in local communities and natural environment. However, the magnitude of the project and intensity of the construction process impose many difficulties to the implementation of the guidelines, increasing the debate on its efficiency.

1.5 IMPACTS, POLICIES & MITIGATIONS

With the installation of the hydropower plant, the city of Altamira went through a process of redefinition of its urban fabrics, with the resettlement of families in flooded neighborhoods, provision of vital infrastructure and requalification of the stream areas. In this process, more than 22.000 inhabitants were resettled in new allotments and households created. The PBA imposed the provision of collection and treatment of 100% of the sewage in the city as one of the pre-conditions for the implementation of the dam. With this, the city that never had a sewage collection system was able to finance a new infrastructure network (NETO, 2014). Furthermore, the construction encouraged the paving of some parts of the Transamazonica Highway, facilitating the connection between Altamira and different cities in the region (NETO & HERRERA, 2016). In this regard, conceiving Belo Monte promoted changes and improvements in the built environment, with vast investments in public infrastructure and equipment.

On the other hand, there are some controversial socio spatial transformations associated to the construction of the dam. The strong migratory process resulted in negative consequences in the social indicators, increasing violence indicators and the degrading quality of life for some groups (NETO & HERRERA, 2016). The construction also lead to socio economic impacts including rise in housing and living costs, affecting the population previously residing in the city. Many of these impacts might be temporary and are associated with the accelerated rhythm of the construction, but the efficiency in implementing some of these compensation programs and the delay in fulfilling these guidelines might aggravate the risk of negative impacts.

figure 1.6 | **Flooding of informal settlements**
image by Aaron Vincent Elkaim
source: http://www.aaronvincentelkaim.com/where-the-river-runs-through

figure 2.1 | **Farmers market in Brasilia neighborhood**
image by the author

chapter **2.**

STRUCTURE OF THE RESEARCH

PROBLEM STATEMENT, RESEARCH AND METHODOLOGICAL FRAMEWORKS

The following chapter explains the structure defined for the research on the mentioned symbiosis between the city of Altamira and the Belo Monte dam. With a focus on past, current and future socio-spatial characteristics of the urban landscape of the case study, the following section determines the objectives of this "research through design" exercise and selects the methods and tools to be explored throughout the urban investigation.

2.1 PROBLEM STATEMENT

Dams, reservoirs, roads, mining sites, ports, among others, are essential infrastructure required for economic development, not only in Brazil but in other (developing) countries around the globe (Cernea, 1997). And besides its global values, such infrastructures are also expected to encourage local socio-economic development, by bringing investments, jobs, and resources to the region in which they are implemented (Frantál et al., 2014). Nonetheless, when considering their magnitude, there is a significant range of impacts associated with its construction, directly influencing the development of urban landscapes hosting or surrounding these mega projects (see Cernea, 1997; Égré and Senécal, 2003; Tilt et al., 2009; Moran, 2016). The graduation thesis explores the knowledge and experiences on urban development and socio economic implications when constructing big infrastructure projects, often in remote and fragile regions. The general scope, however, is not to evaluate the necessity, efficiency and impacts for conceiving this type of infrastructure, but to understand the spatial transformations the construction might bring to surrounding cities and the influence they may have in social networks of local communities. In a planning perspective, the research discusses the potentialities and challenges of urban landscapes subjected to the influence of big infrastructure, looking not only to the actual situation but also to scenarios of future developments and opportunities.

There is usually a large potential for economic growth and sustainable development associated with the construction of big infrastructure. But unless the social and environmental impacts are properly addressed and mitigated through explicit policy, legislation, and financial resources, conceiving such projects is likely to result in negative impacts in the affected communities. A successful implementation relies not only on social sensitive planning and strategies but also in effective institutions, capable of translating mitigation and development plans into successful actions on the ground (CERNEA, 1997).

By analyzing recent transformation in Altamira, it becomes clear that the main changes in the structure of the city were consolidated due to the variety of impacts associated to the construction of the hydropower plant and the consequent compensation and mitigation programs. The transformations, enforced by the PBA (basic environmental plan), were very significant, with extensive investments in roads, bridges, water and waste collection and treatment, schools, and hospitals, besides the 6 new residential neighborhoods designed to accommodate the directly affected population. However, beyond the provision of the required equipments and infrastructure, the dam is also responsible for triggering a new dynamic of development in the municipality. A new dynamic capable of encouraging future socio-spatial transformations in Altamira, even after the conclusion of the dam.

Even when considering a successful consolidation of the compensation guidelines, there is still much uncertainty while discussing possible futures in Altamira. The diversity of outcomes vary according to the effectiveness of the programs created, the capability of the public institutions, the operation of the plant, the settlement of affected population and workforce, the economic development of the region, future migrations or even an eventual population decrease, following the reduction of job opportunities after the conclusion of the dam. These uncertainties both influence and are influenced by the built environment and current development policies, which raises further concerns about the municipality, especially when considering the delicate characteristics of its preserved landscape.

Furthermore, since the beginning of the construction, most of the interventions in public infrastructure that took place in Altamira only became feasible due to financial resources coming from the dam. Aside from the discussion of what has and has not been yet fulfilled, the interventions made in the urban fabric were - and still are - dependent on the construction consortium and the Norte Energia group. Once the guidelines are completed, Norte Energia will no longer be responsible for maintaining many of the programs created, shifting the operation to local government, and the investments in public equipments will come to an end. And with the reduced efforts from the construction consortium, Altamira will eventually have to test its resilience, seeking to integrate the future uncertainties surrounding the development of its urban fabric and social networks.

The outcomes the region city might have will depend on how well the resources provided by Norte Energia to the community are used to produce lasting improvements in the local economy (Moran, 2016). The management of these resources, however, becomes one of the main challenges not only in Altamira but in the whole region, especially when considering the fragility public institutions have.

figure 2.2 | **Fisherman in Altamira**
image by Lalo de Almeida
source: http://lalodealmeida.com.br/site_pt/editorial/belo-monte-2/#!prettyPhoto

2.2 OBJECTIVES

There are two main objectives for the research project:

(1) research and investigate
Identification of the current dynamics shaping the city of Altamira, through different analytical methodologies, looking for the understanding of its morphology and processes, by acknowledging all the multiple layers involved in the development of its built environment. This study is meant to provide an insight of the existing relationship between the construction of a major infrastructure and the changes it has promoted in the development of the municipality. Furthermore, considering all the uncertainties surrounding the project, this study is also intended for the extrapolation of probable futures, resulting in different scenarios for the municipality and investigating the possible outcomes, once the construction of the dam is concluded.

(2) evaluate and design
Creation of a strategic plan, capable of guiding future development in the municipality, by exploring the different scenarios created. The strategies aim to identify gaps and opportunities to be acknowledged in plans and policies, in order to take better advantage of the investments generated and challenges to be addressed, recognizing the unique gaps and potentialities for developing this sensible region.

2.3 RESEARCH QUESTION

There is a strong relationship between the construction of the Belo Monte hydropower plant and the current development dynamic in Altamira. This symbiosis raises many questions and concerns regarding past and future developments in the region. The aim, however, is not to enter the debate on the severity of the impacts or to question whether hydroelectric dams should or should not be built. The aim is to understand the main implications of its construction on the built environment and to explore possible gaps and opportunities of future development in the municipality.

Is the current dynamic of development, promoted by the construction of the Belo Monte dam and mitigation guidelines, resulting in a resilient model for Altamira, capable of promoting sustainable development and
how can strategies and policies be used to further explore the economic potential generated, stimulating growth while minimizing possible risks?

figure 2.3 | **Construction of resettlement neighborhood in Altamira**
image by Lalo de Almeida
source: http://lalodealmeida.com.br/site_pt/editorial/belo-monte/

figure 2.4 | **Social and economic activities associated to the Xingu river**
image by Aaron Vincent Elkaim
source: http://www.aaronvincentelkaim.com/where-the-river-runs-through

2.4 RELEVANCE

(1) Scientific

The construction of big infrastructure projects is necessary for the economic growth of countries. The large scale projects, however, are also known for the extensive impacts they have in the natural, social and urban structures. Within this field of knwoledge, the investigation of the influence the establishment of similar symbiosis might have is extremely relevant for the design and definition of new innovative solutions, able to explore the economic potentials generated while minimizing possible hazards. For the discipline of Regional and Urban Planning, topics including workforce migration, resettlement of affected population, population growth, city expansion, social and spatial justice among others, have a vital importance for the understanding of the selected and similar sites.

Furthermore, the symbiosis between Altamira and the Belo Monte dam offers a unique opportunity to study how interventions and transformations associated with the construction big infrastructure projects, government policies and the resulting development can impact the daily life of neglected communities, affecting their households, jobs and social structures.

Also, despite the main interest in exploring city development is through regional planning, the research scrutinizes different analysis methodologies, introducing design as part of the process. This approach might contribute to a different perspective within the disciplinary body of knowledge.

(2) Societal

The aim is to explore the inevitable development of a remote region of Brazil, accelerated by the construction of a large-scale infrastructure project. From the challenges faced by the affected and migrant population to the fragile management of the public institutions, the research raises a series of relevant topics for the investigation of such urban landscape, common not only in Brazil but worldwide.

The expected outcome is a set of guidelines able to help to detect and diagnosis the fragilities and opportunities of the process and contribute to future urban planning and policies. Besides that, the project deals with a protected landscape, currently under pressure for its natural resources. If not planned, the socio spatial impacts described might increase this pressure by stimulating unorganized urban growth and territorial occupation. The development in such region must be very cautious, aligned with activities and policies capable of protecting the natural habitat and its local communities.

(3) Ethical

Being born in Brazil, abundant with natural resources and hydric potential, the topic of big infrastructure is present my DNA. Beyond the usual urbanism topics, the research engages in discussions including the exploitation of natural resources, preservation of the Amazonian forest, respect to the indigenous communities and rights, national and regional policies, among others, relevant to my formation as a Brazilian and World citizen. The graduation thesis is intended not only as an exploration of relevant topic to the field of study, but also as a discussion on the pursuit of sustainable development and social justice in a developing country, exploring its natural resources without abusing its' magnificent landscape.

2.5 METHODOLOGICAL FRAMEWORK

The research methodology was organized according to different moments of Altamira, framing the products according the different periods, as shown in the diagram below. The sub questions, products, methods and tools adopted are described in this section of the thesis. The different moments of the formation of Altamira were divided into:

(1) with: investigates the relationship and symbiosis between the city dynamics and construction of the project;
(2) before: spatial analysis of the development of the city until the beginning of the construction of the Belo Monte hydropower plant; and
(3) after: scenario analysis, analyzing a series of key factors influencing transformations in the built environment.

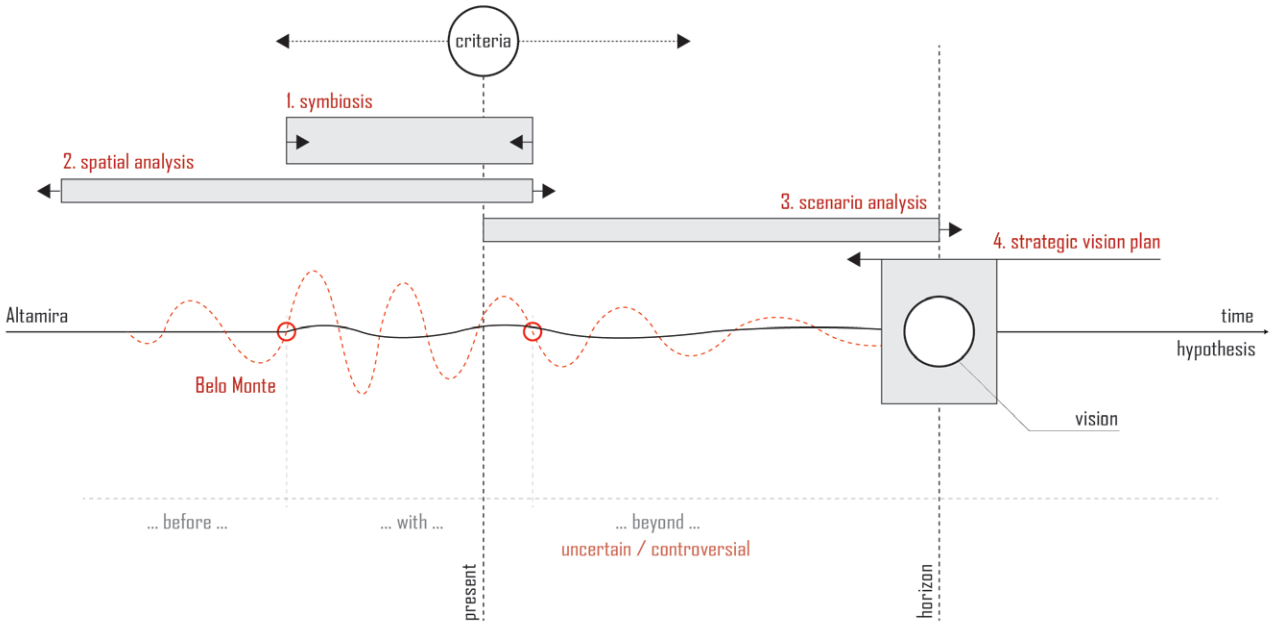
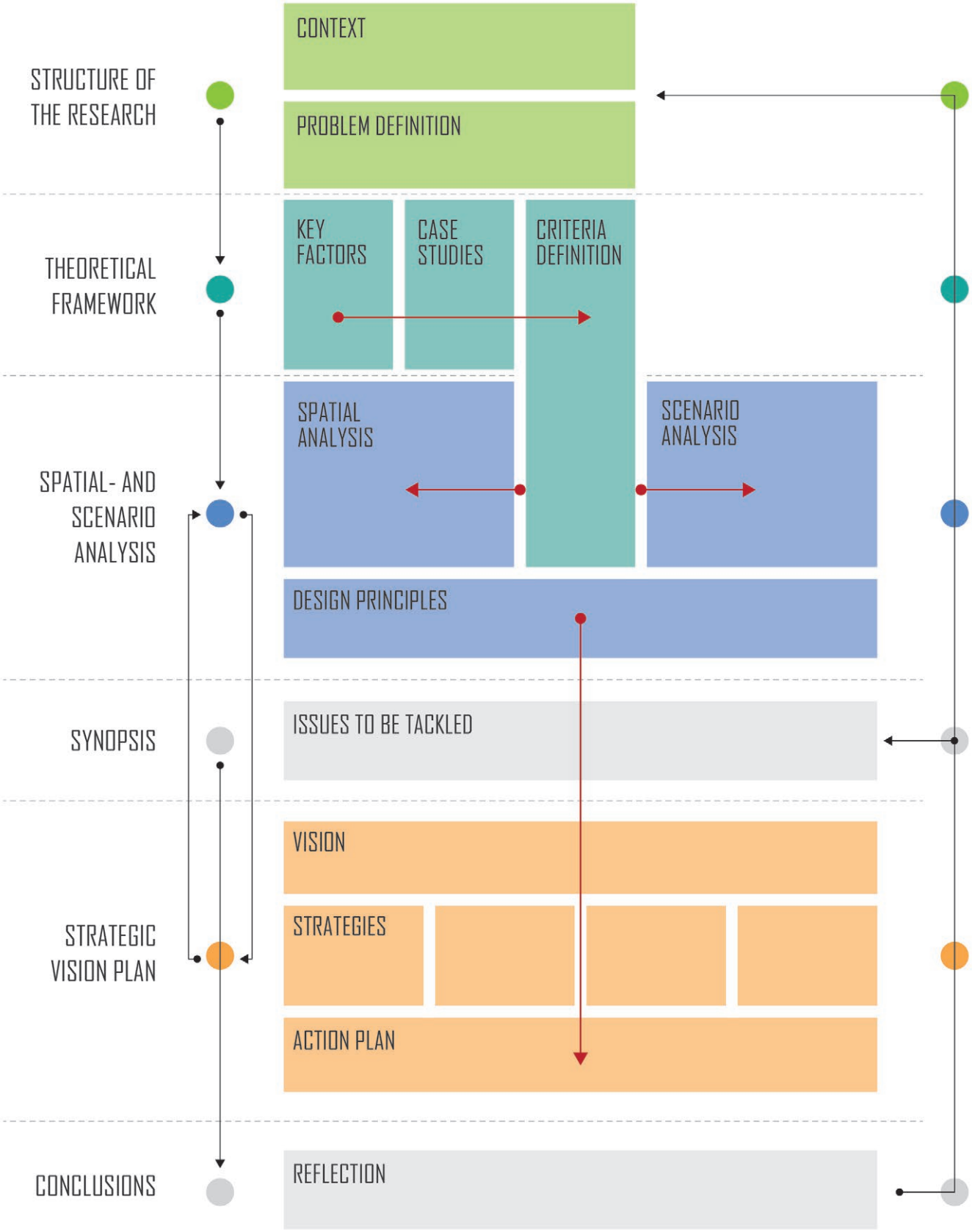


figure 2.5 | **Methodological Framework**
diagram by the author

The diagram on the following page highlights the structure and main methods adopted by the research. A few aspects are worth emphasizing. The first is the importance of the theoretical framework for guiding the analytical and design frameworks. By further exploring the problem definition (new energy landscapes and urban development) in the Amazonian region through the conduction of a precedent study, a scenario criterion was defined, defining a new scope for the spatial investigation. Another relevant is the overlapping process of the methodology, in which different sections and methods are used throughout the research to evaluate the outputs, aiming always to close a 'loop'. Further explanation about the methods and tools adopted is described in the next page.

figure 2.6 | **Methodological Process**
diagram by the author



1. Theoretical Framework

The theoretical framework starts from the point that the influence of big infrastructure in an urban territory is not exclusive to Altamira. The exercise was divided into three parts. The first, within the broad range of impacts, was the definition of key factors to guide the socio-spatial investigation in the city. The second was the identification and analysis of variations of the key factors, according to precedent cities. The third part shows the results of the similarities encountered in the case studies, which lead to the definition of criteria for scenario development.

SQ1. What are the key factors and variables shaping the development of the built environment of Altamira, after the implementation of the dam?

> **Key factors:** 4 key factors were defined as a framework for the spatial investigation of Altamira. They were determined by clustering similar impacts associated with the construction of the dam, identified in the environmental impact assessment documents and in the literature review.

> **Case Studies:** Once defined, the key factors and their indicators were investigated not only in Altamira, but in 10 cities in the Amazonian region, all influenced by the construction of big infrastructure projects. The exercise consisted of collecting raw data and analyzing variations, looking for patterns and behaviors in the years before and after the implementation of the projects.

> **Criteria Definition:** The similarities encountered were then summarized for the definition of a scenario criteria, indicating possible and probable futures for Altamira according to each key factor. The adoption of a scenario-oriented investigation is fundamental for the design of a successful strategy, assuming that the complexity of the subject could lead to a wide range of outcomes, rather than a single inevitable future.

2. Spatial- and Scenario Analysis

The whole investigation was shaped by the key factors and criteria definition, not only guiding the analysis of the socio-spatial transformations but also allowing for a scenario extrapolation. Exploring one key factor at a time, the research had a layered approach. Furthermore, each of the layers led to the creation of a series of design principles, already suggesting possible solutions for the main issues encountered.

SQ2. What are the historical processes and how are the existing plans & policies shaping the development of Altamira?

SQ3. What are the main socio-spatial transformations promoted by the construction of the Belo Monte dam and what future transformations could be expected?

> Spatial Analysis: It consists of an investigation of the spatial characteristics of the built environment of Altamira. The product is an output of different analysis tools, used to understand and communicate the dynamic of the urban fabric of the city. It is an exercise for understanding existing networks, movements, plans, and the spatial configuration and is a fundamental process for the development of other outputs of the research. It explores the territory of Altamira through time, from its early occupation to the extraction of latex, the opening of the Transamazonica highway and recently, the construction of the Belo Monte dam.

> Scenario Analysis: Considering the strong dynamism of the municipality, due to the radical transformations in recent history, there is still much uncertainty regarding several factors that might influence future developments of Altamira. In this regard, scenarios are employed aiming to create a variety of future-oriented constructions of the most relevant key factors. In here, scenarios intend to raise relevant questions rather than providing solutions. The approach explores the extrapolation of trends, resulting in a set of possible and probable futures, acknowledging different outcomes instead of a single one.

3. Synopsis

The synopsis reflects on the conclusion of the spatial- and scenario analysis and articulates the issues to be tackled with the definition of guidelines for the strategic vision plan. The information gathered is still horizontally focused on the 4 key factors so the synopsis exercise proposes to look at the issues vertically, by overlapping the main conclusions of each of the topics.

SQ4. What are the main threats and opportunities surrounding future scenarios of development in Altamira?

> **Evaluation:** First step is the evaluation of the outcomes of the spatial analysis and the scenario building exercise. A SWOT analysis is used for the identification of main gaps and opportunities concerning possible futures. The criteria allow for a focus on the relevant topics for the research.

4. Strategic Vision Plan

The strategic vision plan is the exploration of different strategies for promoting sustainable development in Altamira. The design is intended to be provocative, acknowledging the limitations of a graduation thesis and aiming to generate a debate on innovative solutions for the case study. The method is divided into three parts. The first is the definition of a vision for Altamira, based on the identified issues of the synopsis. The second is the design of four strategies, intended to lead the development towards the proposed vision. Strategies are defined based on the design principles and evaluated according to the scenario criteria. The third part is an action plan, investigating a possible implementation strategy for the plan.

SQ5. How can a design-based methodology be used to better explore the economic potential generated and minimize the risk of further socio-economic impacts?

> **Vision:** The vision allows the creation of a desirable future, having a goal-setting function. The vision is established according to the knowledge on the dynamics of socio-spatial configuration of Altamira. Expert interviews and surveys with the population are also considered for the definition of an ideal scenario.

> **Strategies:** Elaboration of strategies and programs capable of directing the development of Altamira towards the envisioned future. Scenarios are considered for optimizing the master plan, acknowledging a series of possible future.

> **Action Plan:** Investigate the main aspects and characteristics for a feasible implementation of a strategic vision plan. One of the main exercises is the understanding of the stakeholders involved and processes required for the realization of the proposed vision and strategies.

figure 3.1 | **Employee walks under the Belo Monte dam**
image by the author

chapter **3.**

PRECEDENT STUDIES

SPATIAL PLANNING UNDER INFLUENCE OF BIG INFRASTRUCTURE

an investigation of possible criterion for scenario building strategies in the Brazilian Amazonian region

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Big infrastructure projects are known to influence the spatial development of host or surrounding cities as a consequence of a set of primary and secondary impacts associated to their construction. These transformations are expected to happen not only during the construction process, through direct impacts and mitigation programs, but also throughout the future development of the urban landscape. By investigating possible planning strategies to guide this future development, one can realize that there is a variety of uncertainties concerning possible outcomes, especially when considering the magnitude of the structures and investments surrounding the construction of such projects. All these uncertainties suggest the necessity for employing a scenario-based methodology, allowing the investigation a set of multiple probable futures, rather than a single inevitable one. This chapter of the graduation thesis aims to explore what are the main characteristics for exploring this methodology, with the aid of a precedent study of big infrastructure focused in the Brazilian Amazonian region. The objectives in here are: **(1) to identify key factors** shaping the development of the built environment in cities affected by big infrastructure; **(2) to analyze the behaviour of these key factors** identified and its main variables, based on primary data and indicators collected on ten selected precedent studies, all in the Brazilian Amazonian region; and **(3) determine the criteria** necessary for the generation of plausible development scenarios, capable of aiding the elaboration of planning strategies and policies in the specific context.

3.1 INTRODUCTION

Dams, reservoirs, roads, mining sites, ports, amongst others, are essential infrastructure required for economic development, not only in Brazil but in other (developing) countries around the globe (Cernea, 1997). And besides its global values, such infrastructures are also expected to encourage local socio-economic development, by bringing investments, jobs, and resources to the region in which they are implemented (Frantál et al., 2014). Nonetheless, when considering their magnitude, there is a significant range of impacts associated with its construction, directly influencing the development of urban landscapes hosting or surrounding these mega projects (see Cernea, 1997; Égré and Senécal, 2003; Tilt et al., 2009; Moran, 2016). This investigation section aims to identify, within the known range of impacts, what are the main factors directly stimulating transformations in the development of urban settlements influenced by big infrastructure.

The identification of these main factors becomes fundamental while elaborating planning and development strategies for cities under the influence of big infrastructure, searching for the proper mitigation of negative impacts and a maximal exploration of the generated potentialities. However, such task can be quite challenging, especially when considering all the uncertainties concerning the future development of these sites. There is a vast range of impacts to be considered and planning strategies usually assume a successful and efficient unfolding of the environmental (and social) assessments determined to mitigate them (Duinker and Greig, 2007). These multiple uncertainties, a product of the range of impacts and effectiveness of the mitigation plans, lead to the realization that there is not any single inevitable future while discussing future development of these urban landscapes, but rather a set of possible and probable futures (Kosow and Gassner, 2007). And this observation points towards the need for implementing a scenario-based analysis methodology.

According to Duinker and Greig (2007), to understand whether developments can be sustainable, there is the need to evaluate them against scenarios capable of providing a sharp contrast in alternative futures. In this regard, besides the identification of the key factors, there is a necessity to analyze the main variables within them, exploring the range of possible trends and outcomes the might determine future developments (Kosow and Gassner, 2007). To do so, the chapter focuses on one specific context, the Brazilian Amazon region, host of several big infrastructure projects, exploring its vast abundance of natural resources (Fearnside, 2002). To explore possible variables and behaviors, ten different municipalities, all influenced by the implementation of these mega projects, were selected for a precedent study. The main criteria for the definition of the sites were the type of infrastructure, organized according to three categories: (a) transport & logistic; (b) resource extraction; and (c) energy landscape. The variables are then determined according to the key factors identified and compared by looking into primary data collected on demographic, economic and social indicators of each city.

Furthermore, by investigating the variation of different indicators in the selected sites, the research aims to elaborate the criteria for the generation of possible scenarios of future development in these cities. By doing this, the results can be used for describing images possible futures, challenging current assumptions and broadening planning perspectives (Duinker and Greig, 2007).

Category		Type	City	Project	Period	Size *(in million)*
A.	Transport & Logistic	Harbour	Sao Luis, MA	Porto de Itaqui	1970's	> 1.0
			Santana, AP	Porto de Santana	1980's	0.1 - 0.2
		Railway	Maraba, PA	Estrada de Ferro Carajas	1980's	0.2 - 0.5
B.	Resource Extraction	Minning	Parauapebas, PA	Serra Norte Carajas	1980's	0.2 - 0.5
			Canaa dos Carajas, PA	Mina do Sossego / S11D	1980's	< 0.1
			Ourilandia do Norte, PA	Onca Puma	2000's	< 0.1
		Oil & Gas	Coari, AM	Urucu	2000's	< 0.1
C.	Energy Landscape	Hydropower	Tucurui, PA	Tucurui	1980's	0.1 - 0.2
			Porto Velho, RO	Jirau / Santo Antonio	2000's	0.5 - 1.0
			Altamira, PA	Belo Monte	2010's	0.1 - 0.2

figure 3.2 | **Selected cities fo the precedent study**
elaborated and categorized by the author

3.2 ANALYZING KEY FACTORS

primary impacts (EIA)	secondary impacts (EIA)	global indicators (yearly)	key factors
increased migratory flux	transformation of existing social networks	I. estimation of resident population - 1st of July (IBGE) II. voting presence - 1o turno (TSE) III. murderers (100.000 hab) (IPEA) IV. IFDM - general, education, health & work (FIRJAN)	1. population
	risk of unplanned and irregular occupations		
	increased demand for public equipment and services		
	increased demand of public safety		
directly affected population	compulsory realocation of the affected population		
	alteration of economic and social relationships		
	loss of income and sources of production		
	socio-spatial segregation of new allotments		
change in the urban dynamics	better acessibility due to ampliation of road networks	VI. victims of traffic accidents (100.000) (IPEA) VII. water & waste?	2. public resources
	change in the system of basic infrastructure		
	transformation of natural and urban heritages	XI. deforestation (INPA)	
	increased pressure on natural resources		
change in demand and supply	real estate especulation	IV. IFDM - work & income (FIRJAN) V. prices & living costs?	3. jobs & income
	change in cosumption patterns		
increased job offer			
appearance of social tensions		VIII. municipal Income (FAZENDA) IX. taxes Income (FAZENDA) X. REM-F (FOLHA)	4. health & education
increase of tax income			
	overcharge of the public management institutions		
	reliability in energy supply		

figure 3.3 | **Environmental impact assessment and the selection of key factors**
elaborated and categorized by the author

The starting point is the determination of which key factors to analyze. Always within the scope of the spatial planning and urban design disciplines, the variables considered are the ones with a direct or indirect influence on the development of the built environment. The selection relies on the identification of the primary and secondary impacts, associated with the construction of the dam, promoting socio-spatial transformations in Altamira. Figure 3.3 shows the list with many of the impacts encountered by analyzing the environmental impact assessment and further reports organized by local NGOs. The definition of key factors is done by clustering impacts according to their similarity and relationship, as shown in the table above. Another important aspect for the definition of the availability of open data indicators to evaluate the transformations (yearly or decennaly) and to perform a comparative study between the 10 different selected sites. Four key factors are considered for the comparative studies, spatial- and scenario analysis of the research, namely **(1) population**, focused on the variation of population figures; **(2) public resources**, investigating deviations in the GDP per capita figures; **(3) jobs & income**, exploring variables of total employed population and comparative indexes; and **(4) health and education**, focused mainly in quality of life indexes.

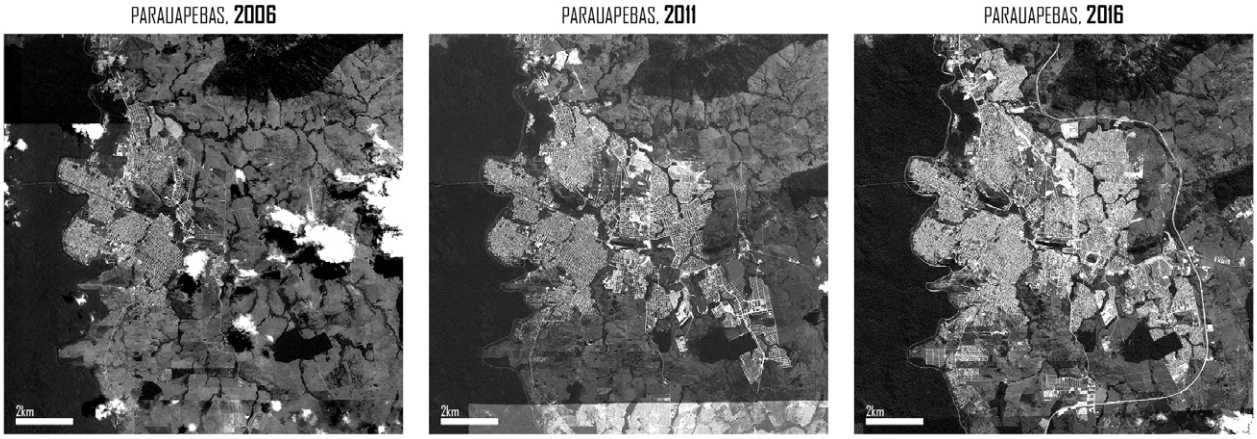


figure 3.4 | **Fast socio-spatial transformations seen in Parauapebas, after the opening of a new mine of the Carajas Complex**
source: GOOGLE EARTH

(I) Population & Migratory Flows

According to Tilt, Braun and He (2009), many of the most challenging impacts of dam and big infrastructure construction relate to migration and resettlement of affected population. As seen in many different case studies, the implementation of big infrastructure is often accompanied by a strong migratory flux, attracting workers in search for the jobs and opportunities generated by the realization of the project (Cernea, 1997). Defined as a primary impact in the environmental impacts assessment of the Belo Monte dam (ELETROBRAS, 2009) the increased migratory flux is selected as one of the key factors shaping the development of the surrounding cities, also leading to several secondary impacts.

The evaluation of migratory flows is elaborated by using data on the population growth rate of the municipalities between 1950 and 2010, according to the official decennial census retrieved from the Brazilian Institute of Geography and Statistics (IBGE, 2011). The following graphs display both the gross number of inhabitants indicated by the census and the growth rate, in percentage, in relation to the previous edition. The growth rate is also compared to the state (Para) and national averages.

The data displays the population variations in the cities of Altamira, Tucurui (energy landscapes) and Sao Luis (harbor city). Before looking into the specific variation between the cities, the first observation on the graphs is the average growth rate in the state of Para since the 1950's, considerably higher than the average in measured in Brazil. This accelerated growth was promoted through the several colonization programs elaborated by the government, seeking to explore the vast and virgin lands of the Amazon region (see Fearnside, 2002; Moran, 2016)

figures 3.5; 3.6; 3.7; and 3.8 | **Population growth in Altamira, Tucurui, Sao Luis and Parauapebas**

Source: Demographic census 1950 - 2010 (IBGE), collected through ipeadata.gov.br. Graphs by the author

Figures 3.5 and 3.6 show the population figures in the cities of Altamira and Tucurui, both influenced by the construction of large hydroelectric power plants. In Tucurui, the graph shows an intense migratory flux during the construction period, when the population jumped from a little under 10,000 inhabitants in 1970 to more than 60,000 in 1980. This growth is mainly associated to the large manpower required for the construction of a project of such magnitude and the indirect job opportunities created by it (Cernea, 1997). There is, however, a radical decrease of the growth rate after the conclusion of the dam, even becoming negative between 1991 and 2000. In Altamira, the implications of the Belo Monte dam is not as evident, probably because the construction works only started in 2010, same year the last official census was disclosed. Nevertheless, the growth rate in Altamira between 2010 and the next official census in 2020 is expected to increase, even with the conclusion of the project and the demobilization of the thousands of workers participating in the construction (NORTE ENERGIA, 2010). Same graph of Altamira (figure 3.5) also reveals a very intense growth rate during the 1970's, when the population jumped from 15,000 inhabitants to more than 46,000 in just one decade. This intense migratory flux is a consequence of the construction and opening of the Transamazonica Highway, one of the several programs promoting the aforementioned colonization of the amazonian region (Moran, 2016). Figure 3.7 shows population variations in the city of Sao Luis, in the state of Maranhao, host of the Itaqui Harbour, inaugurated in 1974. Triggered by the installation of the port, data shows a fast growth rate during the 60's and 70's, midst and after the construction phase. Interestingly, the population figures of the municipality stabilized throughout the following decades and are now within the national average.

Based on observations of the variations encountered in the collected data, the growth rate of the municipalities can be categorized in scales of **elastic to constant** and **sporadic and delayed**, as shown in figure 3.9. This categorization allows further interpretation of behavior patterns between the different investigated sites.

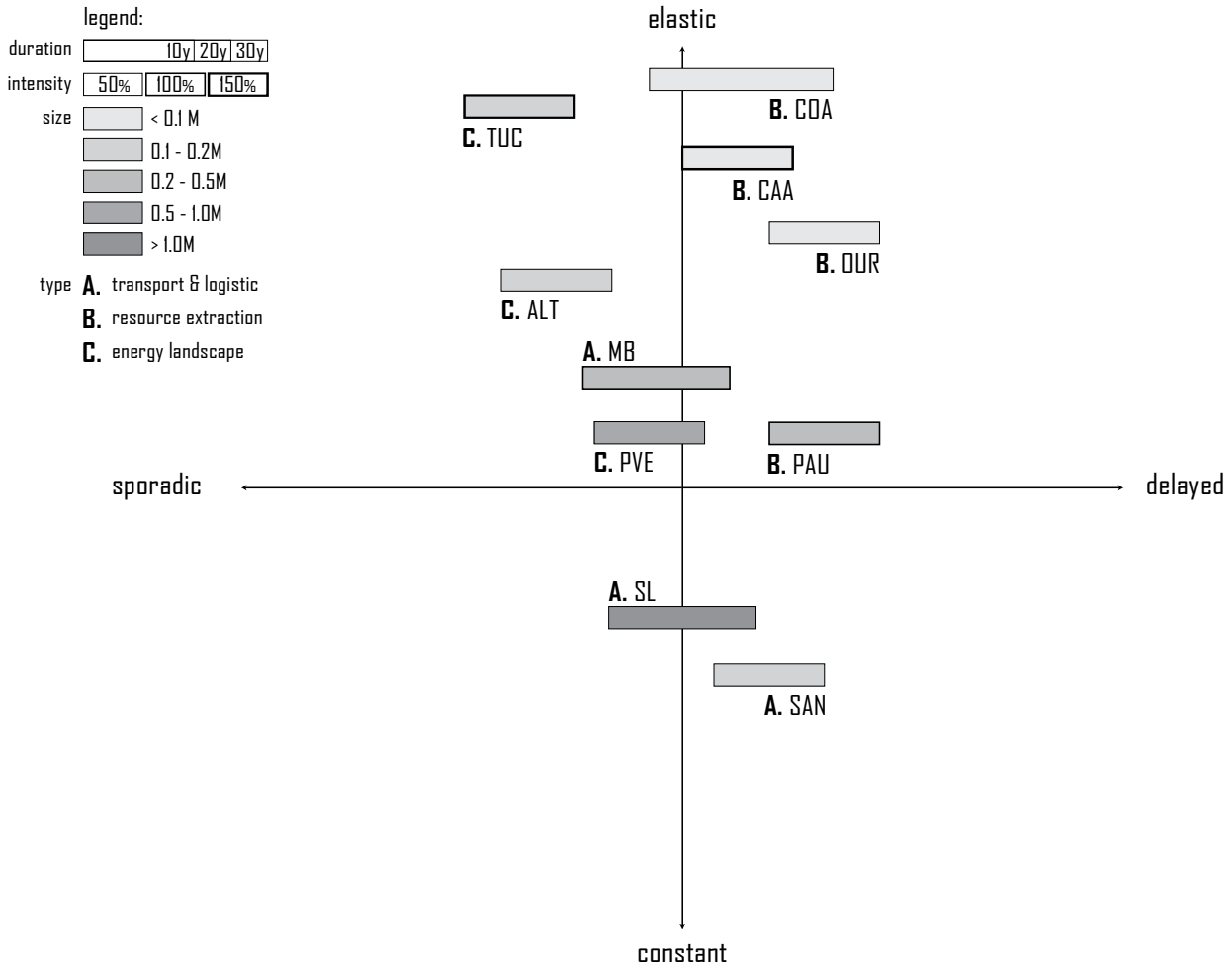


figure 3.9 | **Population growth patters**

Source: Demographic census 1950 - 2010 (IBGE), collected through ipeadata.gov.br. Graph and categorization by the author

Firstly, the graph shows a clustering of municipalities according to the different project types. According to the results, projects of transport & logistic tend to endorse a long-term growth in the affected urban settlements, both during and after the construction phase. Such behavior is likely to be associated with the increase of accessibility stimulated by the opening of new roads, railways or harbors. Distinctively, when considering the projects in the categories of energy landscapes or resource extraction, the results show a bigger elasticity of data variation. The main difference observed now is the time frame in relation to the implementation and operation phases. Cities influenced by resource extraction show an intensive migratory flux starting during installation and lasting throughout the operation of the mine, factory or plant, as a consequence of the large number of direct and indirect jobs required in the process (VALE, 2016). The observations of energy landscapes show a different pattern since the manpower necessary for the construction of the project is higher and the jobs associated to its operation are lesser, resulting in a sporadic migratory flux (Cernea, 1997).

Secondly, an important variable determining the categorization is the size of the city. The results clarify how population figures in bigger cities tend to be more resilient to big infrastructure. This does not mean that the migratory processes are smaller in highly populated settlements. It means that the growth rate in relation to the existing figures is lower, making data variations more subtle. Furthermore, smaller variations are usually easier for municipalities to accommodate, especially when considering the radical transformations seen in the less populated municipalities.

(2) Public Resources

Another primary impact, extensively described in social impact assessments and operation reports, usually issued by the companies responsible for implementation and operation of the projects, is the significant potential for economic development of the municipalities, through increased tax collection and compensation programs (NORTE ENERGIA, 2010; VALE, 2016). When imagining future development of the urban landscape, the amount of resources public institutions and decision-makers rely on can determine the amount of investments in public equipments and local infrastructure and become an important key factor to be investigated.

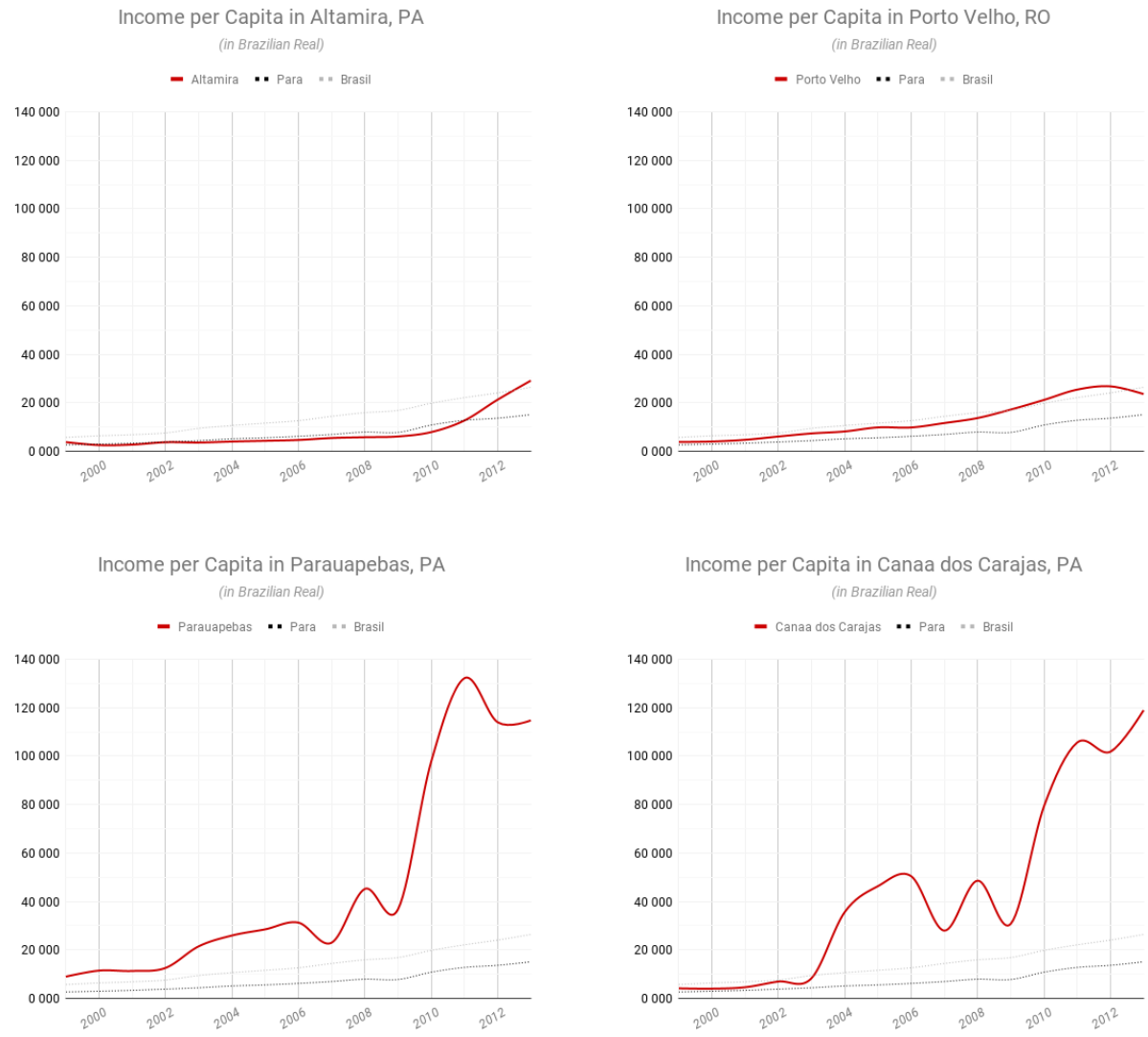
The impact on public resources is measured according to yearly variations of GDP per capita values, between the years of 1999 and 2013, in the selected sites. The collected data is used to evaluate how the implementation of big infrastructure influences the amount of financial resources produced by municipalities, vital for accommodating the incoming population and promoting economic development. Figures 3.10 to 3.13 display the yearly variations of the collected data in Altamira, Porto Velho, Parauapebas and Canaa dos Carajas, comparing the values to the state and national averages.

Oppositely than what observed in the population figures (figures 3.5 to 3.8), the GDP values display the average in the state of Para lower than the national average. This contradiction between growth rate and market value illustrates the fact that, despite the accelerated population growth, the region still lacks in financial resources, in comparison to the rest of the country.

Figures 3.10 and 3.11 show the GDP variations in the cities of Altamira and Porto Velho, both energy landscapes. In Altamira, the income per capita was lower than state average until 2010, year of the beginning of the construction of the Belo Monte dam. The collected data indicates a new dynamic of development after that, with a significant increase of the values, rising above the national average. A similar behavior is visible in Porto Velho after 2008, the year the Jirau dam started being constructed. However, the GDP values started to decrease after 2012, the year the dam was concluded. Considering certain similarities between the projects, a comparable trend might be expected in Altamira over the coming years, with the completion of the construction.

The data gathered on resource extraction typologies constitute the extreme scenarios. In Parauapebas, for example, the values of GDP per capita soared after the opening of a new mining site (Usina 2) in the Grande Carajas complex, in 2013 (figure 3.13). The intense ascension was mainly triggered by the increased job opportunities, tax collection and financial compensations for the exploration of mineral resources (CFEM) (VALE, 2016). The fluctuation present between yearly values can be an evidence of the little diversity of the economic activities, relying on the resource extraction activities surrounding the city.

Adopting a similar methodology than the one used in the population growth indicators, the GDP variations were categorized in scales of **volatile to enduring** and **linear growth to dynamic growth**, as shown in figure 3.14. And again, some behaviour patterns can be investigated based on the result of the classification.



figures 3.10; 3.11; 3.12; and 3.13 | **GDP per capita variation in Altamira, Porto Velho, Parauapebas and Canaa dos Carajas**
Source: IBGE (1999 - 2013), collected through ipeadata.gov.br. Graphs by the author

By sorting the data according to the scales, figure 3.14 displays the distinction between cities according to their size and typologies. Results show how the intensity of the variation is usually higher in smaller urban landscapes, resulting in the volatility of the GDP per capita values, mainly due to a large volume of jobs required by big infrastructure and little diversity of the local market. In this regards, major variations are seen in small cities influenced by resource extraction sites, namely Coari, Canaa dos Carajas and Parauapebas. In contrast to these patterns found in the resource extraction sites, the data collected on the energy landscapes typologies indicates a more linear variation of the values. Nonetheless, the data also shows certain elasticity, usually returning to its initial growth rate after a brief inflated period.

Both figures 3.9 and 3.14 are able to evidence similar behaviours between the different municipalities according to project categories. But regardless of the categorization, it becomes conspicuous the fact that the construction of big infrastructure has a strong influence on the built environment and is likely to change the development dynamics in surrounding cities. By looking at the data displayed in this section, one can assimilate the highlighted variations to both risks and opportunities while envisioning future developments. Some of these potentials are discussed in the following section, trying to understand the range socioeconomic transformations the implementation of big infrastructure might stimulate.

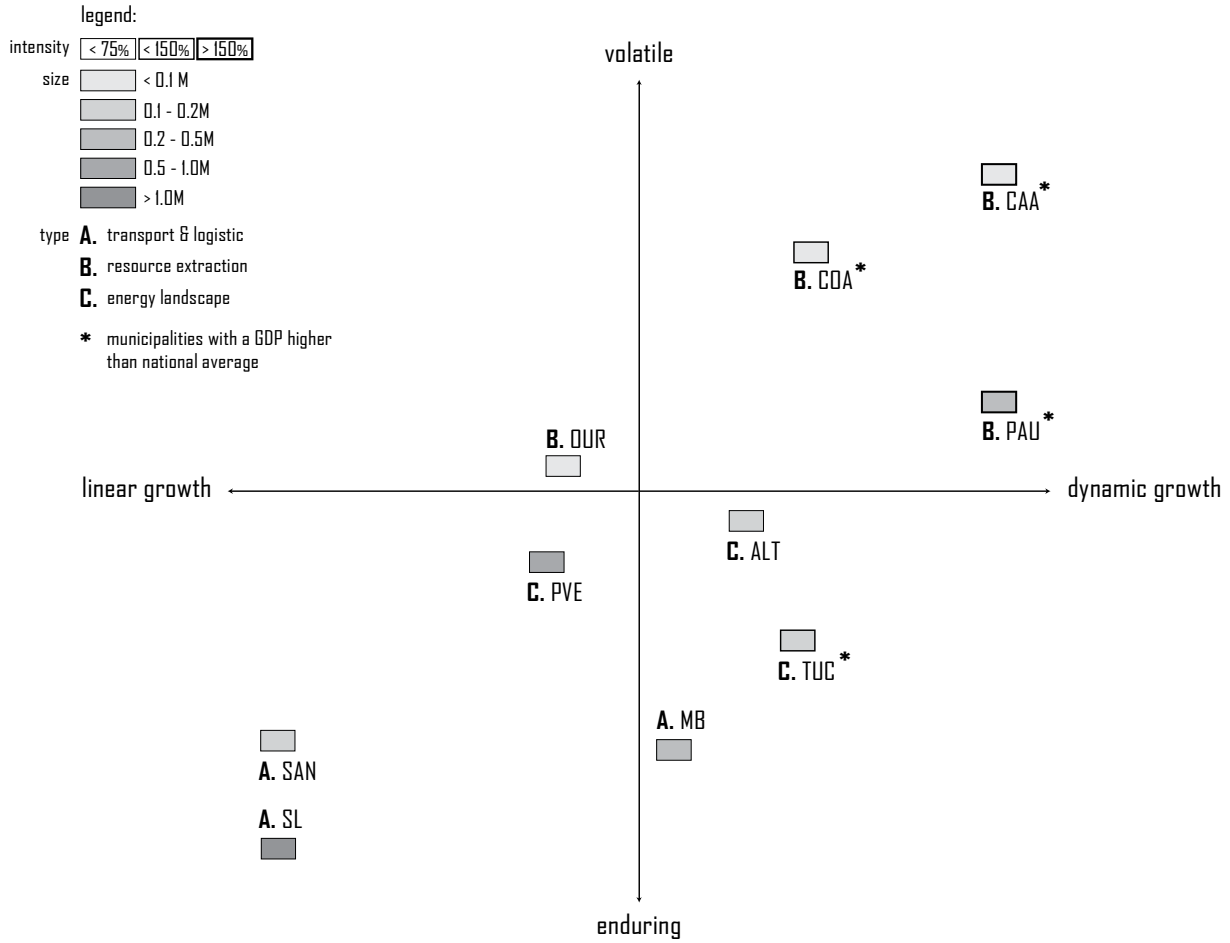


figure 3.14 | **GDP per capita patterns**
Source: IBGE (1999 - 2013), collected through ipeadata.gov.br. Graph and categorization by the author

(3) Jobs & Income

The two following key factors identified can be described as secondary impacts - a wide array of social implications preceding the extensive population influx and modified economic dynamic (Tilt et al., 2009). Secondary impacts include mainly the socio economic and spatial transformations, influencing the daily life of population living in municipalities affected by the implementation of big infrastructure projects. Both impacts described so far have significant influence in employment and income-generating opportunities in areas surrounding the projects (Tilt et al., 2009), emphasizing the relevance for considering jobs as one of the key factors.

To measure possible variations of jobs & income, the data considered was the Firjan Index of Municipal Development (IFDM), elaborated to evaluate the development of Brazilian municipalities, based on indicators in the categories jobs & income, health and education. Organized in a scale from 0 to 1, the index adopts a similar methodology to the HDI (UNDP). It was chosen instead for its yearly issues (2005 - 2013) in a municipal scale, allowing a more sensitive analysis of the different sites. The results display the position the municipalities have in a national ranking rather than the gross numeric value, in order to express the dynamic of development in a national perspective instead of a single static value.

The first remark regarding Jobs & Income indicators (figure 3.15) is the intense variation of the values, mainly in cities influenced by resource extraction and energy landscape projects. The variation is expressed by the length of the columns, showing that during the nine years analyzed by the index, some of the municipalities occupied both the best and the worst positions in the national ranking. This intensity reflects the influence such big projects have in the job market and income opportunities within the surrounding cities, especially in the less populated ones. The influence becomes remarkable when realizing

that 9 out of the 10 selected sites have already been ranked within the best 10% municipalities in the whole country. Such variations are naturally expected, principally when considering the magnitude of the projects have and the manpower they require for construction and operation phases (Cernea, 1997). Further behaviors become visible when looking into the yearly development of some of the sites, in figures 3.16 to 3.19.

The graphs show the yearly index variation in the cities of Ourilandia do Norte, Porto Velho and Altamira, between 2005 and 2013. Two variation patterns can be concluded by interpreting the data collected. Firstly, high yearly variations highlight the dependence the local job market have in the big infrastructure projects, during construction and operation. In Ourilandia do Norte for example, we see a sudden decrease of values in 2009, when the operating company Vale S. A. decided to postpone the opening of the Onca Puma mine, due to little demand of niquel in the international market (Estadao, 2009). This illustrates the volatility the jobs associated to big infrastructure have, especially in smaller cities, where a significant percentage of the market is linked to the projects. Secondly, there is an enormous elasticity of the values. The improvement the indicators show during the construction or operation of the projects is very clear and compelling. However, once concluded, the index usually returns to its initial position in the ranking, rapidly decreasing. This elasticity is visible especially in energy landscapes, as a consequence of the large number of temporary jobs associated to the construction phase (Cernea, 1997; Égré and Senécal, 2003). In Altamira for example, data shows a significant improvement after 2010, year in which the construction of the Belo Monte dam started. The municipality even reached the 1st place of the ranking in 2012. But this value is expected to decrease now that the construction is almost concluded, even when considering a possible success of the worker demobilization programs.

The IFDM data shows the benefits and challenges big infrastructure might bring to the local job market and household income. Improvements, visible quite often, tend to be very elastic, lasting only for a specific period of time. The index also highlights the high dependency municipalities have on the operation of the projects, resulting in a high fluctuation of job offers.

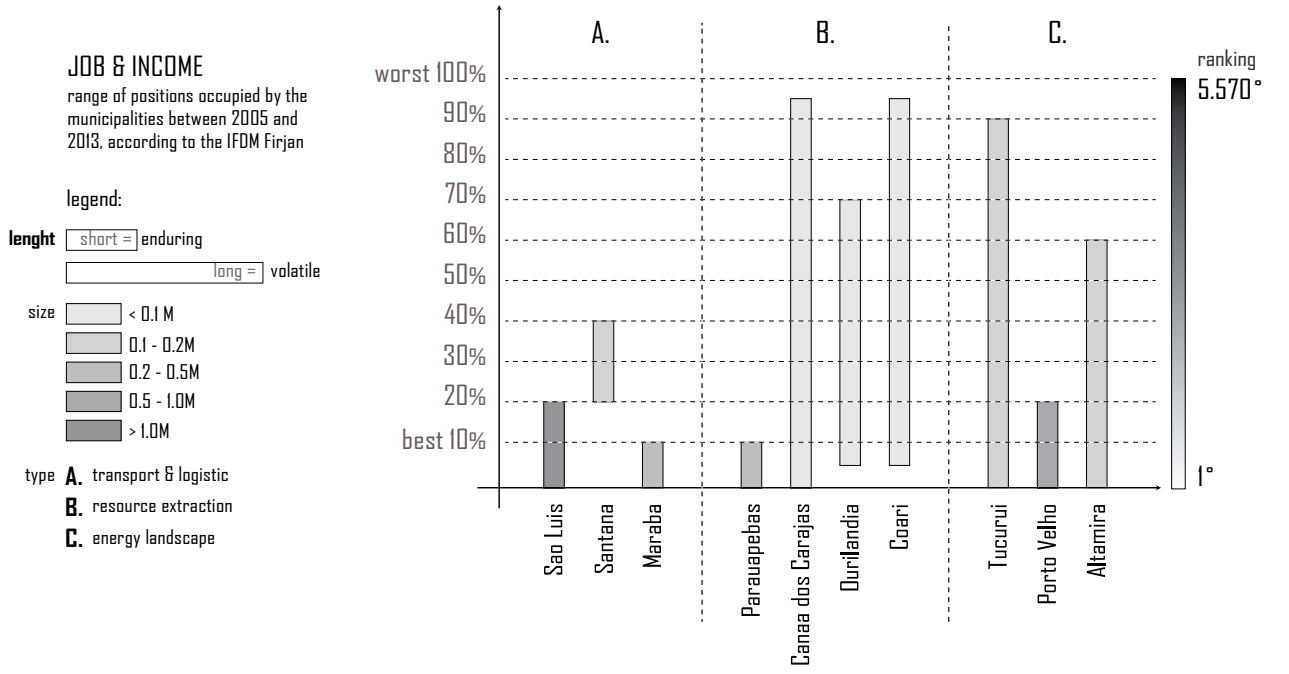
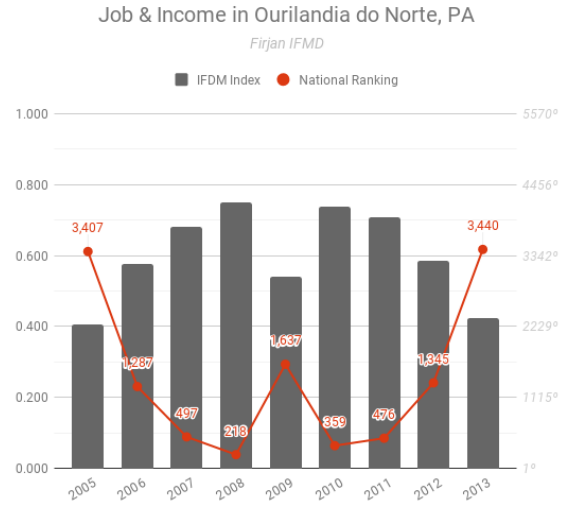
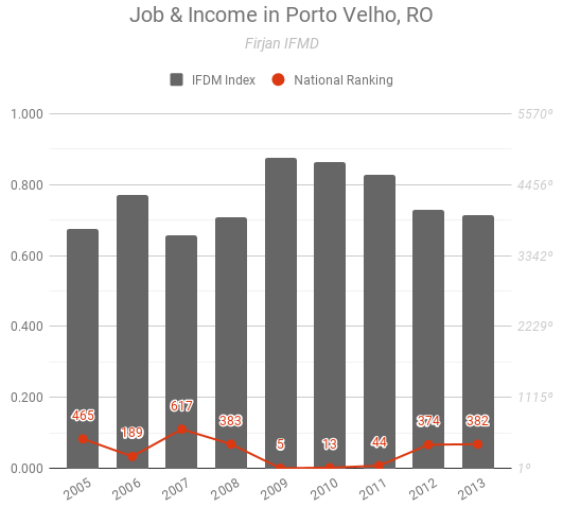
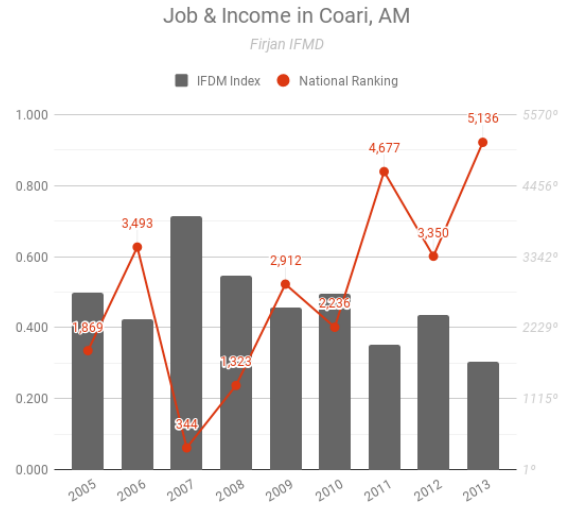
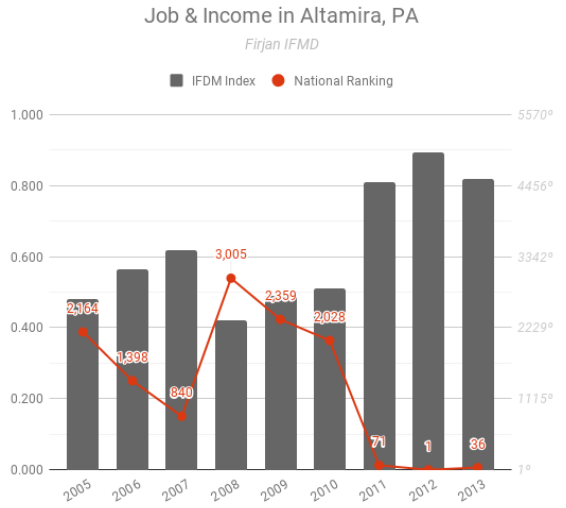


Figure 3.15 | **Index of Jobs & Income, variation between 2005 and 2013**
Source: IFDM Frijan, Graphs and categorization by the author









figures 3.16; 3.17; 3.18; and 3.19 | **Index of Jobs & Income in Ourilandia do Norte, Porto Velho, Coari and Altamira**
Source: IFDM Firjan. Graphs by the author

(4) Health & Education

The fourth key factor was selected to evaluate possible variations in the quality of life of the inhabitants affected by the construction of the projects. Indicators of health and education, measured yearly, display the behavior of the IFDM index according to the quality and accessibility of public equipment. The evaluation looks for variations indicating a significant influence of the primary impacts or mitigation programs. Figure 3.20 displays the data gathered in the categories health and education of the IFDM index, investigating further relevant socio-economic alterations.

Regarding health & education, the first observation is the average position of the selected sites in the national ranking. While the indicators for jobs & income often place the selected sites amongst the top 10% of ranking, the values for health & education are usually ranked over the bottom 50% municipalities of the country. And without exceptions, there are no representatives in the midst of the best 20%. In comparison to the values of jobs & income once again, the graph displays a smaller yearly variation, possibly representing little influence of the projects in the health & education indicators. Another observed behavior is the declining trend dynamic, visible in most of the analyzed indexes. This negative dynamic, however, doesn't necessarily mean that big infrastructure will lead to little or negative development of the health and education indicators. In most of the selected sites raw data shows slight improvements influenced by big infrastructure but, considering the national ranking, the growth rate is still smaller than average, resulting in the reclining positions. The IFDM data also exposes certain elasticity of the transformations, indicating the growth of the index in years prior or following the construction of the project, eventually returning to the initial values in the successive years.

The evaluation of the secondary impacts shows some controversy in relation to the reality explored in the scenarios of primary nature. On the one hand, when looking at variations of the GDP per capita values, there is an often a significant rise of the number of financial resources being collected by the municipalities, evidencing the potential for local development. On the other hand, a different reality becomes visible when investigating the IFDM indexes. There is a high fluctuation of the job market, usually as a consequence to the little diversification of the economic activities in the affected cities. Furthermore, the variations in the health and education indexes are very little, showing a development rate lower than the rest of the country. This controversy manifests the multiscalar nature of the transformations and the difference between the discourses. The data shows that there is a large gap between big infrastructure and consequent improvements in the socio-economic indicators, especially when considering the economic potential generated by the implementation of the project. This discrepancy might be an expression of the incapability of local governance to convert the new resources into significant and lasting improvements for the population. In an index measuring the efficiency of public management (REM-F) created by the periodic Folha, all the sites investigated are classified as "inefficient", as are the majority of the municipalities in the Amazonian region (FOLHA, 2016). This predominance emphasizes the difficulties and challenges of successfully implementing programs and strategies capable promoting sustainable development in the region. According to Cernea (1997), a successful outcome relies not only on social sensitive planning and strategies but also on effective institutions, capable of translating the mitigation plans into successful actions.

But it would also be incorrect to assume that all socio-economic transformations in affected cities are negative. The elaboration of environmental and social impact assessments is required by the national environmental agency, resulting in a series of mitigation programs, necessary for the implementation of these mega projects (Fearnside, 2002). As a consequence, big infrastructure often promotes improvement in some socio-economic indicators. In Altamira for example, by looking at the number of Malaria infections per 1,000 inhabitants, there is a reduction from 17.49 cases in 2008 to 1.22 cases in 2014 (DATASUS). And a similar behavior is visible in other surrounding urban settlements, all within the directly affected area of the Belo Monte dam. This significant decrease is a consequence of one of the many programs created during the planning phase of the dam. Other mitigation programs in Altamira include the construction of hospitals, health clinics, and education units besides the provision of waste and water treatment for every household in the city (NORTE ENERGIA, 2010). The expected socio-economic improvements, however, are not visible in the data collected. Nevertheless, the implementation of those programs is still ongoing, while the data collected measured the indicators up to 2013, meaning improvement might be evaluated in following issues of the index.

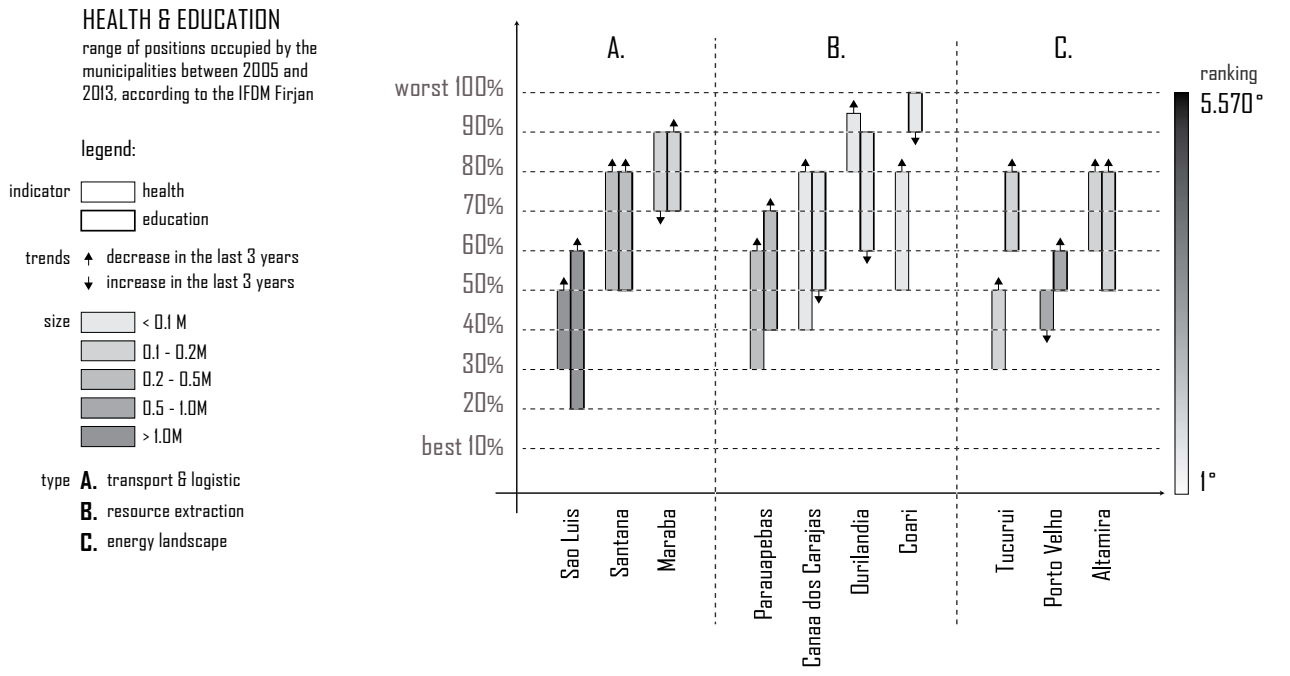
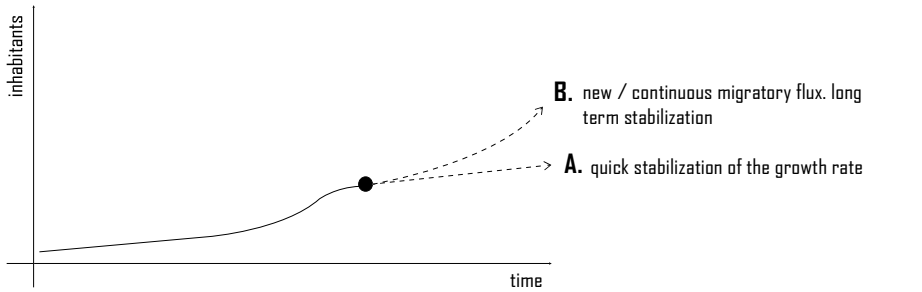


Figure 3.20 | **Index of Health & Education, variation between 2005 and 2013**
Source: IFDM Frijan, Graphs and categorization by the author

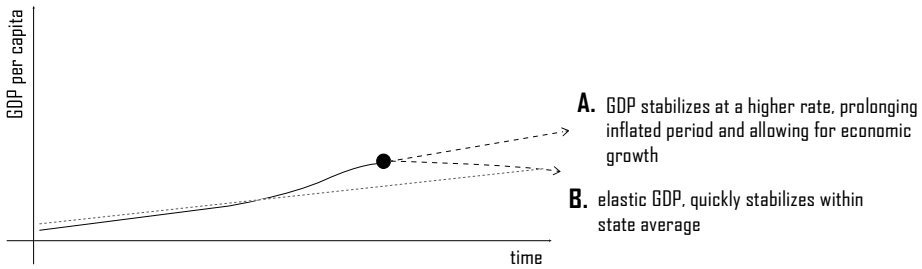
3.3 CRITERIA DEFINITION

The data collected according to each selected key factor and the evaluation of the different variables allowed the observation of a few behavior patterns, as described in the previous sections of the paper. The variations identified can be summarized conforming these patterns, allowing the definition of a set of criterion for scenario building. And despite the clustering by project type visible in most results, similar behaviors could be observed in the data, allowing for a general interpretation of the values. The results are displayed in the diagram below, showing both the key factors and possible variables within them. The key factors and criteria defined to set the framework for the spatial- and scenario analysis of Altamira, in the next section of the research.

I. Population & Migratory flows



II. Municipal Resources



III. Jobs & Income

IV. Health & Education

Figure 3.21 | **Scenario criteria**
Diagram and categorization by the author

figure 3.22 | **Boy plays during the eviction of informal settlements, in Altamira**
image by Lalo de Almeida
source: http://lalodealmeida.com.br/site_pt/editorial/belo-monte-2/#!prettyPhoto

figure 4.1 | **Sreet in Altamira**
image by the author

chapter **4.**

SPATIAL AND SCENARIO ANALYSIS

SPATIAL AND SCENARIO ANALYSIS
an investigation of past, present and future developments in the city of Altamira

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The following chapter of the research aims for a socio-spatial understanding of the urban landscape of Altamira. The investigation consists in the spatial analysis of the city according to the four key factors identified in the precedent studies. The analysis, however, does not focus solely on the past developments and current characteristics of the city. The research also constructs possible future scenarios according to the criteria defined through the observation of the precedent cities, exploring a series of possible and probable outcomes in futures developments of the city. The lessons learned throughout each of the key factors are applied to a series of principles and guidelines, aiding in the definition of a unified vision for the city of Altamira. The chapter is divided into three sections, namely **(4.1) population**; **(4.2) public resources + health & education**, combining two of the key factors; and **(4.3) jobs & income**.

4.1 POPULATION

figure 4.2 | **Farmers market in Altamira**
image by the author

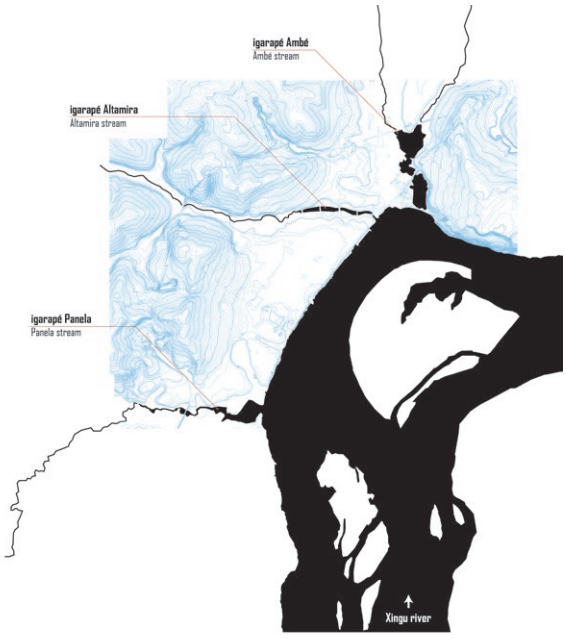
As described in the previous chapter, variations in the population figures of cities under the influence of big infrastructure, due to migratory flows associated to the construction and operation of the projects, usually lead to several impacts in the urban fabric. In Altamira, prior to the construction of the dam, the local government, the national environmental agency, and many social movements ensured the elaboration of a diverse range of programs and projects to compensate and mitigate possible impacts Belo Monte could promote in the city. The first section of the spatial and scenario analysis, focused in the population key factor, aims to investigate the socio-spatial transformations the erection of the project and the implementation of the PBA guidelines had in the development of the urban fabric in Altamira. Within the scope of this section are the topics of population and migratory flows; urban growth and expansion; and neighborhoods and typologies.

The first part of the investigation aims to understand what are the main characteristics and growth dynamics of the territory of Altamira. By investigating its historical formation and analyzing what were the main changes after the implementation of the big infrastructure, the research identifies growth patterns and sensitive areas shaping the development of the city. The methodologies adopted for this goal are comparative mappings and typomorphological studies of a selected group of neighborhoods.

The second part looks into the precedent cities to identify possible and probable future developments, according to the criteria defined in the first chapter of this thesis report. The main spatial behaviors observed throughout the recent development of the case studies are applied in the construction of scenarios of future development of Altamira, highlighting what are the gaps and opportunities concerning urban growth. The lessons learned can then be applied to the definition of coherent plans and strategies, acknowledging a series of outcomes rather than a single inevitable future.

figure 4.3 | **Development of the territory**

The current urban characteristics of Altamira are a fruit of several phases of historical development, gradually shaping its territory. To understand the dynamics of the urban fabric, it is necessary to investigate not only the transformations of the past 10 years but also all the phases that lead the city to its present morphological configuration. The following exercise identifies the historical development of Altamira according to four phases, as described below:



1. Natural landscape & early occupation

2. First urbanization

3. Transamazonica 'boom'

4. Belo Monte 'boom'

N

1. Natural landscape & early occupation,
representing a pre-colonization period when the territory was occupied by different indigenous tribes along the Xingu river;

2. First urbanization,
during the 19th century, in which Altamira had its development accelerated by the extraction and production of latex. Such phenomenon led to the formation of a small urban settlement, oriented by the Xingu river, only means of access to Altamira;

population figures:
1950: 7.539 inhabitants
1960: 11.815 inhabitants

3. Transamazonica 'boom',
following the opening of the highway connecting the Amazon to the rest of the country, during the 1970's. The Transamazonica was the trigger of a strong migratory process, where the facilitated access to the city lead to the attraction of workers and new inhabitants, accentuating the urbanization process. The phase was marked by the intensive and unorganized urban growth, in which a large percentage of the population was residing in informal settlements built over protected areas;

1970: 15.345 inhabitants
1980: 46.509 inhabitants
1991: 72.408 inhabitants

and **4. Belo Monte 'boom'**,
defined by the development since the beginning of the implementation of the dam, in 2010. Shaped by the resettlement of the affected population and the accommodation of a new migratory flow, leading to the sprawl of the city. The spatial transformations of this phase are going to be further explored throughout this section.

2000: 77.355 inhabitants
2010: 99.075 inhabitants
2017: 111.435 inhabitants

water
urban fabric
urban growth
transamazonica highway
infrastructure
maximum flood height
maximum water level
airport

figure 4.4 | **Transformations of the urban fabric**

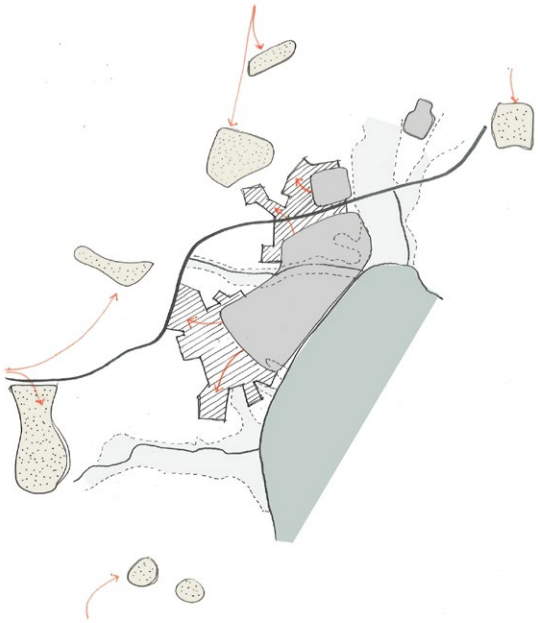
Map shows a summary of the main transformations in the built environment, promoted mainly by the flooding of urban areas, migratory flows and mitigation programs, during and after the construction of the dam.

figure 4.5 | **Population movement patterns in Altamira, after Belo Monte**

The movement of people observed in the city of Altamira over the past years can be described according to two patterns, **dislocation** and **expansion**, as described in the diagrams below.

i. dislocation

represents the movement of the affected population by the flooding of the dam. 6 new resettlement neighborhoods (RUC) where built outside the city center to accomodate this "existing" population



ii. expansion

with the attracted migratory flows the urban fabric developed in two ways: (1) the expansion of the formal city, following major transportation axis and (2) the creation of several residential allotments in the periphery of Altamira

water
maximum water level
maximum flood height
transamazonica highway
main roads
airport

transformations:

flooded areas - removed families
resettlement of affected families (RUC)
new focus of informal settlement
urban development before Belo Monte
urban development after Belo Monte
development of private allotments

figure 4.6 | **Typologies of Altamira**

Map shows the current typologies of Altamira according to the development of the different phases. The grey represents the growth of the "formal city" over the years. The brown areas are the new private residential developments and in red the resettlement neighborhoods, for the population directly affected by the construction of the dam.

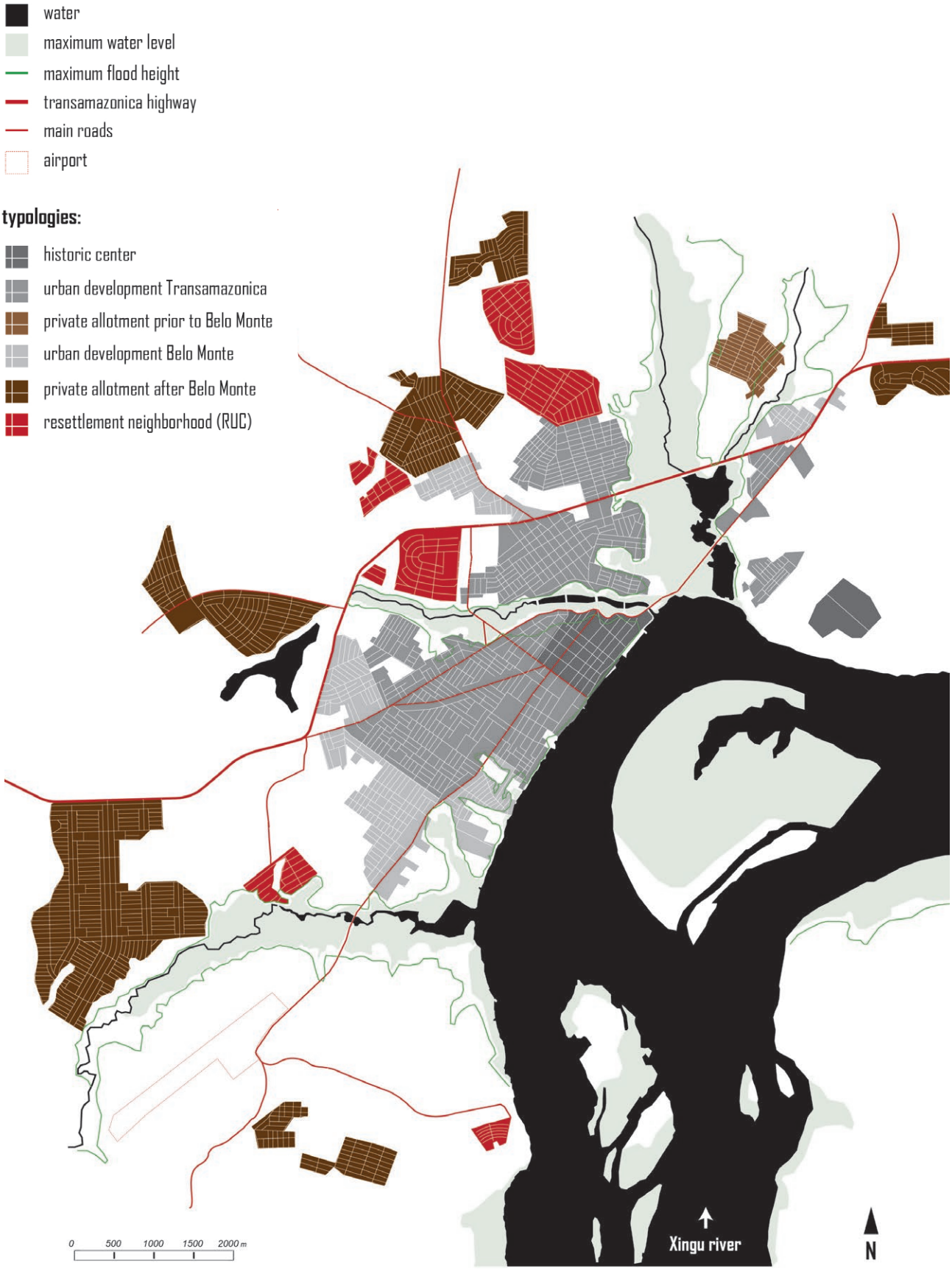


figure 4.7 | **Occupation of the built environment**

But the typologies map in the previous page expresses only the spatial configuration and infrastructure patterns of the different neighborhoods in Altamira. The following map shows the occupation and density of the identified neighborhoods. In here, it becomes clear how the older part of the city has a higher occupation rate than the new expanding areas. The map also highlights the dense occupation in the resettlement neighborhoods, where the all the houses were already built as determined by the compensation guidelines. In a contrast, the map also displays the currently low occupation in the new residential allotments in the outskirts of Altamira, where just a few groups of housing units are spread out along the vast areas of the enterprises.

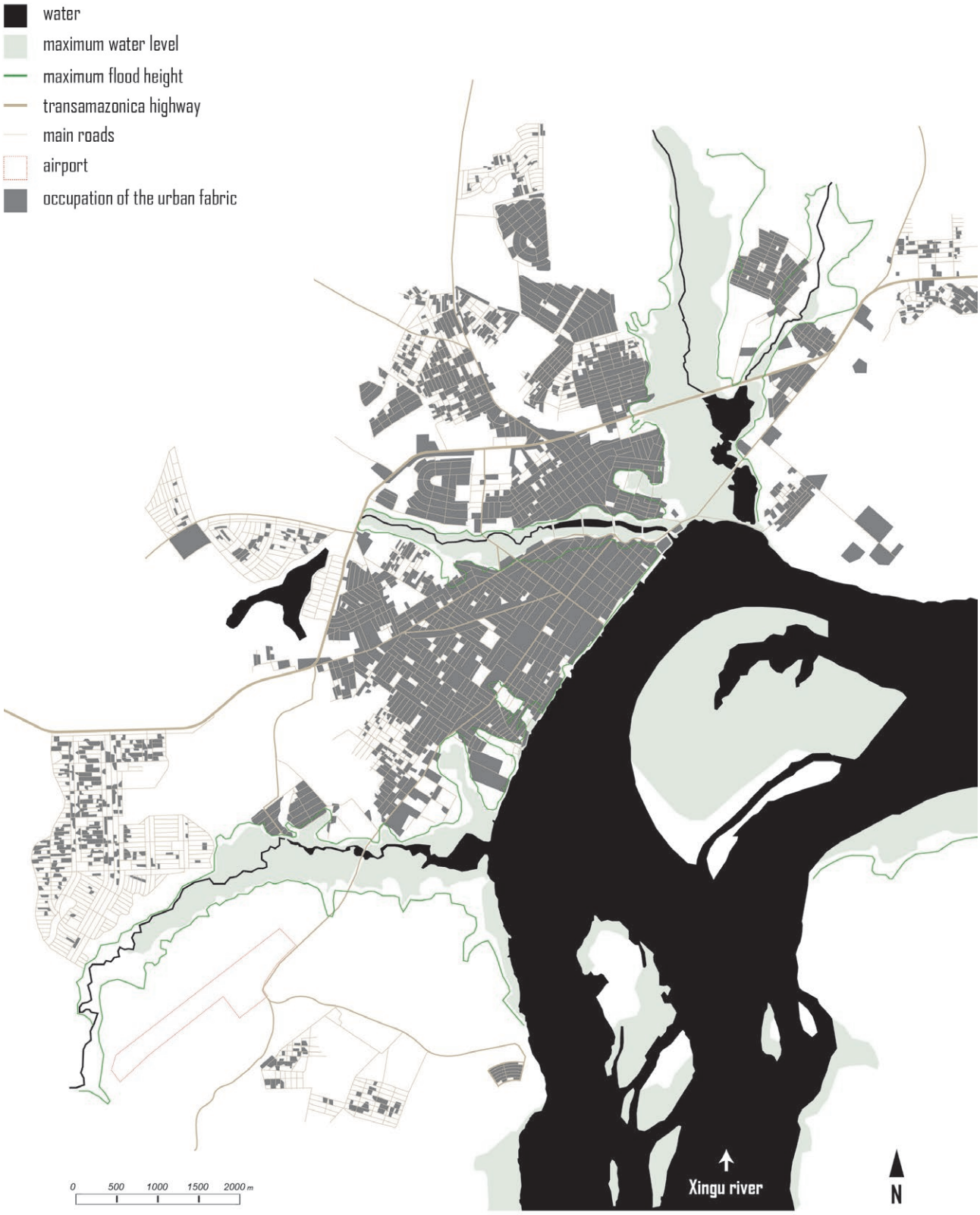


figure 4.8 | **Typomorphological studies**

To further understand the spatial characteristics in the different typologies, the following exercise investigates the typomorphological structures of the urban fabric in a closer scale, looking into the main differences of the built environment and average densities.

Occupation in the historical center

average plot size:
variable

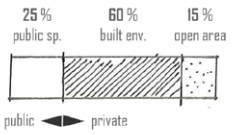
households per block (avg):
35 hh/block

inhabitants per households (IBGE):
3.5 inhabitants/household

estimated density in typology (current):
50 - 75 inhabitants/ha

potential density in typology:
75 inhabitants/ha

average occupation (ha)



Occupation in Jardim Independente I
(Transamazonica phase)

average plot size:
20 x 10 | 200m2

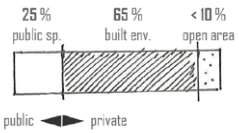
households per block (avg):
25 hh/block

inhabitants per households (IBGE):
3.5 inhabitants/household

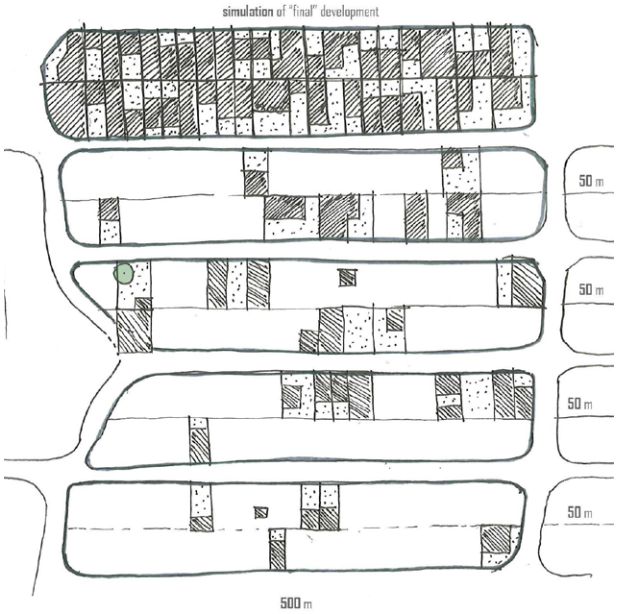
estimated density in typology (current):
100 - 125 inhabitants/ha

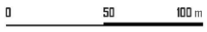
potential density in typology:
125 inhabitants/ha

average occupation (ha)



Occupation in Cidade Nova
(private residential allotment)





average plot size:
25 x 10 | 250m2

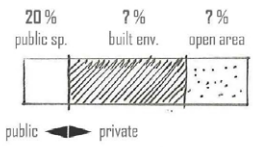
households per block (avg):
8 hh/block (estimation of **40**, once full)

inhabitants per households (IBGE):
3.5 inhabitants/household

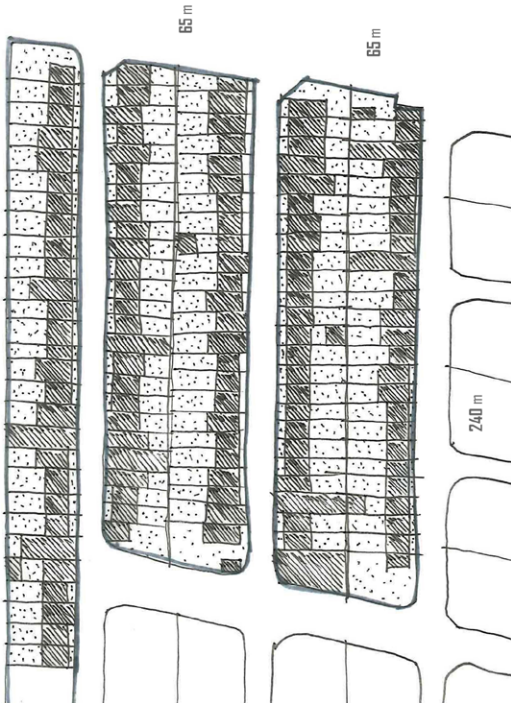
estimated density in typology (current):
10 - 20 inhabitants/ha

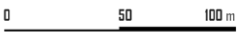
potential density in typology:
50 - 75 inhabitants/ha

average occupation (ha)



Occupation in Sao Joaquim
(resettlement neighborhood)





average plot size:
30 x 10 | 300m2

households per block (avg):
45 hh/block

inhabitants per households (IBGE):
3.5 inhabitants/household

estimated density in typology (current):
75 - 100 inhabitants/ha

potential density in typology:
100 inhabitants/ha

average occupation (ha)

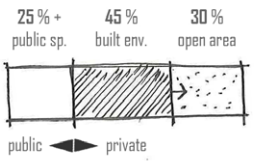


figure 4.9 | **Growth and densification of the urban fabric**

The typomorphological studies investigate four typologies of Altamira, each one from a different development phase, chosen for being representative of other similar typologies of the urban tissue. Between the selected sites, the main differences can be described according to two categories, namely the characteristics of the built environment and the current occupation patterns.

Regarding the characteristics of the built environment, the typologies differ from each other in both block and plot sizes. In the historical center, blocks are larger, without a specific plot size. This variety results in a diverse range of building typologies. In the neighborhoods Jardim Independente (urban allotment planned by the municipality), Cidade Nova (private residential allotment), and RUC Sao Joaquim, the analysis shows standardized urban typologies, with the repetition of block and plot sizes and proportions. This type of urban fabric is resulting in a homogeneous occupation of the ground.

But, besides the urban design variations, the main differences are seen in the occupation patterns of each neighborhood. For example, it is possible to see in the central areas of the city a consolidated occupation, with fully occupied blocks bounding the streetscapes. There is a large diversity of both residential and mixed-use typologies, resulting in a heterogeneous urban fabric. In Jardim Independente, there is also a consolidated occupation but with the repetition of similar residential typologies, contrasting with the city center. In the resettlement neighborhood Sao Joaquim, the repetition of typologies is even stronger, however, it is already possible to see how the appropriation of the households by the affected population is already starting to transform the streetscape. The occupation of Cidade Nova and other new residential allotments is the most striking, with very low and sparse occupation rates, resulting in a fragmented and segregated urban tissue.

Based on the occupation patterns identified, a few areas were defined within the urban fabric, determining which parts are already consolidated and which are the transforming neighborhoods, with large potential for growth or densification.

view of typical street in city center,
with single-family housing. corners are usually occupied by local commercial buildings

view of street in jardim independente I,
with single-family housing, few two stories buildings and some commercial points

view of street in cidade nova (allotment development),
single-family houses, spread out. very low density, little diversity

view of street in RUC sao joquim,
modular single-family houses. transformations are being gradually built by the inhabitants

figure 4.10 | **Probable developments of the urban fabric**

The following map indicates which are the consolidated typologies in the urban fabric and which are the spaces sensitive for future densification, expansion or growth. Interestingly, by looking into this overview it is possible to identify the different typologies according to two development rings. Surrounding the core of the consolidated city center is an inner-ring of expanding urban fabric, characterized by little occupied allotments, usually planned by the municipality. Further away form the center, in the outskirts, is the outer-ring, composed by the new private residential allotments.

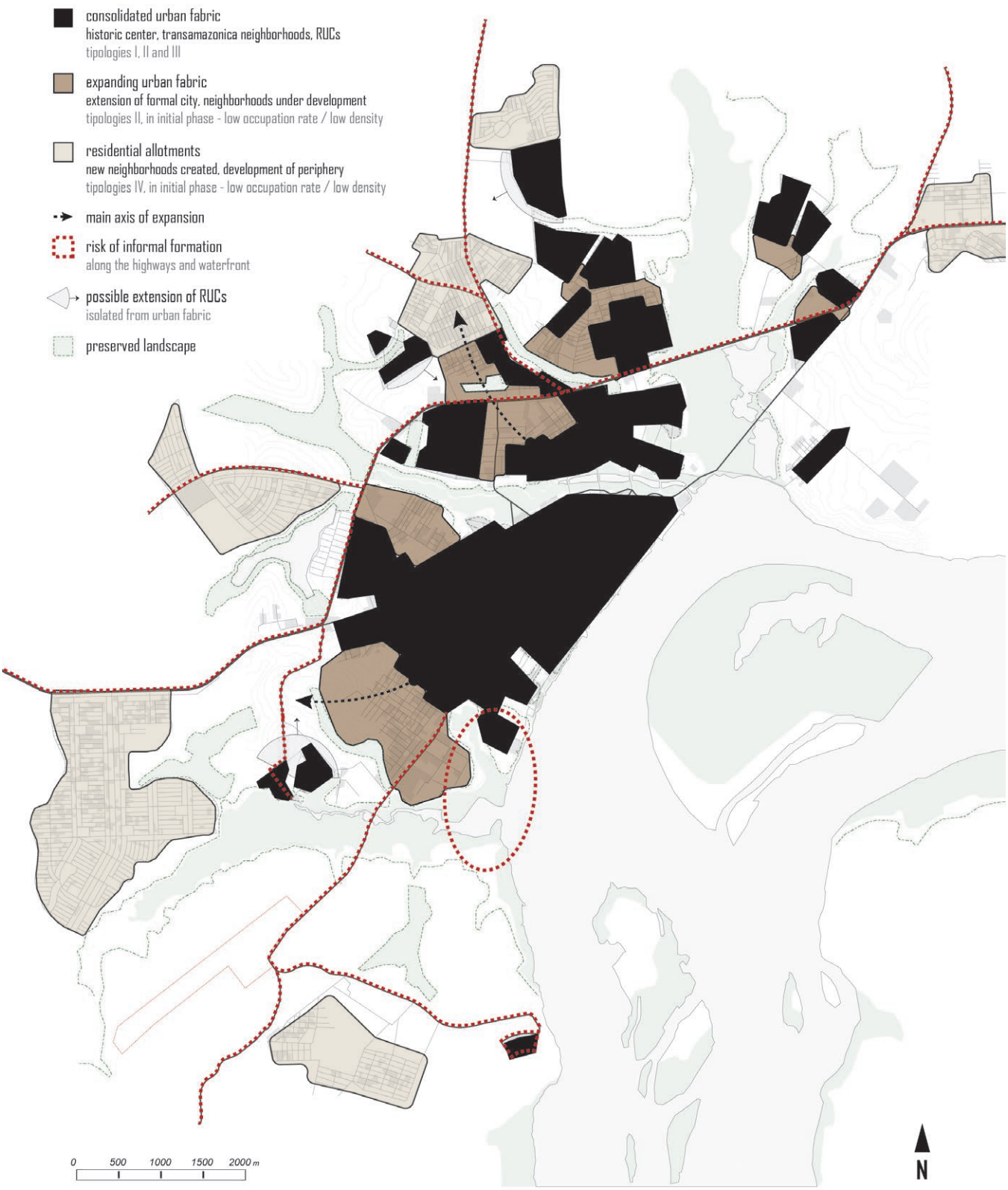


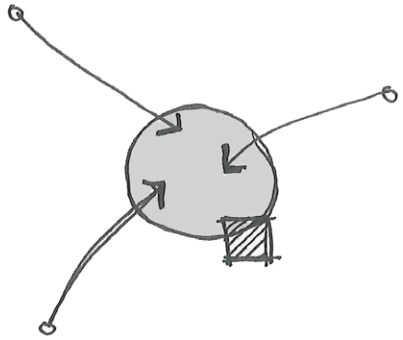
figure 4.11 | **Probable & possible futures**

According to the precedent studies criteria and expert interviews, three different possible scenarios of future development of the population figures and urban growth were defined, as shown in the diagrams below. All three scenarios take into account the projections of population figures, based on similar behaviors seen in the precedent cities and a few possible events that might have large impacts in Altamira, such as the Belo Sun mining projects, the Ferrograo railway, or the implementation of a new dam in the surrounding regions. Each of those events could strongly influence the growth of the urban fabric in the city, by promoting new migratory flows, increasing or even reducing the estimated population rise rate.

historic population figures & growth

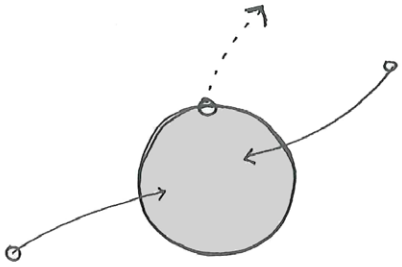
growth and estimations based on official census (IBGE) and comparative studies

1950	1960	1970	1980	1991	2000	2010	2020	2025 A	2025 B	2025 C
7,669	11,987	15,345	46,496	72,408	77,439	99,075	117,500 est.	160,000	130,000	120,000
		+ 25%	+ 200%	+ 50%	+ 8%	+ 25%	+ 20%	+ 50%	+ 20%	+ 5%



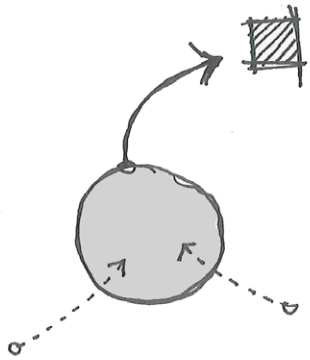
A | **continuous**

scenario considers the implementation of a new "big infrastructure" project, the Belo Sun gold mining complex. the construction and operation will promote a new wave of migratory flow, resulting in the rapid expansion of population figures



B | **stabilized**

Belo Monte "boom" is gone...
migratory flow continues for job opportunities and services in Altamira, but in a controled rate, within average



C | **decreased**

scenario considers the possible annoucement of a new dam in the surrounding regions, demanding "specialized" workforce for the construction. part of the population might leave looking for jobs in the new dam, resulting in a decrease of the population growth rate

figure 4.12 | **Scenario projection,** according to precedent studies

Based on a spatial observation of the precedent cities, the following patterns could be identified as possible development scenarios plausible for the city of Altamira. It is important to stress that the exercise is not intended provide a precise definition of future development models. Instead, it simply allows the observation of the expansion patterns, highlighting similarities and differences related to different variations in population figures. The diagram below shows the risks and potentialities encountered while investigating possible behavior of the urban fabri according to the three scenario definitions. The conclusions evidence the transformations in each of the typologies defined in the spatial analysis of Altamira (core, inner- and outer- rings).

	A | Continuous	**B |** Stabilized	**C |** Decreased
RISKS	1. Continuous migratory flows and fast growth rate might result in further expansion of the urban fabric before densification. Intensity might promote the creation of new residential allotments, meaning further sprawl of Altamira.	1. Even with the controlled migratory flow, the growth of Altamira might still add pressure in the protected areas, especially considering the possibility of re-appearance and/or formation of informal settlements within the urban tissue.	1. a similar behavior might become visible in the expanding fabric of the inner-ring. little "formal" occupation might lead to informal settlements and the degradation of the already constructed infrastructure.
	2. High demand for housing might result in an increased real-estate value, focusing growth in the outer-ring rather than densifying the inner-ring and core of the city.	2. With the controlled growth and focus of development in the core and inner-ring of Altamira, the outer-ring becomes a challenging issue for the urban fabric. The little occupation might not be enough for the configuration of proper and diverse urban tissue, leading to the degradation and marginalization of some of the residential neighborhoods in the outskirts of the city	2. With the controlled growth and focus of development in the core and inner-ring of Altamira, the outer-ring becomes a challenging issue for the urban fabric. The little occupation might not be enough for the configuration of proper and diverse urban tissue, leading to the degradation and marginalization of some of the residential neighborhoods in the outskirts of the city.
	3. Intensive growth might be faster than the provision of infrastructure and public equipment [formal urbanization] resulting in a deficient network, especially concerning waste and water treatment.		
	4. Additional pressure in the already challenging road network and public transportation systems might increase accessibility problems in Altamira, promoting marginalization of isolated neighborhoods.	3. Continuous migratory flows might lead to the [irregular] expansion of the resettlements neighborhoods (RUCs) due to the growth of local communities, especially in the most isolated ones.	3. a decreased growth of Altamira might still add pressure in the protected areas, especially in neglected parts of the city. There is the possibility of re-appearance and/or formation of informal settlements within the urban tissue
	5. An accelerated growth might add pressure to protected areas, especially considering the possibility of re-appearance and/or formation of informal settlements within the urban tissue.		
POTENTIALS	1. The Belo Monte 'boom' has left some emptiness in the urban fabric in Altamira, mainly due to real estate speculation. A new 'boom' is likely to promote a new dynamic of occupation, filling up these gaps. However, this same dynamic might leave new gaps in less consolidated "expanding" urban fabric.	1. Stabilization of the migratory flow leads to the regularization of real estate values in the city, especially in the central areas. This regularization promotes occupation and densification of the core and inner-ring of the city, because of the proximity to jobs, provision of infrastructure and accessibility.	1. Stabilization of the migratory flow leads to the regularization of real estate values in the city, especially in the central areas. This regularization promotes occupation and densification of the core and inner-ring of the city, because of the proximity to jobs, provision of infrastructure and accessibility
	2. Occupation and densification in the residential allotments [outer-ring] conforming a city like "urban fabric" instead of partial occupation. This new urban texture, however, will be focused on specific nodes.	2. Vast and extensive investments have already been made in the infrastructure of the "formal" Altamira. A stabilized growth would concentrate in areas in which basic infrastructure is already provided, ensuring the proper installation and quality of new housing units.	
	3. Intensive growth might promote the creation of alternative commercial centers rather than rely solely on the central area of Altamira. This is likely to encourage the diversification of activities.	3. The growth even stabilized, might promote the creation of alternative commercial centers rather than relying solely on the central area of Altamira. This is likely to encourage the diversification of activities.	
	4. The growth of the city might incorporate some new neighborhoods [especially resettlement ones] into the urban fabric, preventing marginalization.	4. By expanding its inner-ring, the urban fabric of Altamira might incorporate some of the new resettlement neighborhoods, preventing a possible marginalization.	

figure 4.13 | **Scenario A**

CONTINUOUS MIGRATORY FLOW

possible & probable transformations in the urban fabric assuming a continuous development of the migratory flows

densification in the allotment neighborhoods
high growth of the population rate attracts new residents to the allotments for its affordable prices. Aglomeration of houses starts to form a denser urban fabric in a parts of the neighborhoods. The high demand might also lead to the expansion of some of the neighborhoods

creation of new private residential allotments
the high demand for housing might promote the creation of new allotments, seeking to explore the rising population figures in Altamira. A similar pattern can be seen in Parauapebas, between 2006 and 2016 and in Maraba, between 2004 and 2014

densification of the inner-ring typology
high demand for housing and proximity to city center result in the occupation and densification of new neighborhoods created. Economic prosperity due to a possible implementation of the Belo Sun mining complex is likely to promote the elevation of prices in this area, hampering the full development of the area

expansion of the "formal" city
fast growth rate might lead to the sprawl of the inner-ring of development. There will always be "expanding urban fabric" typology, and with the densification of the city center this boudary will grow outwards

formation of informal settlements
due to rapid growth, high demand of affordable housing and inflation of prices. Focus in the access highways and the Panela stream

expansion of the isolated RUCs
with the formation and growth of local communities, relatives and familiars search for closer locations to settle

figure 4.14 | **Scenario B**

STABILIZED MIGRATORY FLOW

possible & probable transformations in the urban fabric considering a quick stabilization of the growth rate in Altamira

occupation in the allotment neighborhoods
slower occupation of the residential allotments. few concentrations of denser urban fabric start to be formed, while large areas remain fragmented and empty, with little density. risk of degradation and marginalization

densification and expansion of the core of Altamira
decreasing prices with the conclusion of the dam proximity to jobs in the city center promote occupation and densification of neighborhoods inside the "formal city"

expansion of the "formal" city
There will always be "expanding urban fabric" typology, and with the densification of the city center this boudary is likely to grow outwards

formation of informal settlements
informal settlements might appear in the riverfront and along the highways, closer to existing infrastructure in the lower occupation neigborhoods.

expansion of the isolated RUCs
gradual increas of local communities might result in the expansion of some of the planned neighborhoods

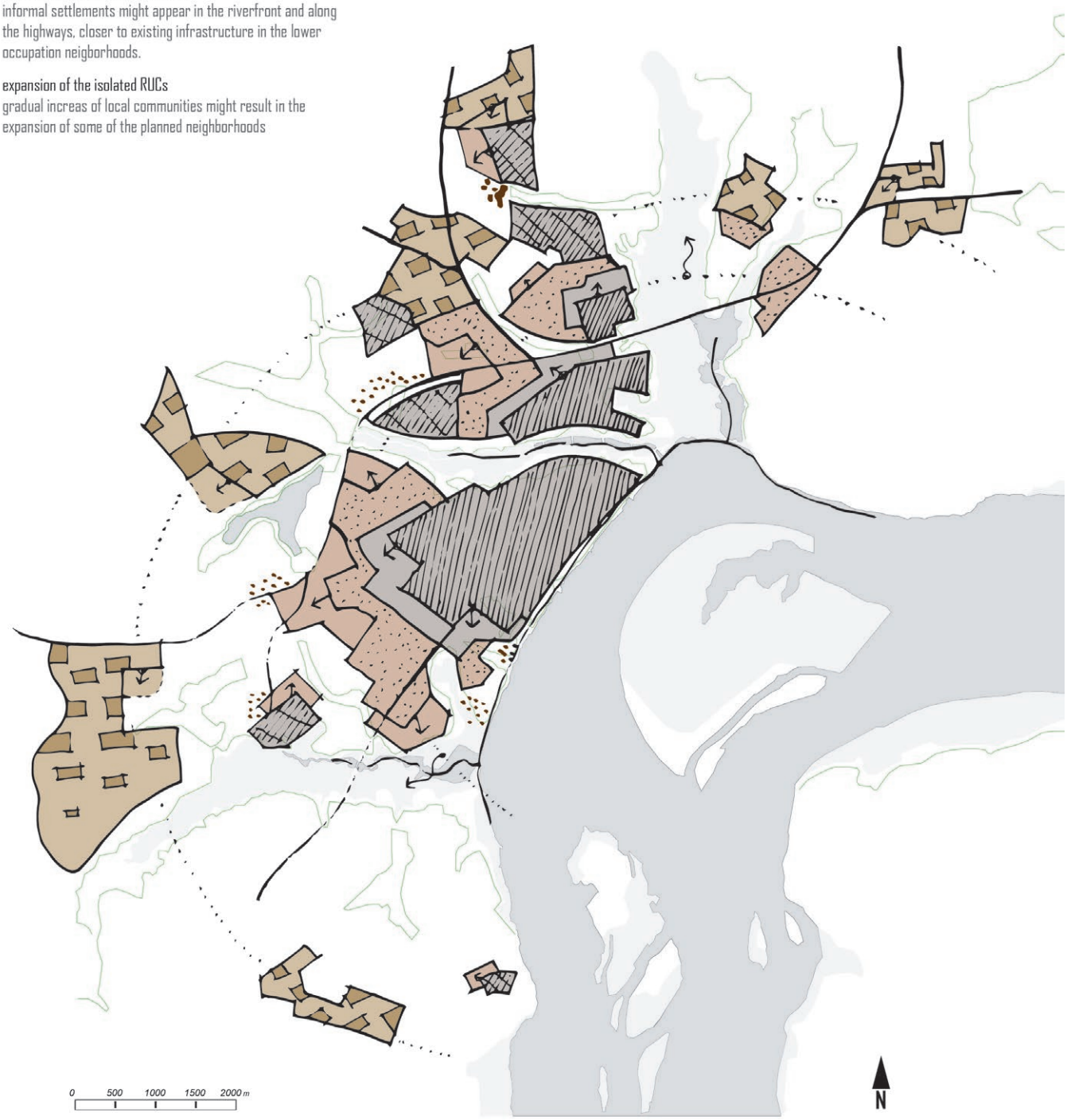


figure 4.15 | **Scenario C**

DECREASED GROWTH RATE

possible & probable transformations in the urban fabric assuming a possible decrease in the growth rate in Altamira

occupation in the allotment neighborhoods
punctual occupation in the allotment ring, insufficient for densifying the urban fabric. Neighborhoods remain fragmented and little diverse. High risk of marginalization

densification of central areas
decreasing prices with the conclusion of the dam proximity to jobs in the city center promote occupation in neighborhoods inside the "formal city"

occupation in expanding urban fabric
lower formal occupation of this typology, due to lack of demand. Risk of occupation by informal settlements, because of proximity to central areas, existing infrastructure and accessibility

formation of informal settlements
informal settlements might appear in the riverfront and along the highways, closer to existing infrastructure in the lower occupation neigborhoods.

densification in RUCs
gradual transformation and appropriation of the planned neighborhoods and housing typologies

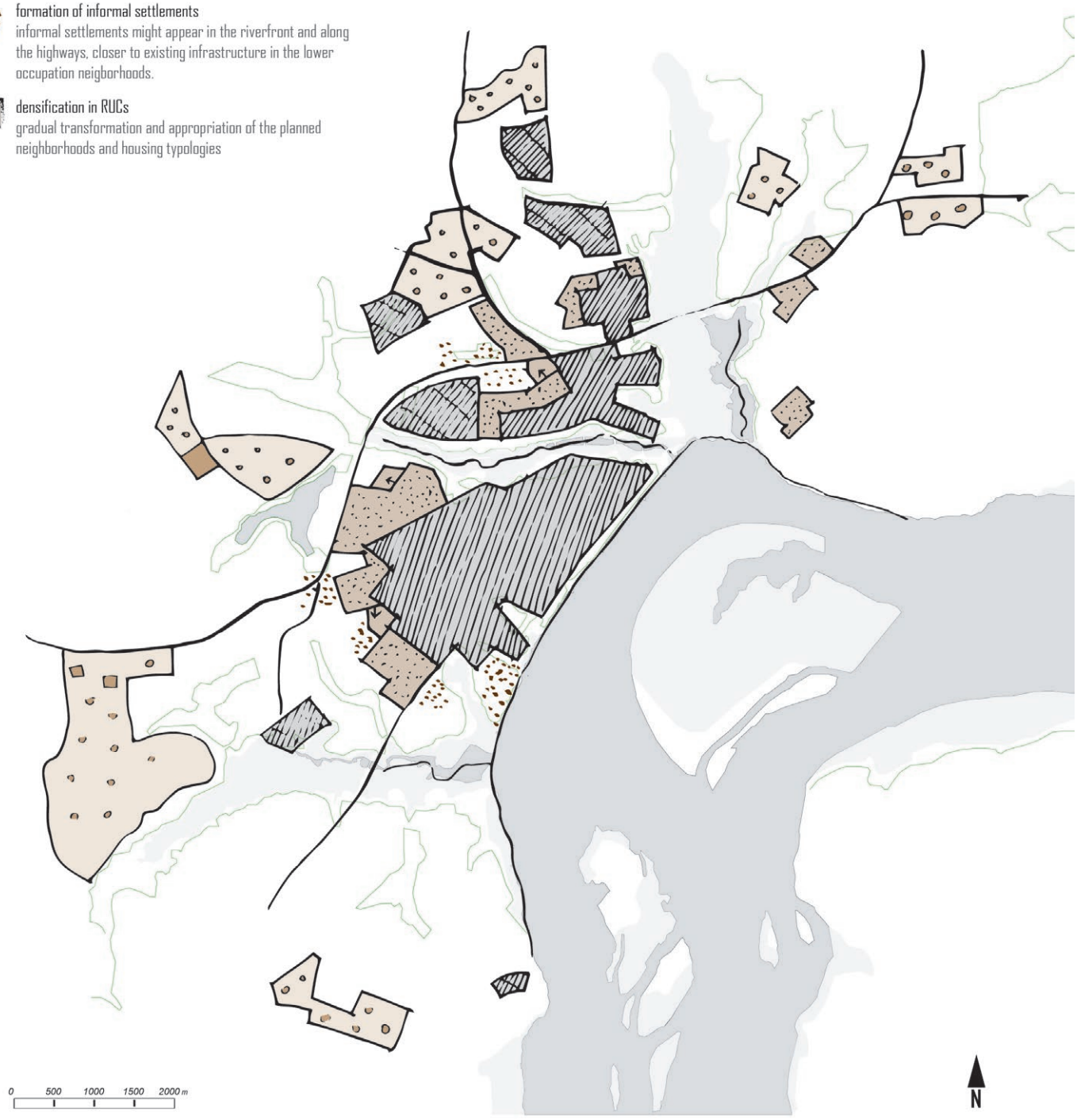
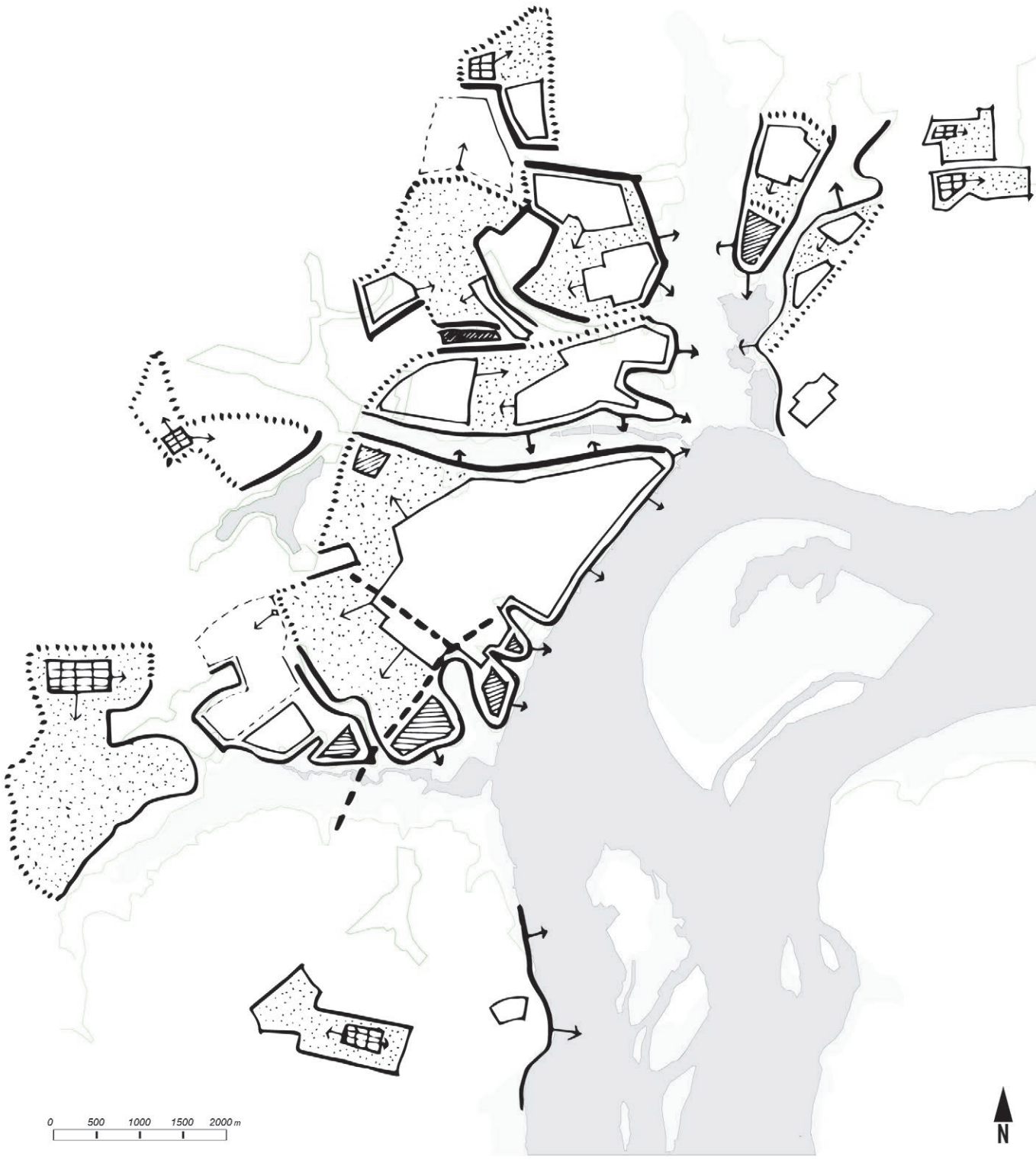


figure 4.16 | DESIGN PRINCIPLES FOR POPULATION AND URBAN GROWTH



Based on the scenario extrapolation, it is possible to reach a few conclusions regarding the possibilities of expansion and growth of the urban fabric in Altamira. A few of the observations, critical in all the three scenarios, are tackled in the following map, showing a vision with a series of guidelines and principles for future growth.

In a first impression, the realization of a stabilized scenario would seem ideal for the city of Altamira. But, as seen in the previous analysis, there is no ideal outcome, since all of them propose many challenges for future development. This fact might be associated with the extremely accelerated expansion of the city during the period of construction of the Belo Monte dam, resulting in the sprawl of neighborhoods with low occupation rate and density. In a short-term horizon (2025) it is very unlikely to imagine a population increase significant enough for densifying this vast urban tissue created in Altamira. And even when assuming such growth as a possibility, the intensity is likely to promote further expansion of the city before proper densification of the neighborhoods, as seen in the Parauapebas precedent study. Accelerated growth can lead to further sprawl while a controlled or smaller growth, if not properly directed, can result in the marginalization of some of the distant neighborhoods.

Another important aspect concerning growth in this region is the sensibility of the natural landscape surrounding the cities. And, as seen in the scenario simulations and experienced during the site visit, the protected areas are continuously under pressure of occupation, especially with informal settlements. Even though most of the population living in irregular conditions was resettled and is now living in 'formal' neighborhoods, future growth (in the Amazonian context) is likely to result in the (re-)appearance of informal typologies throughout the city. In addition to that, the current development dynamic of the formal city is also compromising the preservation of the natural resources in Altamira, especially the water. In a conversation with Marcelo Salazar, coordinator of the ISA Institute in Altamira, he pointed out the need for revitalization of the river-front and use. Marcelo states that, along with the new elite that arrived with the construction of the dam, new mansions are being built in the riverfront of the Xingu river, right outside the city center. This type of development is happening between the streets and water, blocking any sort of public access to the margins of the river, establishing a clear boundary between city and water.

The vision map acknowledges these challenges and tackles them with the establishment of a few gestures and principles guiding future growth, regardless of size and volume, aiming to explore the potentialities identified and avoid the consolidation of the potential risks. It is important to keep in mind, however, the necessity of a flexible strategy, capable of adapting according to different scenario outcomes.

hard boundaries
Delimitation and consolidation of hard boundaries for the growth of the urban fabric, ensuring the preservation of protected areas. Especial attention should be paid to the Xingu river and streams flowing towards it. The city, currently neglecting the water, should acknowledge its presence and emphasize the development according the water. Riverfront should be occupied with the provision of public infrastructure giving access to the water, instead of private properties blocking it.

soft boundaries
The new edges of the city, indicating possible areas for growth, according to availability of land, accessibility and provision of infrastructure. Ideally, Altamira would grow within those margins, avoiding further sprawl of the urban fabric.

potential axis of development
Existing axis crossing through multiple typologies and densities of urban fabric. Potential for further densification, considering accessibility, proximity to city center, and capacity for expansion.

consolidated urban fabric and expansion direction
Central areas of the city should be constantly developing and expanding, especially considering the already existing infrastructure, diversity and opportunities present in this typology. Resettlement neighborhoods should expand to be incorporated within the "formal city".

densification of existing urban tissue
Before expansion of the "soft boundaries" of the city, the less dense parts of the urban tissue, where infrastructure is already existing, should be further developed

risk areas, special attention
Areas currently occupied by informal settlements or sensitive for future occupation.

nodes for densification
Priority of densification in specific parts of the residential allotments, allowing diversified and alternative centers.

4.2 PUBLIC RESOURCES + HEALTH AND EDUCATION

The following section of the spatial and scenario analysis focuses simultaneously on two key factors: public resources and health and education. This combination was decided due to the similarity of the subjects and their scope, investigating both the provision of infrastructure and public services in Altamira and the governance structures responsible for further development and maintenance of the transformations in the built environment. The spatial analysis looks into the mobility infrastructure, the integration of the urban fabric and provision of public equipment related to health, education, and leisure, through different research methodologies. Possible future outcomes are also extrapolated according to patterns identified in the precedent studies, developed earlier in the graduation thesis. This section was divided into two parts.

Firstly, the analysis has the intention of understanding what were the main socio-spatial transformations promoted by the construction of the Belo Monte dam and how were they influenced by the compensation and mitigation strategies established in the PBA guidelines. With this in mind, the mapping exercises are usually done by comparing two different moments of the city of Altamira, before and after the implementation of the mega project. The main aspects of the investigation were defined according to three plans predicted in the PBA guidelines, namely the "Plan of Urban Requalification", the "Plan of Attendance to the Affected Population", and the "Plan of Institutional Articulation".

The second part investigates existing variations in tax incomes and management structures in Altamira, looking for a relationship between public resources and the provision of quality urban services. This analysis is done mainly through a comparative study based on the 10 identified precedent cities. The conclusions are then applied on the definition of possible future scenarios and the implications of each scenario in the development of the city, which are used as a framework for the development of a vision for the spatial integration of the public systems in Altamira.

"Cities influenced by the Belo Monte dam are receiving a lot of financial compensation, but we see very little changes"
Josefa, mototaxi driver

... the PBA and the compensation guidelines leave a legacy for the city, without a doubt ...
Nubia, works at Norte Energia

"Equipments and infrastructure were not properly executed. They are brand new and are already in poor shape"
Pericles, born and raised in Altamira

... the greater concern now is about the maintenance. It will be a huge challenge for the municipality to take over ...
Jose Neto, professor at UFPA

figure 4.17 | **Predicted interventions**

source: Masterplan Altamira (2010) and PBA Belo Monte (2010)

Overview of the planned transformations prior to the implementation of the dam, according to the city's masterplan and compensation guidelines. Main intervention expected is the construction of a diversion of the Transamazonica, allowing the city to grow along the existing urban section of the highway, as shown in the map below:

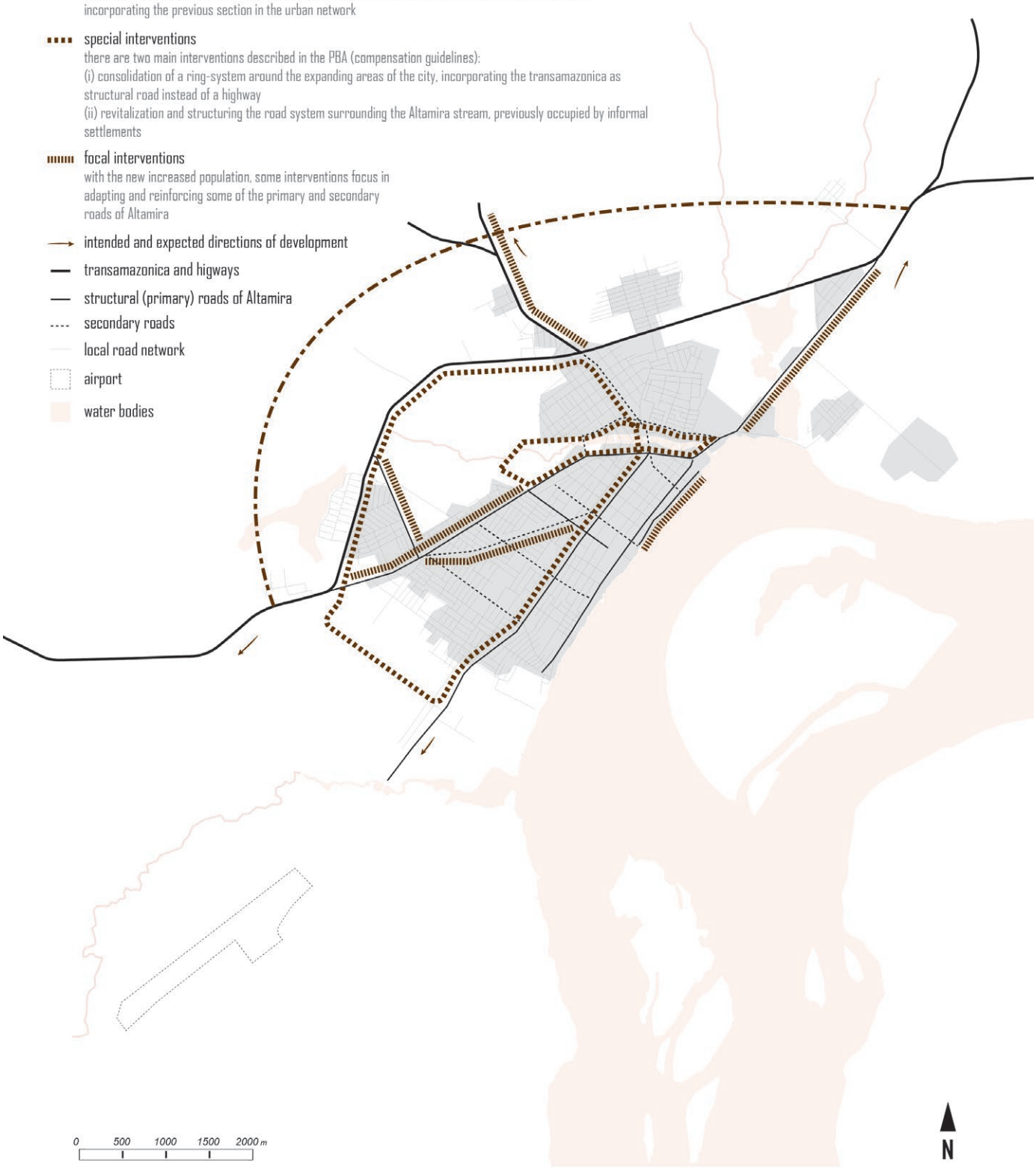


figure 4.18 | **Current road network in Altamira**

Highway and road network connecting the city after the implementation of the dam. In a comparison with the existing plans of the municipality and compensation guidelines, it is possible to notice that many of the proposals were not accomplished. The Transamazonica is still crossing through the city, nowadays being used as an important connecting urban axis. Furthermore, the ring-system around the expanding areas of the city was not consolidated. On the other hand, there was the implementation of several focal interventions, re-organizing the mobility within the central areas of the city.

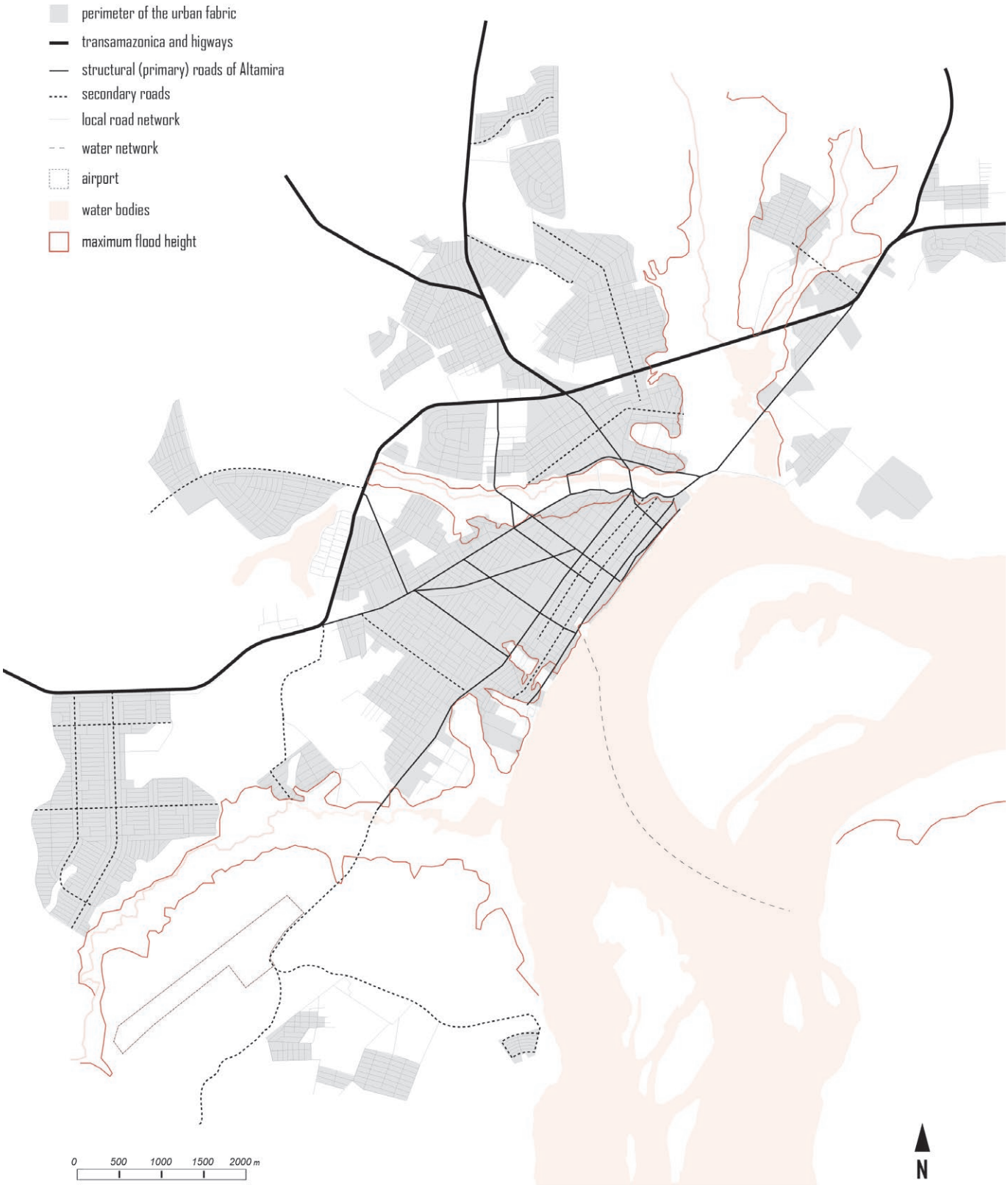


figure 4.19 | **Public transport network**

source: Municipality of Altamira

Public transport in Altamira is composed by 8 micro-bus lines, connecting the distant neighborhoods to the city center. Tickets cost BR$ 3,00 (around 0,75 Euro) per ride. The fleet counts with 10 buses, out of which 8 are constantly operation (1 for each line) and 2 are reserve. The lines started operating recently, during the construction of the dam, as a consequence to the urban sprawl and high demand for a public mobility system. All the lines leave from a central terminal and connect the different residential allotments or resettlement neighborhoods in the outskirts of Altamira.

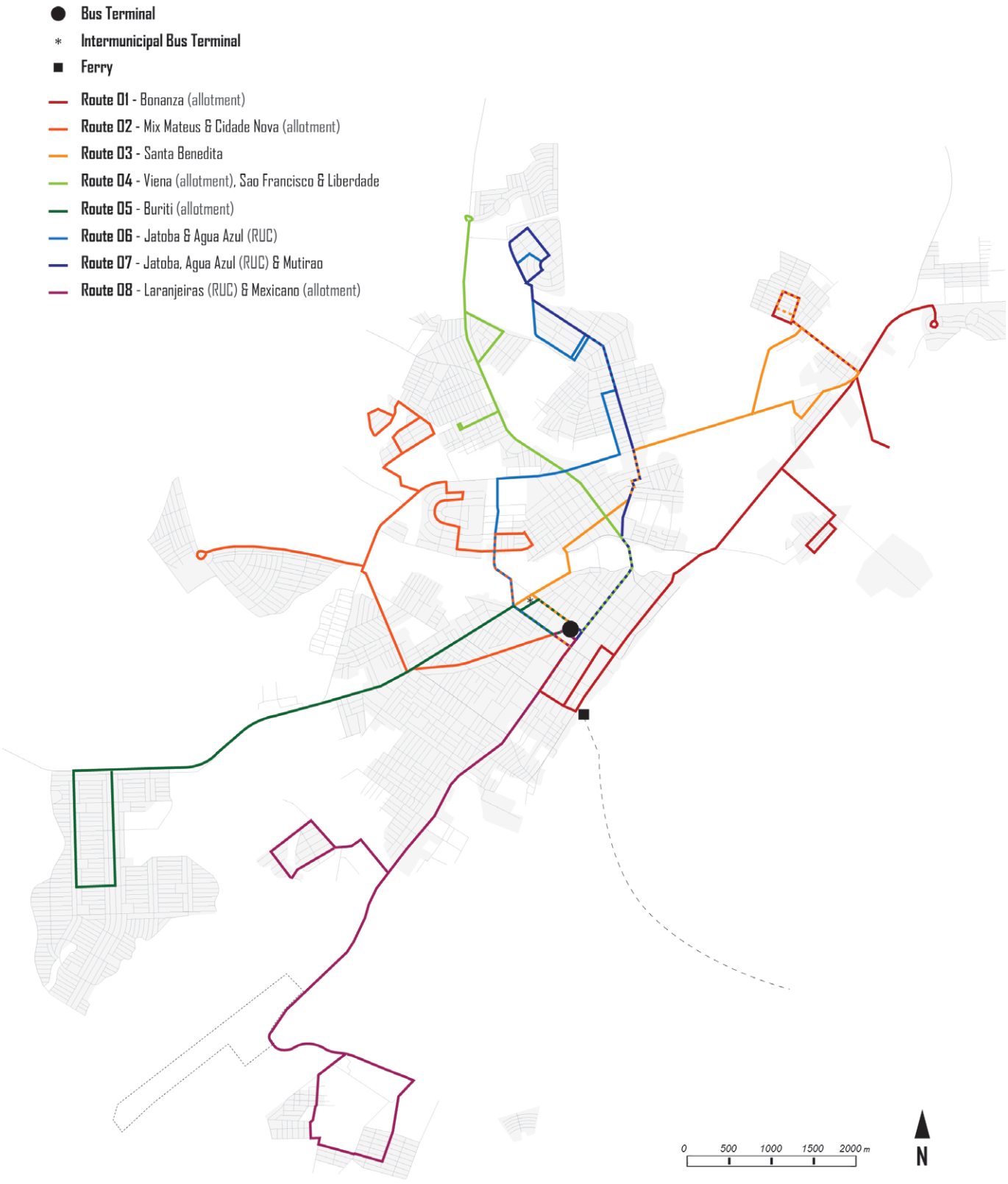


figure 4.20 | **Connectivity**
(space syntax analysis)

Comparative analysis of spatial connectivity of road network in Altamira, before and after the construction of the Belo Monte dam. The methodology adopted is the segment length and connectivity analysis, with considered distances of 200m, 400m, 800m (walking) 1200m, 2000m (cycling) and 5000m (driving) for the software calculations.

Altamira **2008**

In the simulation for the year of 2008, it is possible to identify the roads structuring the traffic in the city, compatible with the model identified in the PBA. A few points were under pressure, specifically surrounding the Altamira stream, due to its centrality and limited crossing options.

Altamira **2017**

In the 2017 simulation, many transformations are visible. The first would be the restructuring of the network inside the old city of Altamira. The system around the Altamira stream was redesigned and a new axis (Av. Irma Clores Mendes Oliveira) was constructed. Another visible transformation is the pressure added to the Transamazonica highway in function of the sprawl of the new residential allotments. Especially in the west section, we see how the highway has become a vital part for the urban connectivity in Altamira.

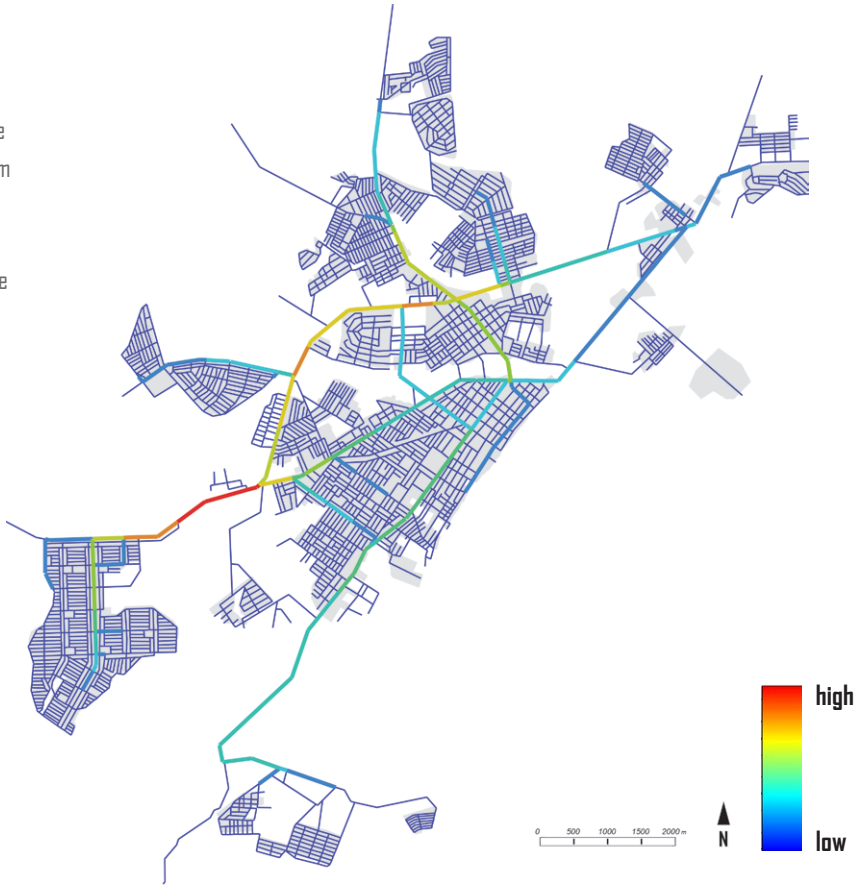


figure 4.21 | **Integration**
(space syntax analysis)

Comparative analysis of spatial connectivity of road network in Altamira, before and after the construction of the Belo Monte dam. The methodology adopted is the segment length and integration analysis, with considered distances of 200m, 400m, 800m (walking) 1200m, 2000m (cycling) and 5000m (driving) for the software calculations.

Altamira **2008**

In the 2008 simulation, we the integration of the road network before the implementation of the Belo Monte dam. The historic center, supported by the diagonal axis of the avenue Jarder Barbalho and highway Ernesto Aciole, is very well articulated in the urban fabric. Still, inside the Transamazonica perimeter, the neighborhood of Brasilia and expanding neighborhoods towards the airport have a lower connectivity. Mutirao and other occupations beyond the main highway were poorly connected to the rest of the network.

Altamira **2017**

In the simulation post- Belo Monte it is possible to notice some improvements in the integration of the tissue within the Transamazonica highway, mainly due the reinforcement and construction of the structuring roads of the city center. However, it becomes quite visible the little integration of the new residential allotments, highlighting their poor accessibility. Furthermore, the map also points out the separation of the resettlement neighborhoods to the central part of Altamira.

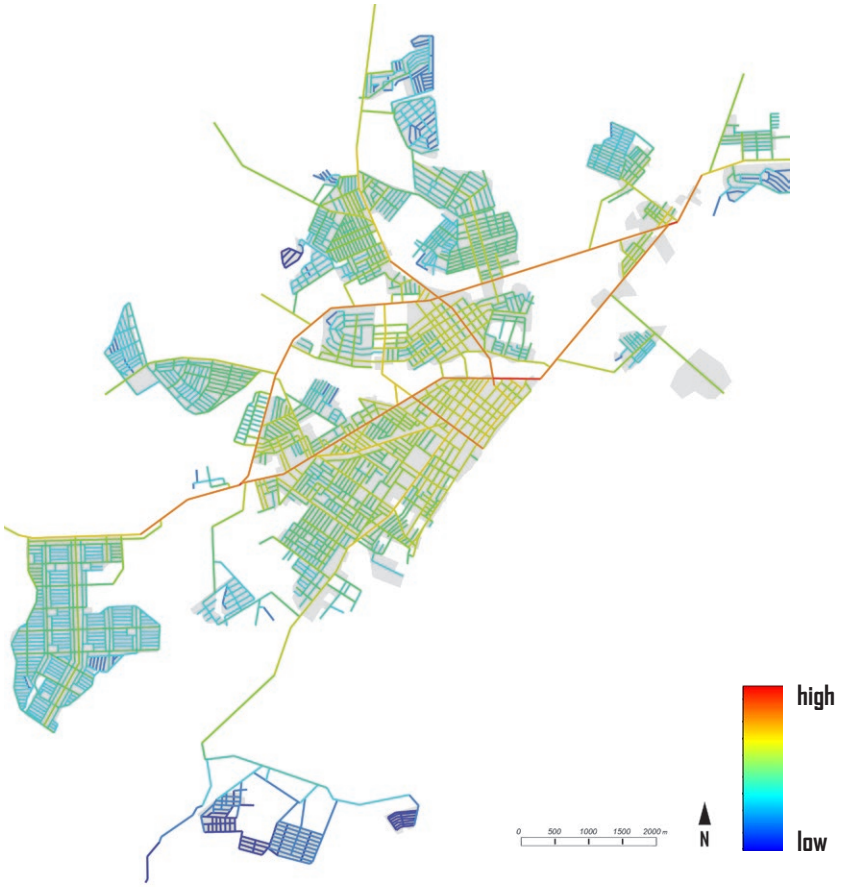


figure 4.22 | **Street typologies**

City center residential typology: The street typology in the central areas of the city is usually on a small scale, focused on the local traffic. As seen in the section below, there is very little potential for densification, considering the narrow profile of the roads. Sidewalks are often small and irregular, making them little accessible. It is often very common to see water accumulation in the streets, due to poor or inexistent drainage systems. But, regardless of the technical challenges, the profile of the streets emphasize the quiet residential environment frequent in Altamira before the construction of the dam. .

sidewalk
0.50 - 0.75 m

road
5.00 - 6.00 m

sidewalk
0.50 - 0.75 m

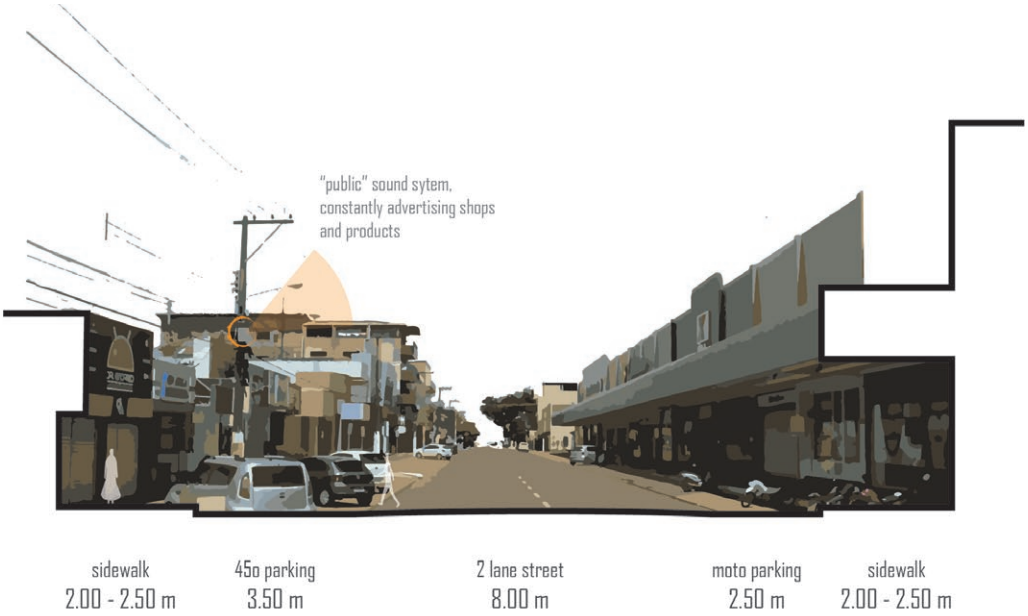
Consolidated urban fabric typology - structural roads: In the structural streets, the road profile is usually wider, in order to accommodate the heavier traffic and public transport (buses). Some of the primary roads in Altamira also have a central garden separating the traffic, as shown in the images below. The sidewalks are again narrow and many times (but not always) irregular. This wide profile and the often low-density occupation in the surroundings could represent an interesting potential for densification of the typologies along those axes.

sidewalk
1.00 - 1.50 m

road
7.00 - 8.00 m

sidewalk
1.00 - 1.50 m

City center commercial typology: The section below displays the profile of one of the main commercial streets in the city, Rua Sete de Abril. Even with the proximity to the residential streets, the character in the commercial roads is completely different. Sidewalks are usually more generous (and accessible), parking is organized between cars and motorcycles and the traffic lanes are wide and comfortable. In the section it is also possible to visualize an eventual potential for densification along these axes of the city, especially considering the single-family and single-story typology of a great part of the buildings.



Typology in resettlement neighborhoods: This street typology was designed for the accommodation of the new resettlement neighborhoods. The roads have almost always two wide lanes, for local traffic and public transportation. The sidewalks were built out of prefabricated concrete slabs as strips next to the asphalt of the roads. The installation was many times challenging due to the high declivity in some of these neighborhoods. This shows a high degree of deterioration and poor maintenance, especially when considering the resettlement neighborhoods were built less than three years ago. Based on the dimensions of the profile the occupation (even though consolidated) could be densified if necessary.

figure 4.23 | **Potential for densification**

Based on the street typology studies, the map shows which roads in Altamira have the capacity for expanding its occupation and density. Even though some occupation typologies would have a high potential for densification, a proper development pattern relies on the density capacity of the existing road network.

Figure 4.24 | **Condition of public spaces**
The sequence of images below points out the degradated condition of public spaces and sidewalks in Altamira, seen in all of the typologies highlighted before.

steps on a sidewalk

public telephone blocking sidewalk in one of the residential streets

waste blocking the narrow sidewalk. poor drainage of the roads

roads and the installation of the sewage system

sidewalks and occupation typologies along the roads

different typologies, with green corridors, in some of the avenues

roads, sidewalks & nature

sidewalk typology and bus stops in the RUCs

water reservoir in the neighborhoods

figure 4.25 | **Parks & public space**

One of the frequent comment made by experts during the site visit in Altamira is that the city lacks public spaces. The map in the following page supports this argument, by displaying all parks and squares in Altamira, clearly concentrated in the margins of the river, within the historical city center. The map also shows how the new residential allotments do not have any type of planned or designed public space. In the resettlement neighborhoods small squares were planned for the local population. Below, the images illustrate the typology of some of the public spaces encountered in the city. It shows the, with an exception of the riverfront and a few specific squares, parks are not thoroughly designed and seen as quality public space.

1. Xingu riverfront promenade & beach

Revitalized during the construction of the dam, main public space and use of the city.

2. Altamira stream park

Constructed along the Altamira stream, previously occupied by informal settlements. Some housing units were (outside flooding areas) were left inside the park.

3. Ambe stream park

Similar to the Altamira stream park, the Ambe park was built in an area previously occupied by informal settlements.

4. Panelas flooded areas

Still, within the consolidated urban fabric of Altamira, some lower areas had to be evicted with the construction of the dam. The picture shows one of them, still unoccupied and not being yet used.

Figure 4.26 | **Parks & recreation**

The infrastructure of public spaces in the city of Altamira. Map below shows the locations and walkable distances to the parks and squares of the city.

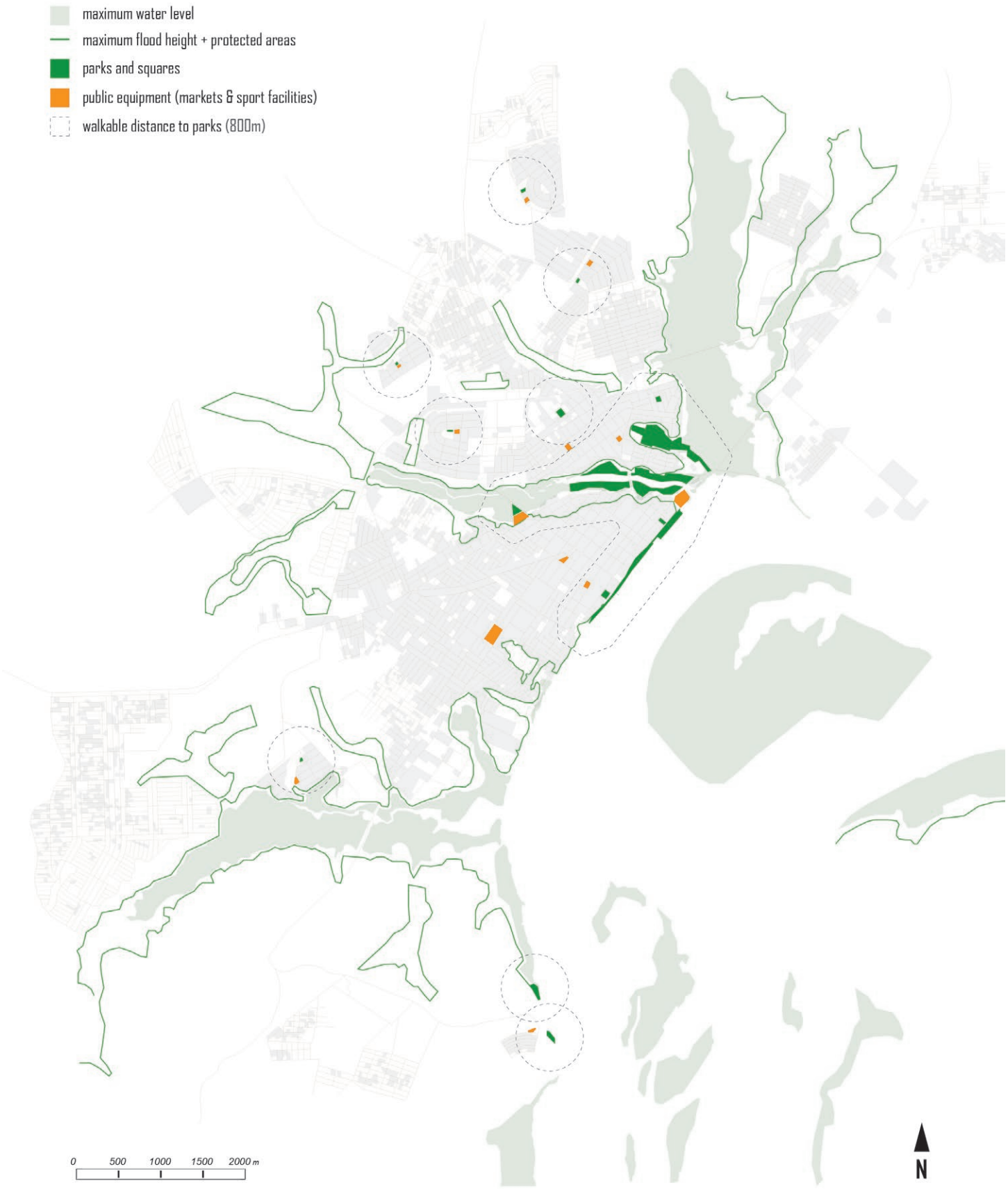


figure 4.27 | **Schools & Education** (after Belo Monte)

source: EIA Belo Monte & escolas.inf.br/pa/altamira

Location of schools and universities after the implementation of the Belo Monte dam. Map also shows the distances to primary, secondary and high-schools in the city, assuming walkable and cyclable distances.

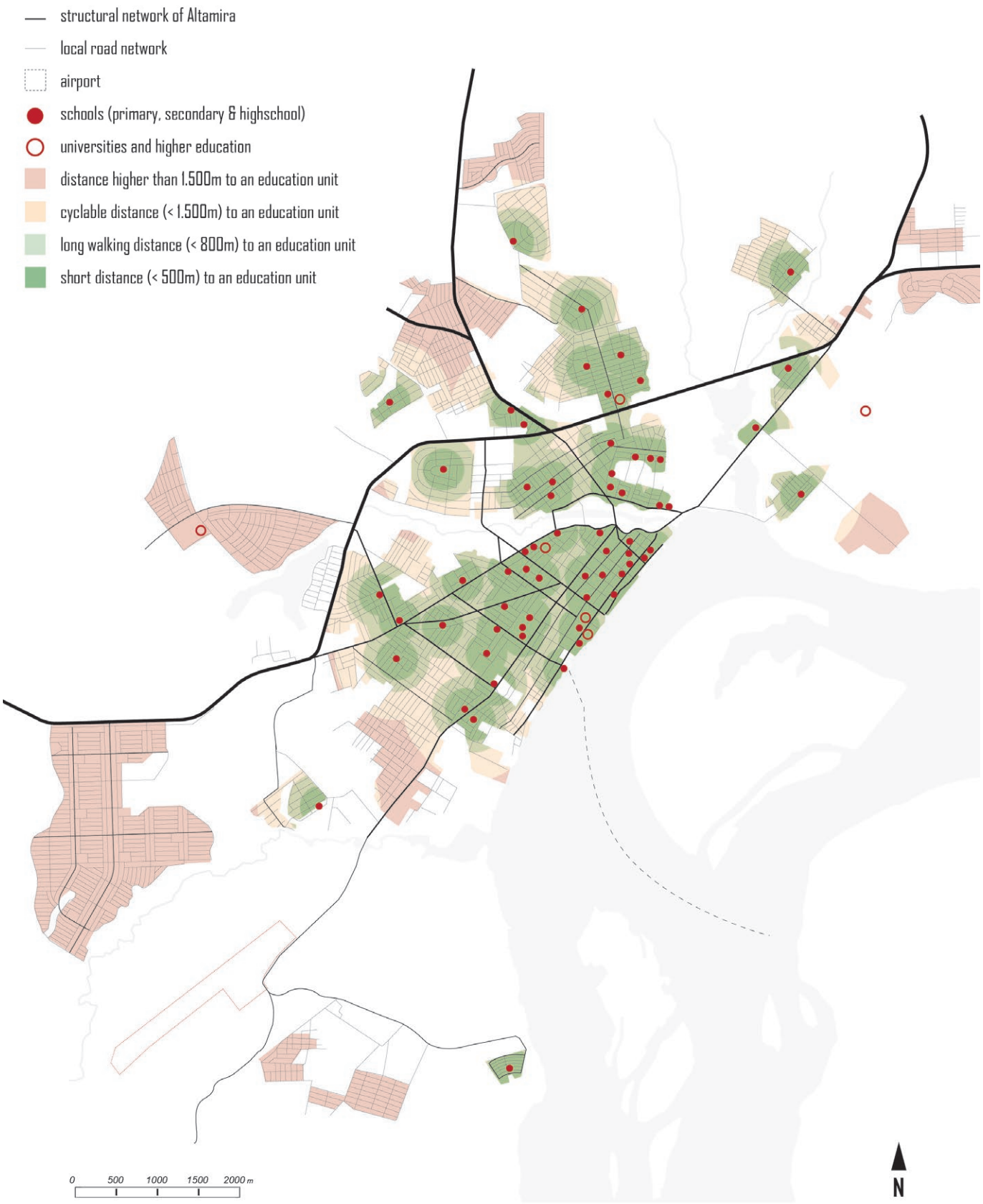


figure 4.28 | **Accessibility and availability of public health equipments** (after Belo Monte)

source: EIA Belo Monte

Location of hospitals and health-care units in Altamira. Accessibility measured by estimated traveling time both by car and walking. The trip was calculated based on average speed and the distances are estimations based on a crow flies simulation.

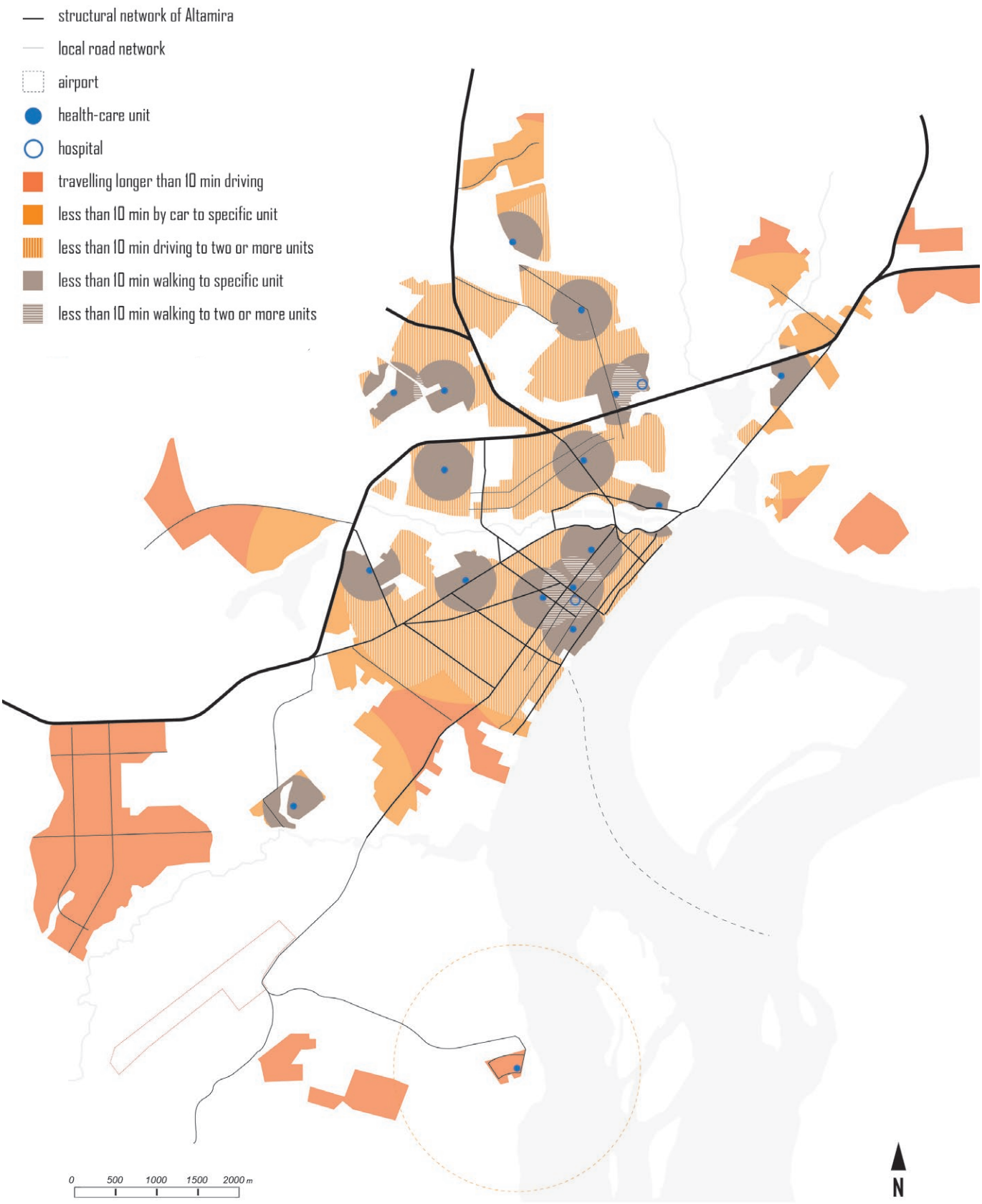
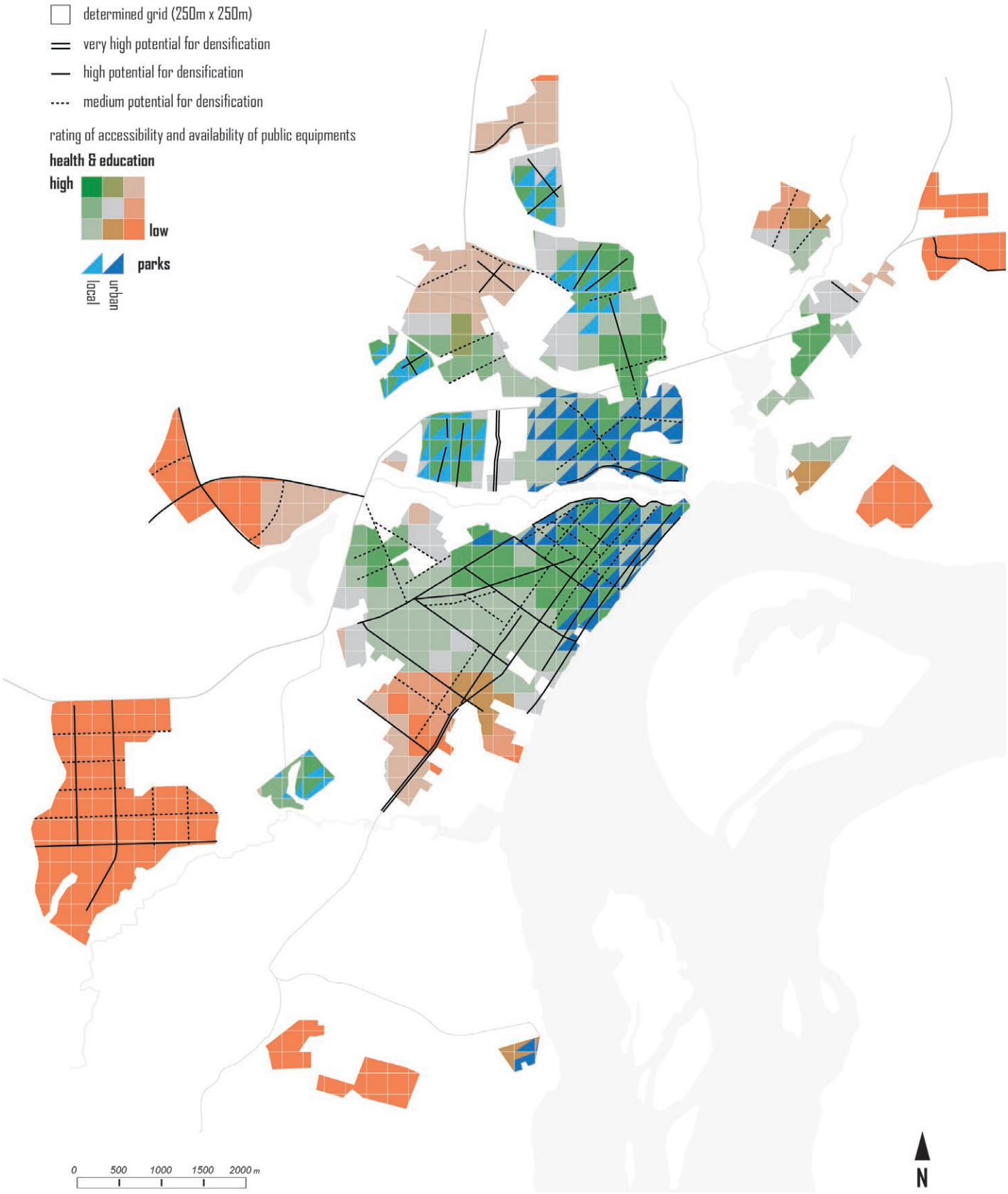


figure 4.29 | **Accessibility and potential for development in Altamira**

Based on the walking and cycling distances to public equipment, the following exercise adopted a grid (250m x 250m) to evaluate accessibility ratings in different parts of Altamira. Dark green squares represent sections with consolidated health and education infrastructure. Orange indicates the weak and fragile sections. Overlapped with the map is the identified axis with potential for development, highlighting the best-integrated options.



As seen in the spatial and scenario analysis, the city of Altamira is highly challenged by the provision of proper public infrastructure. The current situation shows a very concentric system, meaning that existing equipment is mainly located in the central areas of the city while the accessibility in the outskirts becomes limited. An exception is found in the new resettlement neighborhoods designed and constructed with the provision of education, health and leisure equipment. However, considering their distance to central Altamira, there is little integration to the urban fabric, compromising mobility and accessibility in these neighborhoods. It is also important to highlight here that the analysis investigated the provision of equipment in a spatial perspective by looking into locations and distances. This exercise does not take into account the quality or efficiency of the institutions.

In an overview, the new residential allotments are again showing to be problematic for the urban tissue, disconnected from the existing public equipment and systems. The accessibility map highlights how the outer-ring of the city have little proximity to- and availability of health, education and leisure facilities. Furthermore, by looking back into the space syntax simulations, it becomes evident the lack of integration the allotments have within the entire fabric of Altamira and how much the transport system relies in the Transamazonica highway as an "urban avenue". Such a peripheral growth demands extensive provision of new mobility infrastructure and public amenities, besides the maintenance of the existing systems. An example emphasizing the challenge can be seen in the bus lines developed after the construction of the dam, where a new system had to be created so that the sprawled neighborhoods could be connected to central Altamira, in a concentric model, rather than creating a proper network of public transportation. This fact also points out the lack of long-term planning strategies in Altamira, where the provision of solutions are usually executed according to the appearance of new problems and issues, rather than being constructed towards the consolidation of an integrated vision. Based on the spatial analysis it is possible to note that, even with the definition of a masterplan in the year of 2010, the growth of the city has been completely apart from the guidelines established, especially since the start of the erection of the Belo Monte dam one year after. This fact confirms the little sensibility the plan had towards the new dynamic promoted by the hydroelectric power plant and the inefficiency of public management to ensure a proper execution of the main guidelines designed.

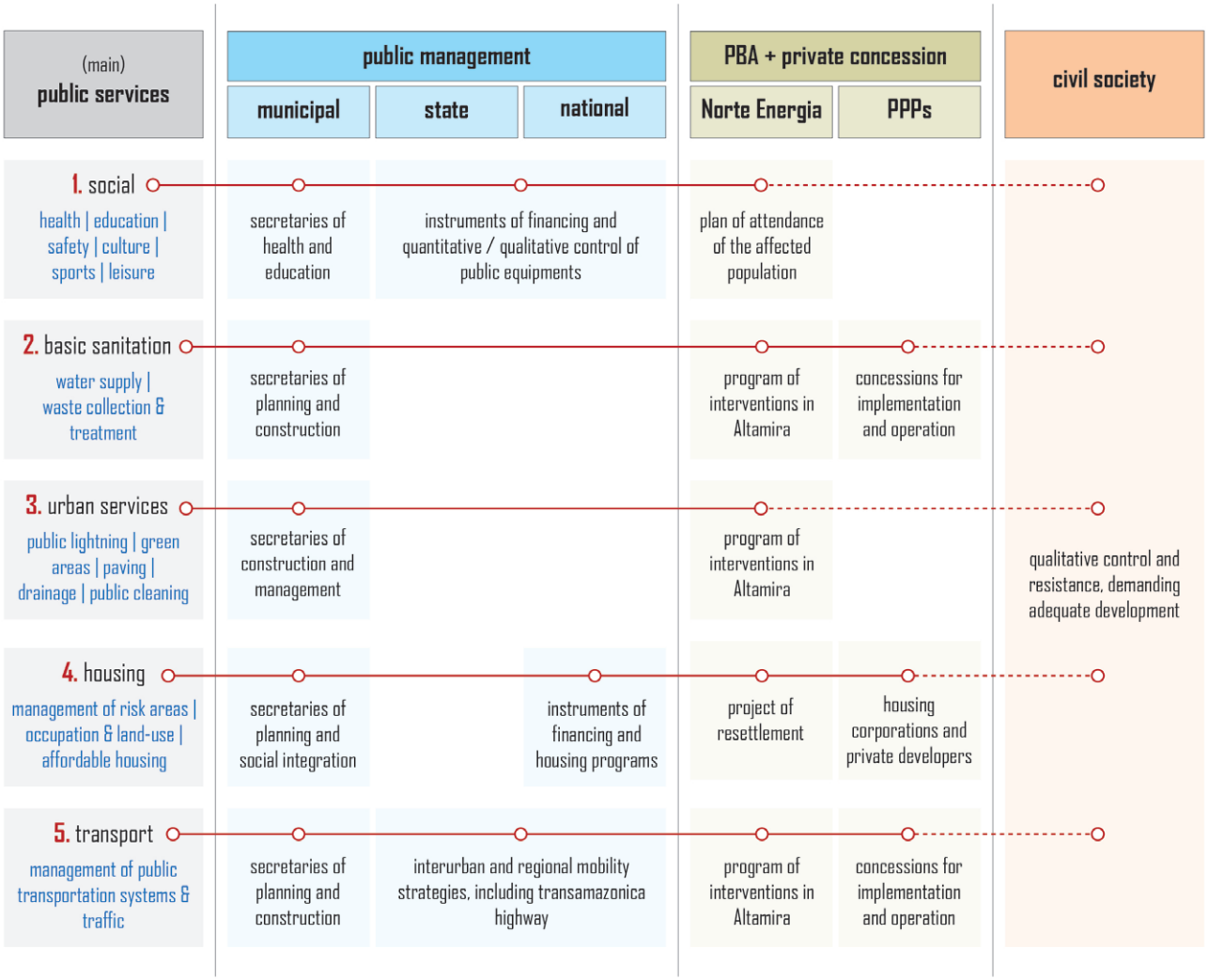
"Is the current dynamic of development, promoted by the construction of the Belo Monte dam and mitigation guidelines, resulting in a resilient model for Altamira, capable of promoting sustainable development?"

By looking back into the first part of the research question of this graduation thesis some conclusions can already be drawn. But before providing an answer to the question, it is important to understand the scope of the "dynamic of development" mentioned which, rather than looking solely into the programs of the PBA, lead to an investigation of the socio-spatial transformations of the city as a whole and the influence the compensation guidelines had in the process. In this regard, the growth, the expansion and every transformation in the urban fabric of Altamira after the beginning of the construction phase can be associated with the implementation of the dam. With this in mind, and based on the spatial analysis of the population, public resources and health & education key factors, it is possible to affirm the city has been through a not-sustainable sprawling process, where several new residential neighborhoods where created in the outskirts of the city with little density and without the provision of proper mobility infrastructure and public amenities. This development also resulted in a little-integrated model, in which the new neighborhoods, including some of the resettlement ones constructed by Norte Energia, are not very accessible.

The model created by the compensation and mitigation guidelines has promoted many improvements to the infrastructure in the city of Altamira which would not be possible without the investments and efforts coming from the dam. However, the intensity of the transformations and the resulting unplanned growth show the lack of resilience of the model, unable to accommodate the new development dynamic within the city's masterplan and PBA guidelines. This does not necessarily mean that the projects were poorly designed, but there is clearly a lack of sensibility of the new dynamic of the city and on the governance structures and challenges of implementing such large-scale programs.

figure 4.30 | **Governance & public management**

Diagram showing the main public services (according to the EIA Belo Monte) and the implementation and management structures for each of them. Public management is divided into three scales, national, state and municipal; private concessions involve the implementation of the compensation and mitigation guidelines by Norte Energia and possible future concessions; and civil society represents groups and NGO's supporting or protesting against the dam.

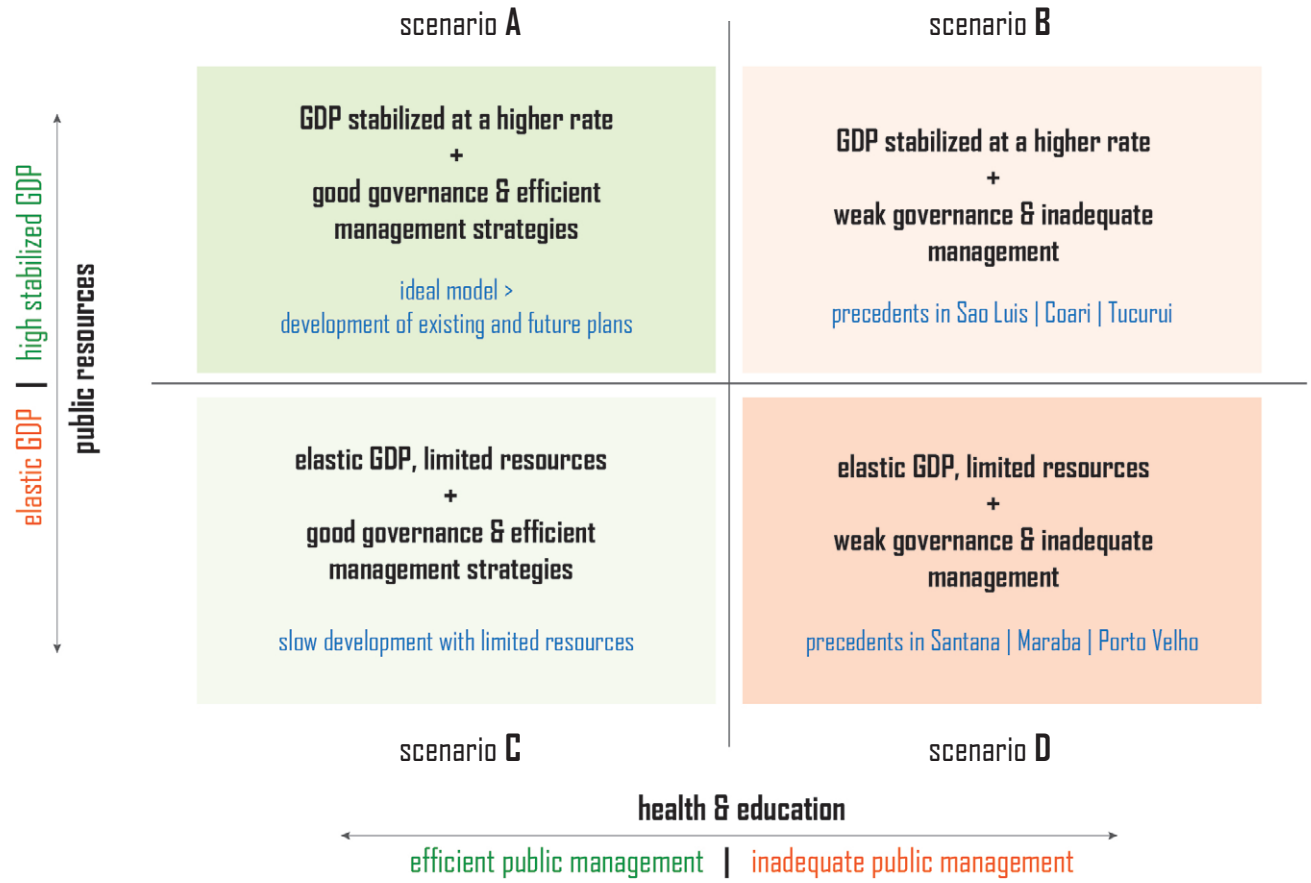


One of the main discussions currently surrounding the implementation of the guidelines is concerning the maintenance of the projects and programs constructed. The diagram above organizes which were the programs intended to mitigate impacts on the public services, under the responsibility of Norte Energia, and which are the governance structures responsible for development and maintenance of the new equipment and infrastructure. It is also interesting to mention the role civil society have within the public management structure, supporting and/or opposing every decision and project execution, demanding further development of the plans with the intent to ensure the just compensations and improvements in the quality of life of different groups of Altamira.

The PBA guidelines also include a program entitled "Program of Institutional Articulation", aiming to prepare the public management structures to the new challenges associated with the implementation of the dam. One of the conclusions of the EIA Belo Monte points out to the little preparation affected municipalities have to accommodate the new population flows, assuming they are lacking infrastructure, housing programs, and public services, and are unable to develop adequate urban planning strategies and tools.

figure 4.31 | **Definition of scenarios for the 'public resources' and 'health & education' key factors**

According to the key factors and scenario criteria identified in the precedent studies, different scenarios envisioning future development of Altamira could be defined. As mentioned before, the criteria combine possible outcomes of two different key factors: public resources, including infrastructure and income; and health & education, meaning public equipment and management. The definition of four different scenarios is described in the table below:



The resulting scenario criteria is a combination of outcomes seen in the precedent studies, in orange, and possible (ideal) futures assuming proper and efficient public management in Altamira. The distinction between precedent and ideal takes place because none of the ten cities investigated in the key factor analysis showed significant improvements in the health and education indicators after the implementation of big infrastructure projects. This shows that, even with an increased GDP per capita in some of the cases, public management was unable to design or operate efficient programs and policies able to promote long-lasting improvements of the public equipment systems.

This difference also highlights one of the main challenges for planning in the region. As José Miranda Neto mentioned during an interview in Altamira, many studies and plans were designed for the city and, although beautiful, they all lack the sensibility of what the local population needs and what are the governance processes. José pointed out the city's masterplan as an example which, as seen in the spatial analysis, was unable to shape the development of the city. Many of the major transformations seen in the urban fabric were not predicted or determined by neither of the masterplan or the compensation guidelines, emphasizing the fragility of such planning tools might have.

By looking into these probable outcomes the challenge of future maintenance of the projects accomplished can again be questioned. Even with all the unplanned development of the urban fabric, the PBA still ensured the construction of vast infrastructure networks for Altamira, which will demand constant maintenance in order to operate properly. Assuming the inadequate public management seen in the precedent studies, a successful strategic plan would require other tools rather than masterplanning solely operated by public management to ensure proper use of what was built and the consolidation of a legacy for Altamira.

Scenarios for the 'public resources' and 'health & education' key factors

The definition of possible and probable scenarios and their respective spatial transformations are explored in this section through the selected precedent cities. Following the criteria established by combining both of the key factors, the exercise looks into the streetscape of some of the studied sites aiming to define a plausible narrative and framework for Altamira. However, since the analysis relies on case studies, the spatial configuration is only explored in the scenarios B and D, assuming all precedent cities were identified according to them. Scenarios A and C represent an ideal outcome of the health & education indicators, fact that has not been seen in any of the 10 cities. A spatial framework for such outcomes would be a faithful realization of the design of a vision and/or a masterplan, considering an efficient management of the available resources and programs.

The categorization of the sites was made according to the variations of the IFDM Firjan Indexes in the categories Health & Education. The conclusions can be supported by looking into the REM-F (Folha) index and ranking, measuring the efficiency of public management by combining tax income with indicators of health, education and waste management. However, by looking into a second ranking, called IFGF Firjan, evaluating the administration of tax income by local governments, some contrast becomes visible. In the Firjan index, of the years 2012 and 2014, municipal administration of the 10 sites was often ranked as excellent. This difference is related to the different criteria and methodologies of the indexes, having the first one comparing resources with socio-economic variations while the second focuses mainly in the management of the resources. The difference points out to the fact that in most of the cities the resources are in fact being invested into public infrastructure and equipments, however, the strategies and programs have not been successful in improving the quality of public systems and thus improving quality of life of the local population.

City	REM-Folha 2014				IFGF 2012	
	Index	General Ranking (5,281 municipalities)	Tax Income	National Tax Average	Index	Ranking (5,220 municipalities)
Sao Luis	0.457	48.3%	0.124	0.166	0.5419	42.4%
Maraba	0.237	99.1%	0.131		0.7219	5.6%
Santana	0.348	88.2%	0.046		0.6182	22.8%
Tucurui	0.371	82.8%	0.142		0.3825	81.2%
Parauapebas	0.284	96.7%	0.490		0.7553	3.2%
Coari	0.247	98.8%	0.215		0.5058	51.5%
Ourilandia do Norte	0.303	95.0%	0.156		0.8381	0.6%
Canaa dos Carajas	0.343	89.1%	0.414		0.4388	68.9%
Porto Velho	0.347	88.2%	0.128		0.8126	1.1%
Altamira	0.307	94.5%	0.123		-	-

Legend REM-Folha				Legend IFGF		
Index		Ranking	Tax Income	Index		Ranking
Inefficient	0.108 - 0.395	Worst 25%	Below national average	Critical Management	< 0.400	Worst 25%
Little Efficiency	0.396 - 0.453	50% - 75%	Within national average	Challenged Management	0.400 - 0.600	50% - 75%
Some Efficiency	0.454 - 0.499	25% - 50%		Good Management	0.600 - 0.800	25% - 50%
Efficient	0.500 - 6.656	Best 25%	Above national average	Excellent	> 0.800	Best 25%

Scenario B

INCREASED public resources + INADEQUATE application of resources and/or INEFFICIENT management

Coari | Tucurui | Parauapebas | Canaã dos Carajas

The cities of Coari, Tucurui, Parauapebas and Canaa dos Carajas can be used as examples of a scenario where the income of public resources has significantly increased, above state and national averages, while socio-economic indicators have shown little or no improvement in the past years. Out of the four cities, the Firjan Index shows Tucurui and Coari with critical management of tax income, justifying the inexistent improvement of infrastructure. In Parauapebas and Canaa dos Carajas, on the other hand, the tax income has grown to be much higher than national average with the IFDM index ranking them as "good management". Still, socio-economic indicators show little improvement, especially in the Health & Education key factor. This fact might be explained by the fast urbanization rate taking place in both cities and by the lack of sensible and efficient planning tools.

Scenario D

LIMITED public resources + INADEQUATE application of resources and/or INEFFICIENT management

Santana | Maraba | Porto Velho

In the cities of Santana, Maraba and Porto Velho, figures are showing a little variation of tax income, beneath the national average. The lack of resources combined with an inadequate application of the resources can be seen spatially in the images of the matrix, especially in the inner - and outer- rings, where poorly maintained roads, improper sidewalks, lack of drainage systems and waste are commonly visible.

figure 4.32 | **Matrix of spatial framework,** according to precedent studies
source: Google Street View

figure 4.33 | **Integration, network & infrastructure**

By looking into the scenario simulation exercise it becomes clear that the projects predicted in the masterplan have become obsolete, for two main reasons. Firstly, the projects were design prior to the construction of the dam, envisioning a different expansion of the urban fabric. The current extension of the city goes beyond what was predicted, as shown in the previous section of this thesis. Having said so, the interventions were expected to integrate the central part of Altamira, within the Transamazonica highway. The consolidation of such projects (deviation of Transamazonica highway and urban ring-road) wouldn't have much effect in the new and expanding urban fabric since they were designed for a different purpose. Furthermore, the trajectory for a possible deviation would be more complicated nowadays, assuming the development of residential neighborhoods throughout the initial route. A second reason for discarding the interventions predicted in the masterplan would be the feasibility for consolidating projects of big magnitude. As seen in the future extrapolations, supported by the precedent studies, in only one of the (ideal) outcomes the realization of the deviation of the Transamazonica highway would become a reality.

With this in mind, and understanding some of the challenges of public infrastructure systems in Altamira, a few principles were designed aiming for improvements in the integration and accessibility of the existing network. The following guidelines are a series of smaller projects, allowing for phasing and their feasibility in different scenarios outcomes. The interventions were divided into three categories:

(1) **Transamazonica interventions**, aiming to relieve traffic pressure from the highway by organizing the main connections and removing secondary crossings, preventing the transformation of the highway into an "urban avenue". Roundabouts are introduced in the intersections with most intensity, improving traffic flow and helping to prevent accidents. Marginal roads are proposed as a solution for bottlenecks, in the sections were the Transamazonica has become the only option connecting the expanding tissue to the central city;

(2) **Accessible waterfront**, creating a new system of avenues in the riverfront of the city, stimulating a new hierarchy in the road network, independent from the Transamazonica highway. The design also intends to stimulate the public use of the waterfront, preventing private occupation of the margins as it is currently happening. The introduction a waterfront road network could also reinforce the definition of boundaries for the protected areas, aiding in the control for irregular occupation. Furthermore, this system proposes to connect the different parks and green areas of the city, promoting the use of- and creation of new leisure spaces;

(3) and **connected city**, aiming to improve the integration of the expanding fabric into the city. By looking into little-integrated neighborhoods, the strategy focuses on improving the network by introducing new connections and extensions of existing roads. The objective is to create new axis in the urban fabric by investigating new articulations within the existing road infrastructure. Furthermore, cycling lanes are used as alternative networks for further connecting different neighborhoods in Altamira. The trajectory was chosen based on envisioned routes, the potential for implementation of bike infrastructure, and declivity.

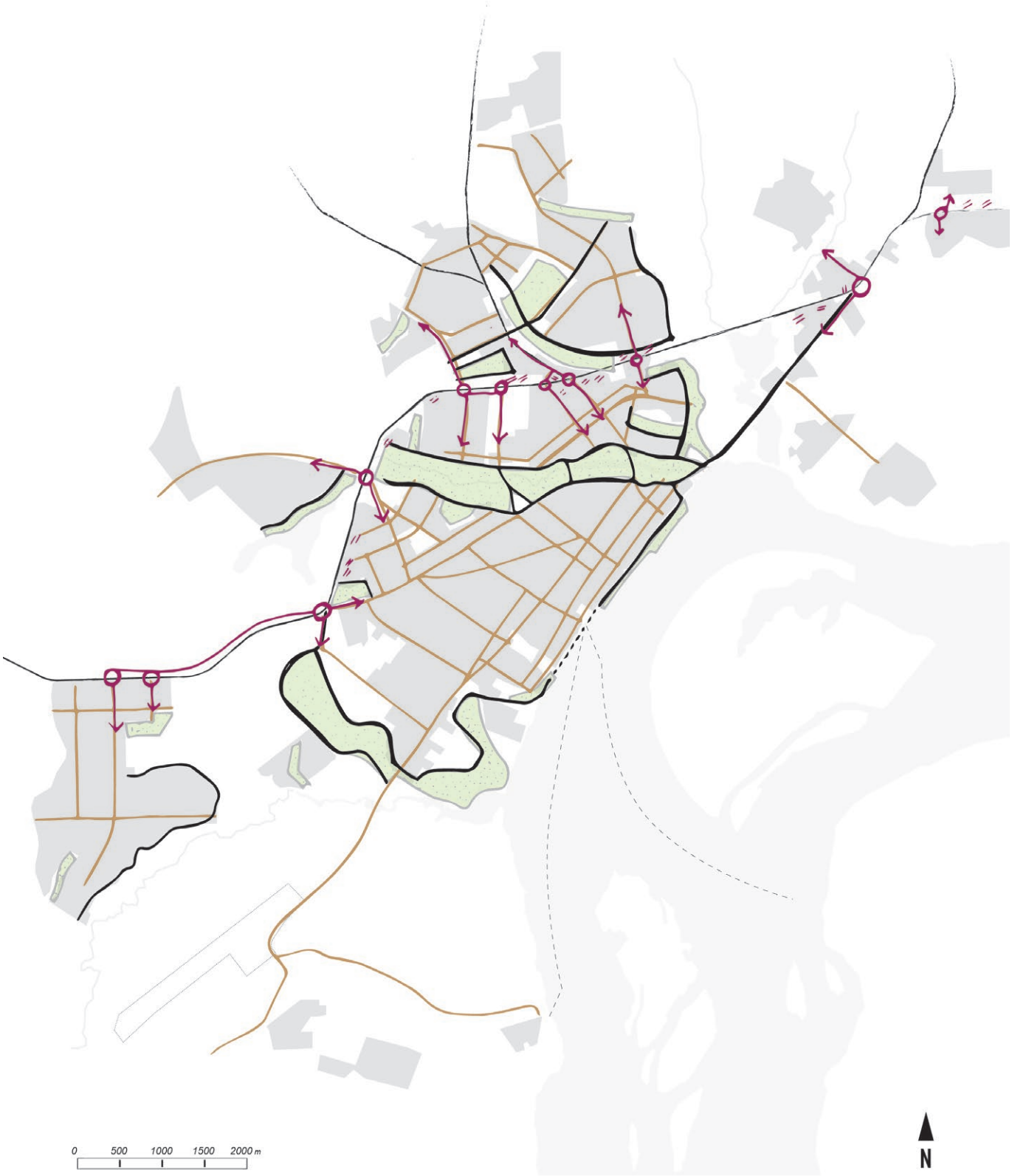
The maps in the following page show the guidelines of each of the categories and their respective space syntax simulation, individually. This was done in order to evaluate the efficiency and impact each of the designs might have in the integration of the urban fabric, aiding in future determinations of key projects and phasing strategy. Besides the integration guidelines, future strategies should aim for a better accessibility of the public services throughout the urban tissue, including the new neighborhoods. Future development should include the provision of further schools and health units, especially in the outer-ring of Altamira, currently lacking all types of equipment.

(1) transamazonica interventions

(2) accessible waterfront

(3) connected city

figure 4.34 | DESIGN PRINCIPLES FOR PUBLIC RESOOURCES + HEALTH & EDUCATION



Guidelines and principles for the development of infrastructure in Altamira. The conception discards a possible deviation of the Transamazonica highway, assuming its consolidation would only be feasible in a specific positive scenario. The map below shows the space syntax simulation of the integration of the urban fabric after the implementation of the design guidelines. The expanding neighborhoods in the inner ring and resettlement neighborhoods were prioritized, considering the higher occupation density (and potential) and existing public equipments. The integration of residential allotments in the outer ring becomes more challenging due to the magnitude of infrastructure required for doing so. In this regard, the aim was to improve connectivity, relieving the transamazonica highway from local traffic.

high integration

little integration

perimeter of the urban fabric

transamazonica and higways

proposed waterfront road network

private occupation hampering waterfront accessibility

delimitation of parks and preserved areas

roundabouts and primary connections across the transamazonica highway

interruption of secondary connections to the transamazonica

new and reinforced axis for connected city

4.3 JOBS AND INCOME

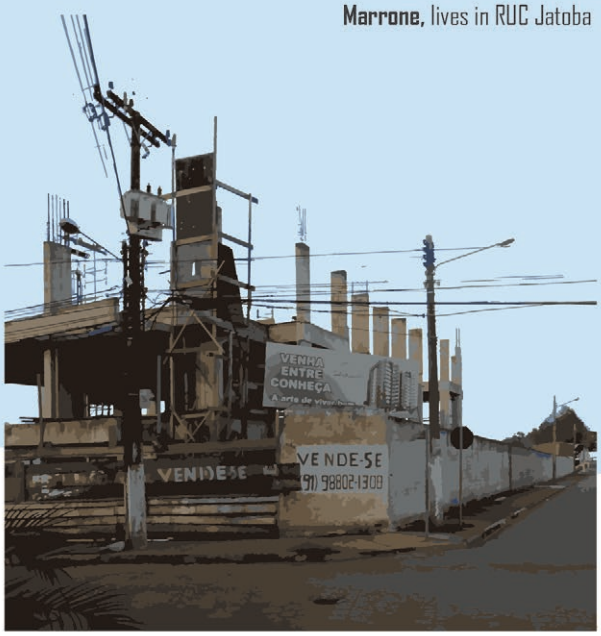
Another framework influenced by the construction of big infrastructure is defined by possible variations in the economic activities and job market of a city. In Altamira, since the beginning of the implementation phase, there was a drastic increase in the IFDM index, leading the city to reach the top of the national ranking in the year of 2014, in the category jobs & income (figure 3.19, page 40). And even though the index values are currently declining, mainly due to the decrease in the amount of manpower required in the construction site, such a prosper period might be able to stimulate the attraction to- and creation of new industries and businesses in the region and thus to promote the creation of additional jobs. But according to the surveys conducted with the local population during the site visit, the improvements consequent of the Belo Monte dam, even though prosperous, where only temporary. Amongst several complaints, the recurrent topics were the increasing unemployment rate; the high cost of living; a real estate speculation, leading to the inflation of housing prices in Altamira.

The following section investigates the spatial transformations seen from the perspective of the jobs & income key factor. Within the scope of the topic are the development of economic activities according to each sector, the influence of the construction of the dam in the local job market and the impacts the implementation of Belo Monte had in the land use organization of Altamira. Once again, the spatial analysis compares the spatial characteristics of the city before and after the erection of the hydroelectric plant. For the land use analysis, the current typologies and their distribution along the urban fabric are compared with the zoning plans defined by the masterplan of the city, in 2010. Possible future outcomes are then investigated according to the precedent cities.

"The project has brought a lot of business. Belo Monte was good for those who knew how to explore it"
Ocirlene, lives in RUC Sao Joaquim

... Belo Monte has affected the city by the amount of job opportunities generated ...
Miqueias, professor at UFPA

"It is hard to find jobs! City lacks in investments"
Marrone, lives in RUC Jatoba



... there were a lot of jobs, but during the construction phase ...
Danilo, works in the city center

Employed population and average income, during the construction of the dam

The following graphs show variations in the average monthly income and in the total number of employed population, between 2006 and 2015. The graphs are also comparing the values of Altamira with the Tucurui (energy landscape) and Parauapebas (resource extraction) case studies. Regarding incomes, the graph shows the increase from an average of 2.0 minimum salaries in 2010 to a peak of 3.5 in 2012, influenced by the jobs related to the Belo Monte dam. On the other hand, one complaint often heard in Altamira is concerning the increase in the costs of living and rents in the city since 2010.

Regarding the total employed population, the graph shows a drastic increase from around 10.000 jobs in 2010 to over 45.000 jobs in 2014. This variation is clearly influenced by the Belo Monte project and the 25.000 direct jobs associated with its construction. However, as it is expected in big infrastructure projects, the graph also shows a fast decrease in employees since 2014, towards the final phase of the construction process. And this decrease is felt by the local population, which often criticizes the growing unemployment rate.

figure 4.35 | **Average monthly income** (x min. salary)
source: IBGE. Censos Demografico. Trabalho e Renda. 2010

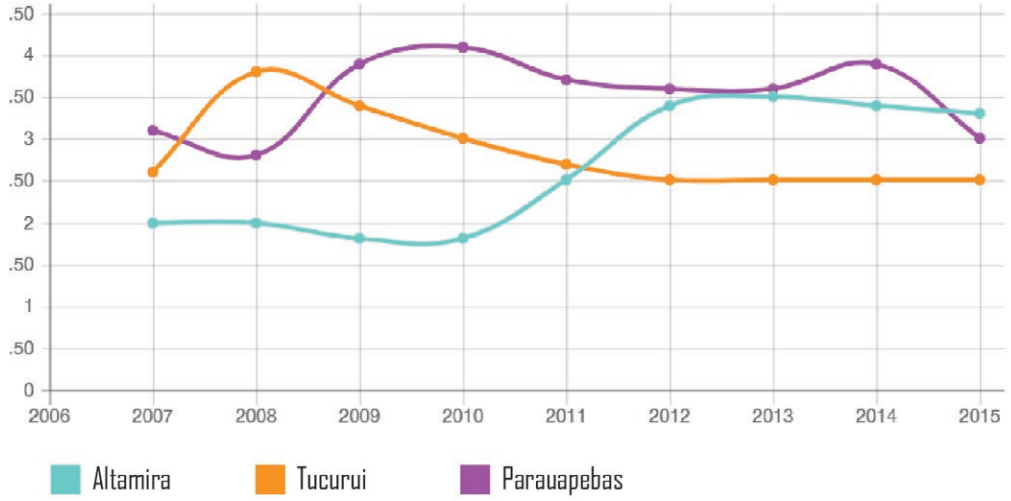


figure 4.36 | **Total employed population** (with income)
source: IBGE. Censos Demografico. Trabalho e Renda. 2010

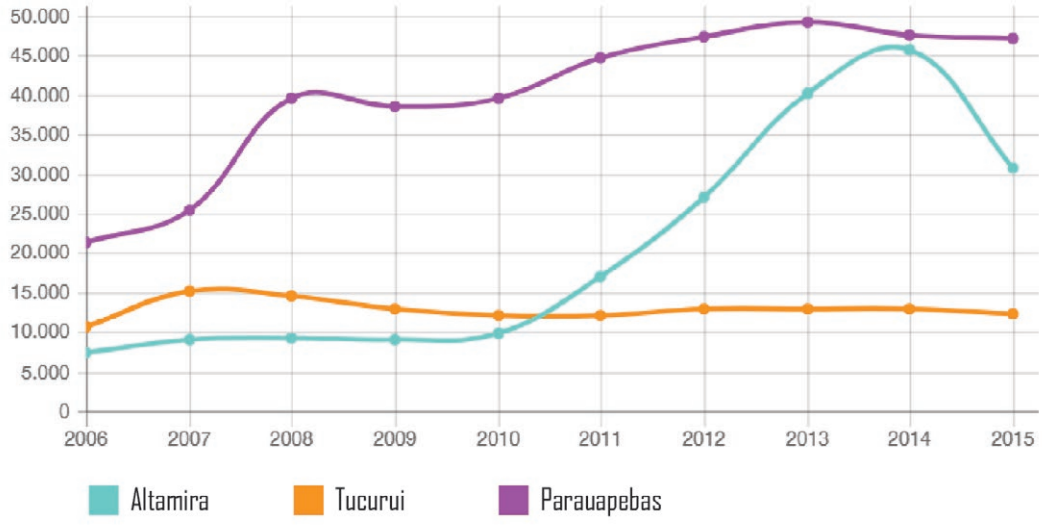
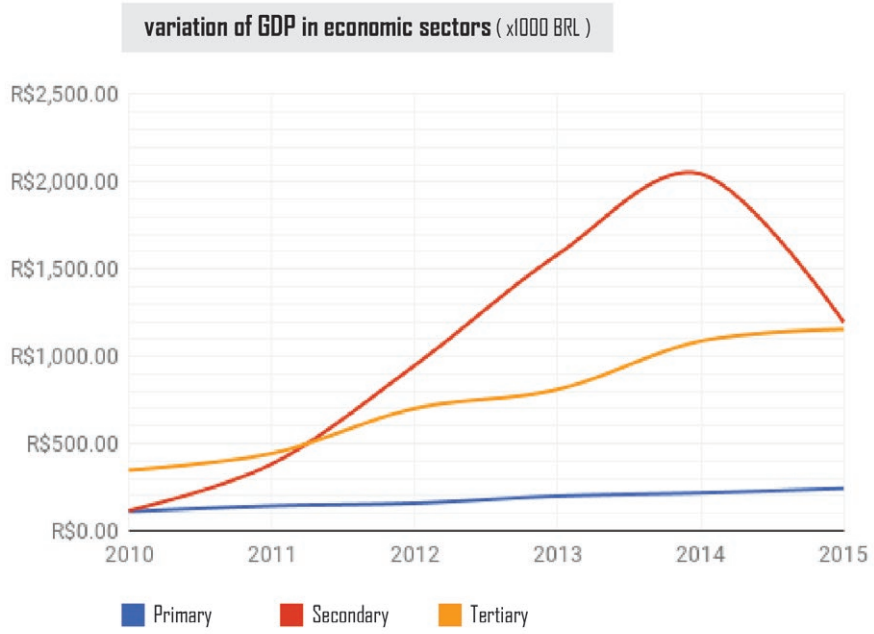


figure 4.37 | **Economic activities in Altamira**

source: IBGE. Censos Demografico. Trabalho e Renda. 2010

The graph below shows the variation of the gross domestic product according to different economic sectors in Altamira. Historically, the main economic activities in the region were associated with the primary sector and with a few industries working with the processing of raw materials (ELETROBRAS, 2010). As shown in the graph, there is an enormous variation of the values between 2010 and 2015, especially in the secondary and tertiary sectors. This variation can be directly associated with the conception of the dam and the magnitude of its construction site (and contracts associated to it). The influence of Belo Monte is seen mainly in the secondary sector, including civil construction, with an intensive growth peaking in 2014. This relationship is also highlighted with the decline seen after 2014 when the construction started to reach its final phase. The tertiary sector also shows a significant growth, but rather constant, associated with the big infrastructure project, increase in population figures and urban growth. The primary sector, on the other hand, has had a slow and steady growth during the five years shown in the graph.



Primary sector

Mainly livestock and agriculture, developed after the opening of the Transamazonica highway. The region is the main big producer of cacao and coffee of the state. Large areas occupied by woods and forest, being used for both low impact (vegetal extractivism) and high impact (lumber extraction) activities (Altamira, 2010).

Secondary sector

According to the city's masterplan, in 2010 the main activities of the secondary sector were associated to extractivism and food processing. A significant amount of companies were also related to wood and mineral extraction, including furniture makers, sawmills, and wooden miter manufacturers. But, as shown in the graph above, there has been a radical transformation in this sector, because of the implementation of the Belo Monte project. Activities related to civil construction were developed in function of the construction of the dam, the execution of the PBA guidelines and the expansion of the city, making the economic sector the largest source of income in the municipal GDP.

Tertiary sector

Mainly retail and food services, such as restaurants, pensions, bars and small hotels. A rapid transformation is also visible after the implementation of the big infrastructure and the increase of population, rising the demand of several activities of the tertiary sector. This category also includes services associated with the extractive industry, equipment and repair for agriculture, and tourism, still on a small scale.

figure 4.38 | **Commercial and industrial clusters,** before and after Belo Monte

source: EIA Belo Monte & Masterplan 2010

The map below shows the mains commercial and industrial clusters in Altamira, before and after the construction of the dam. The commercial use, previously concentrated in the central area of the city, starts to spread out after the beginning of the implementation of Belo Monte, but still within the core and inner-ring of Atamira. This highlights how the increased population leads to an increasing demand for goods raising the commercial potential. As for the industrial cluster, the map shows a new concentration of industries close to the Ambe stream

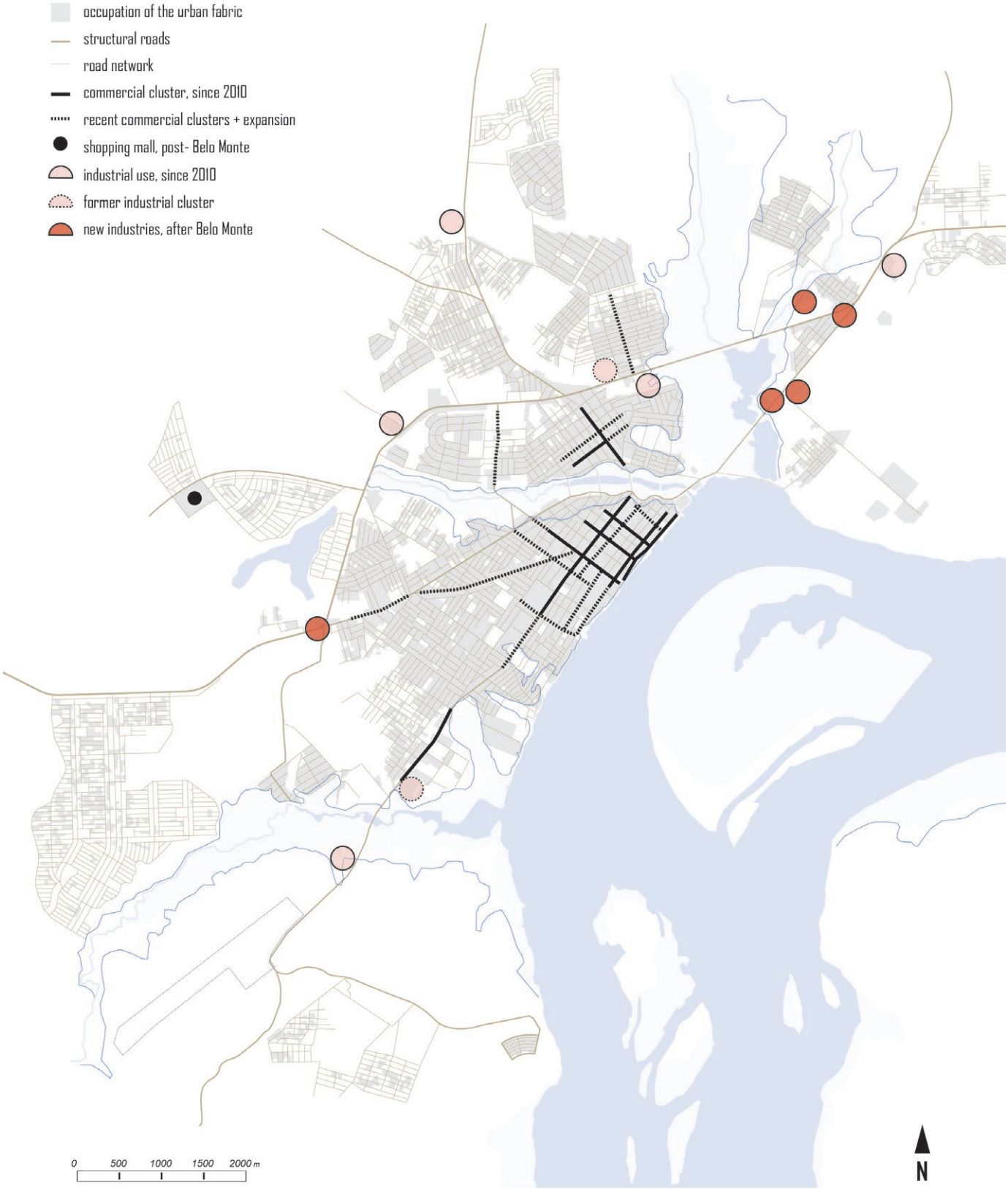
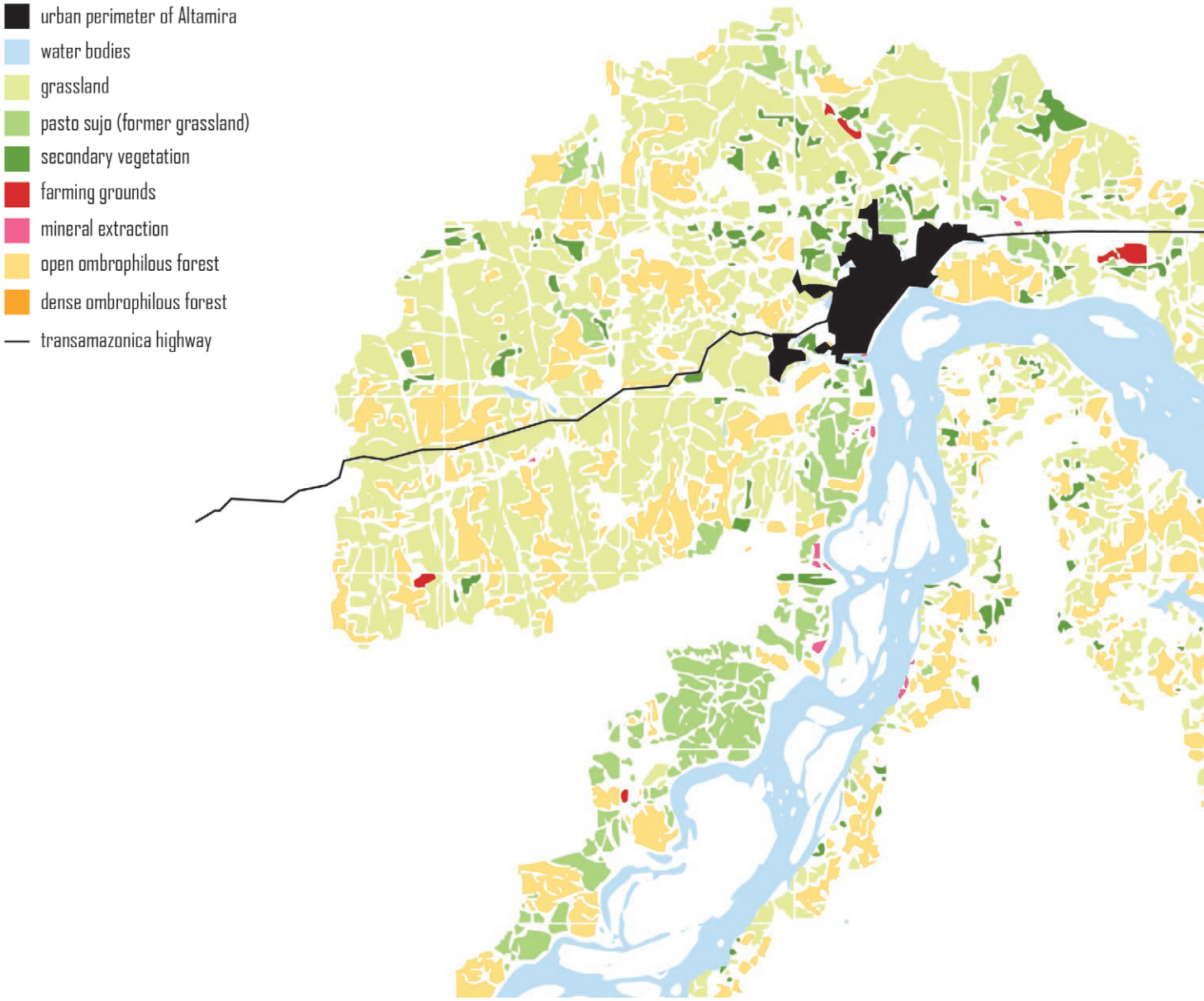


figure 4.39 | **Use of soil, production and vegetation surrounding Altamira**, in 2006

source: EIA Belo Monte

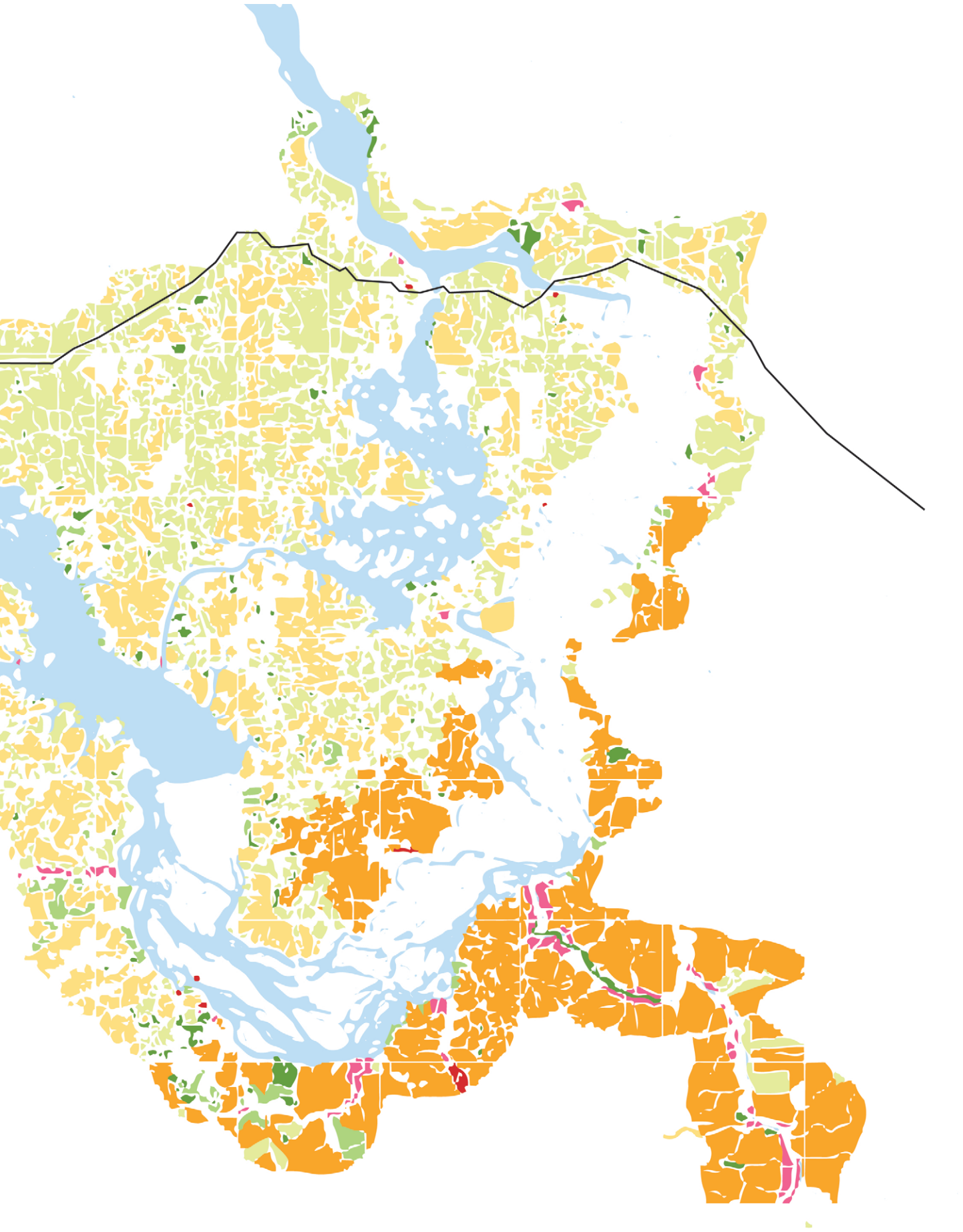
The map represents the production activities in the areas under the indirect influence of the construction of the dam. Data in the map highlights the predominance of grassland in the surrounding area. As for the natural landscape, there are some clusters of open ombrophilous and secondary forests in the outskirts of the city and margins of the Xingu, but no dense primary vegetation.



Use of soil in the Altamira region (1970 - 2006)

source: IBGE. Censos Agropecuarios 1970, 1980, 1985, 1996 and 2006

Categories	1970	1980	1985	1996	2006
Open Area	**12,214**	**95,876**	**132,700**	**400,432**	**x**
Farming Ground	2,539	19,636	18,211	37,914	33,835
Grassland	4,241	72,062	76,199	313,965	312,980
Planted Wood	288	50	294	1,793	1,256
Not Used	5,146	4,128	37,996	46,760	x
Natural Grassland	**3,612**	**5,992**	**9,260**	**22,972**	**69,066**
Natural Forest	**870,900**	**486,462**	**274,698**	**68,742**	**273,109**


0
5
10
15
20 km

Land use, according to city's masterplan, 2010

The revision of the city's masterplan, designed in 2010, determined a land-use plan for future development of the city, in which the following zones were created and assigned to different parts of Altamira. Already acknowledging the increase of population predicted in the environmental impact assessment of the Belo Monte dam, the first remark on the existing plan concerns the city's boundaries which, as seen in several moments of the spatial analysis, have significantly expanded due to the creation of low density housing typologies. It is also interesting to note that, besides the densification proposed in the city center with the zones **ZC, ZM I** and **ZH II**, the transformations predicted were supported by the existing corridors of the city, including the Transamazonica highway. Furthermore, the plan envisioned large areas for industrial use, aiming to incentive the expansion of the economic sector in Altamira, promoting the diversification of the job market.

ZHC - historic city center zone: Area intented to preserve the historic heritage of the city. Occupation by low density, single-family housing and commerce and services in a local scale, including restaurants, bars and hotels.

ZC - central zone: Area intended for verticalization, aiming a higher density occupation, with mixed use typologies. Bussiness district, with regional scale commercial use and services.

ZM I - mixed use I zone: Area determined by plots and blocks surrounding the primary roads in the city center, characterized by commercial or service ground floor occupation and pluri-family residential use in the upper floors.

ZM II - mixed use II zone: Area determined by plots and blocks surrounding the main roads outside the city center, characterized by the occupation of the ground floor with local-scale commercial activities and single-family housing in the upper floor.

ZH I - residential use I zone: Housing zones closer to the historical center of the city, aiming for a higher density. Predominance of pluri-family buildings and incentive of institutional and public use for its strategic location.

ZH II - residential use II zone: Predominance of residential, single-family, low density typologies. Incentive for social-housing projects in these areas. Local-scale commercial use is also encouraged within the neighborhoods.

ZIA I - industrial use I zone: Areas characterized for heavy industrial use, excluding any other type of occupation.

ZIA II - industrial use II zone: Areas production and transformation industrial activities, allowing the occupation of commerce and services in the surroundings. Pluri-family buildings could also be constructed, if properly implemented.

ZEE - structural equipment zone: Public or private areas destined for the institutional or special uses. Determined by its strategic locations.

ZIP - environmental landscape zones

figure 4.40 | **Land use, according to city's masterplan,** 2010
source: Masterplan Altamira, 2010

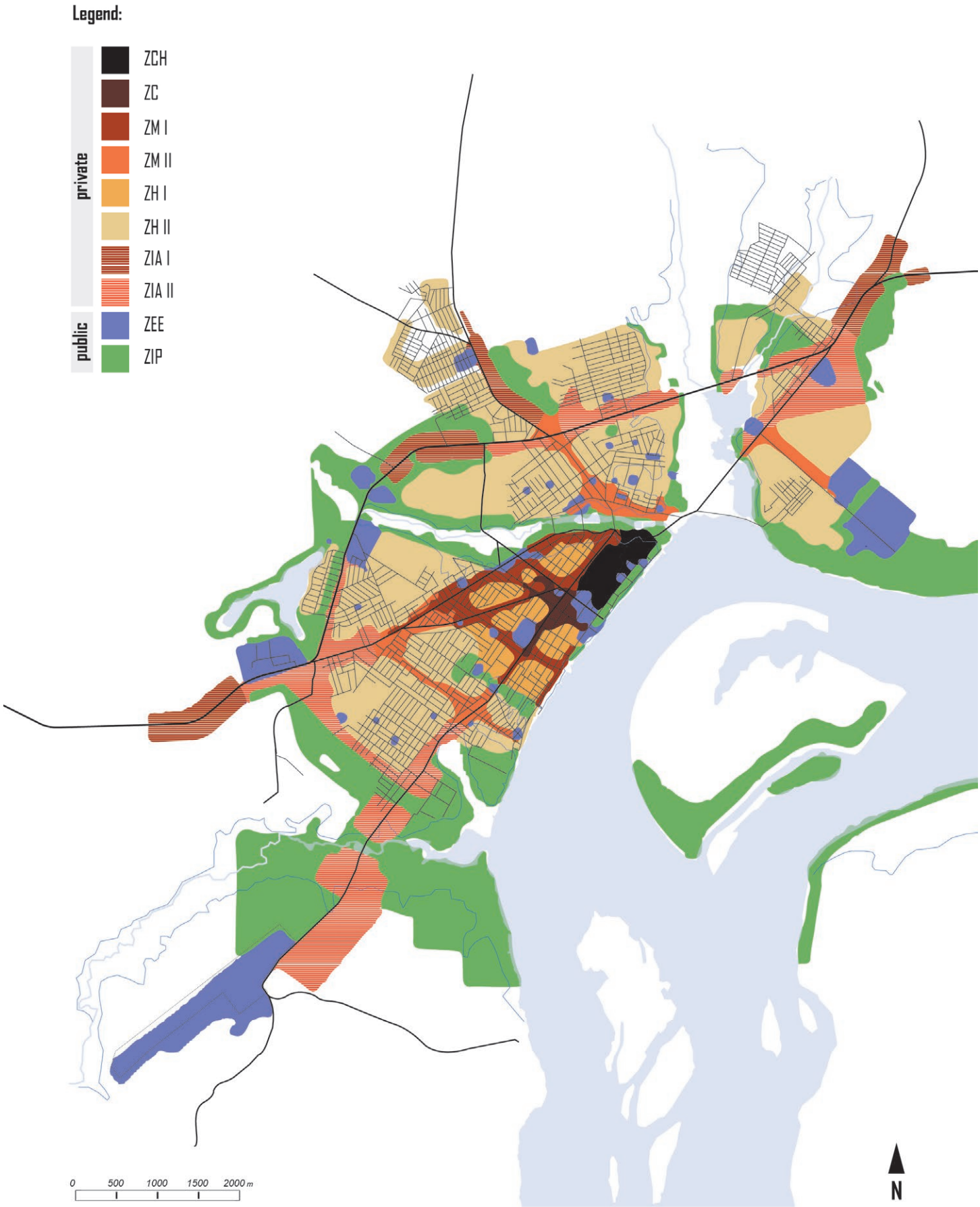
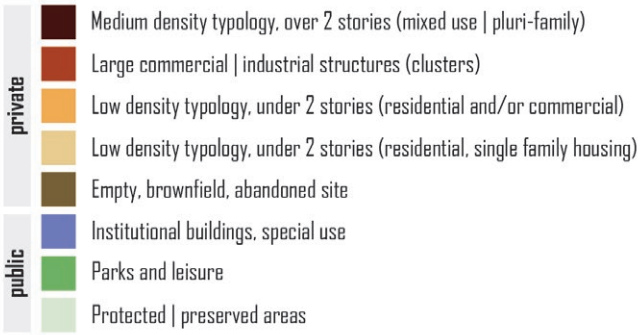


figure 4.41 | **Land use typologies in the neighborhoods**

Land use and occupation patterns in the different neighborhoods. The analysis was made by classifying building typologies according to the categories described in the legend. Spaces of public use were also considered in this exercise. The investigation focused on the four neighborhoods already discussed in the typo-morphological studies, namely (1) city center; (2) Jardim Independente I; (3) Cidade Nova; and (4) RUC Sao Joaquim. Even though there are other types of urban fabric in the city, the selected neighborhoods are analyzed as potential samples.



(1) City Center

(2) Jardim Independente I

(1)

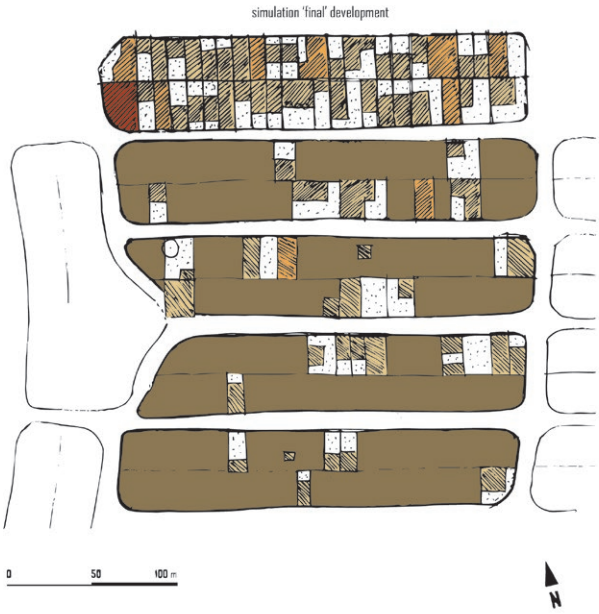
(1)

(2)

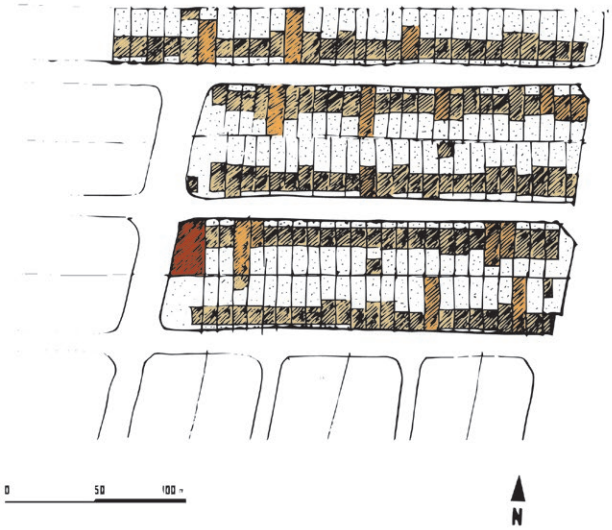
Occupation use in Altamira

The different typologies in Altamira show a large diversity of occupation patterns, as seen in the drawings below. In the city center, there is a mixed-use occupation, with a combination of low and high-density typologies. The presence of public services and equipments is more frequent than in any other neighborhood in the city, counting with schools, clinics, public buildings and parks. But even though it is a central area provided with good public infrastructure, there is still quite a few empty lots within the urban tissue. In Jardim Independente, a sample of inner-ring typology, it is possible to notice the predominance of residential, single-family, low-density typology, with the exception of few mixed-use buildings in every block. The occupation is more constant than in the city center, with fewer empty lots. In Cidade Nova, residential allotment, most of the fabric is still empty. This might be associated to the recent occupation in this typology and to the vast amount of similar projects available. The current occupation is mainly low density residential use, with few small stores or local services spread around. In the resettlement neighborhoods the typologies were designed as single-family residential, with commercial or institutional lots on the corners. However, as the affected population appropriate their new households there is the appearance of a diversity of commercial or service uses, as an expansion of the original typology. It is a dynamic neighborhood, under a 'bottom-up' model of transformation.

(3) Cidade Nova



(4) RUC Sao Joaquim



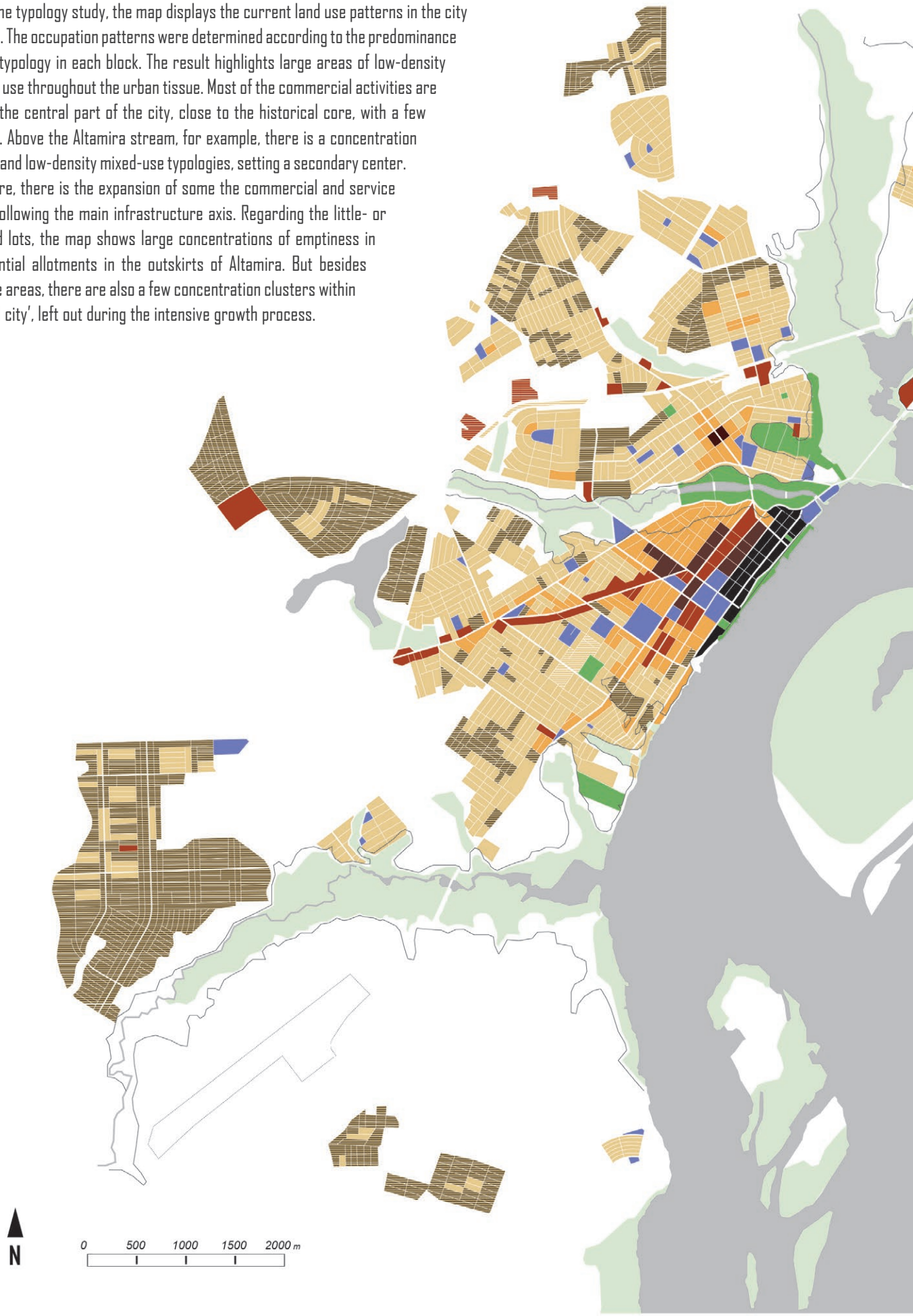
(3)

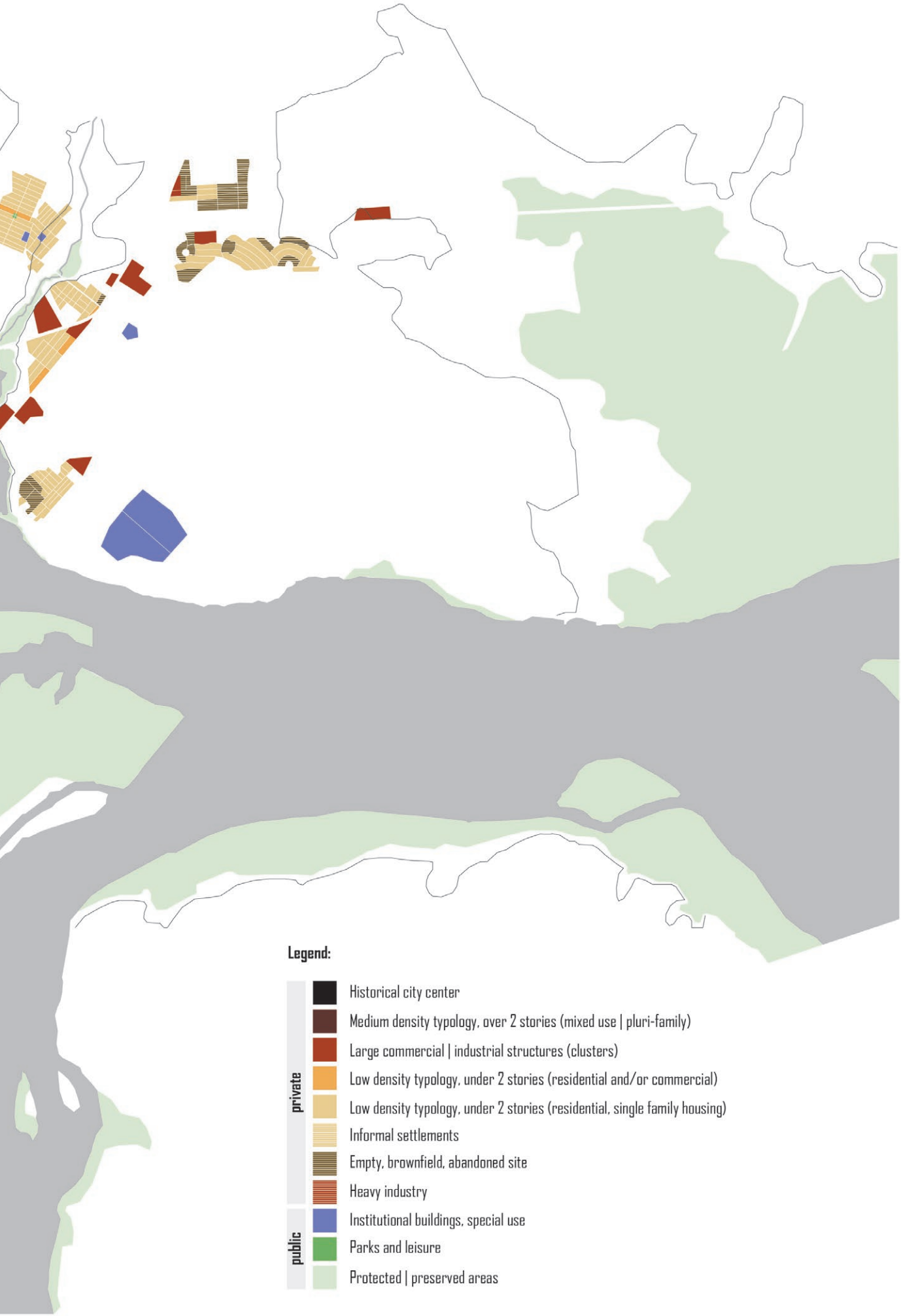
(4)

(4)

figure 4.42 | **Current land use in Altamira**

Based on the typology study, the map displays the current land use patterns in the city of Altamira. The occupation patterns were determined according to the predominance of certain typology in each block. The result highlights large areas of low-density residential use throughout the urban tissue. Most of the commercial activities are located in the central part of the city, close to the historical core, with a few exceptions. Above the Altamira stream, for example, there is a concentration of medium and low-density mixed-use typologies, setting a secondary center. Furthermore, there is the expansion of some the commercial and service activities following the main infrastructure axis. Regarding the little- or unoccupied lots, the map shows large concentrations of emptiness in the residential allotments in the outskirts of Altamira. But besides those large areas, there are also a few concentration clusters within the 'formal city', left out during the intensive growth process.




Legend:
private
Historical city center
Medium density typology, over 2 stories (mixed use | pluri-family)
Large commercial | industrial structures (clusters)
Low density typology, under 2 stories (residential and/or commercial)
Low density typology, under 2 stories (residential, single family housing)
Informal settlements
Empty, brownfield, abandoned site
Heavy industry
public
Institutional buildings, special use
Parks and leisure
Protected | preserved areas

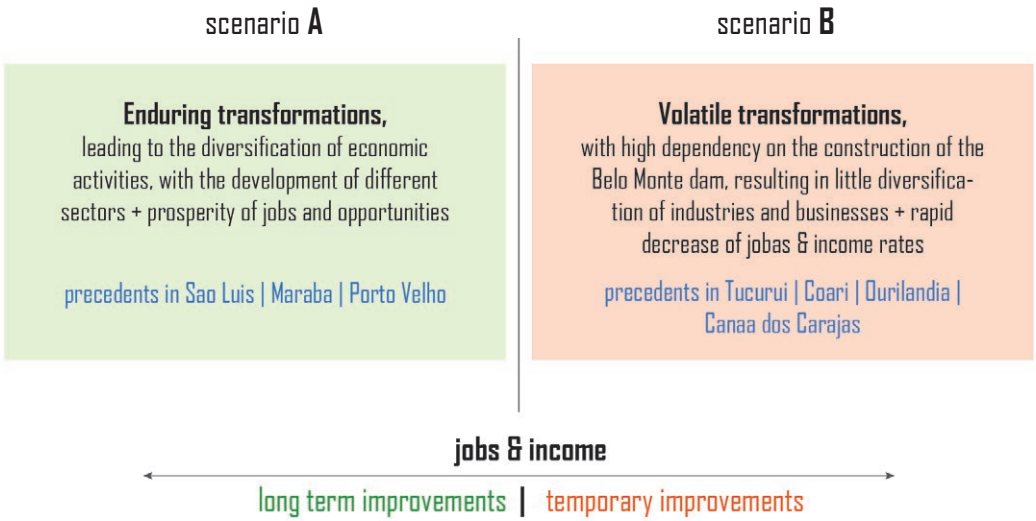
As already seen throughout the analysis of the other key factors, there is a huge gap between the vision designed for the masterplan and the current spatial characteristics of Altamira. The conception of the land use map aimed to accommodate the new arriving population within city margins, by promoting the densification of its core and full occupation of the land surrounding it. Instead, what occurred was the sprawl of the city, with the predominance of low-density residential typologies. And, due to the intensity of the growth, many empty or little-occupied plots and blocks remained present in the urban fabric. Regarding land use, the main challenge faced since the start of the construction of the dam is the accommodation of households for new families. The most accentuated differences seen between the proposed vision and the current development are in the zones **ZM I & II** and **ZH I & II**, concerning the residential use of the soil. The lack of housing programs and a severe real estate speculation, combined with the inefficiency of public management in applying the designed plans, hampered the development and densification of housing typologies according to the masterplan, resulting in the quick spread of households in the new private and affordable allotments.

Another dissimilarity is seen in the industrial zones of the city. Rather than having a ring around the center as designed in the masterplan, there are currently only a few clusters of industries along the Transamazonica highway. This development is still consistent with the land use plans of the municipality, however, the creation and attraction of new industries were smaller than what was expected. The development of the secondary sector might be fundamental to cope with the increasing unemployment rate now that the construction of the dam does not demands much manpower. A revision of the zoning plans might be necessary, assuming the deviation of the Transamazonica might not become a reality.

Regarding the commercial potential and services of the city, there was a clear increase in the activities, especially due to the inflated population. But the development focused mainly in two locations within the core of the city, next to the historical center and right above the Altamira stream. The new neighborhoods constructed on the outskirts are almost strictly residential, accentuating the monocentric model of the city. Considering the already challenging mobility patterns, the little diversity of the urban fabric is likely to add even more pressure to the limited infrastructures.

figure 4.43 | **Scenarios for jobs & income**

As seen in the introduction of this section, the number of employed population is already decreasing towards the conclusion of the construction of the dam, indicating a possible future trend. But, rather than trend extrapolation scenarios, the following exercise relies on the lessons learned from the precedent cities to elaborate normative plausible outcomes for the job market in the city. According to the patterns identified with the case studies, there are two probable scenarios to be considered for future developments in Altamira. The first one (scenario A), seen in Sao Luis, Maraba and Porto Velho, suggests enduring transformations following the implementation of big infrastructure, leading to the diversification of activities in each economic sector and thus to a prosperity of jobs and income. This model is seen in the indicators of either of the cities affected by transport & mobility infrastructure or largely populated urban centers. The second scenario (B), seen in Tucurui, Coari, Ourilandia do Norte and Canaa dos Carajas, assumes that the transformations in the job & income indicators are dependent on the implementation or operation of the mega-project, leading to a volatile market. Improvements tend to be temporary in such an outcome.



Scenario A
ENDURING transformations
Sao Luis | Maraba | Porto Velho

This scenario assumes that a few factors following the conclusion of the dam could lead to the diversification of the economic activities in Altamira. The population increase, the location of the city in the region and the availability of strong commercial and service activities consolidate the city as an important urban center in the state of Para. This position could attract even more migrants and different businesses to Altamira, boosting the local industries and creating new job opportunities for the population. Furthermore, the energy stability coming from the hydroelectric power plant and the improved accessibility due to the paving of the Transamazonica could also work as an incentive for new industries to come to the city.

Scenario B
VOLATILE transformations
Tucurui | Coari | Ourilandia do Norte | Canaa dos Carajas

By looking into the jobs & income indicators extracted from the IBGE census, it is already possible to see a significant decrease in the values, especially since 2014. This scenario assumes that the values will keep dropping alongside with the decrease of manpower required in the construction sites of the dam. Also, considering that most of the increment in the city's GDP was associated to civil construction, it is likely to expect that the existing industries and businesses associated to the secondary sector will also be affected. In this outcome, the unemployment rate will keep rising, hampering the current development dynamic of Altamira.

figure 4.44 | DESIGN PRINCIPLES FOR JOBS & INCOME

By looking into the spatial and scenario analysis, under the scope of the jobs & income key factor, some new urban challenges could be identified. Despite the definition of a zoning plan by the municipality, the recent development of the city, promoted by the implementation of the Belo Monte project, was intense and unorganized. The result, as seen in this section of the thesis, is a vast expansion of the urban fabric beyond the proposed boundaries, predominately by new low-density residential typologies, often empty or unoccupied. This new occupation model is resulting in the formation of monofunctional segregated neighborhoods, dependent on the commercial potential and economic activities of central Altamira. Adding to this, the growing unemployment rate and the decreasing activities in the second sector, a direct consequence of the reduction of jobs required by the dam, are affecting the income of the local population, compromising real estate development and hampering further diversification of the job market.

To cope with the identified issues, a few principles were designed aiming for an improved occupation and land use in Altamira, promoting the development of proper and coherent housing typologies and facilitating the development of economic activities. Again, the guidelines proposed are a combination of a series of smaller projects, ensuring their feasibility in different scenarios outcomes, through phasing strategies. The main interventions are divided into two categories: **(1) living** and **(2) working**.

(1) living principles aim for the expansion of the housing stock in Altamira without the replication of the current low density, sparse, residential typologies. The main objective is the consolidation of livable and accessible neighborhoods within the existing urban fabric, without further sprawl of the city. Two main strategies are adopted to achieve such an objective. The first one is the delimitation of areas and facilitation for the development of medium density mixed-use typologies in the waterfronts and margins of protected areas. While the previous zoning plans recognized mainly mobility infrastructure as a potential axis for development, the proposed design acknowledges the importance of water and preserved landscapes as important areas to be buildup. Such zoning strategy should entice private developers to invest in the determined areas, ensuring the definition of solid boundaries in the protected areas and exploring its full potential. The second strategy its the incentive for mixed-use and residential occupation of vacant spaces within the existing urban fabric. On the residential allotments, the same strategy is done through the creation of clusters, focusing the construction of households and densification in strategic areas before spreading out, promoting the creation of secondary centers in Altamira.

Furthermore, one fundamental aspect to be tackled in every 'living' principle, is the definition of **social housing programs**. Probably the main reason for the challenging occupation patterns is associated with the increased real-estate values following the implementation of the dam, leading the population with lower income to the popular allotments in the outskirts of the city. Any proposed housing strategy should be inclusive, ensuring a significant share of affordable units in every neighborhood, preventing further sprawl and the formation of informal settlements and promoting diversity in the city.

(2) working principles were designed to encourage the development of new businesses and industries in Altamira, promoting the creation of new jobs and opportunities. The strategies consist of the definition of clusters for densification of economic activities, facilitated by its strategic locations and accessibility. Two main projects were defined as possible 'triggers' to induct the envisioned transformations, both in the margins of the Xingu river. The first one is the creation of a harbor (currently inexistent) and an industrial park, aiming to endorse investments in the already existing extractivism and food processing activities. The second project would be the creation of an 'urban operation' in the margins of the river, right outside the historical center. The waterfront in the selected area, as mentioned before, is currently being occupied by mansions, blocking the public access to the river. An urban operation would advocate for new high-density typologies, not only mixed-use but also associated with tourism activities, adding land value to the properties, simulating the transformation of the current occupation patterns. This strategy is beneficial for the development of the little tourism industry in Altamira and for the civil construction sector, currently declining due to the smaller demand of the dam.

Finally, when considering public spaces, a fundamental aspect of the strategy is attributing a proper use to the green areas determined. While some will become parks and have a recreational use, others can be used for productive activities, such as extrativism or small-scale agriculture. This is important to ensure they remain protected, without future irregular occupation or activities.

figure 5.1 | **Sreet in Altamira**
image by the author

chapter **5.**

SYNOPSIS

SYNOPSIS
A vertical overview of Altamira

The previous spatial and scenario analysis highlights the main transformations occurred in Altamira since the beginning of the implementation of the Belo Monte dam. With it, it becomes evident the influence the large-scale infrastructure had in the development of the urban fabric, especially when analyzing each of the specific key factors determined. The previous exercise also allowed for the extrapolation of possible and probable future scenarios, by looking into socio-spatial patterns identified in similar case studies of amazonian cities. Furthermore, the individual analysis of the key factors lead to the definition of principles for a future Altamira, aiming to evince the necessary guidelines for the envisioned sustainable development of the city.

The information gathered, however, is still horizontally focused in each of the key factors. By looking back into the main question and structure of the research, the following chapter aims to synthesize the socio-spatial analysis of the city vertically, by overlapping and interpreting the conclusions of the previous sections of the graduation thesis. Such exercise will lead to the definition of the main topics to be tackled while discussing planning strategies and a future urban design for Altamira.

The chapter is divided into three parts. The first aims to demonstrate the main conclusions (positive and negative transformations) and determined principles for future development in Altamira. The second, points out the author's remarks on the current development dynamic in Altamira, based on the conducted research and spatial analysis. It is the synopsis of the horizontal conclusions. Finally, the third part looks back into the structure of the graduation thesis, reflecting on the research question and challenging the current planning approaches adopted during the construction of the dam.

5.1 POSITIVE AND NEGATIVE TRANSFORMATIONS IN ALTAMIRA

The graph below summarizes the main conclusions according to the key factors explored. Besides the identification of positive and negative outcomes, the graph also displays the principles explored in the analysis of each of the topics, tackling some of the discussed issues.

Population		
Conclusions	**(+)**	**(-)**
	Resettlement of irregular housing along the streams. Provision of housing with proper basic infrastructure	Sprawl of the city: New residential neighborhoods before densification of the core
	Redifinition of waterfronts with parks & leisure areas	Pressure on the natural landscape, with irregular occupations and hard boundaries
	Expansion of the mixed-use central typology	Segregated and fragmented urban typologies
		Lack of housing programs on a municipal scale
Principles	**(i) Definition of urban boudaries**	
	(ii) Expansion directions + risks	
	(iii) Densification patterns	

Public Resources + Health & Education		
Conclusions	**(+)**	**(-)**
	Provision of basic infrastructure, unique for the region	Little integration and connectivity in some of the new neighborhoods
	Opening of important new avenues and roads, improving connectivity in central areas	Little accessibility, job opportunities and public equipment in new neighborhoods, resulting in a concentric model for Altamira
	New parks and public spaces	Transamazonica as an urban avenue, heavily overcharged
	Construction of several buildings destined for public equipment, such as schools, clinics and hospitals	Pressure on public management. Responsibilities usually belong entirely to the administration of the city, without considering important stakeholders
	High visibility and effort in strenghtening public management	Large gap between planned and executed. Limited masterplan and vision for the city
Principles	**(i) Connectivity**	
	(ii) Accessibility & Public Services	
	(iii) Public Spaces & Civic Life	

Jobs & Income		
Conclusions	**(+)**	**(-)**
	Growth of the secondary and tertiary sectors.	High dependency of economic activities on the construction of the dam.
	Increase of employment and income generation opportunities.	Little diversity of land-use activities.
		Little occupation rate and urban vacancies in several neighborhoods.
Principles	**(i) Living in Altamira**	
	(ii) Working in Altamira	

5.2 VERTICAL CONCLUSIONS

It is indisputable the fact that the executed guidelines of the PBA lead to a positive development of Altamira and will leave a legacy for future generations. Projects such as the resettlement of families living in protected areas and the provision of a waste treatment system for the entire city, for example, would never become feasible without the effort and investments of Norte Energia. However, as seen in the conclusions of the socio-spatial analysis, there is still a large gap between the PBA and the new dynamic of development promoted by the construction of the dam. It becomes important to understand the limitations the mitigations and compensation programs have, failing to (successfully) address some of the challenges of a fast- and constant-changing Altamira. Based on the previous conclusions, this section identifies a few critical topics for future development of the city, either poorly addressed by the programs of the PBA or beyond the expected development proposed by the masterplan, that should be tackled upon while designing a strategic plan for Altamira.

1. Intensity of construction process and migratory flows

Combined with a short time frame for the implementation of the mitigation guidelines and programs resulted in an unorganized growth of Altamira and some poorly executed projects. The overlapping execution of dam and compensation projects was unable to accommodate a fast-increasing population which lead to much social tension in Altamira. This issue is a reflection of the bidding model adopted for large-scale infrastructure and the short-term planning mentality of brazilian governments. Such challenge should be addressed for future implementation of big-projects, throughout Brazil, and in Altamira, with the possible implementation of the Belo Sun gold mining project. Incorporated by the scenario approach, a successful design for the city should be able to accommodate the possibility of such an intense growth.

2. The natural environment and agribusiness

Spatial analysis shows that there is a hard boundary between men and nature not only in Altamira but also in most Amazonian cities. The city does not acknowledge its natural landscape. Built oriented by the Transamazonica highway, the city is facing backwards to the Xingu river. Informal occupation and private properties are currently taking over the riverfronts and the streams. Little green is visible in the public spaces of the city and the abundance of natural diversity is barely seen while visiting the city. Added to this, agricultural production is seen as the enemy of the natural landscape (and has been in many cases) and has not been developed properly over the past years.

There is an urgent need for acknowledging the Amazon, its diversity and natural resources, not only as an untouched preserved landscape but also as part of the culture of the city, to be explored and maintained by its population. Implementing sustainable production practices could bridge the gap between urban and natural, by exploring (or even regenerating) the existing resources. By doing so, the preservation of the Amazon becomes more than invisible lines determining protected areas. It becomes a network of communities and activities maintaining and caring for the territory.

3. Land-use and expansion

Most of the new challenges associated with the new dynamic of development in Altamira are a consequence of the expansion of low-density residential neighborhoods beyond the margins of the city. The intense increase of the population figures combined with the lack of housing programs in a municipal scale resulted in the sprawl of the city rather than its densification. And this can be considered a waste of resources, when taking into account the vast amount of investment of the municipality and Norte Energia in developing the central areas of Altamira. Instead of a compact model, with the full exploitation of the provided urban infrastructure and constructed public equipment, the city grew to be a monocentric model, with segregated residential neighborhoods on its outskirts, high demand for new public equipment and poorly designed public spaces.

An inclusive strategy for the future development of Altamira should not only aim to further densify the core of the city, exploring the existing infrastructure and equipment, but also to determine occupation patterns and typologies for these new neighborhoods. An important point is also to understand that, differently that in the Netherlands, the brazilian territory has vast amount of land available and a very challenged land regularization system, which encourages urban sprawl in most case studies. This means that strategies should be carefully designed preventing further sprawl of the urban tissue, in case of a growing population scenario.

4. Society and inclusiveness

With a controversial discussion since the first proposal in the 70's, the Belo Monte dam has engaged several groups in a on-going pro-con debate regarding its implementation. Even with its construction almost concluded, there is still much resistance of the local NGOs and traditional or affected communities, demanding the proper implementation of the compensation guidelines. This resistance has shown to be very effective, especially when considering the efficiency, impact and guidelines of the implemented project in comparison to the first one presented, more than 30 years ago. However, this controversy has also resulted in a fragmented society, divided according the never-ending polarized discussion.

Furthermore, with the intensity of the process and amount of investment brought to the city, indigenous tribes, local communities and minority groups were very often left out of the decisions. There were of course the creation of several programs benefiting those groups, but without the proper implementation of them in the social structure of the city. By visiting Altamira, one can note that the local cultures and traditions of the first phases of the city were overlapped by the recent growth and the new concentration of wealth. A successful design should aim to incorporate the different groups again, highlighting the richness of the local and traditional communities of the amazonian region and the Xingu river.

5. Public management

Is no new challenge for Altamira. Inefficient public management has been one of the main issues throughout the development of most cities in the amazonian region, poorly applying the exploitation of resources into long-lasting investments in the urban fabric. One of the critics of this thesis on the PBA is the definition of scopes, in which most of the interventions are constructed by Norte Energia while the operation is always left to the municipality. Such process keeps adding pressure in an already challenged management of the city, which likely to lead to the degradation or even collapse of some of the interventions.

For a sustainable design proposal, the responsibility of the programs should be shared between different stakeholders instead of relying solely on the public sector. This could ensure not only a more efficient management of programs, but also the integration and participation of different sectors and groups.

5.3 REFLECTION

The horizontal and vertical conclusions can then be tackled with- and incorporated into a new urban development strategy for Altamira. But before jumping into a design, the following section aims to debate on the current planning processes adopted during and after the construction of the dam in Altamira, based on the proposed structure of the thesis. The focus here is to reflect on the first part of the research question: "Is the current dynamic of development promoted by the construction of the Belo Monte dam and mitigation guidelines, resulting in a resilient model for Altamira, capable of promoting sustainable development?"

The first part is to understand the "current dynamic of development" phrased in the question. By looking back into the two first chapters of the thesis, which investigate the variation of indicators and the main socio-spatial transformation of the urban fabric, it becomes undeniable the fact that the construction of the dam influenced the trajectory of development in Altamira, promoting the emergence of a new dynamic. This influence is twofold and could be described as cause and reaction. The implementation of the dam, considering the size of the investments and the quantity of job availability, is without a doubt the main and trigger motive for the variations, establishing a new reason for Altamira. And as described in the environmental impact assessment of the project, there is an immense range of direct and indirect impacts associated with its construction, which contribute to the constitution of the new dynamic of development. The reaction part of the influence is the creation and execution of the compensation programs and projects associated with the identified range of direct and indirect impacts. These guidelines (PBA) are the main planning instrument adopted in Brazil to prevent the consolidation of negative impacts and to try to explore the development potential generated, directly resulting in socio-spatial transformations of the urban fabric.

Figure 5.2 | **Locals hunting in the forest**
image by Aaron Vincent Elkaim
source: http://www.aaronvincentelkaim.com/where-the-river-runs-through

Before discussing whether it is resulting in a resilient model or not, it is important to understand what are the planning instruments currently guiding urban development and their scope. In Altamira, when the construction of the dam started, the two employed instruments were the PBA guidelines and the city's master-plan. While the master-plan aimed to guide the future urban development of the city, through the implementation of a new zoning and mobility plan, the PBA focused on the mitigation and compensation of impacts. However, as already seen in the spatial and scenario analysis, the master-plan of the city became obsolete with the implementation of the dam and the new dynamic of development, unable to accommodate the intensity of the transformations. With this, the PBA overlapped the master-plan as the main planning instrument of Altamira. In an urban development perspective, this fact has become very problematic, since the compensation guidelines consist in an agglomeration of independent projects and programs rather than a unified vision for the city, as described in the diagram. The main challenge is that the executed programs focused mainly on the mitigation and compensation of impacts without having a proper alignment with the former municipal vision for Altamira. To summarize, the PBA is focused on impact management and, thus, is not an integrated urban development strategy. And even though not yet entirely conclusive, the lack of integration between the different projects and programs can be used to challenge the argumentation of a possible resilient model for the city.

Regarding a potential sustainable development of Altamira, the current model can be questioned for a few of the following reasons, identified throughout the research. The reflection is done by looking into the sustainability triangle and the balance between economic, environmental and social values:

Economic: There is still a strong reliability of the projects on the investment and management of Norte Energia. Once the PBA is concluded, the operation and maintenance will be up to the municipality since most of the projects implemented propose that the public sector will assume full responsibility without investigating other possible stakeholders. Also, with the conclusion of the guidelines, further expansion of the infrastructure and equipment network to the new neighborhoods of the city will rely on public resources to become feasible. Another issue to be mentioned is the intense growth of job and income opportunities in the secondary sector and the little diversification of the activities, expressing the dependence of the job market on the construction and operation of the dam.

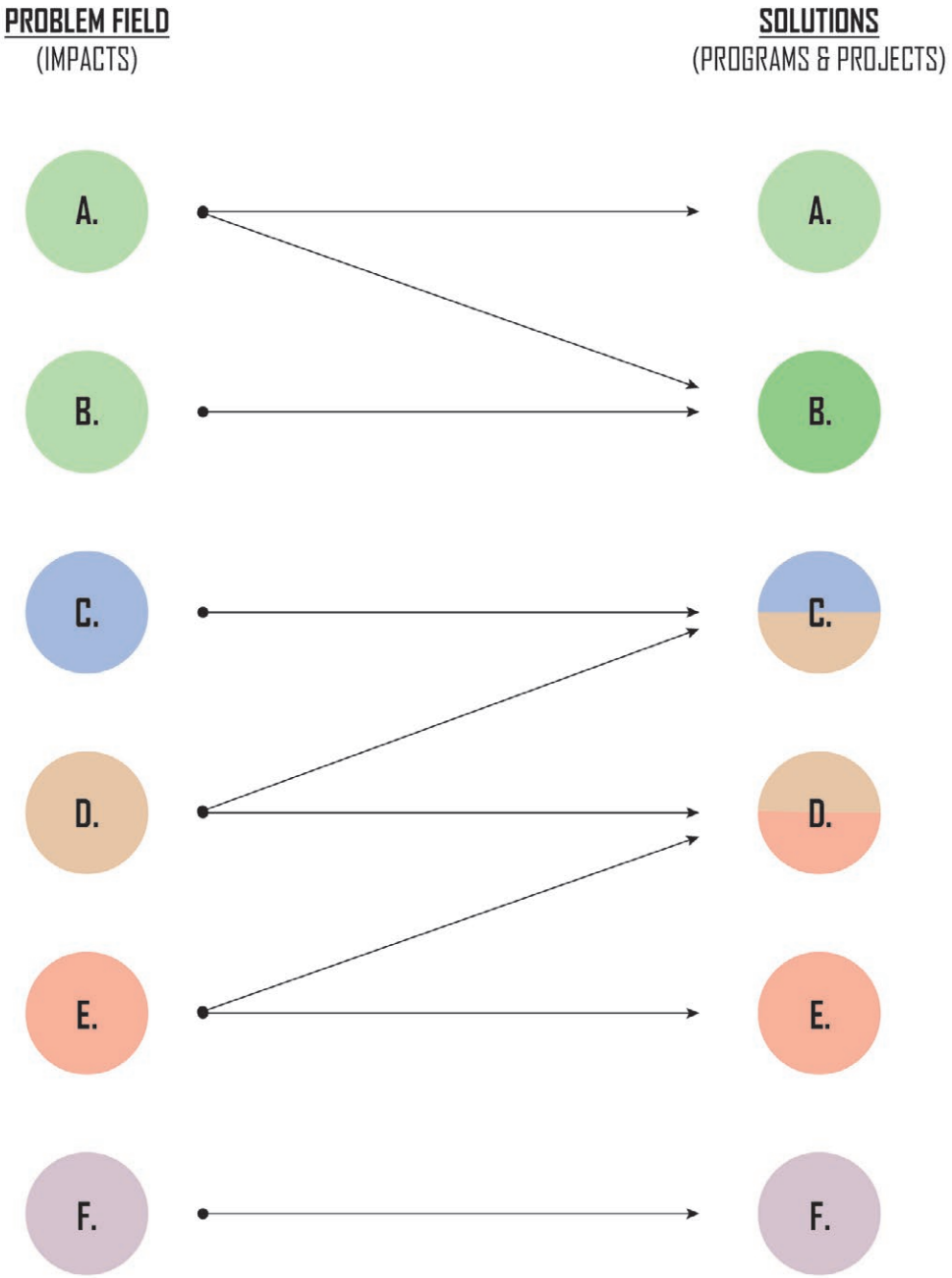
Environmental: Men, city, and production are currently separated from nature. There is a clear boundary segregating Altamira from its natural landscape, currently neglected by the urban tissue and its population. This is expressed by lack of public use of the waterfronts or streams, currently being occupied by private property. Added to this, protected areas and preservation practices are simply isolated with the definition of imaginary lines, separating traditional communities and their productive activities from their environment. There is little articulation between the natural landscape and the economic or social values of Altamira.

Social: There is, within the new dynamic of development in Altamira, little acknowledgment and inclusiveness of local communities (mainly indigenous and ribeirinhos). These groups were heavily influenced throughout the recent transformations and were resettled and/or compensated without being properly included in the social structure of the city. Added to this, the Belo Monte hydroelectric plant resulted in a strong social tension between different groups and stakeholders, building up since the first proposals in the early 80's.

There is no doubt the PBA and investments coming from the Belo Monte dam lead to a positive development of Altamira, with the implementation of several fundamental projects and programs improving the urban tissue and the quality of life of its inhabitants. Also, based on this, positive variations can be expected on selected indicators (key factors) of the city on the next census, especially on the ones associated with health & education. However, based on the socio-spatial analysis of the city, there are several critical issues identified as a consequence of the big-infrastructure, which were not acknowledged and/or incorporated by the PBA. When reflecting upon the evolution of the city in an integrated urban perspective, it is possible to conclude that the recent transformations were unable to create a resilient model and to promote a sustainable development. This does not mean that the Belo Monte dam led to a negative outcome in Altamira. It simply concludes that the processes and instruments adopted were unable to fully accommodate the associated impacts and to exploit the potentials and resources attracted during its construction.

figure 5.3 | **Current planning approach**

The following diagram illustrates the current approach of the mitigation and compensation programs of the PBA towards the impacts associated to the construction of the dam. One of the main challenges is the lack of an unified vision for the city. The design of programs is usually addresing one or two specific impacts, without a general vision or general planning strategy. This results in a fragmented PBA, where programs are often overlapped or disconnected to each other. As a result, even with a successful implementation of some of the programs, the PBA failed to organize urban development as a whole.



This conclusion points to the fact that there is an urgent need for implementing a new planning tool in Altamira, able to fulfil the gaps and opportunities that resulted from the construction of the dam and the implementation of the compensation guidelines. This exercise is explored in the second part of the research question of this graduation thesis: "How can strategies and policies be used to further explore the economic potential generated, simulating growth while minimizing possible risks?"

Based on this, the design of new strategies and policies for Altamira was framed according to the following diagram. Identified according to the selected key factors, the new urban challenges set the framework for the definition of a vision for future development of the city. The development strategies and programs are designed under the planning principles of the unified vision, ensuring alignment and integration between different proposals within the same urban context. With this, rather than having specific programs for specific impacts, each of the strategies tackles several of the identified challenges aiming for a cross-related implementation and management of the programs.

figure 5.4 | **Football match in indigenous community**
image by Aaron Vincent Elkaim
source: http://www.aaronvincentelkaim.com/where-the-river-runs-through

Figure 5.5 | **Proposed planning approach**

The master's thesis present a different approach to planning in the region. With the PBA almost concluded, the dam leaves a few legacies and new challenges for the city of Altamira. Based on the spatial and scenario analysis, the main issues identified, according to each key factors, set the framework for the elaboration of an unified vision for Altamira. The aim is to bridge the gap between the fragmented projects of the PBA by addresing new issues caused by the accelerated development of Altamira over the past years. But instead of coming with specific programs for specific challenges, the proposed output consists in four strategies, leading towards the envisioned future of Altamira. Each of the strategies acknowledges the problem field of each of the key factors, aiming for a trans-disciplinary and cross-related approach.

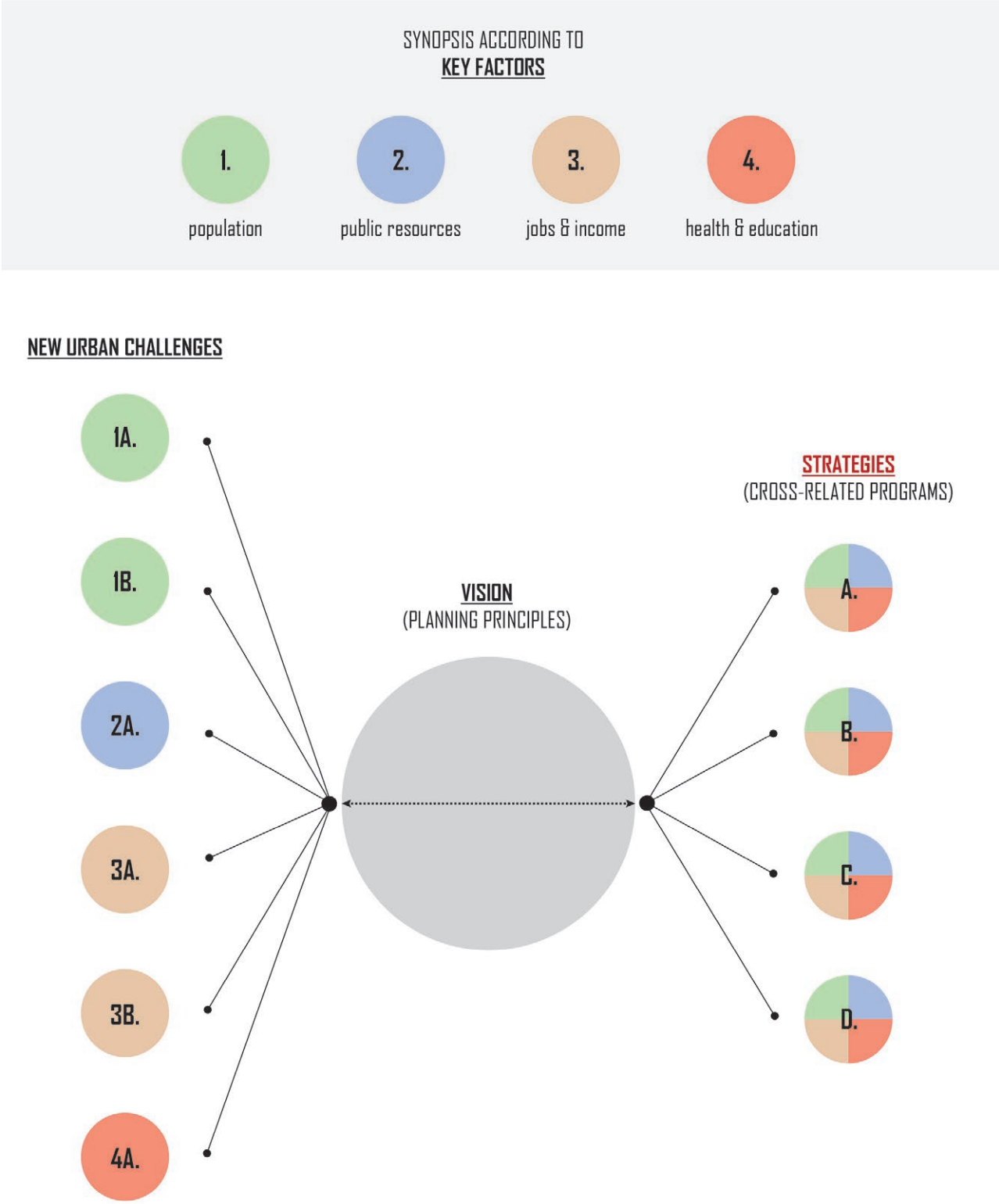


figure 6.1 | **Pier in the city center**
image by the author

chapter **6.**

STRATEGIC VISION PLAN

STRATEGIC VISION PLAN
Proposed strategies and programs for promoting sustainable development in Altamira

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The following chapter elaborates the design of a strategic vision plan for Altamira, exploring different projects, programs, and strategies aiming to promote a sustainable development in the city. Based on the conclusions of the spatial- and scenario analysis, the design seeks to come up with innovative solutions for a few of the key challenges identified on the built environment, guiding future developments according to the proposed vision. The strategic vision plan is structured according to three parts: **(1) vision**, proposing development principles and an ideal outcome for Altamira; **(2) strategies**, designed to shape future urban development and the built environment; and **(3) action plan**, suggesting the necessary operations for the implementation of the strategies.

The design described is intended to be **provocative!** Acknowledging the limitations of an individual, one-year-long graduation work, the solutions proposed have the purpose of generating a debate on possible strategies to be adopted for the city. The vision creates a necessary bridge between city, nature, and society while the strategic plan comes up with bold and innovative solutions, aiming for the engagement and participation of multiple stakeholders in the discussion of a sustainable future for Altamira.

6.1 A VISION FOR ALTAMIRA

Altamira acknowledges the abundance of natural resources surrounding its territory. The encounter between built- and natural environments, between human and nature, is now celebrated. Traditional productive activities are recovered and innovated, in a trans-disciplinary collaborative process including local communities, education and research institutions, private- and public sectors. The implementation and expansion of sustainable production practices encourage the growth of the primary sector and industry, providing job and income opportunities for the population. Effective housing programs and densification strategies ensure an adequate and low-impact expansion of the urban tissue, incorporating the natural landscape instead of isolating it. Natural and economic resources are applied towards the construction of inclusive public equipment and infrastructure, improving quality of life of the entire social structure and promoting public life. **Altamira sees an inclusive green growth!**

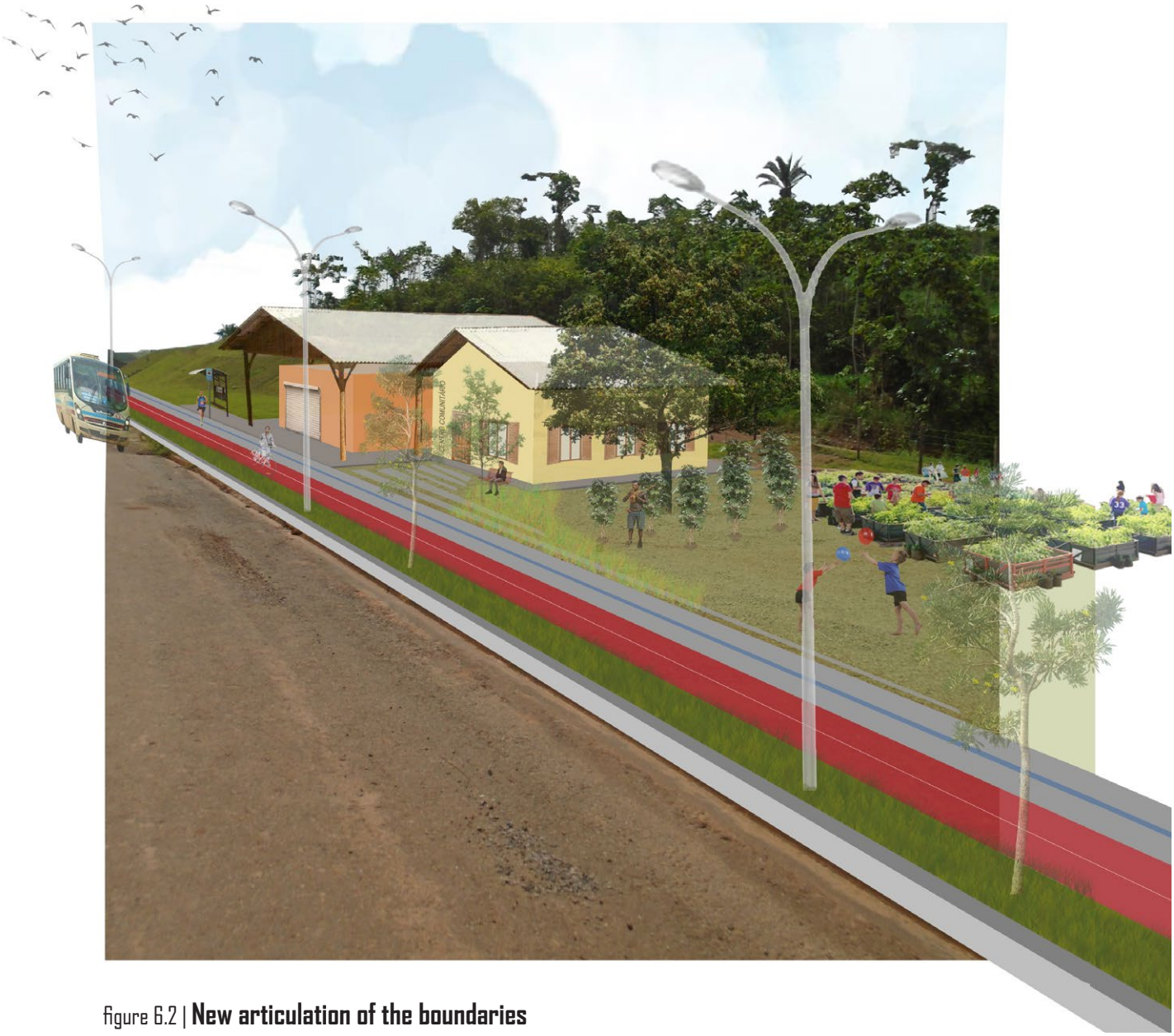


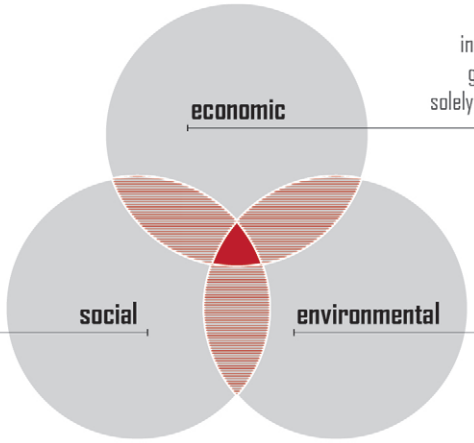
figure 6.2 | **New articulation of the boundaries**

Figure 6.3 | **Values and approach**

balanced values

Aiming for sustainable development, the new programs and practices in the city should fit within a social, economic and environmental framework, always looking for a balance and dialogue between the different values. Solutions have benefits and/or low impacts in each of the categories, fully exploring the current economic potential, environmental abundance and social diversity of Altamira and the region.

With the conclusion of the PBA and the investments coming from the construction of the dam, future urban programs should incorporate different financing and income generation strategies, rather than relying solely on municipal resources for development

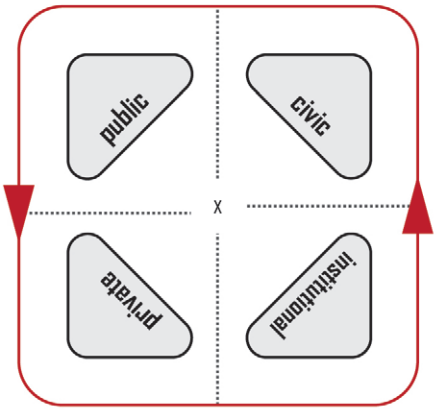


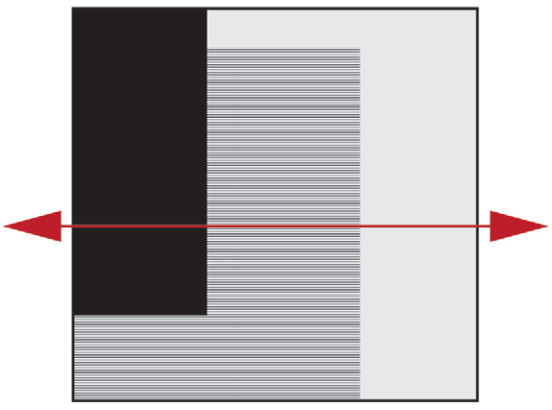
Encouraging shared responsibility and promoting public life becomes a priority in Altamira. Strategies need to ensure the engagement and privilege of different groups, including minorities and traditional communities, currently neglected.

When the abundance of natural resources and the productive practices stop being contradictory and start complementing each other. Urban developments acknowledge the richness of the natural landscape and break the existing boundary between Altamira and the Amazon.

collaborative governance

Shared responsibility is key for a successful implementation of new urban strategies. Rather than overcharging the already challenged public management system, the new programs should search for trans-disciplinary approaches for their installation, operation, and management. Each intervention should take into account the responsibilities and interest of each of the stakeholders, aiming to efficiently explore the knowledge and resources available, facilitating the feasibility for realization. Such principle also increases collaboration between different groups, promoting dialogue and transparency in the decision-making process, possibly reducing the current tensions of Altamira's social structure.





multi-environment

One of the main challenges for preservation practices is the definition of boundaries. Usually, when designing urban strategies, the focus relies solely on the built environment. The proposals should acknowledge the different environments of the region and overcome the existing boundaries. Built-, rural- and natural environments are recognized in the new urban strategies, encouraging a sustainable articulation between territories, instead of their isolation. Both rural- and natural landscapes are understood as fundamental for protection purposes, economic activities and preservation of the local practices and traditions.

6.2 STRATEGIES

figure 6.4 | **Many problems, one vision, four strategies**
The vision is adopted in order to set a framework between different approaches, resulting in the unity and coherence of the urban design, instead of its fragmentation. Structured by the vertical conclusions of the spatial analysis, the aim is to align series of projects with the critical topics encountered in Altamira, resulting in an integrated strategy design.

Four strategies were defined, each of them dealing with problems and challenges identified in each of the key factors. The strategies were conceived according to the design principles determined throughout the investigation of each topic. This method was adopted because it does not only addresses the current issues of Altamira but also allows the extrapolation of possible future scenario developments. The different principles were clustered by topics, constituting the four strategies for Altamira, namely: **Altamira & the Natural Landscape**; **Altamira & Public Life**; **Altamira: Live & Work**; and **Special Projects**.

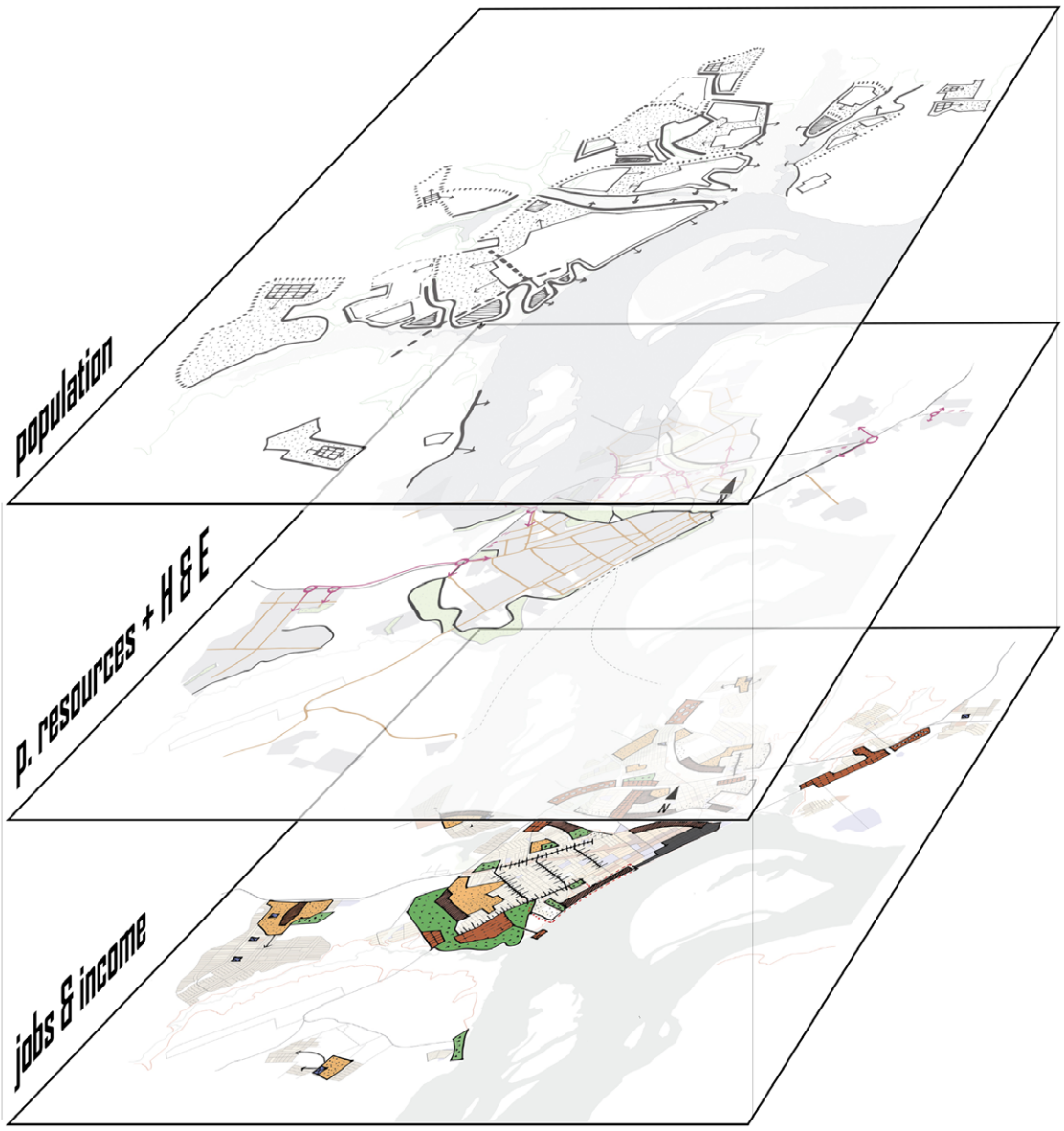
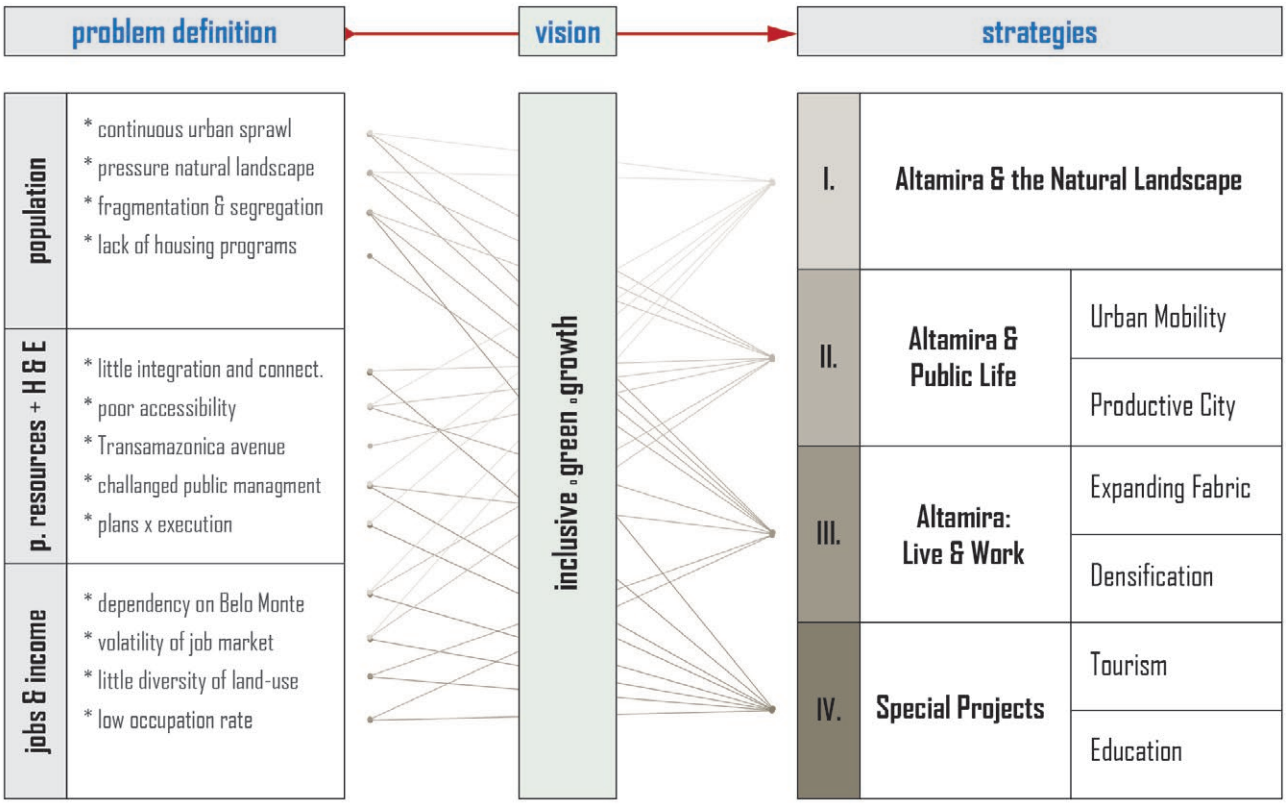


figure 6.5 | **Strategies and issues tackled**



1. Altamira & the Natural Landscape

The strategy intends to break the boundaries between urban, rural and natural. Acknowledging the Amazonian landscape and its resources should be a priority. But rather than having isolated preservation practices, the strategy looks for sustainable production practices, combining preservation to production, jobs, and culture. Also, by adding economic value to current preserved and reforestation environments, the design explores possible participation and collaboration of multiple stakeholders, preventing the responsibility to rely solely on the public management and compromising the feasibility of the project.

2. Altamira & Public Life

The strategy includes projects of integration and connectivity, bridging the gaps left by the fast and intensive growth that Altamira had over the past years. Production programs are also included within this strategy, employing and processing the resources and outcomes of the Natural Landscape strategies in a transparent and public way, encouraging the participation of different groups in the process and activating existing and new public spaces in the city. The strategy seeks accessibility and inclusiveness.

3. Altamira: Live & Work

Focused on typologies, land-use, zoning and job market, the strategy aims to define principles and policies for a growing Altamira. The strategies are divided into two sections, expansion and densification, considering the different approaches necessary for different urban tissues. The design explores and details different block typologies, bridging the gaps encountered between the current zoning plans and the development of the city.

4. Special Projects

Special projects are used as triggers for promoting spatial transformations, providing jobs and bringing resources. It is intended for the diversification of activities and for the trans-disciplinary approaches involved. In some of the programs, the incentive of such projects might be fundamental for 'closing the circle' and becoming feasible, especially considering the consolidation of a future scenario with limited public resources and poor management. The two special projects proposed are the development of tourism, exploring the natural potential, and of an education hub, exploiting the already existing equipment in Altamira.

Introducing a fourth dimension

A final (and important) remark before jumping to the urban strategies is the introduction of a fourth dimension for the design. In Altamira, instead of time, the fourth dimension accounted is UNCERTAINTY. In a territory under constant transformation, it becomes indispensable the notion that there is no single future outcome. Instead, there is a range of possible and probable futures, which could each lead the development of the city to a variety of directions. So, when planning with a long-term vision, beyond the 4 years of a government period (frequent time-frame adopted in public strategies in Brazil), there is the need of structuring the design according to different scenarios, preventing it from quickly becoming obsolete.

Scenario development was already discussed in this graduation thesis and possible outcomes were extrapolated according to criteria identified (based on the investigation of case studies, page 42) each of the key factors. The gaps and opportunities discovered with this exercise were tackled in each of the design principles and later incorporated in the definition of the four strategies. But, in addition to that, scenarios can also be a valuable tool for evaluating the expected result of the urban design, testing its efficiency according to different developmental outcomes. With this in mind, possible future models were determined. This was done by re-evaluating the case study cities conforming to the criteria identified and clustering similar behaviors, as shown in the diagram below. The result was three models, namely the **big city model**; the **resource extraction model**; and the **Tucurui / Maraba model**.

These models, described on the following page, are intended as an evaluation tool for each of the proposed urban strategies. They are not intended as a precise image of possible futures of Altamira. Instead, they simply extrapolate key factors based on similarities encountered in other precedent cities. The knowledge produced is used as a comparative tool, aiming to check the coherence of the proposal with different future developments. The exercise is also expected to point out possible gaps and opportunities for the implementation of the strategies according to each of the models.

Category		City	Criteria			
			I.	II.	III.	IV.
A.	Logistic & Transport	Sao Luis, MA	A	A	A	B
		Santana, AP	A	B	A	B
		Maraba, PA	B	B	A	B
B.	Resource Extraction	Parauapebas, PA	A	/	A	B
		Canaa dos Carajas, PA	A	/	B	B
		Ourilandia do Norte, PA	A	/	B	B
		Coari, AM	B	A	B	B
C.	Energy Landscape	Tucurui, PA	B	A	B	B
		Porto Velho, RO	A	B	A	B
		Altamira, PA	A	/	B	B

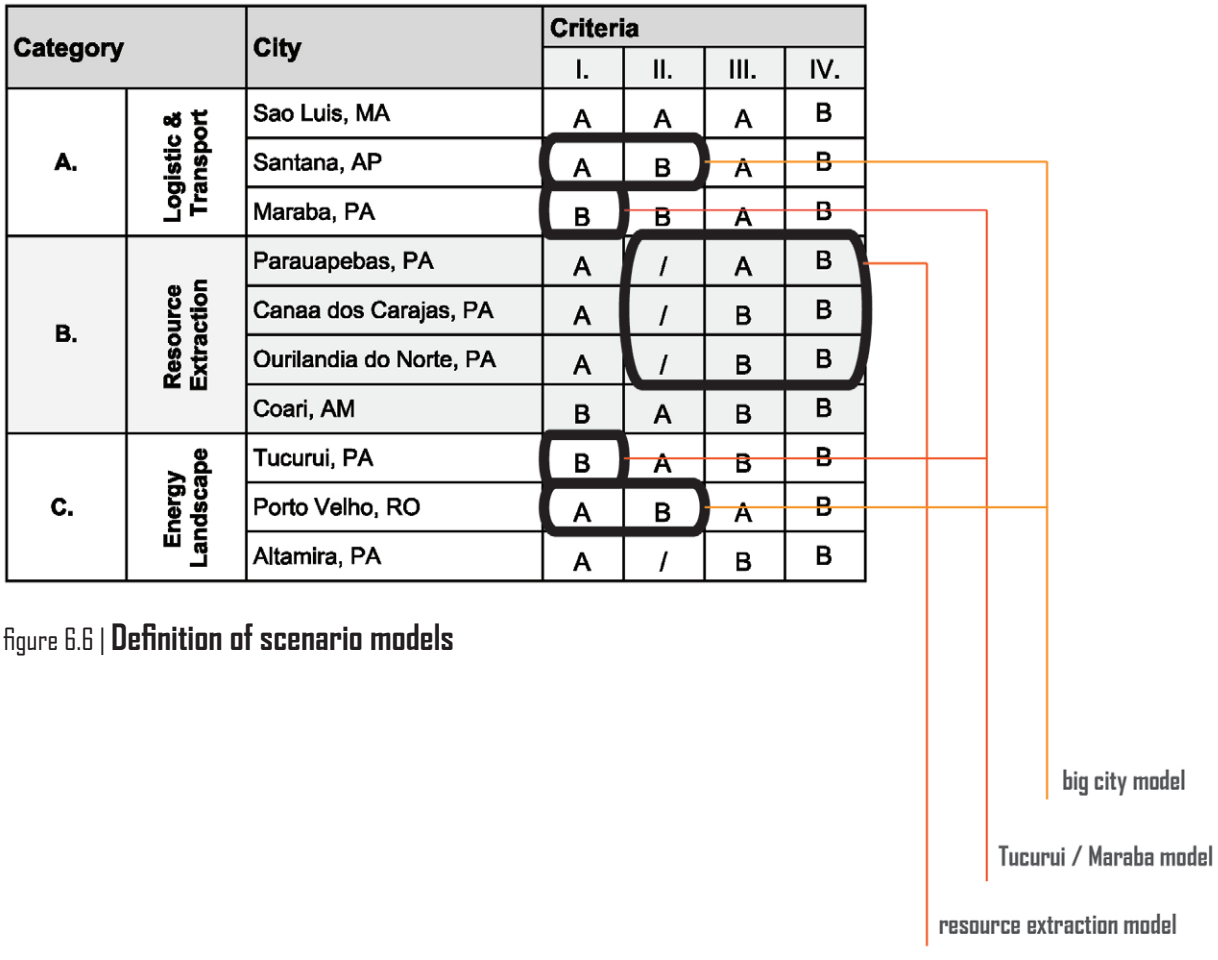


figure 6.6 | **Definition of scenario models**

the big city model	population	Population growth is quickly stabilized. Pressure on housing is controlled and real-estate market returns to normal. Occupation occurs on current private or urban allotments, without further expansion.	Main transformations are **focused on the PBA**. With its conclusion and limited resources, there is little investment in public equipment and infrastructure, resulting in a **slow development rate**. Challenged public management might lead to the **degradation of some of the mitigation programs**. Dependency on Belo Monte and little diversification is **unable to solve the high unemployment** rate.
	p. res. + H & E	Focus on (poor or efficient) mitigation of impacts. Resources and programs are not efficient in promoting improvements of public infrastructure. Potential generated is not properly explored.	
	jobs & income	Temporary prosperity. Lack of long-term planning results in a quick decrease of GDP and job offer after the conclusion of the dam. Little diversification of market results in elasticity.	
the resource extraction model	population	Population growth is stabilized. Continuos demand for housing, but controlled. Occupation of both inner- and outer- rings of Altamira. Possible development of new allotments or informal settlements.	The implementation and conclusion of the dam lead to a **lasting increase of public resources.** But an innefficient management leads to **investments in individual projects without long-term planning**. Population keeps increasing, in a controlled rate. **Risk of further expansion of the urban fabric**, with new allotments or irregular settlements. **Unemployment remains a big issue**, without alternatives to fulfill the void left with the conclusion of the dam.
	p. res. + H & E	Significant and lasting increase on GDP and public resources facilitates the construction of equipment and infrastructure. Challenged management, however, might lead to an inadequate application of resources.	
	jobs & income	Temporary prosperity. The increased GDP is a reflection of taxes and operation of the dam, without the diversification of the job market. Unemployment rate rises.	
the Tucurui / Maraba model	population	Conclusion of the dam and consolidation of the city as a sub-regional center lead to a continuous migratory flow. Demand for housing keeps increasing and urban expansion is constant. Probable informal development.	The scenario is shaped by a **continuous and intense migratory flow**. Might be associated with the possible implementation of the **Belo Sun** mining project. Urban fabric keeps **sprawling quickly, without proper densification**. Increasing demand for public infrastructure and equipment. Intensity might result in **lack of accessibility and informality**. The new migratory flow might **increase job and income generation opportunities**, with the diversification of the economic activities.
	p. res. + H & E	Enduring increase on GDP and public resources. Challenged management, however, might lead to an inadequate application of resources. Increasing demand and pressure for expansion of the network.	
	jobs & income	Increasing population also brings new opportunities, leading to the diversification of job market. Gradual and partial decrease of unemployment rate, with the development of new income generating opportunities.	

strategy 1/4

ALTAMIRA & THE NATURAL LANDSCAPE

figure 6.7 | **Degradated landscape in the Amazon**
image by Coen Wubbels
source: http://www.bbc.com/travel/story/20141028-the-road-transforming-the-amazon

One of the main objectives for the future development of Altamira and other cities in the Amazon is the acknowledgment of the natural landscape, its forests, and rivers. However, the definition of 'preservation' often separates nature from men, assuming human occupation always degrades the environment. The following design strategy aims to break this boundary by stating that human activities are instead necessary for the regeneration and maintenance of the surrounding nature. Added to this, the model of establishing boundaries and defining preserved 'intouchable' landscapes has proven to be expensive, inefficient and unsuccessful. The proposal investigates socio-economic practices and trends capable of re-establishing a dialogue between the Amazon, its local communities and the built environment, by promoting a sustainable exploration of the vast amounts of natural resources available whilst regenerating the fragmented landscape.

As concluded in the synopsis of the spatial analysis, urban development in the Amazonian Region, has been neglecting and harming the natural environment, especially since the opening of the Transamazonica highway in the 70's. The first and second maps on the following page, retrieved from the Atlas of Forest Landscape Restoration Opportunities, highlight the predominance of fragmented and degraded conditions and the high human pressure in the landscapes surrounding the city of Altamira. With this image in mind, there is no doubt that land restoration practices in the region have become an urgent necessity, especially considering recent agricultural and urban expansions. However, even though the momentum for such practices is growing, financing and putting a value on the value of a restored landscape is no easy task (WRI, 2018). But, as defended by the president of the World Resources Institute Andrew Steer, 'it can also be an attractive business'. The third map emphasizes the large potential available for the implementation of productive restoration practices.

The first strategy investigates how Altamira could be designed to explore the potential of these businesses and practices, promoting a sustainable development of the urban fabric by celebrating the abundance and diversity of the natural resources available. By doing so, benefits including wood and non-wood products, income for ecotourism, gains in agricultural production, amongst other could be expected for the municipality and its population (WRI, 2018). And even though the strategy goes beyond the boundaries of the city, the design focuses on the articulation spaces (current boundaries) where human and nature meet. With the fast urban expansion rate and unorganized growth, the built environment added pressure to natural one, resulting in the definition of a hard boundary. Rather than isolation, the strategy asks for a celebration of these articulation points between men and nature, assuming not only the present conditions but also future developments.

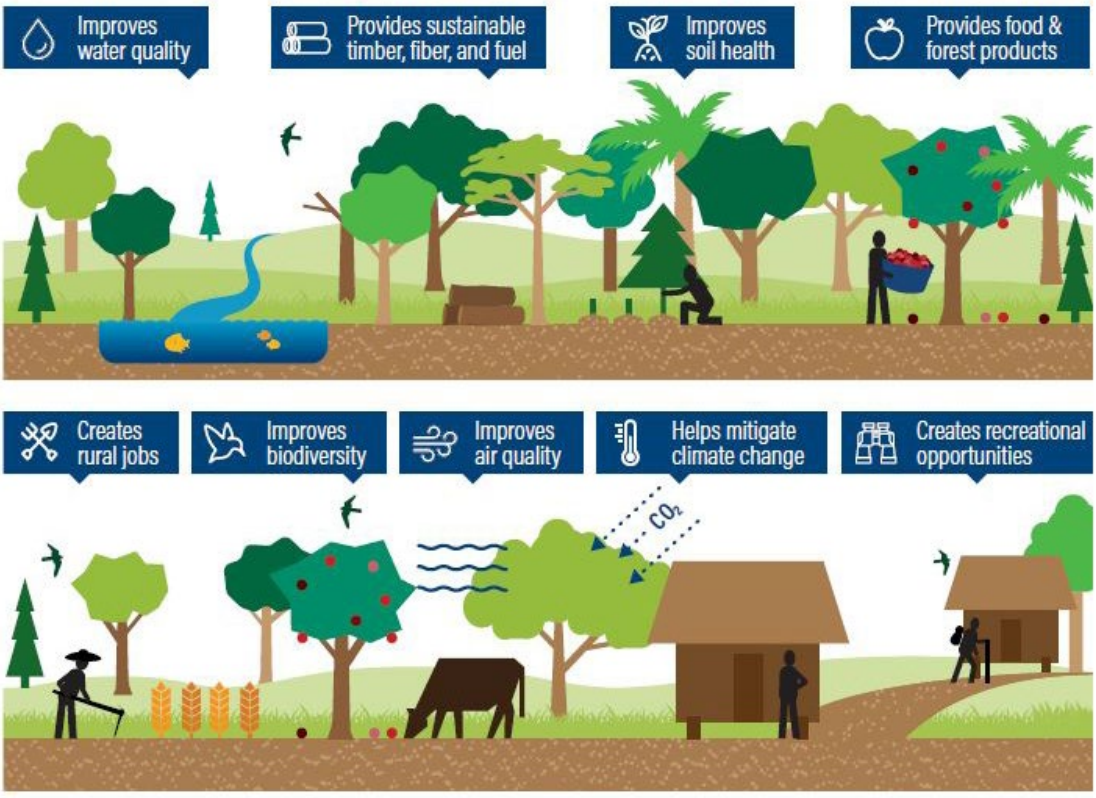


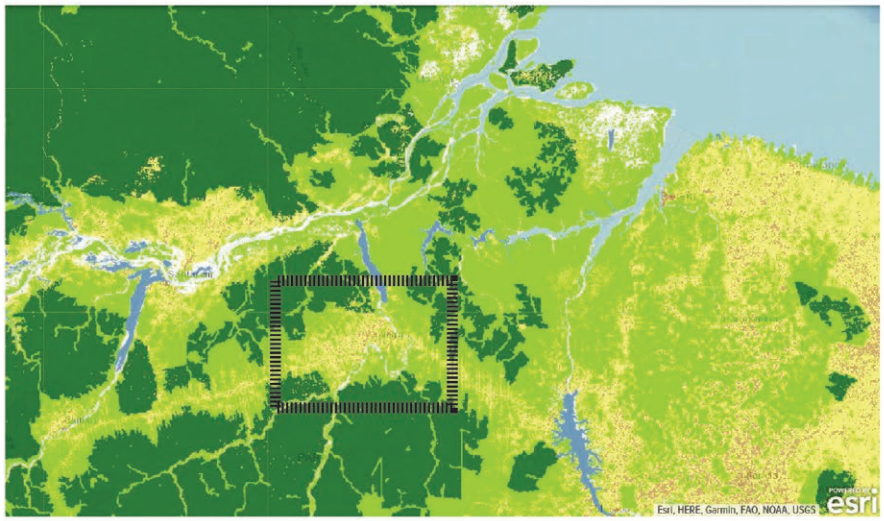
figure 6.8 | **Benefits of a plant-based restoration**
source: WRI

figure 6.9 | **Vegetation conditions, human pressure and restoration opportunities**
source: Atlas of Forest Landscape Restoration Opportunities

1. **current conditions**
of forests and woodlands

legend:

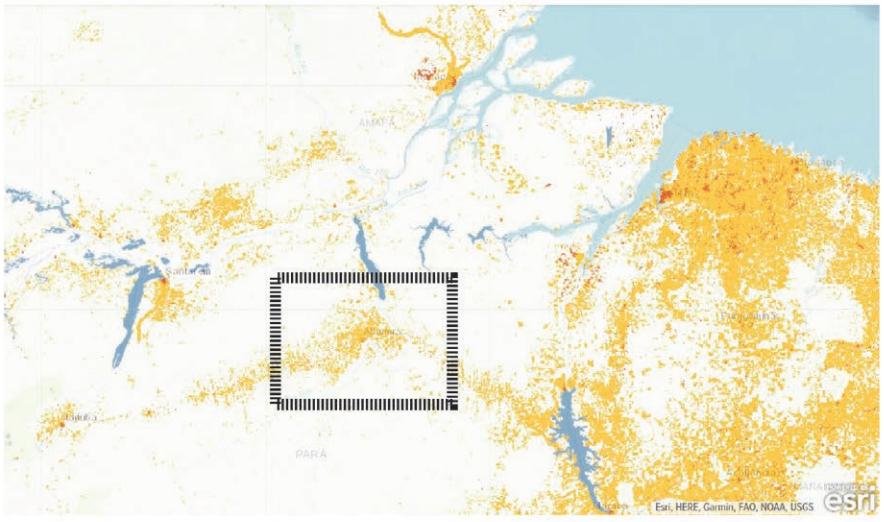
- intact
- fragmented / managed
- degraded
- deforested



2. **human pressure**
land-use intensity and density

legend:

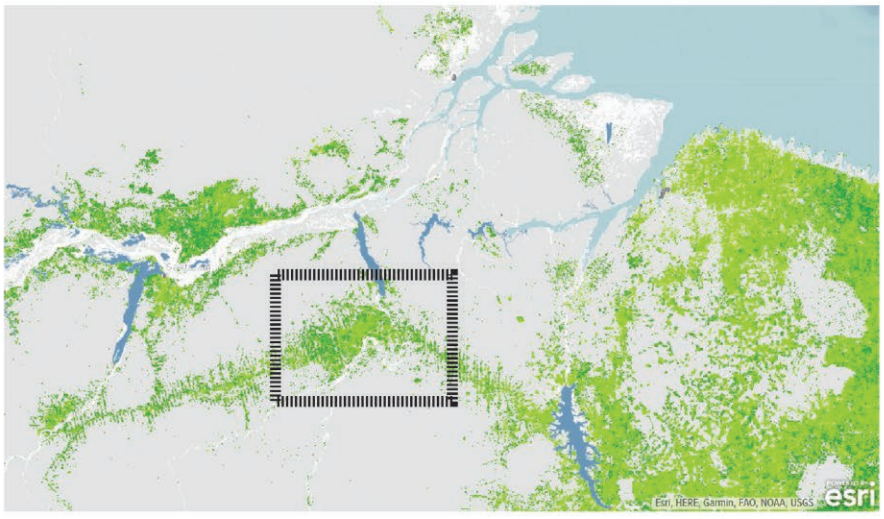
- high human pressure
- moderate human pressure
- low human pressure

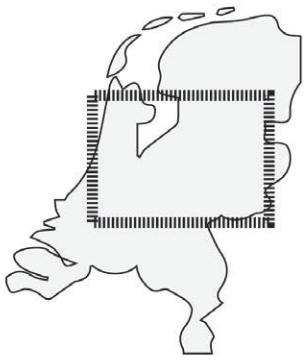


3. **restoration opportunities**

legend:

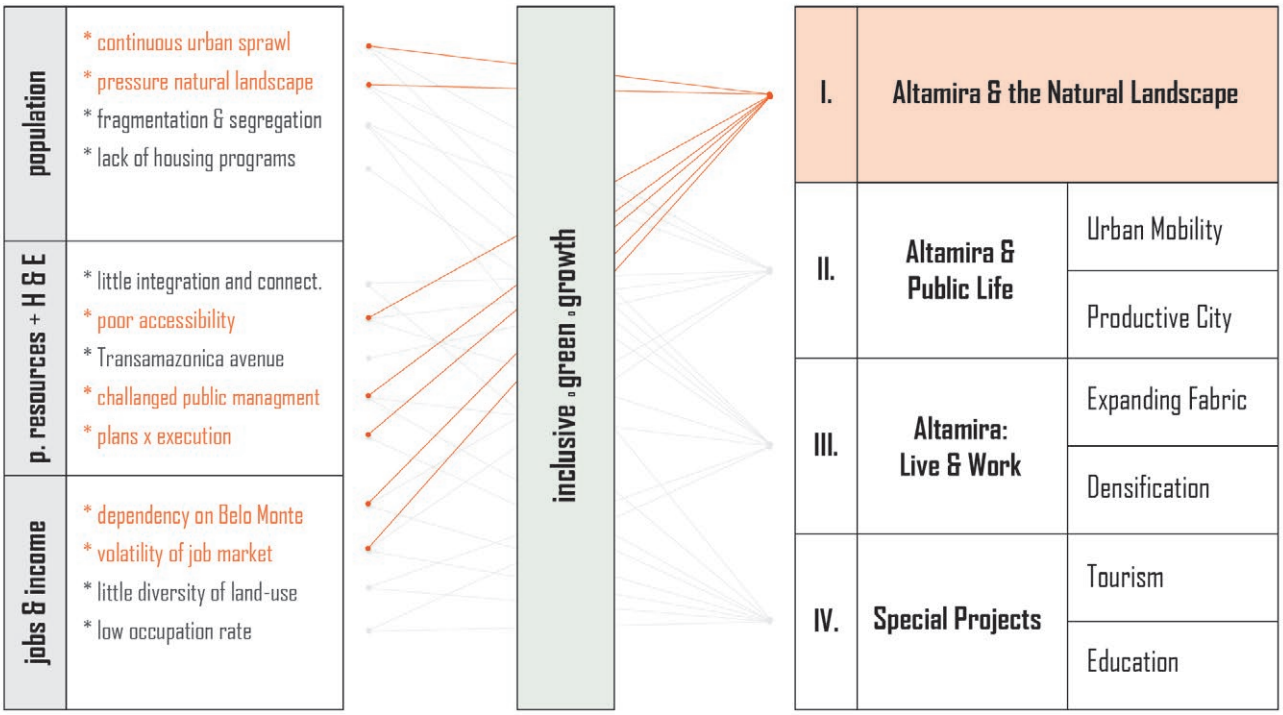
- wide-scale restoration
- mosaic restoration





Proportion of the highlighted area

figure 6.10 | **Socio-spatial issues tackled**



Besides its main principle of acknowledging the natural landscape of the Amazonian region, the strategy was also designed to tackle several of the spatial challenges identified in Altamira, as shown in the diagram above. Mainly concerned about the possibility of further urban sprawl, there is the need to define the boundaries of the urban fabric. Instead of a simple delimitation of protected and isolated areas, which has shown to be expensive, ineffective, and susceptible to irregular occupation, introducing productive activities and revenue generation might ensure the proper determination of a porous and ambiguous boundary. The benefits are expected to be twofold. On the one hand, the effort of restoration landscapes, facilitated by a possibly profitable business model, encourage the creation of jobs and highlights the potential of the natural environment, once properly explored. This could raise the awareness of the population and positively influence the mindset of the inhabitants, embracing the 'green' landscape. On the other hand, the jobs and economic activities associated to the exploration of natural resources can reinforce the delimitation of the areas which are protected, removing some of the pressure from the municipality and environmental agencies and ensuring a proper preservation boundary. Furthermore, the strategy aims to promote the development of the primary sector, resulting in the creation of new jobs and income generation strategies.

figure 6.11 | **New urban expansion & boundaries**
image by the author

figure 6.12 | **Types of vegetation**

Designing the strategy

The first step is to understand different 'types of green' of the region. Based on the characteristics of each of the ecologies, different 'sustainable' practices were chosen for their potential of not only regenerating landscapes but also encouraging low-impact productive activities. The relationship between ecologies and the possible activities is shown in the diagram in the previous page. The chosen practices also recognize that without economy, there is no balance. By adding a monetary value to the reforestation practices such solutions could attract the interest of the private sector, resulting in efficient preservation model, besides numerous benefits for local communities, such as job creation, income opportunities, and empowerment. In here it is also to remember that restoration is a long-term affair. Native species and ecosystems will not be able to recover it short periods of time (WRI, 2018).

The design of the plan, shown in the following page, was conceived based on the boundaries determined with the principles of the population key factor, already incorporating the expansion axis and future growth of the city. The intent is to ensure that future occupation will acknowledge the natural landscape, preventing irregular or unorganized urbanization of the waterfront, streams, and preserved areas. To do so, interest areas were selected and productive activities were determined according to the current conditions of the sites. It is important to understand that the areas within the urban fabric are quite small for the implementation of such practices, thus needing to be associated with larger productive areas outside the city limits. With the delimitation of the perimeter for new productive activities, the new boundaries were designed, imposing limits to urban growth and spaces of articulation between men and nature. These boundaries are conceived as a network of marginal roads and avenues, ensuring public use of the waterfronts and streams. Their representation is further detailed in the Altamira & Public Life strategy.

Another important factor of the plan is the realization that the production cannot be fully explored without proper development of the food processing industry and urban infrastructure to do so. In this regard, associated with the strategy is the proposal for the creation of a harbor and two industrial parks in the city. The harbor is a necessity pointed out by Valdir Narzeth (vice president of the commercial association) and Marcelo Salazar (coordinator of ISA), both who highlighted how imperative its implementation is for the development of the industry and provision of jobs in Altamira. The site chosen for the new port is on the urban fabric expanding on the margins of the Xingu, a little before the Panela stream. There, besides the central location, the profile of the site would facilitate the construction without extensive grounding. The industrial parks are located according to their logistic qualities, both in currently unoccupied areas within the urban tissue. The first is located next to the new harbor and the second in on of the intersections of the Transamazonica highway, area in which industry is already being developed.

Implementing the strategy

Regarding its implementation, the strategy relies on the growing interest of governments and their sustainability goals to become feasible. Many of the projects, however, have a high implementation cost, hardening the economic feasibility of the strategy. When considering the challenged public management of the city and the possible limitation of the public resources in the future, the conception might become a little utopian. To cope with this, the design suggests that new public policies need to be implemented to attract the private sector into participating. There are today, nationally and globally, several funds, organizations, and initiatives interested in financing reforestation practices. The combination of new policies encouraging development, the expectation of proper infrastructure for installations, and the affirmation of the municipality as a pioneer in facilitating reforestation practices might result in the right recipe for attracting investments and businesses to Altamira.

Regarding its management, the design predicts a transdisciplinary approach, taking care that the responsibility does not rely solely upon the public sector. The engagement of the private sector and the participation of educational institutions and local organizations is fundamental to a successful implementation. An overview of the stakeholders involved, their influence and interest, is described on page 132.

types of vegetation

(sustainable) socio-economic activities & cycles

riparian vegetation

Vegetation next to streams and river, inside the APP's (protected areas).

1ry and 2ry vegetations

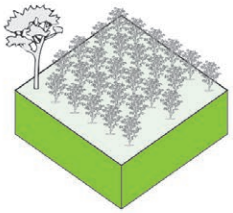
Dense ombrophilous forest. Large biodiversity.

regeneration landscape

Reestablishment of vegetation or increase tree cover through natural or assisted processes.

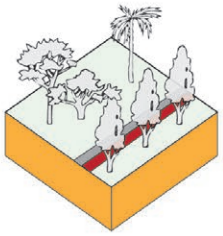
agriculture land

Productive fiels surrounding the urban areas. Some might considered degraded lands.



parks & leisure

Designed landscape for public use of the population of Altamira



long cycles **(+ 50 years)**

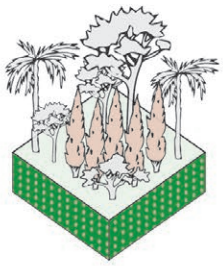
non-productive vegetation

Preserved and protected areas, without human extraction and activities

extractivism

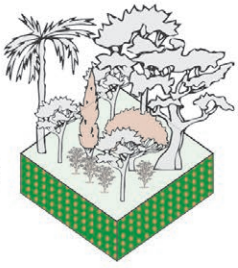
Extraction and use of natural resources produced in the forest in small scale practices. Also ensures preservation and maintenance of the vegetation.

medium cycles **(+ 15 years)**



wood agroforestry

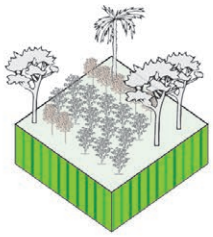
Production system integrating crop and forest components through a combination of tree species. Products imply a reduction (temporary) of forest biomass.



non-wood agroforestry

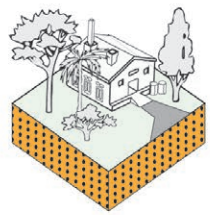
Production system integrating crop and forest components through a combination of agricultural crops. Products do not affect the standing forest. Focus on native species.

short cycles **(seasonal or - 15 years)**



rotative agriculture

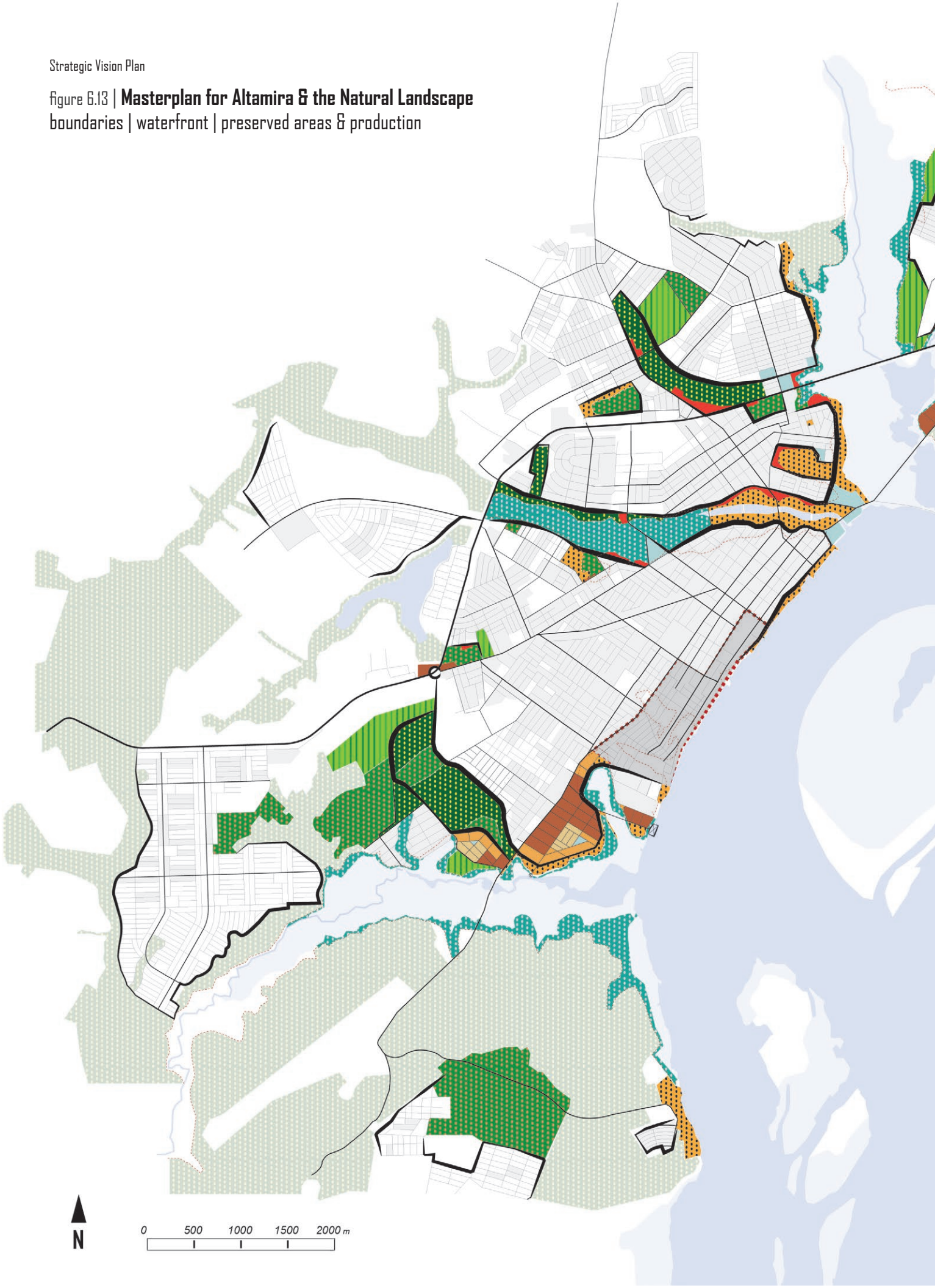
combination of permanent and temporary crops, ensuring rotativity of production and nutrients, preserving the fertility of the soil.

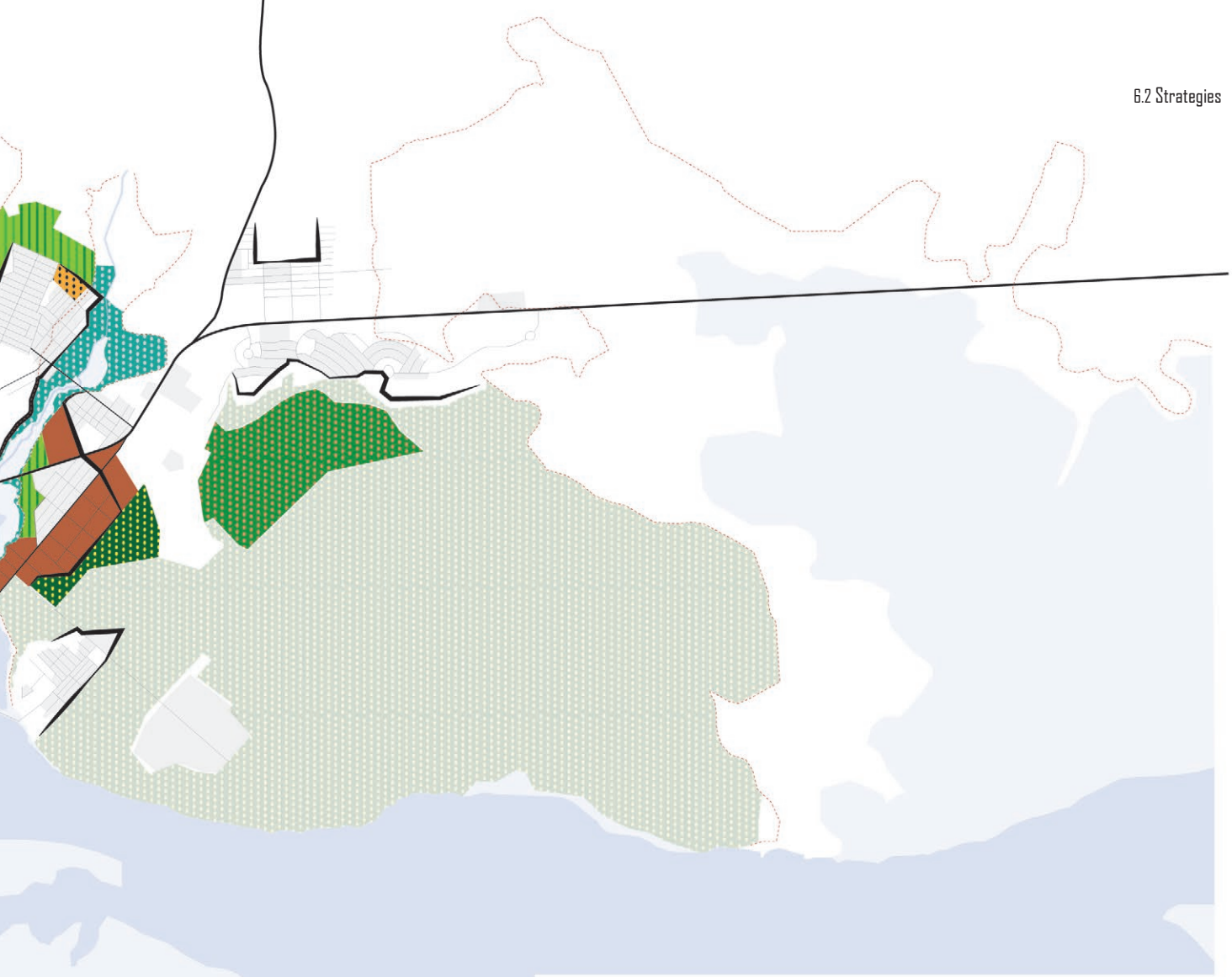


production centers

community centers for maintenance, gathering, selecting, connecting, learning, preserving and so on...

figure 6.13 | **Masterplan for Altamira & the Natural Landscape**
boundaries | waterfront | preserved areas & production





Legend:

boundaries, passage territories connecting human activities and nature, delimitation through new waterfront avenues

extendend road network, connecting neighborhoods to the new waterfront avenues and determining urban typologies in the risk areas

natural landscapes & parks

- **non-productive vegetation:** riparian vegetation, wetlands & floodable areas
- **extractivism:** 1ry and secondary vegetation; recovery and reforestation areas
- **agroforestry:** production of wood and non-wood goods; recovery areas
- **rotative agriculture:** existing and urban farms; medium and low cycle production
- **parks:** leisure; public space; and production centers
- **opportunity for extractivsm:** 1ry and 2ry vegetation surrounding Altamira

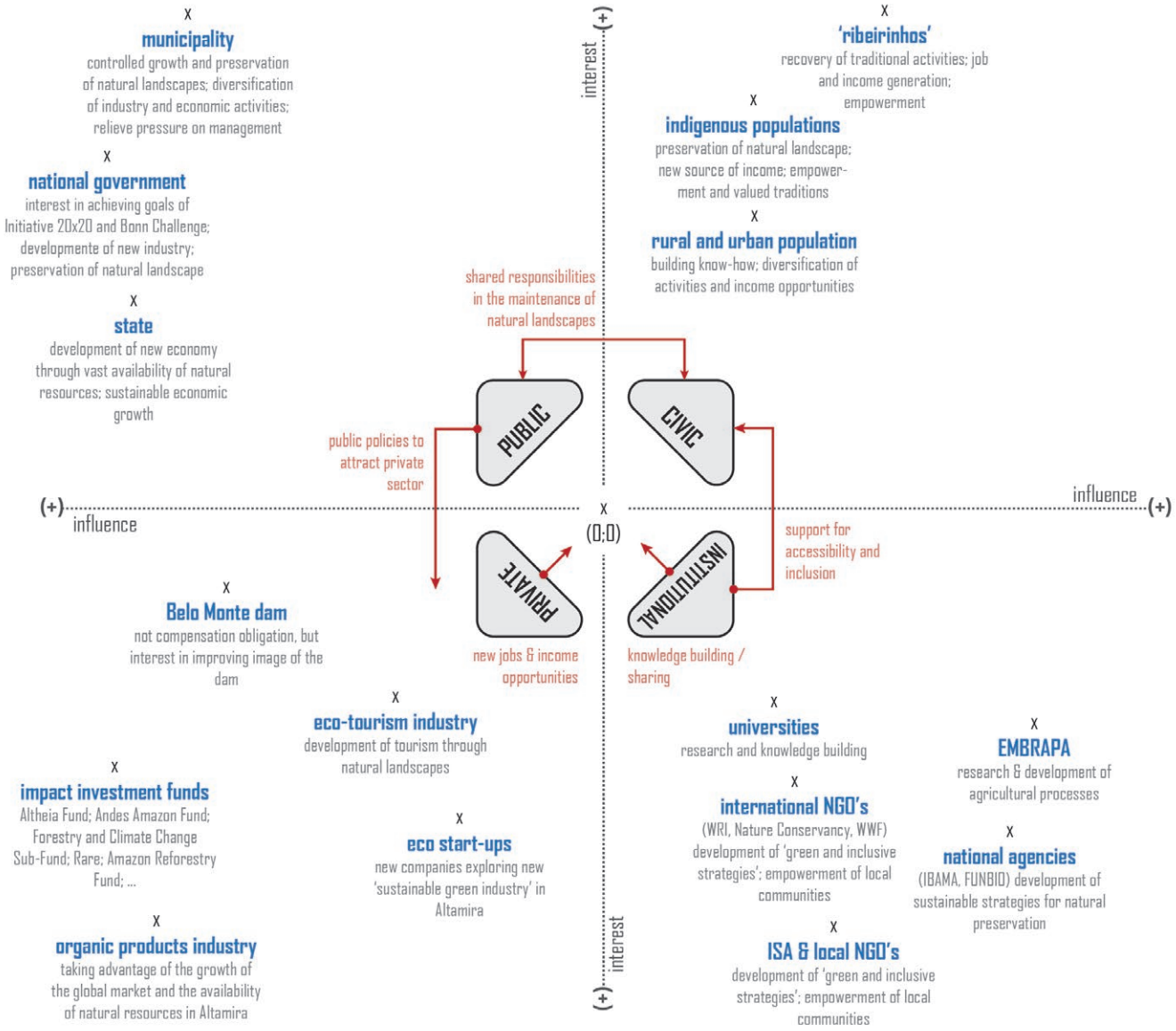
urban occupation & zoning

- **irregular occupation:** over riparian vegetation; flooded areas or park boundaries
- **commercial & industrial use:** two clusters for the development of local industry
- **mixed-use medium density typologies:** occupying the waterfronts
- **low-density residential typologies**
- **public equipment**
- **new harbour:** promoting the development of local food processing industry
- **special intervention:** for transformation of privately occupied waterfront

figure 6.13 | **Stakeholders, interest & influence**

PUBLIC MANAGEMENT is fundamental for implementing facilitating strategies for the development of a 'green and inclusive' strategy for Altamira and its surrounding region. If successful, the initiative will contribute to both the economic growth of the region and the preservation of the natural landscape, possibly reducing maintenance and management costs.

the CIVIC SOCIETY can expect many benefits of the proposed agroforestry practices. First, new sources of **income generation** and the development of the food processing industry. This also result in new **job opportunities**, includling gathering, croping or processing activities. Secondly, the initiative **empowers local communities** of indigenous people and 'ribeirinhos', highlighting their culture and values towards the natural landscape.



engamegent of the **PRIVATE SECTOR** is fundamental for the feasibility of the strategy. The implementation relies on the emerging trend towards the expansion of sustainable production in degraded lands (WRI, 2018). Furthermore, increasing concerns over the impact of consumption on the environment have influenced what and how people buy. The global revenue of organic foods and drinks, for example, has jumped from U$ 33 billion in 2005 to U$ 82 billion, ten years later (WRI, 2018).

INSTITUTIONS are important for two main reasons. The first is to bridge the gap between civic society and governments, ensuring a inclusive and just implementation of the proposal. The second is knowledge building and exchanging, ensuring the creation of adequate know-how and facilitating the realization of the process.

figure 6.14 | **Evaluation of the strategy according to possible future outcomes** (threats and opportunities)

OBSERVATIONS ◄ ► CONCLUSIONS

	SCENARIO MODELS			COMMON OBSERVATIONS	STRENGTH	◄ POTENTIALS
	BIG CITY	RES. EXTRACTION	TUCURUI | MARABA			
OPPORTUNITIES	* less agressive real-estate development might facilitate land regularization * high unemployment rate = pressure for diversification * pioneer project = attraction of funds as alternative source of income	* available resources + interest of funds might motivate public sector * visibility and enthusiasm of different groups might encourage an adequate mgnt. * alternative for diversification of job generation activities as a response to high unemployment rate	* high visibility in Altamira might be used to attract investors * possibility of implementation within new mitigation programs (Belo Sun) * availability of resources, pressure of environmental agencie and NGOs might encourage implementation	* interest and necessity for the implementation of a harbour in Altamira	1. interest and necessity of implementing a harbour and developing processing industry in the city 2. pioneer project. potential for attracting funds and investments	1. high visibility of the strategy and of Altamira 2. pressure for the diversification of job opportunities 3. 'sustainable' nature of strategy as leverage for support
THREATS	* limited resources might hamper the implementation, since its not seen as a priority * incomplete or partial implementation due to lack of resources	* continuous real-estate activity might increase pressure on natural landscape	* high pressure on natural landscape due to an intensive occupation rate * increased land value = no more interest from the private sector * diversification of industry = loss of interest * fast growth lead to new urb. challenges = little priority	* weak policies and control could lead to aggressive production practices instead of sustainable ones * land ownership and regularization	1. alignment and engagement with real-estate activities and developers 2. loss of interest of public and private sectors, depending on the scenario outcome	1. increasing land value in case of the implementation of the Belo Sun project might harm interest of private sector 2. land ownership and regularization
					RISKS ►	WEAKNESS

By evaluating the strategy according to possible scenario outcomes, a few points showed up to be vital for a successful implementation. As seen in the table above, the main strengths of the strategy, in all of the scenarios, is the interest of multiple stakeholders in a possible implementation of a harbor and the visibility this sort of strategy can have, able to attract several levels of investment. The strategic vision plan needs to be properly articulated by exploring those two factors as possible triggers allowing the feasibility of the design. At the same time, an inadequate articulation with some of the identified stakeholders could result in the loss of interest in a few of the possible future outcomes, increasing the risk of failing to implement. Of course, the interest of the different parties becomes key for a successful implementation. In this regard, few key projects, based on partnerships with pioneer companies and research and educational institutions, could be used as a strategy for triggering the expected outcome and engaging with further stakeholders.

The analysis also shows a few weaknesses that could hamper the envisioned development of Altamira. The first of all is land ownership and the challenging land regularization process in Brazil. The proposed activities would be implemented in both public and private lands and would rely on either lease, 'common land', or 'right to use' sort of contracts. Beyond traditional practices, those might be seen as not-feasible by the juridic system and land-owners of the region. The elaboration of public policies facilitating the agreement of these types of contracts can be one solution to prevent the collapse of the strategy. The second big challenge is associated with a possible implementation of the Belo Sun mining complex and a likely migratory flow associated with it. An intensive population growth will probably again result in the inflation of land value in the region, retracting the interest from investors and owners, which might find different and more profitable ways of exploiting it.

strategy 2/4

ALTAMIRA & PUBLIC LIFE

figure 6.15 | **Hole in the wall, looking into a distant Xingu river**
photo by the author

Enhancing the public life

The second part of the strategic vision plan looks into the challenges identified in the public space and equipment systems in Altamira. The aim is to provide innovative solutions capable of encouraging the growth of public life in the city, by promoting connectivity, integration, and accessibility in the form of infrastructure projects. Considering the accelerated urban growth over past years and the increasing social tension, the strategy becomes fundamental for organizing and planning the public sphere, with the objective of **improving the livability** in the built environment of Altamira. The strategy is divided into two parts. The first one, **Urban Mobility**, explores a series of mobility infrastructure projects necessary for connecting and integrating the fragmented expanding urban tissue of the city. The second one, **Productive City** seeks to articulate the natural environment strategies with the public life in Altamira by designing a network of spaces destined for the production of the proposed reforestation practices.

Again, several issues of each of the key factors are tackled with the implementation of the strategy, as shown in the graph below. The first part of the strategy tackles the challenges of a fast-growing urban fabric, including the fragmentation and segregation of new neighborhoods, the increasing pressure on the natural boundaries, and the frequent use of the Transamazonica highway (vital for the economic development of the region) as an urban avenue. The second part explores mainly the lack of accessibility seen in the city and the volatility of the job market, very dependent on the construction of the Belo Monte dam.

Urban Mobility

The city of Altamira has grown rapidly over the past 10 years and, even though much infrastructure has been constructed, the urban fabric faces serious challenges of connectivity and integration. The map on the following page illustrates the series of interventions designed for coping with these issues. The projects are divided according to three categories **(A)** Transamazonica interventions, focused on ensuring the functionality of the highway; **(B)** accessible waterfront, coping with growth pressure and ensuring public access to the waterfronts; and **(C)** connected city, integrating the new neighborhoods to the expanding urban fabric. The design aimed at interventions with high benefits and low impacts, avoiding the outline of new roads over multiple empty or constructed properties. The most radical and shocking transformation proposed is related to the interventions in the Transamazonica, currently a fundamental axis for the mobility in Altamira.

Figure 6.16 | **Socio-spatial issues tackled**

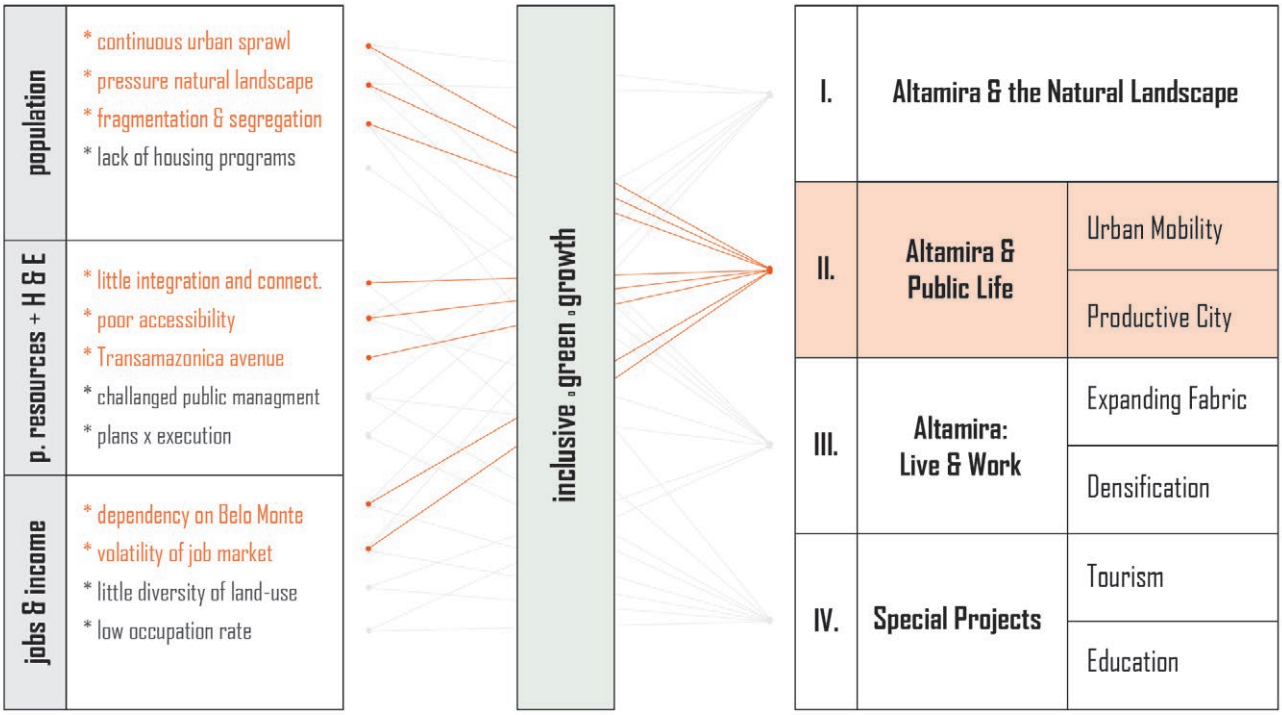
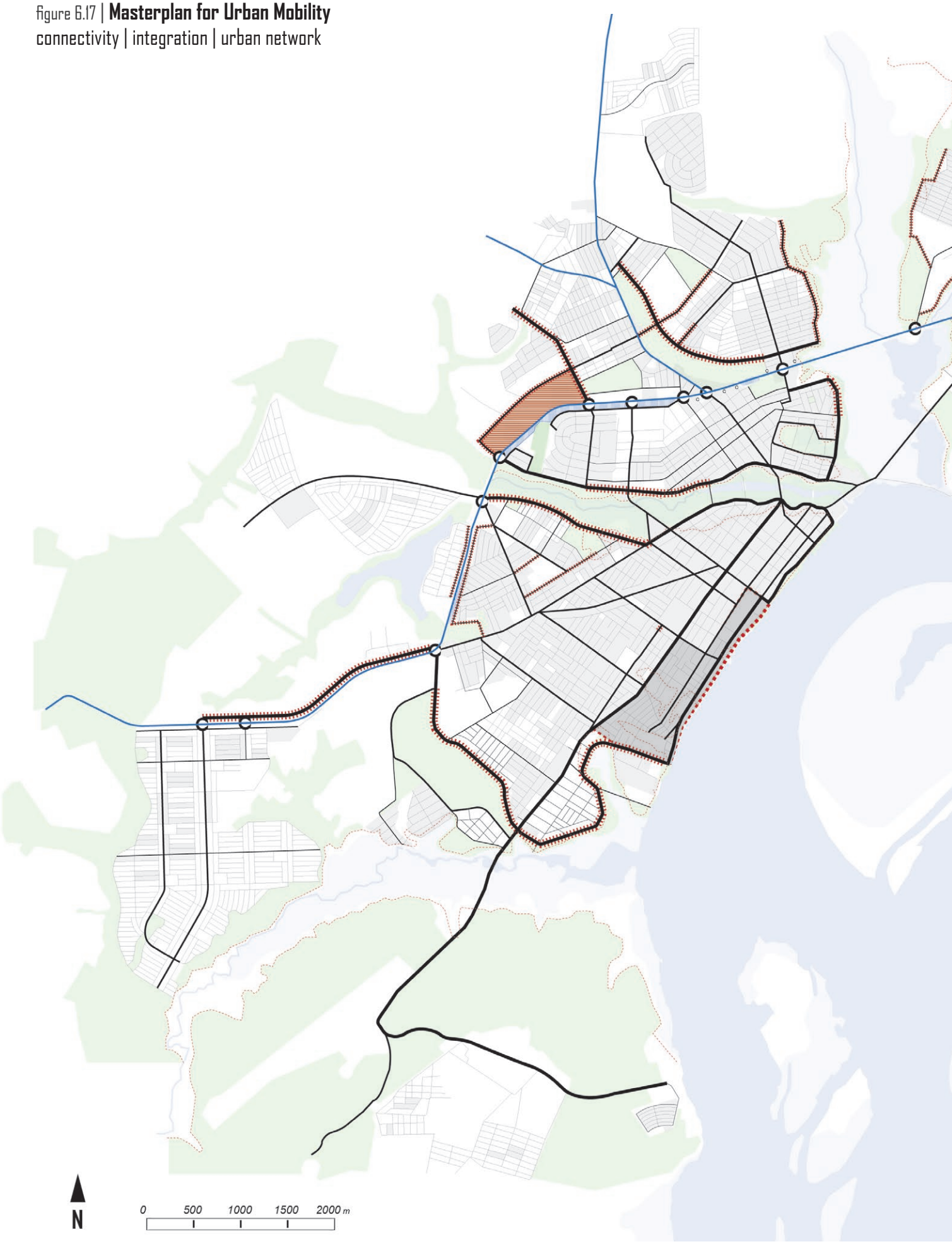


figure 6.17 | **Masterplan for Urban Mobility**
connectivity | integration | urban network



(A) transamazonica interventions

Predicted interventions aiming to prevent the Transamazonica Highway to become an urban avenue. The strategy consists in a series of projects controlling and organizing traffic, including marginal avenues in bottleneck sections, roundabouts in the main crossings and the interruption of secondary roads currently connected to the highway. Such interventions are **fundamental assuming a scenario with intensive population growth**, with the possible implementation of the Belo Sun gold mine. In this regard, the construction of the projects could be integrated into the compensation guidelines of the mining complex, coping with the high costs of the interventions.

(B) accessible waterfront

One of the most vital and urgent interventions for future growth of the city. The strategy aims the construction of roads and public spaces in margins of the waterfronts of the city, ensuring that the whole population will have access to the water and **promoting the articulation between city and nature.** Solutions were designed to prevent situations such as the ones shown below:

(C) connected city

Ponctual interventions aiming to improve the connectivity and integration of Altamira. Projects have different scales, from inter-neighborhood avenues to local roads. Key projects are selected for critical situations, of either poor accessibility or optimum results. The strategy also considers future residential and mixed-use allotments, created by the municipality, aiming to accommodate future growth.

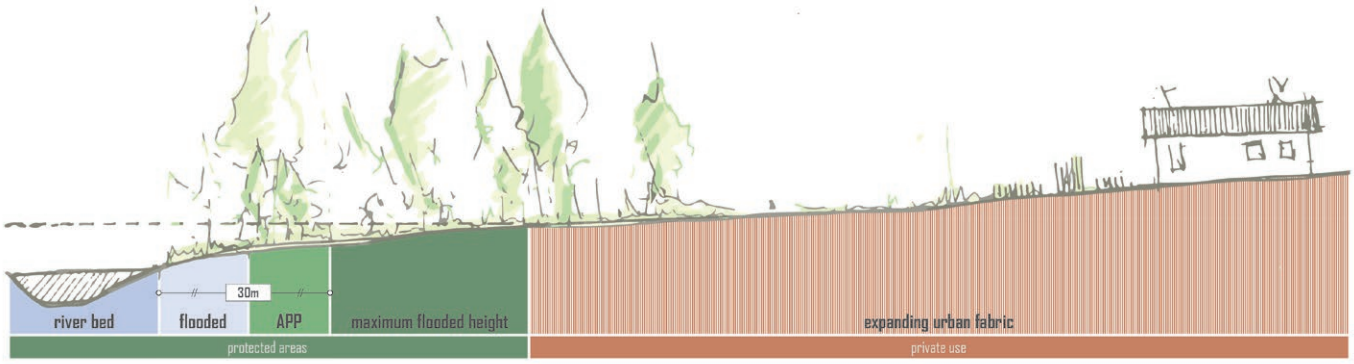
Legend:

- **structural avenues and interventions,** including new waterfront system
- **primary roads,** connecting multiple neighborhoods
- **secondary roads,** between different neighborhoods
- **local interventions,** for improving local connectivity
- **new roads and connections,** to be constructed
- **Transamazonica nodes & intersections**
- **Cul-de-sac,** limiting connections to the Transamazonica highway
- **informal occupations along the Transamazonica,** to be regularized
- **possible site for heavy industry, along the Transamazonica highway**

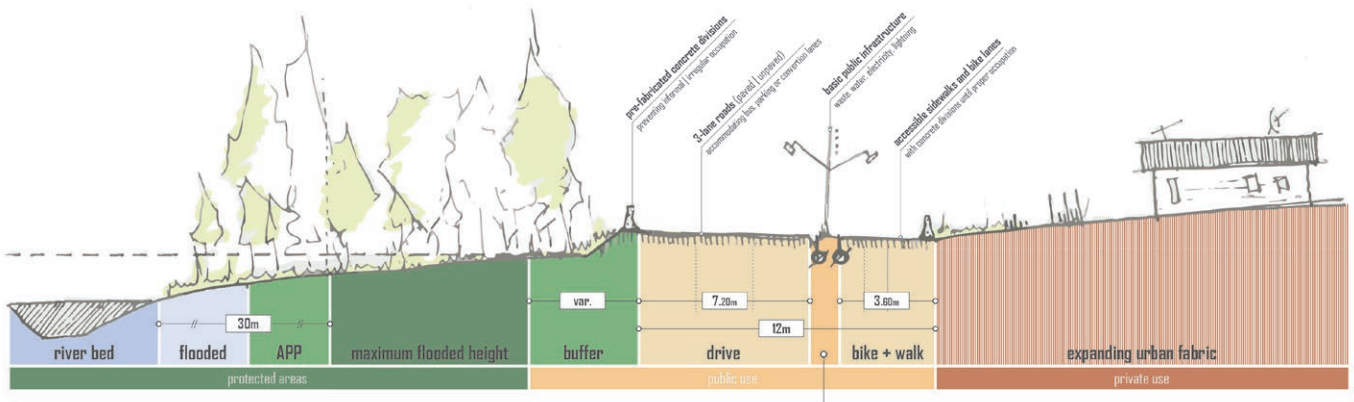
figure 6.18 | **Accessible waterfront and opening new marginal avenues**

As described in the previous map, one of the main objectives of the strategy is to accommodate future growth while ensuring public access to the waterfronts and parks of the city, preventing the repetition of the current pattern of private occupation. The design of marginal avenues is the solution chosen for promoting the envisioned development. The challenge today is that private properties are currently bordering protected areas, preventing access or even maintenance and control of the river and streams, as shown in the first section below. The avenues would explore these boundaries, by introducing a buffer between private and preserved. The implementation, even though difficult, assumes that land acquisition will easier in the margins of the properties, especially considering most of the sites have a low density of occupation. It is important to realize that in Altamira, the opening of a road does not imply a paved street. Considering the urgency of the matter and the current condition of the built environment, simplicity is always welcome, as represented in the photo-collage on the next page.

Furthermore, beyond the articulation and accessibility function, the roads and avenues play an important role in the city's basic infrastructure system. The first function is flood control, by defining the limits of the new maximum flood height and preventing housing developments beyond it. The second is their significance for the installation of an efficient waste and water treatment systems, considering their location on the margins of the streams, lowest points of the city. Finally, the roads are also important for the mobility of the city, creating a new system of marginal avenues, eventually connecting the whole city. The avenues are also ideal for the construction of bicycle lanes, because of their little declivity.



current waterfront occupation and land-use
private properties and urban allotments bordering protected areas



proposed waterfront roads and occupation
public roads in the boundaries between private allotments and preserved areas, ensuring access to the waterfront

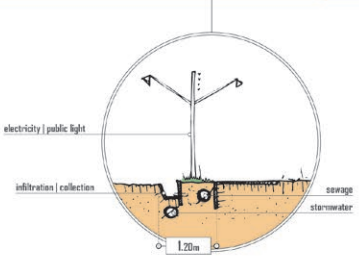


Figure 6.19 | **Opening of new marginal avenues**

figure 6.20 | **Productive City**

The second part of the strategy focuses on the new 'sustainable' production practices introduced in the city. The aim is to bridge the gap between producer and consumer by bringing part of the reforestation and agricultural processes into the urban fabric. The intended articulation is important for its collaborative function, promoting the interaction between different groups, leading to the activation of public spaces in the city, many times neglected. The design of the strategy consists in the construction and distribution of a network of 'production centers' throughout the urban tissue, connected by the public transport and bicycle networks. Clustered by type of production, these centers are destined for the processing and distribution of cultivated goods, aiding local producers to run their businesses. Furthermore, by exploring the potential of the production, the program also includes education and leisure activities, looking to integrate different groups, stakeholders, and activities together.

These production centers become the articulation between men and nature, between producers and consumers, between tradition and innovation. Operated by different stakeholders, the centers are designed for supporting, facilitating and exchanging the production of the reforestation practices and urban farms. In order to provide the required technical support, they are associated with local research and educational institutions, building up knowledge and sharing it with the population through classes and workshops. The distribution of several buildings over the city forms a network of active spaces, promoting the public life in Altamira. The program of the centers include:

Production and processing: Destined for producers, businesses, and consumers. Offers technical support and equipment facilitating production and processing processes. Can be clustered according to different types of products, as suggested in the graph on the next page.

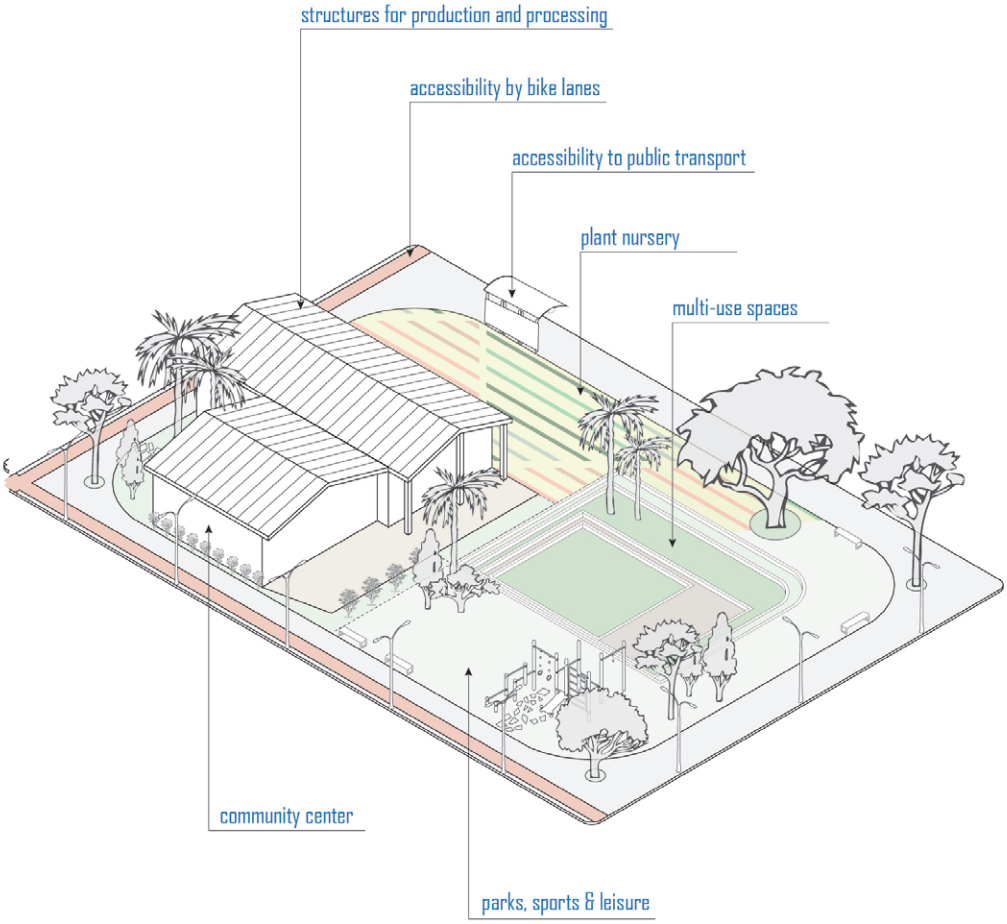
Community centers: Spaces for knowledge exchange and cultural manifestation. Courses and workshops are offered to assist agriculture, production, and micro-financing, supporting local business owners.

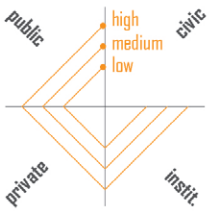
Plant nursery: Cultivation of seeds and plants of local species. Production are not only the end destination of the products but also the start. Technical support allows for the development of the nursery, incresing the capacity of reforestation practices and bringing awarness to the urban landscape.

Multi-use spaces: From markets to arenas, are intended for the exchange of goods and culture between different groups.

For its implementation and maintenance, the centers count with the creation of a multi-sector management team. A collaborative approach was again chosen to avoid to rely on the full responsibility to the already challenged municipality, a fact that could hamper the development of the program. Furthermore, the participation of local NGOs and institutions could ensure an inclusive operation, accessible to all different communities of Altamira. The diagram on the following page highlights the expected input and output, according to the different groups.

The map on the following page illustrates the proposed network for the centers, distributed over the neighborhoods of the urban tissue and accessible by the existing public transport system and a new proposed infrastructure of bike lanes. Most centers are located next to parks, existing or proposed, aiming for the activation of these spaces. The production is divided into clusters for facilitating and optimizing the production of specific goods traditional to the region and coping with equipment installation prices. Considering the amount of centers proposed in the design, possible cluster headquarters are suggested according to the accessibility and visibility of their sites, possibly working as trigger projects for the implementation of the strategy. The harbor and both industrial parks are also highlighted since they are directly associated with the production and activities of the centers.





how would production centers work and operate?

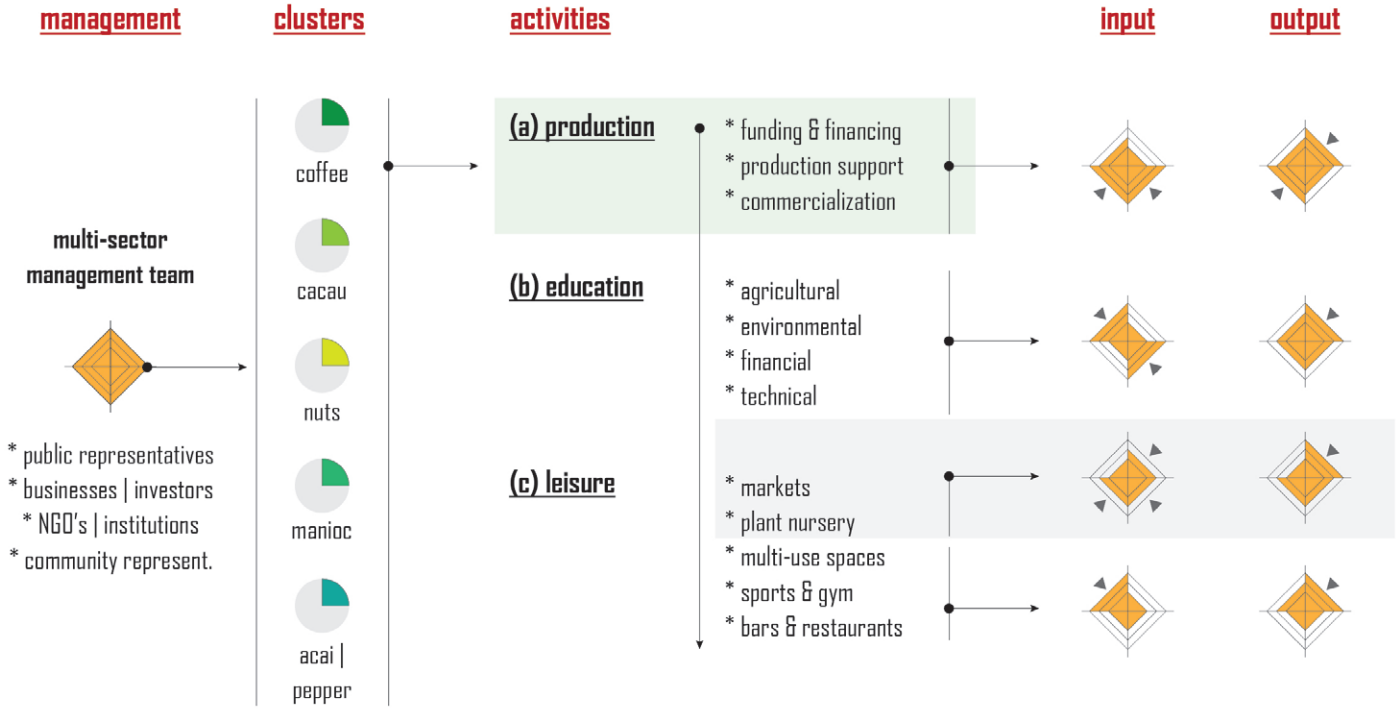
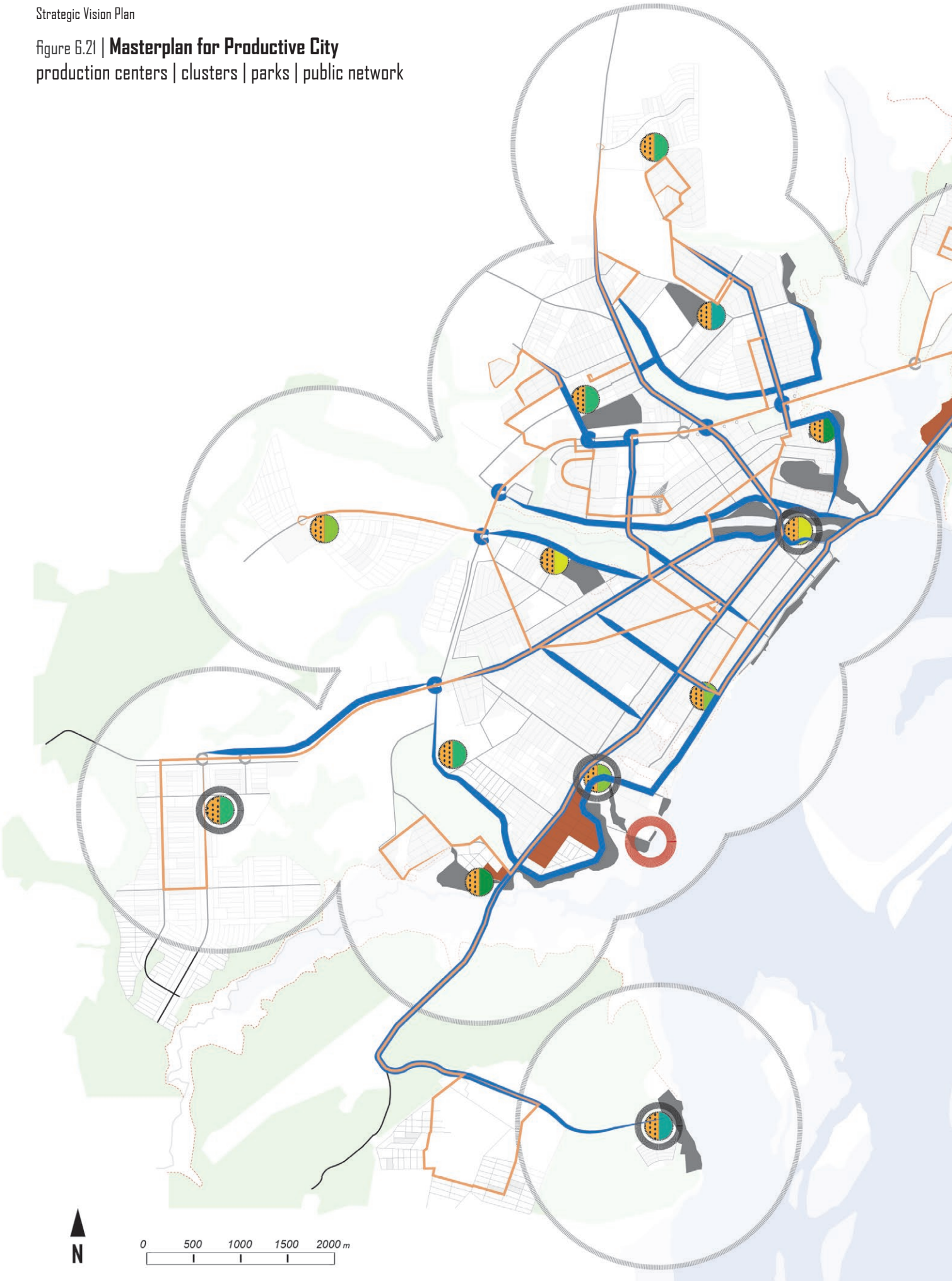
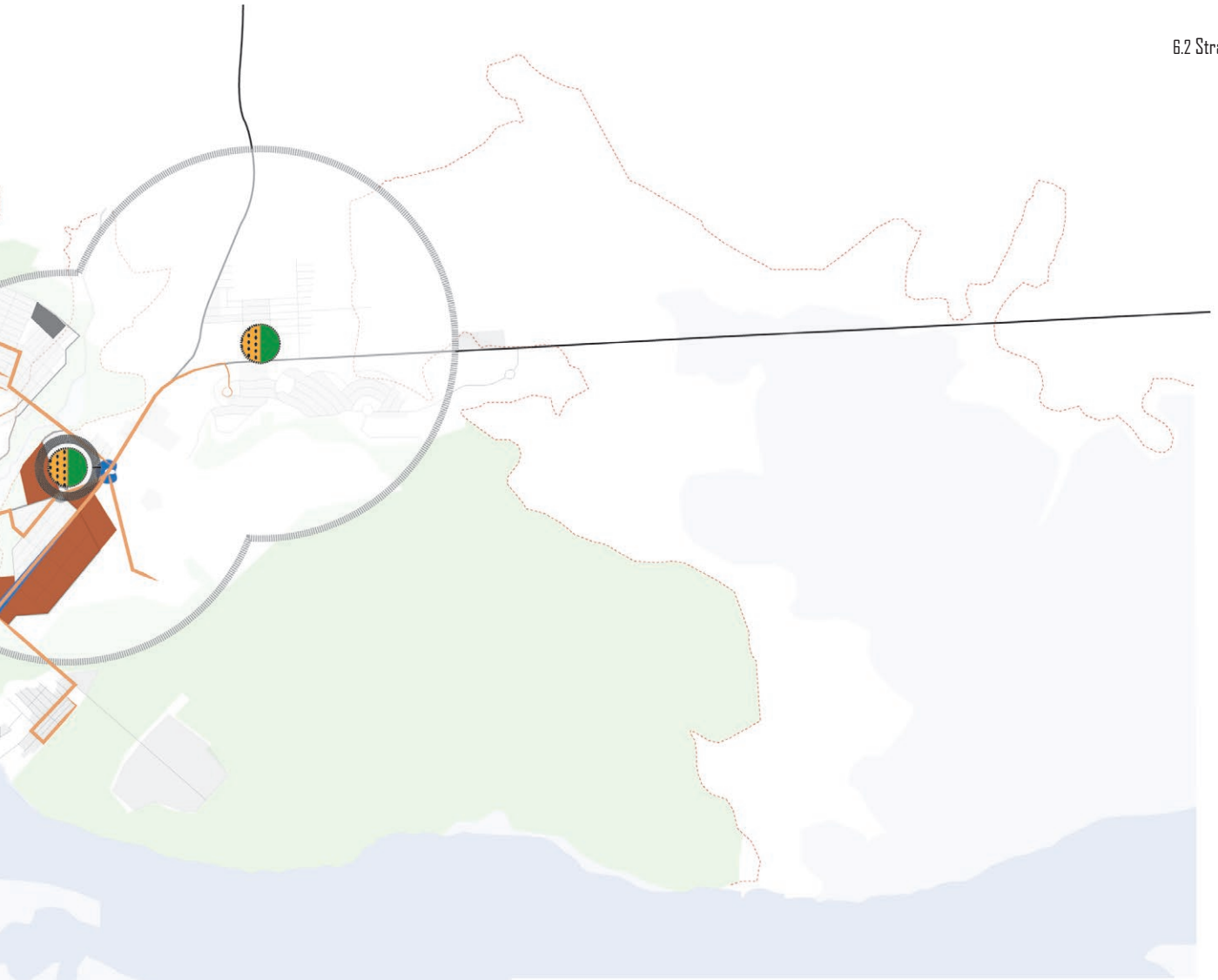


figure 6.21 | **Masterplan for Productive City**
production centers | clusters | parks | public network

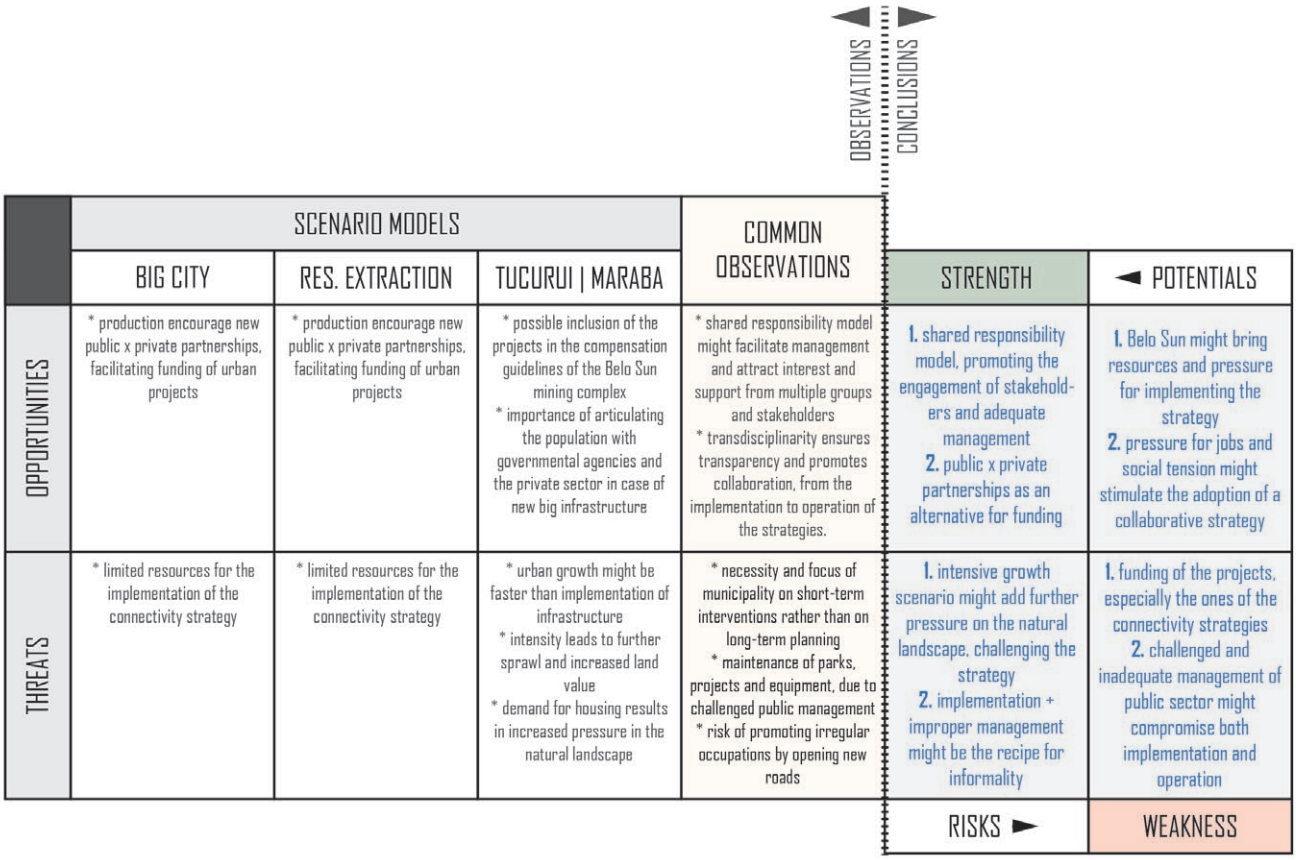




Legend:

- production centers
- possible product clusters
  - cacau
  - coffee
  - nuts & rubber
  - manioc & vegetables
  - pepper & acai
- product cluster headquartes
- cyclable distance to production centers (1500m)
- new proposed harbour for Altamira
- industrial clusters for product and food processing
- parks & recreation (existing and proposed)
- proposed bike-lane network for Altamira
- existing public transport system (bus lines)

figure 6.22 | **Evaluation of the strategy according to possible future outcomes** (threats and opportunities)



By evaluating the strategy according to the possible future scenarios of the city, a few strengths and weaknesses come to light, guiding a future action plan for a successful implementation of the programs. The main challenge, seen mainly in the first two scenarios, is concerning funding strategies for the project. Especially within the urban mobility framework, most of the projects have a high cost of implementation. And in a scenario of limited public resources, their implementation might not be feasible. There are a few tools that could be implemented to cope this issue, including a phasing strategy and possible public-private partnerships. In the third scenario, assuming the implementation of the Belo Sun complex, the costs and construction of the projects could be included in the new compensation guidelines.

A second challenge identified is the possible inadequate public management of the city. Such a fact could lead to a quick deterioration or poor implementation of the programs. In this regard, the consolidation of the shared responsibility model becomes fundamental for ensuring an efficient management and proper functioning of the strategy, primarily concerning the productive city guidelines. Special attention should be paid in monitoring programs, preventing the appearance of informal settlements along the new road network.

On the other hand, one potential that was diagnosed is the pressure the high unemployment rate could exert in the municipality for implementing the strategy. Within the urgent search for the diversification of the job market, the construction of integrating infrastructure and the production centers could become a reliable source of job and opportunity generation. With the interest of the municipality and the support of local institutions and private companies, aiming to explore these new growing market, the consolidation of the vision might become economically feasible.

figure 6.23 | **New (little used) Altamira stream park, previous informal settlement**
photo by the author

strategy 3/4

ALTAMIRA, LIVE & WORK

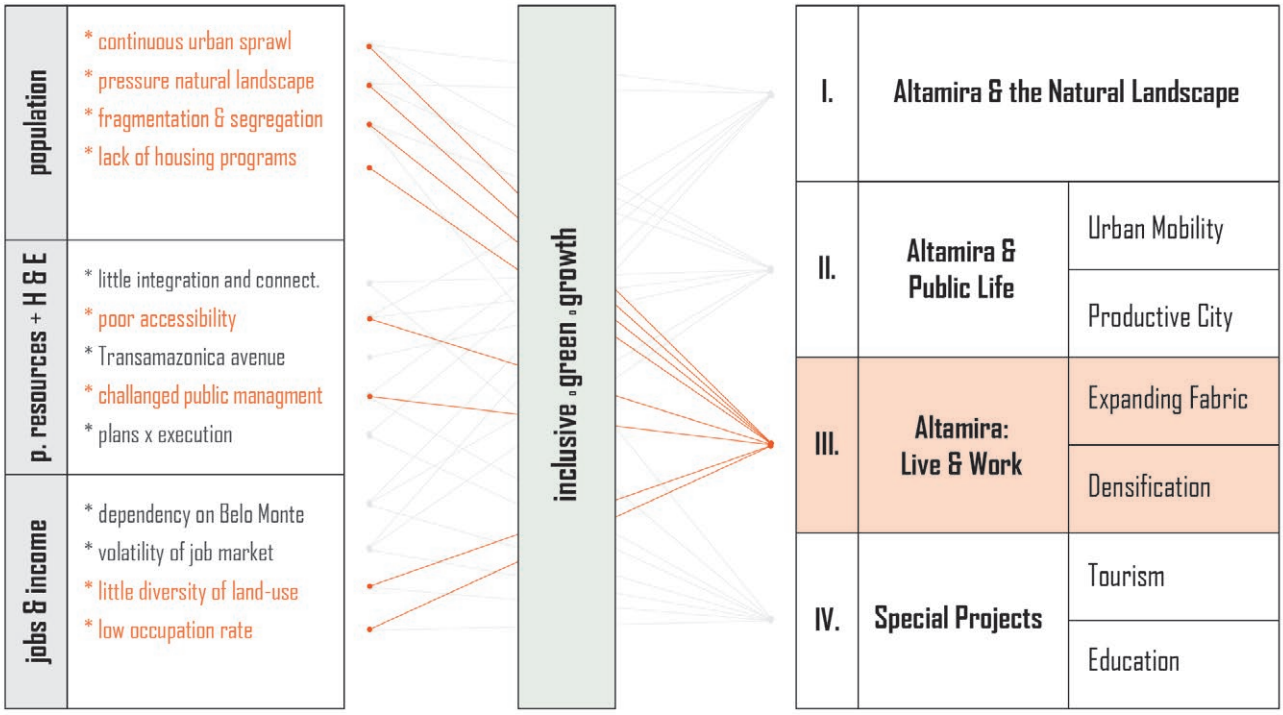
figure 6.24 | Social housing complex, financed by the national housing program
photo by the author

Exploring new urban typologies in Altamira

After exploring the boundaries of the city, the articulation between men and nature, and proposals for the public sphere of the city, the third strategy consists on the proposals for the built environment and its development. Assuming an inevitable growth of the city, the following chapter investigates the urban characteristics of an expanding and densifying urban fabric, looking for solutions, typologies, and policies capable of stirring and organizing future variations of the population figures. The strategy becomes fundamental for the success of the first two, assuming the current sprawling occupation pattern analyzed in the territory, a fact that keeps pushing the boundaries of the city and adding pressure to the natural environment. With this in mind, the proposals not only investigate possible ways of promoting the occupation and densification of the existing tissues but also predict possible expansion axis and typologies, ensuring the accommodation of all the probable future outcomes.

As shown in the table below, the strategy expects to tackle all the challenges identified under the population and migration key factor. Predicting a continuous urban growth and the mentioned tendency for sprawl, mainly due to the availability of land, the programs aim to define typologies coherent with the sensible urban fabric instead of generic zoning plans. The solutions aim for inclussiveness, considering the little accessibility of the central neighborhoods and the marginalization of the peripherial ones. The diversification of the land-use is also within the scope of the strategy, trying to promote a new mixed-use occupation in the many segregated residential allotments of Altamira.

figure 6.25 | **Socio-spatial issues tackled**



But first, new housing programs

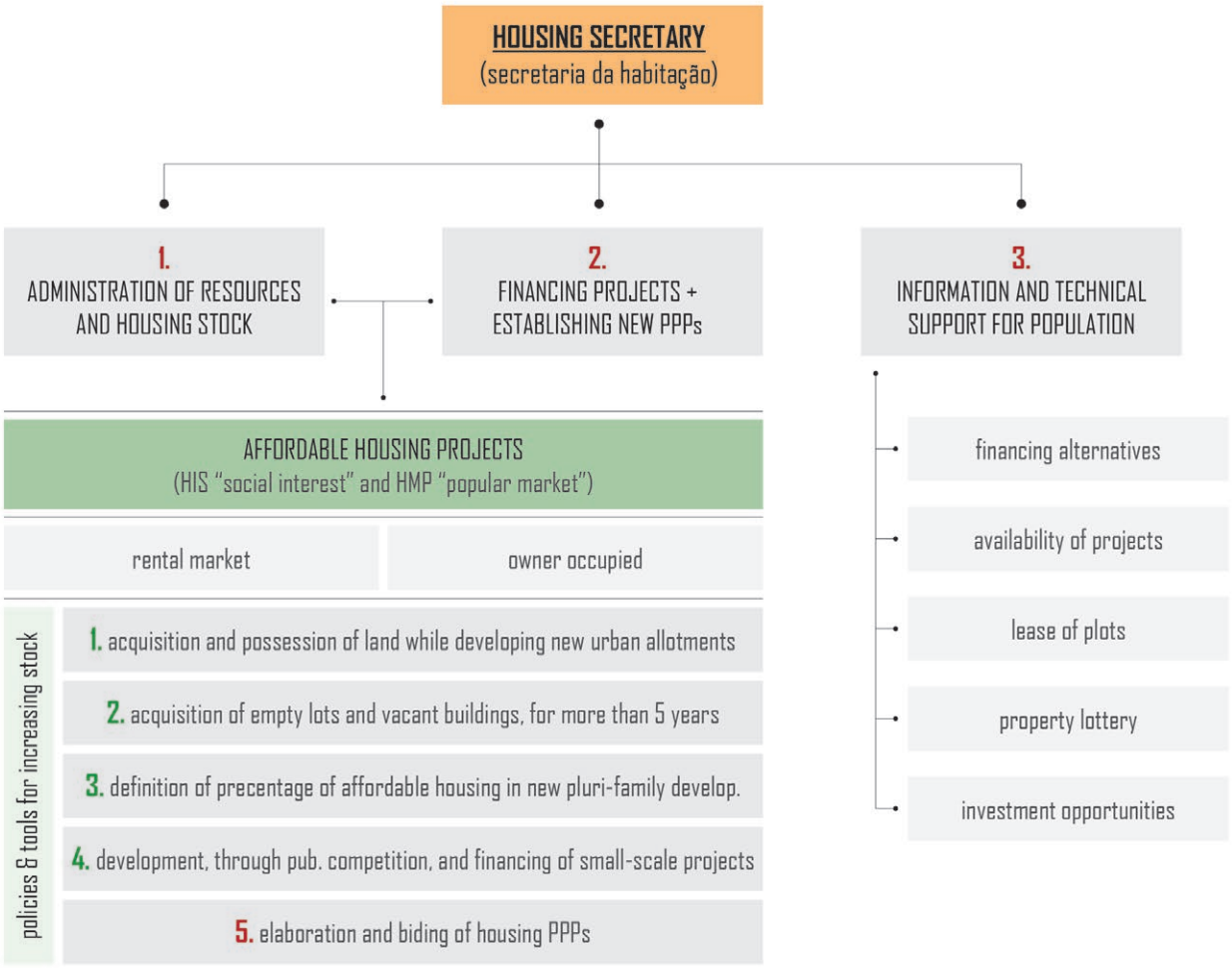
The first step in dealing with the built environment and population growth is the necessity of implementing new housing programs. This issue was already scrutinized throughout the research and it is strongly responsible for the current low-density sprawled occupation pattern in the city. Relying solely on the federal financing programs, the affordable housing stock is currently low, unable to accommodate the demand for low-income typologies. Besides that, the inflated land value led to the development of the housing units in the outskirts of the city, away from the economic activities of the center. This segregation and the insufficient unit stock could lead to the re-appearance of informal settlements in the central area of the city, especially considering the number of vacant plots. An example is already seen along the Transamazonica highway, as shown in the picture below, where informal settlements are gradually starting to be formed.

To cope with this housing issue, the strategy proposes the implementation of a new housing secretary. This would be a new department of the municipality of Altamira, responsible for monitoring, managing and developing the affordable housing stock in the city. Such department is already incorporated in many municipalities in Brazil and could become an efficient and long-term solution for the implementation of new programs and their maintenance. Within the scope of the new secretary, there are the administration of (public) resources and housing stock, the responsibility of funding projects, the establishment of possible public-private partnerships, and the communication with the population, providing transparent information and support regarding stock and financing opportunities. The new department could not only advocate the successful implementation of housing programs in Altamira but also build up knowledge for a long-term, resilient model. The diagram in the next page highlights some of the possible policies and tools to be adopted by the municipality.

One of the tools to be considered is the development of housing public-private partnerships. Following a model already used in Sao Paulo, the diagram shows the participation, input, and output of the different sectors aiming the development of additional units. Assuming the possibility of a future scenario with limited public resources, such program introduces a collaborative solution, releasing some of the pressure and responsibility from the municipality.

figure 6.26 | **Informal settlements along the Transamazonica highway**
photo by the author

Figure 6.27 | **Proposed housing secretary**



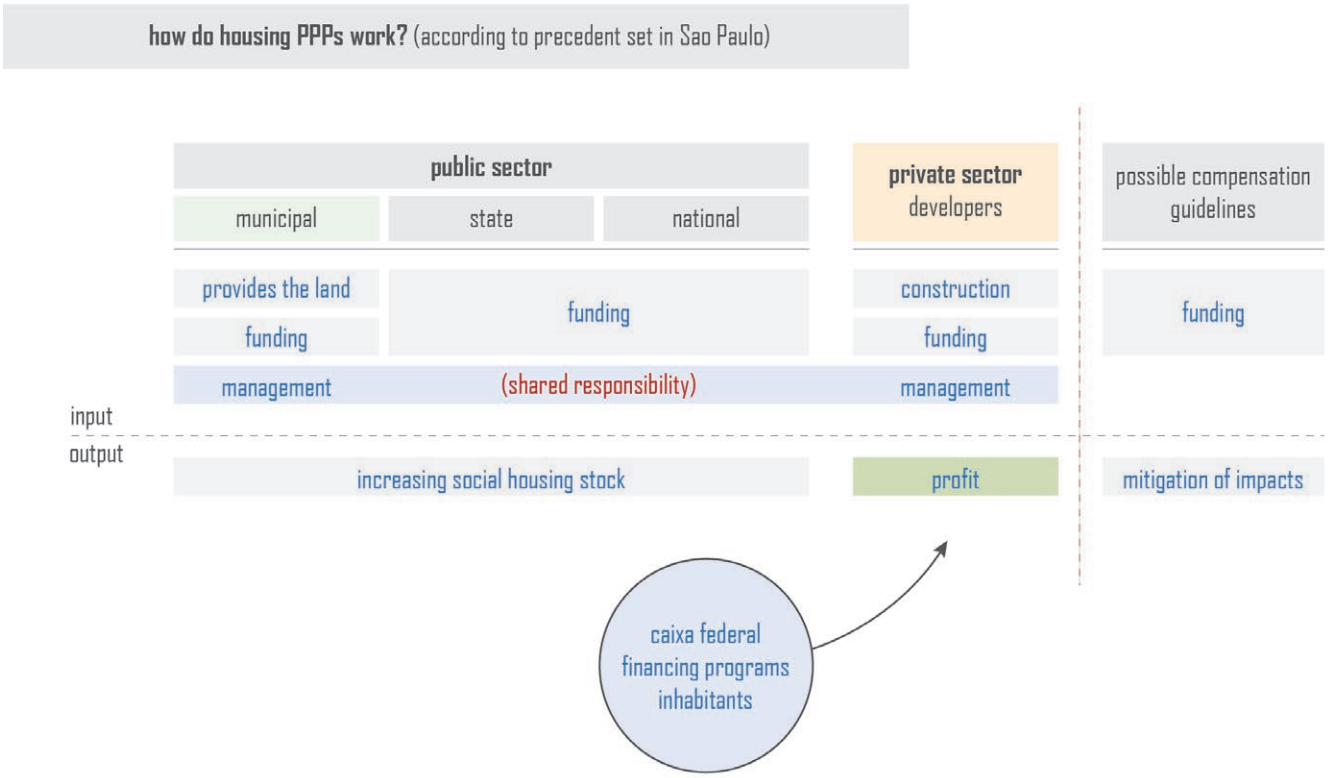


figure 6.28 | **Zoning approaches**

Before jumping to the design of solutions, it is important to understand the current planning tools adopted for the development of the urban fabric in Altamira. The revisited masterplan of the city, issued in 2010, proposed a new zoning plan (page 97). The plan consists in the determination of different occupation patterns and densities and their distribution along the urban fabric. This method, however, has shown to be little efficient for the development of the city, which grew outside of the guidelines defined, leading to the current sprawled model. There is, of course, the need to consider the intensity of the migratory flows associated with the construction of the dam, very responsible for the unorganized outcome. But besides the Belo Monte factor, a few critics can be made to the tool adopted. The first one is regarding the disconnection of the zones with the existing conditions of the site. The plan is very much linear and does not recognize the sensible characteristics of the different typologies, allowing or not the development according to the designated zone. The second one is the contradiction of the plans with the existing urban structures, as shown in the diagram above. The definition of the zones is naturally associated with current infrastructure and equipment of the site, but the similarity of the block and property division is not necessarily taken into account, a fact that can prevent a successful outcome of the plan.

With this in mind, the proposals of this strategy look for solutions specific and coherent to each of the urban typologies identified on the following page. Rather than working solely with a zoning plan, the design explores the existing block occupation patterns and investigates feasible adaptations and transformations aiming to shape and accommodate future growth of the city. The new typologies are later distributed spatially over the urban fabric of the city, determinating areas for expansion and densification.

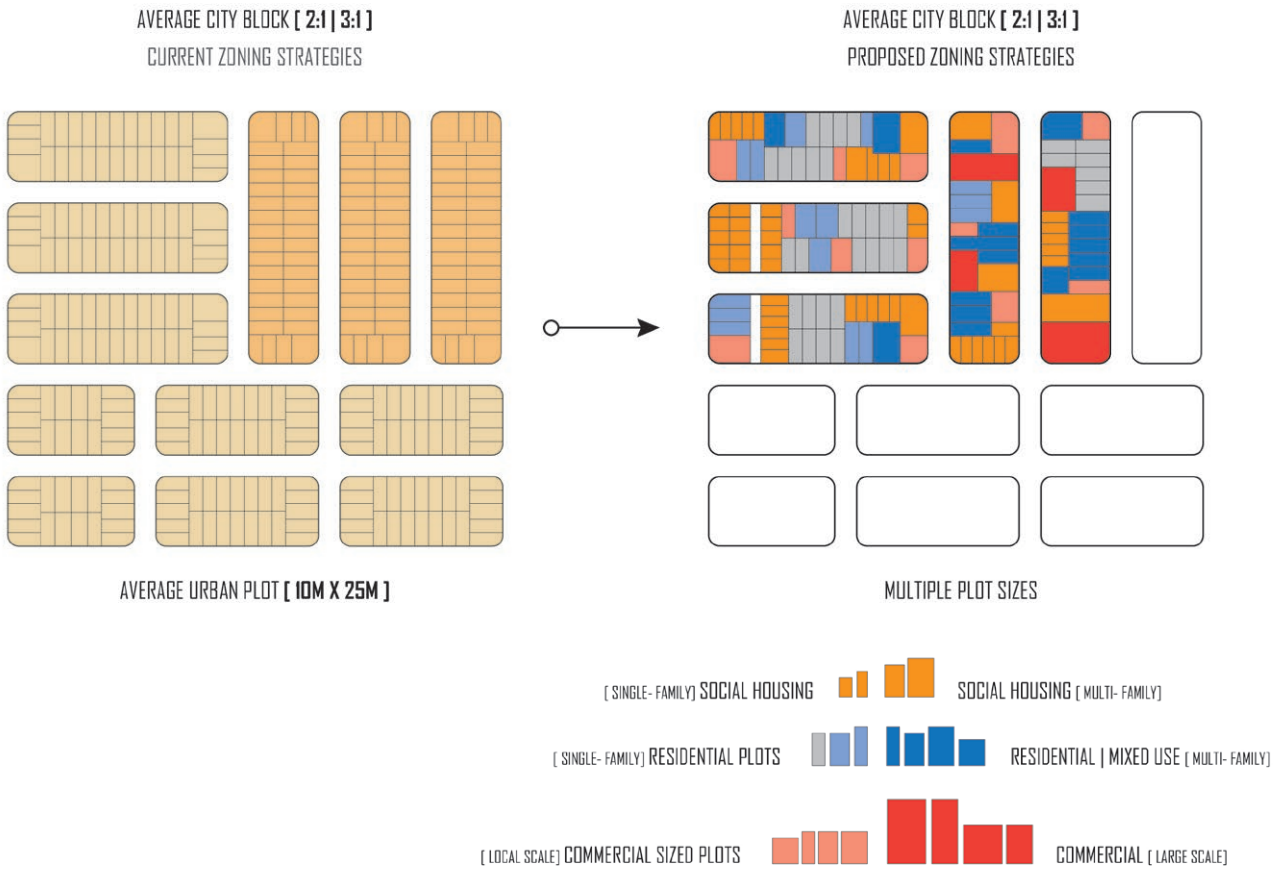
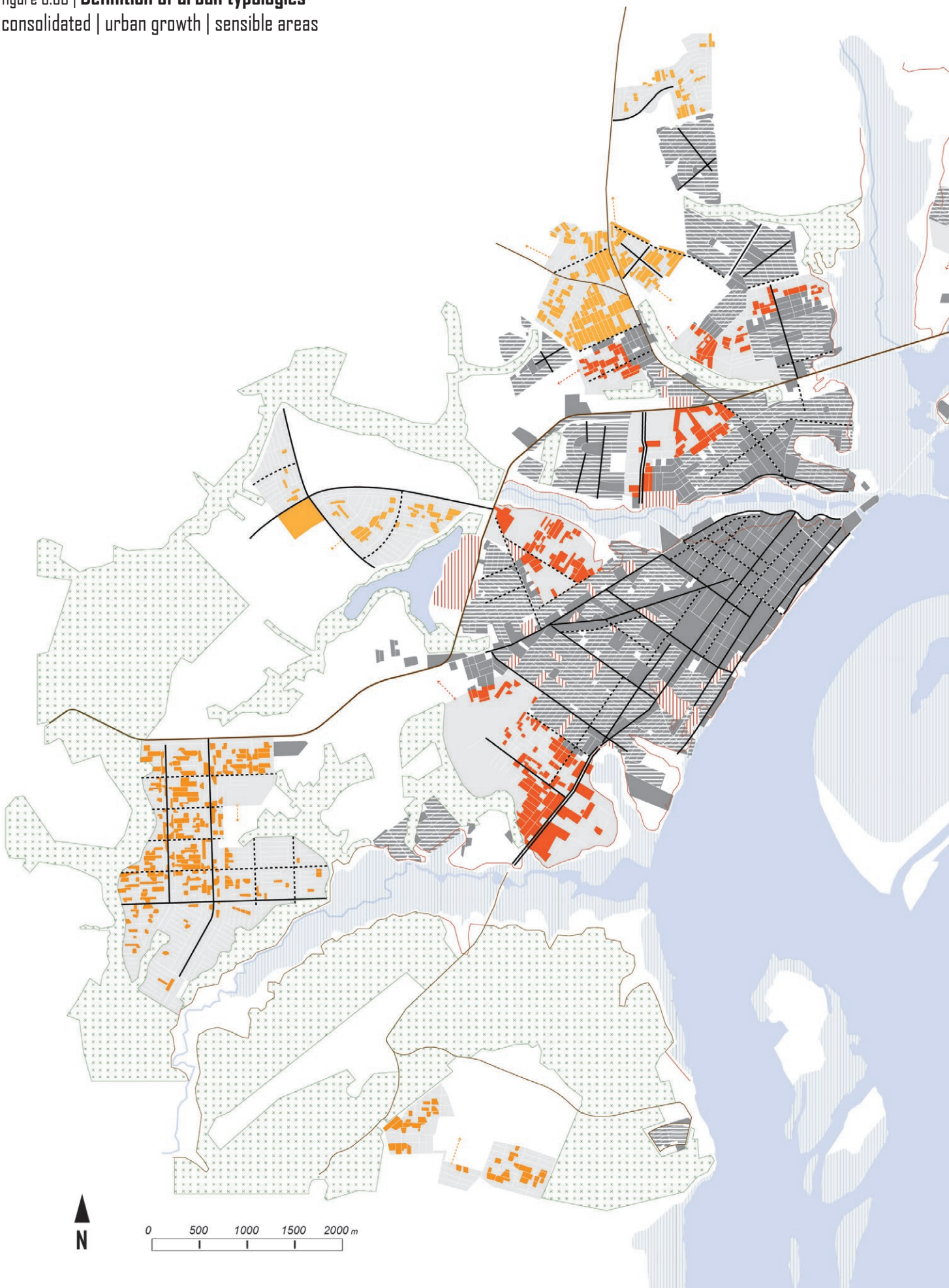
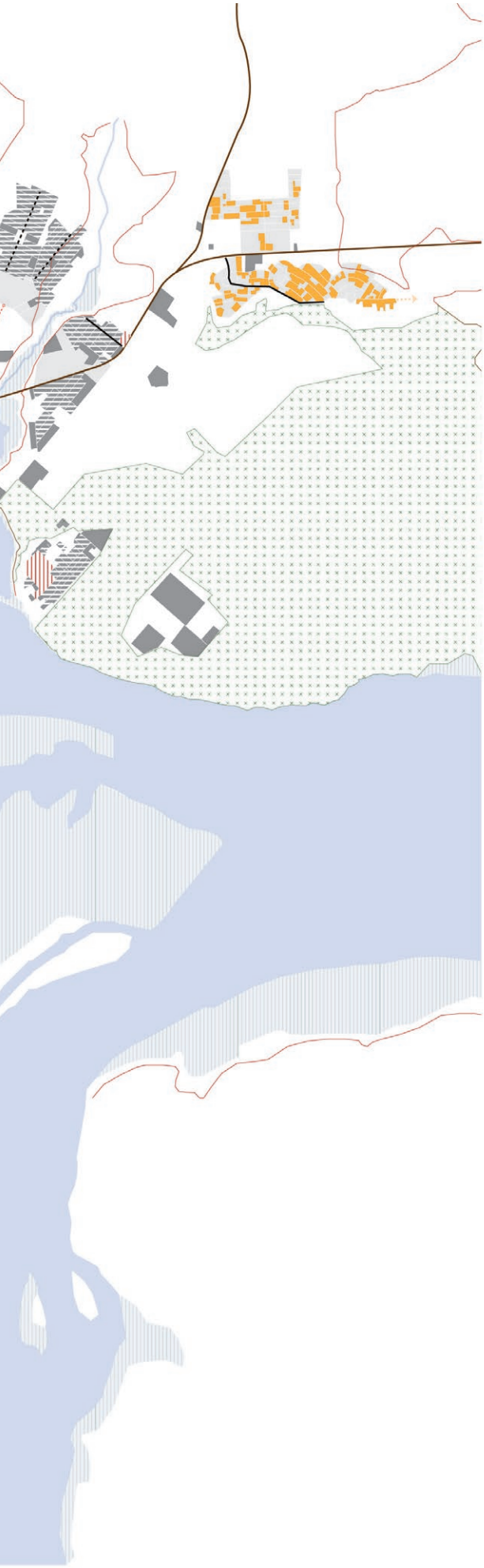


figure 6.29 | **View of an expanding low-density residential typology**
photo by the author

figure 6.30 | **Definition of urban typologies**
consolidated | urban growth | sensible areas





URBAN TYPOLOGIES

1. expanding

a. urban allotments

b. private allotments

2. densifying

For the determination of a strategy for future development of the built environment, it is imperative to first understand the different typologies composing the urban fabric. Rather than adopting a zoning masterplan for the whole city, common planning tool in Brazilian cities, the current methodology proposes the definition of several urban block guidelines, to be implemented in each of the typologies identified in Altamira. This results in a design that corresponds to specific urban characteristics instead of a generic model reproduced in every neighborhood. The urban typologies, shown in the map, where diagnosed while analyzing spatial characteristics according to every key factor. The urban blocks and guidelines are designed for the development of the following typologies:

1a. urban allotments

Surrounding the consolidated neighborhoods of the city, the expanding urban tissue consists of current or future development of new 'urban' neighborhoods. Implemented by the municipality in form of allotments, the proximity they have from existing infra-structure and equipment imply a large potential for growth and densification.

1b. private allotments

Private allotments are probably one of the main challenges for future development of Altamira. Their distance to central areas, low-density and occupation rate, and mono-functionality combined with the vast empty area still to be occupied resulting in a little accessible model of the urban fabric, with high risks of marginalization.

2. densifying (core of the city)

The consolidated tissue of the city, usually developed before the implementation of the Belo Monte dam. Despite the higher occupation rate many empty plots or brownfields are still visible in the urban landscape.

legend:

urban boundaries
- maximum flood height
- preserved areas
- possible axis of expansion

neighborhoods & typologies
- sensitive areas for development
- private residential allotment typology & occupation
- urban expansion typology & occupation
- consolidated urban occupation
- low density residential typology
- empty and derelict sites, brownfields

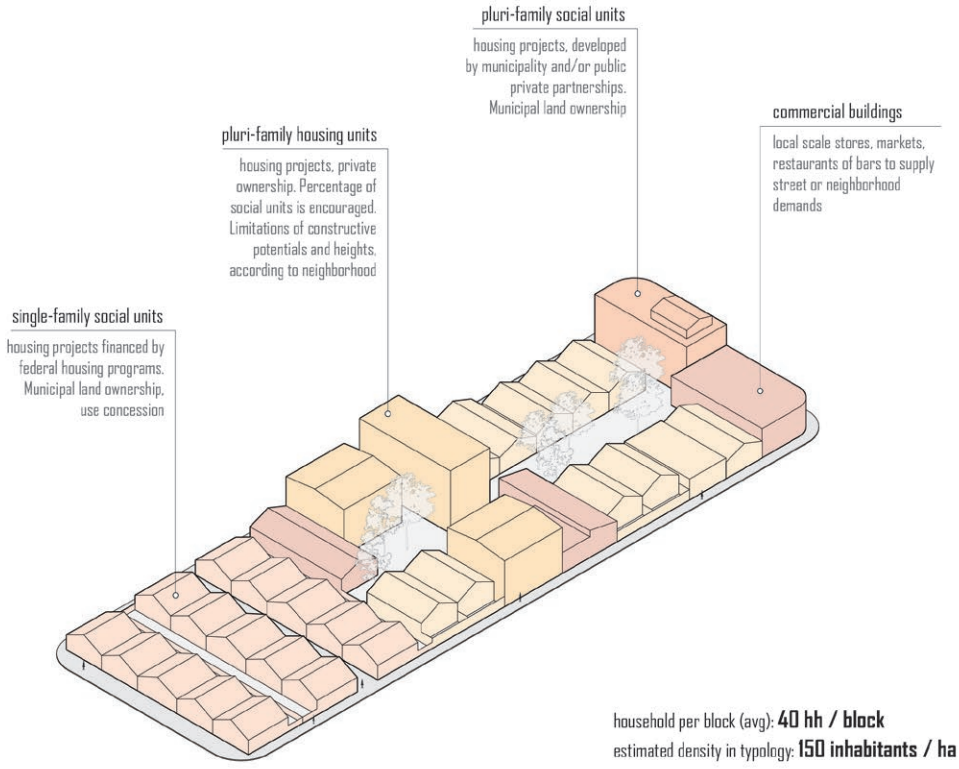
infra & densification
- very high potential for development
- high potential for development
- low potential for development

1a. Expanding urban allotments

The following diagrams show the main guidelines defined for the development of urban blocks in the expanding neighborhoods of the city (inner- and outer-rings). Even while assuming traditional block sizes and proportions, the design proposes a diverse division of property sizes, encouraging a mixed-use and mixed-typology occupation. Concerning the distribution and regularization of land, the expanding typologies play a fundamental role for the implementation of efficient housing programs, contributing for the increase of properties owned by the municipality. Administered by the proposed housing secretary, the land can be used for the construction of new affordable units, to be developed either internally or by public-private partnerships.

figure 6.31 | **Low-density residential typologies**

Similar to the 'traditional' block typology identified in the expanding urban fabric, the design encourages a different variety of buildings by distributing plots of different sizes. Local commercial use (shops, markets, bars, restaurants) and small-scale pluri-family units are predicted, promoting the densification and diversification of use, without compromising the main characteristics of the typology.



legend:

social h.
- Single-family units
- Pluri-family unit, medium density
- Pluri-family unit, large structures

res.
- Single-family units
- Pluri-family unit, medium density
- Pluri-family unit, large structures

com.
- Local market and stores
- Neighborhood-scale commercial use and offices
- Larger structures, city and region scales

ind.
- Local industry, low impact
- Heavy industry

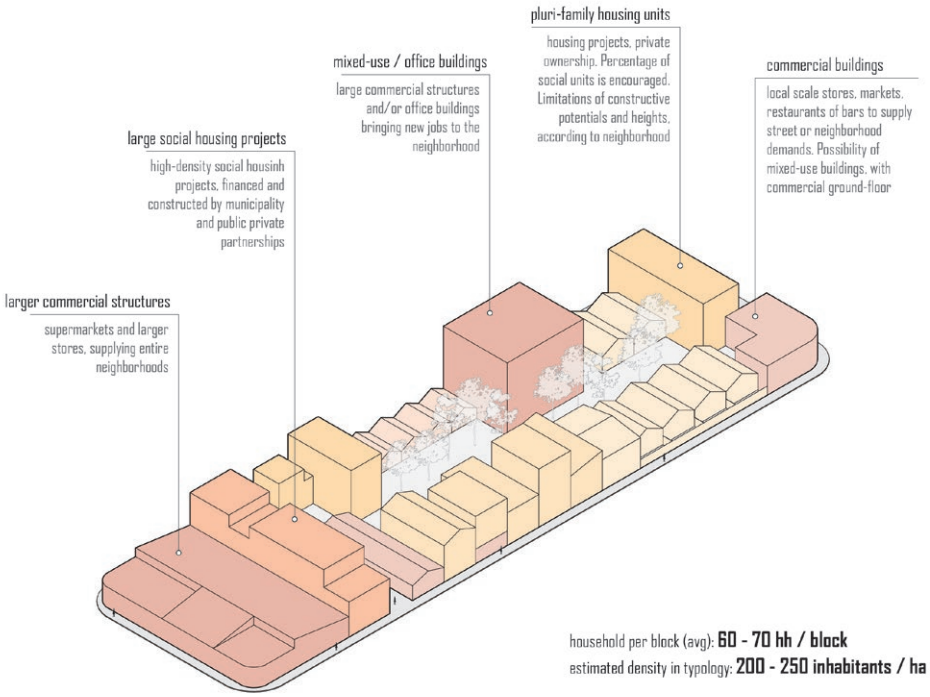


figure 6.32 | **Medium-density mixed-use typologies**

Differently than the low-density typologies proposed, the medium-density design is intended to be developed surrounding the new infra-structure nodes in the city. It proposes a higher density of residential occupation including the definition of minimum percentages for affordable housing units, varying according to different neighborhoods. The commercial use goes beyond local street markets, allowing the construction of supermarkets, stores, and even small office buildings. The 'traditional' single-family typology is preserved, assuming its popularity and avoiding radical solutions.

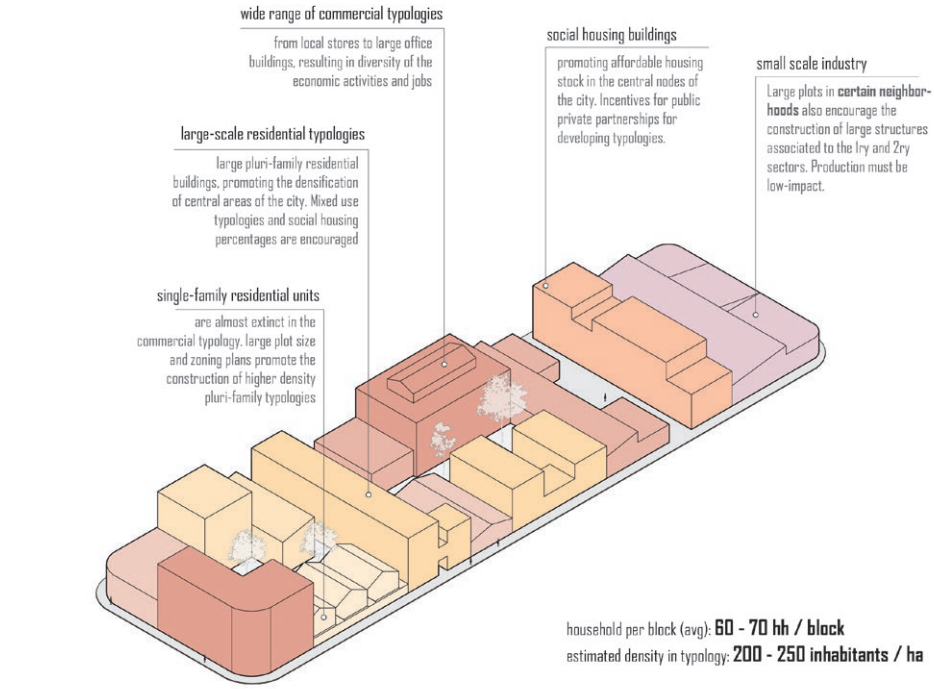


figure 6.33 | **Medium-density commercial typologies**

The guidelines encourage the development of a mixed-use medium-density typology allowing the diversification of economic activities and jobs in different neighborhoods and promoting the development of sub-centers in the city. The estimated density is similar to the one on the residential blocks. The plots and building typologies, however, are larger, aiming for the construction of pluri-family structures and a higher density in important nodes of the city. Mixed-use building and a diversity of programs are intended for promoting vitality in the streets.

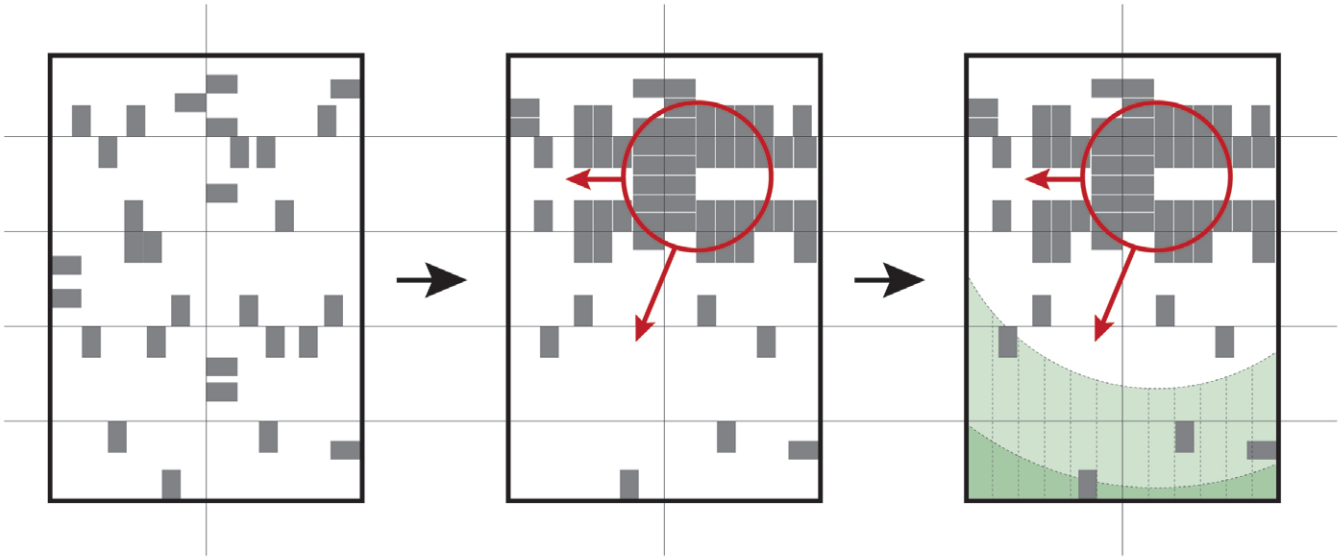
1b. New private allotments

figure 6.34 | **Strategies for occupation and densification of the outer-ring typologies**

current occupation pattern of the allotments

envisioned occupation pattern of the allotments

possible sustainable occupation pattern of the allotments



land is privately owned by developers, (random) organization according to plot sales

node development, promoting densification of a 'core', rather than an homogeneous sprawl of single-family residential units

but what tools and policies to use to encourage the allotment owners?

the implementation of small scale urban agriculture could be introduced as a source of income for the plots left empty for later development. Such strategy could also benefit the local community with the provision of jobs

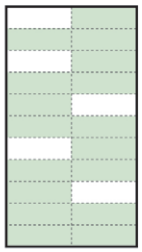
how do the urban farms work?

15 - 25 %

residential occupation

percentage for **sale**

Owner occupied plots. Small percentage allows area for agricultural production and introduces a new 'rural' typology.



> 75 %

agricultural production

percentage for **lease**

Contracts of 5, 10 or 20 years allowing the use of land for production. Yearly or monthly rents, with possibility of purchase.

benefits for developers:

(1) Rents provides a steady income also preventing empty plot maintenance costs.
(2) Option of purchase after lease also ensures that a full revenue (or higher) will be achieved.
(3) Possible tax reduction policies, encourging the implementation of cluster densification and agricultural sites in the allotments.

implementation & financing alternatives

1. Land Owners & Developers

Stock and accessible land opportunities by temporary lease contracts. Reliable use of properties might facilitate low rate financing with banks, funds and/or institutions.

2. Municipal Policies & Funds

Public policies encourage the formation of small scale agricultural enterprises. Productive Natural Landscape strategies contribute to the formation of public funds supporting such practices.

3. Community Banks

Community banks have shown to be successful in supporting low-income entrepeneurship projects in Brazil. Affiliation with institutions such as 'Banco Palmas' and 'PDRSX' could ensure the provision of resources for local communities

4. Production Centers

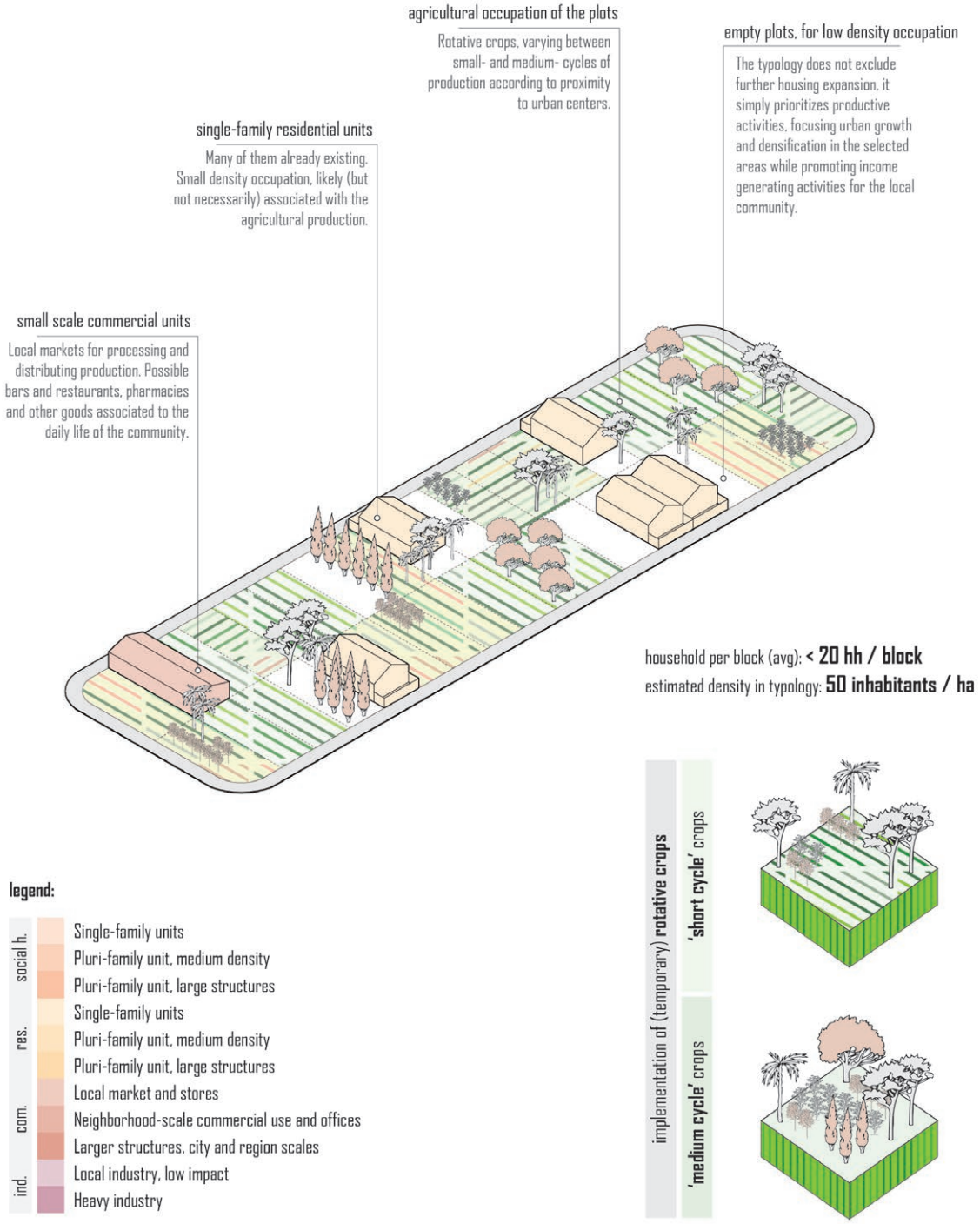
Facilitates the commercialization of goods and sales. Common use of equipments and facilities might generate a model for local food processing. Centers also offer technical support and financial know-how through courses and workshops.

5. Local Producer

Facilitated financing opportunities and accessibility to land leases offers new job and income generation opportunities. Community banks and production centers encourage knowledge building and community formation.

As concluded by the spatial- and scenario analysis, the new private allotments on the outskirts of the city have shown to be very questionable for the composition the urban fabric, mainly for their sparse and peripheral occupation patterns and their lack of land-use diversity and access to public equipment. With this in mind, defining possible occupation guidelines and programs in the private allotments becomes vital for the envisioned sustainable development of the city. To cope with current with the occupation issues highlighted, the strategy proposes a 'node focused development' pattern, defining cores for the construction of new households, concentrating the construction of households in a few hubs, closer to existing infrastructure and public equipment. Such strategy would promote densification and diversification of a few urban blocks, promoting the creation of small urban centers in each of the allotments. However, designing such transformations can be quite challenging when considering that the land is privately owned. The diagrams on the previous page show a proposal for a possible partnership model between municipality and developers, using urban agriculture as a temporary land-use occupation. Such practice would promote not only the desired development for the neighborhoods but also contribute to the urban production of strategies 1 and 2 while providing jobs and income generation opportunities. The diagram below shows the main guidelines defined for the development of the proposed typology.

figure 6.35 | **Rural occupation typology**



2. Densifying

But besides guiding the development of the expanding urban tissue, it is important to have projects and programs capable of promoting the densification of the core of the city, exploring the existing provision infrastructure and equipment. And even though the medium-density typologies designed could likewise be applied for promoting the densification in consolidated low-density residential neighborhoods, different guidelines also need to be adopted aiming to optimize the occupation in the main articulations of the city. With this purpose, two new block layouts are described in the following diagrams, suggesting transformations in the central neighborhoods of the city.

figure 6.36 | **Axial densification typology**

Design for an axial densification on the main roads and avenues of Altamira. Based on location, infrastructure and capacity for accommodating further traffic, the following guidelines aim for the densification and verticalization of the central areas of the city, aiming to increase the housing stock. A new and increased height limit is adopted for ecouraging the development of large housing, commercial and mixed-use developments. The focus should be on the edges of the blocks, punctuating the crossings while maintaining the local characteristics and commercial potential in the center part. Special attention should be paid throughout the process, preventing new buildings to overlap the strong commercial dynamic of the city center. A percentage of the new stock should be destined to the affordable housing market.

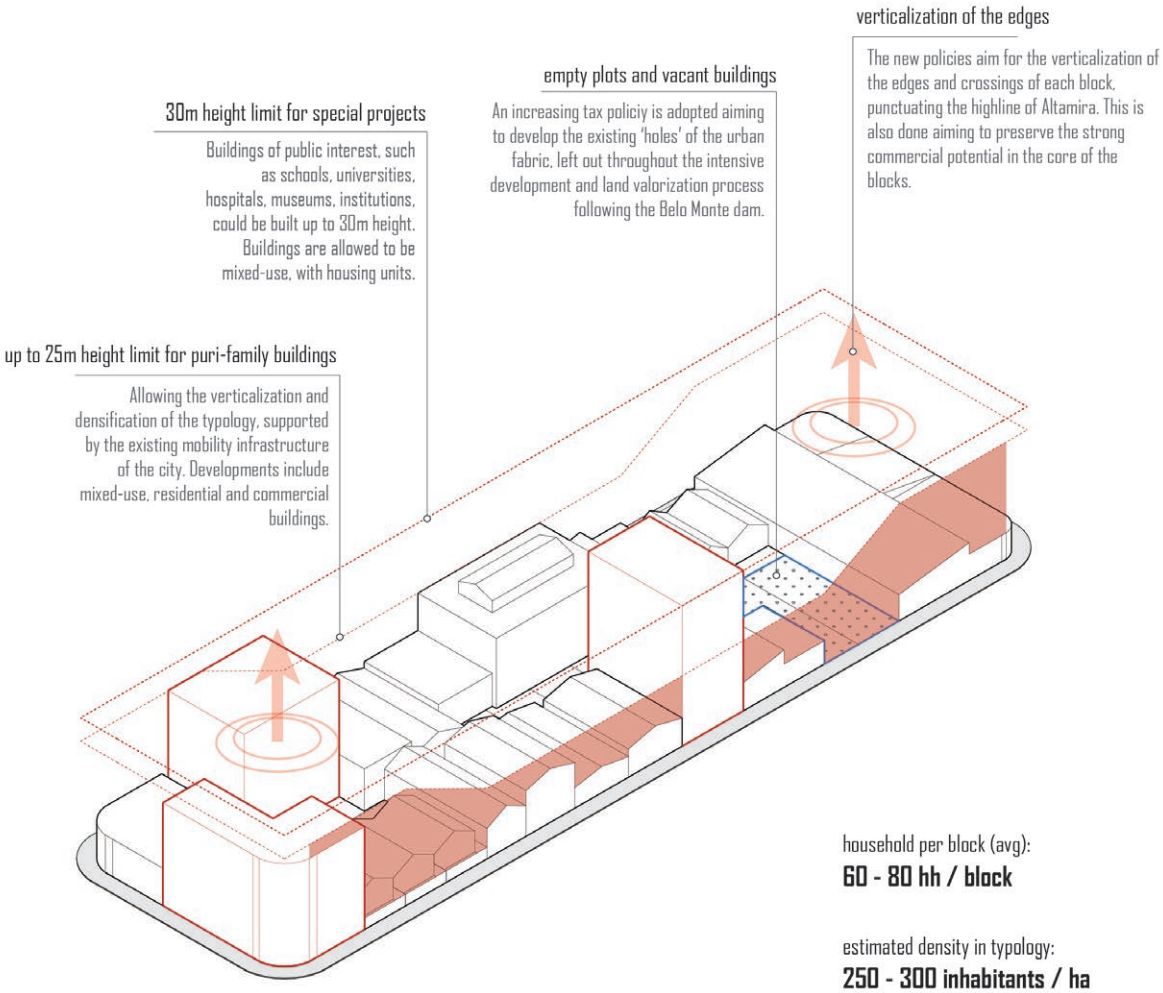
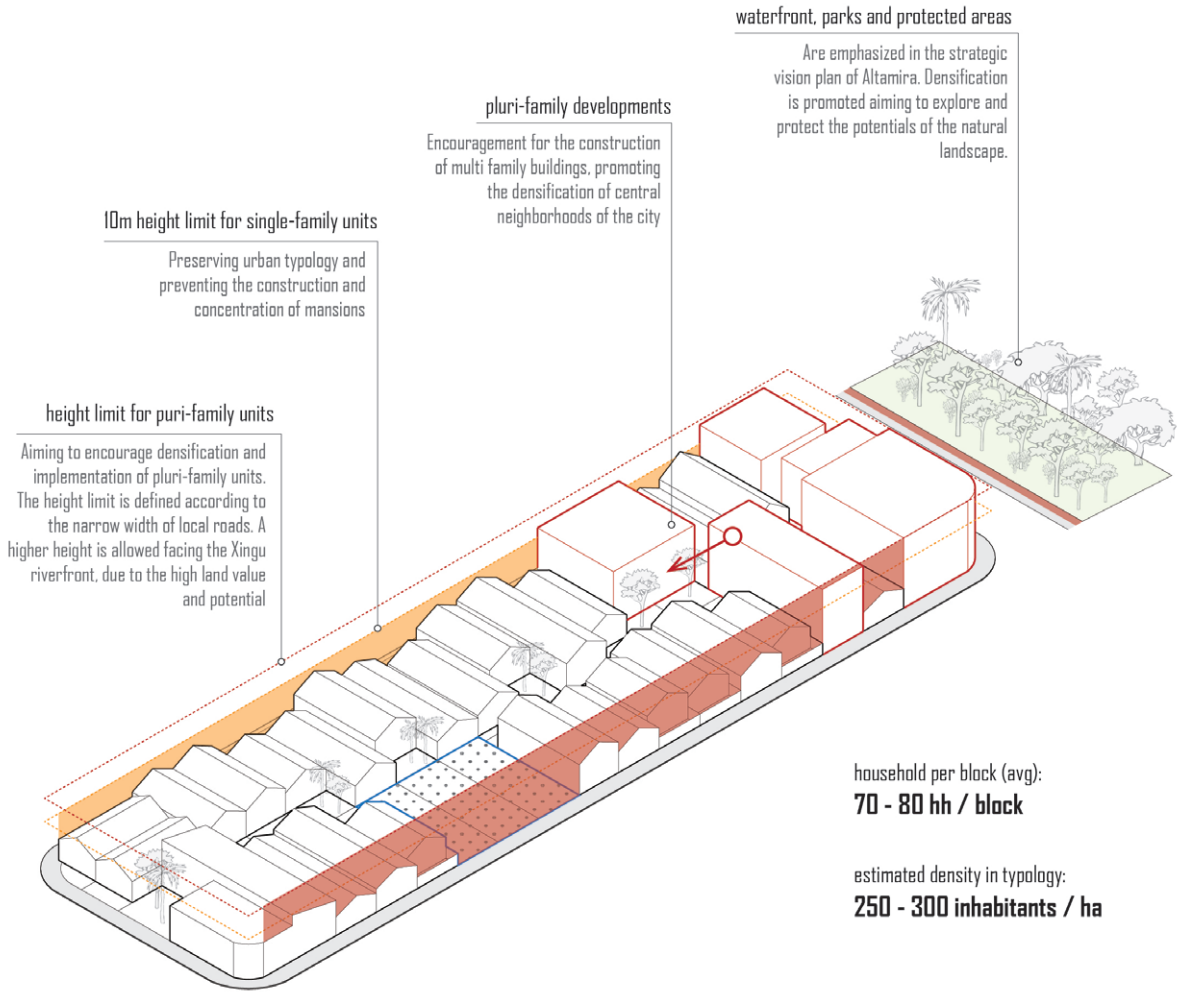


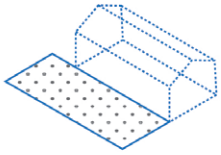
figure 6.37 | **Waterfront densification typology**

Guidelines for the densification of the waterfront boundaries of the city. New zoning policies are introduced aiming to explore the existing infrastructure and potentials of the natural landscape for the implementation of mixed-use typologies. Considering the already consolidated built environment in most of the central areas selected, the policies designed encourage the verticalization and densification through the construction of puri-family housing units, facilitated by a new definition of minimum height and additional floor area ratio. Again, a percentage of units for the social market should be included in every new development, increasing the affordable housing stock.



legend:

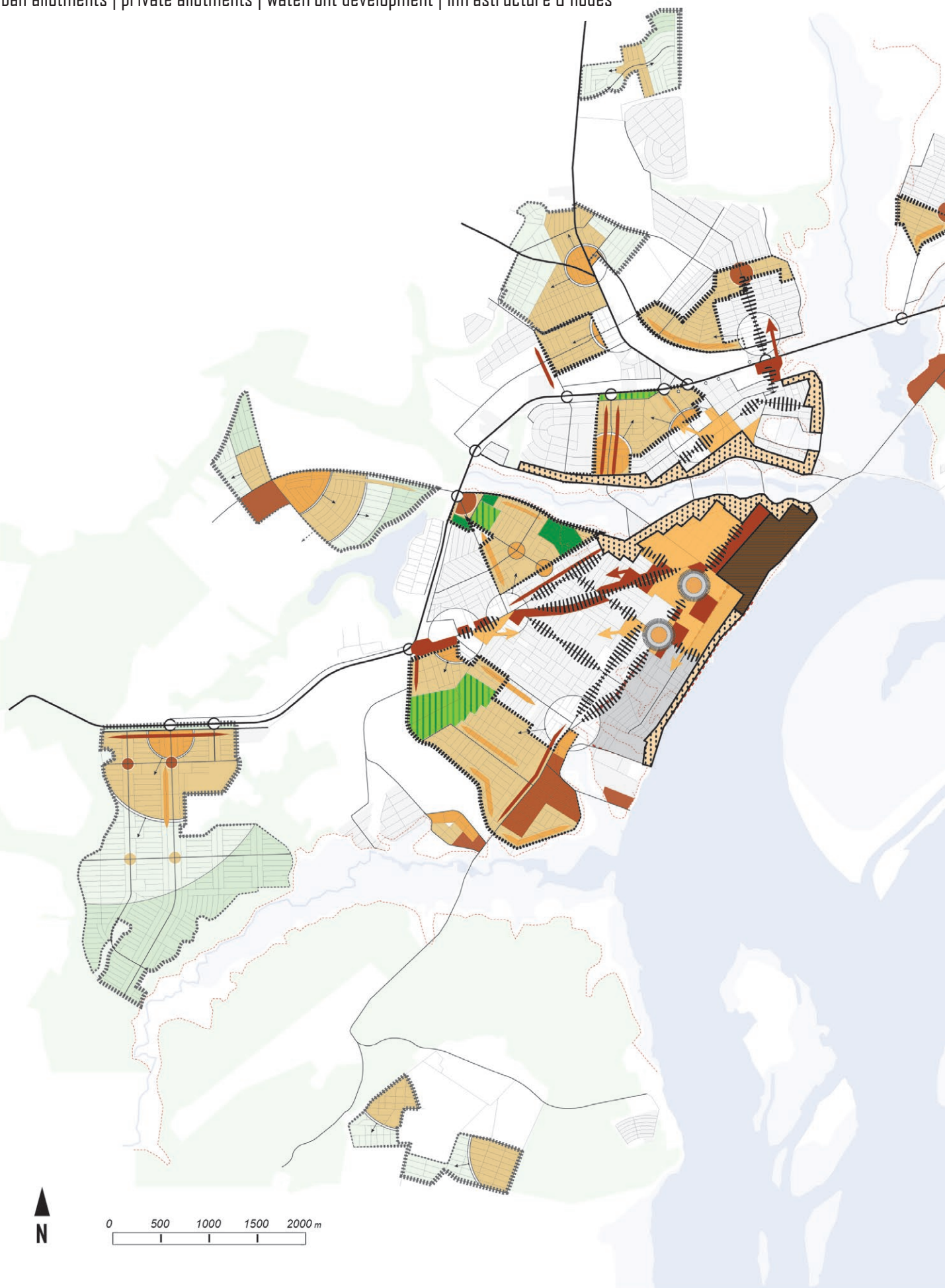
- Existing typology (mixed-use, low density)
- Proposed densification pattern
- 10 meter high limit for single-family housing units
- heigh limit for pluri-family projects (15m in streams and 20m in the Xingu waterfront)
- Waterfront, parks and protected areas
- Expansion of proposed typology



empty lots and vacant buildings

One constant observation in the built environment of Altamira is the abundance of empty lots and vacant buildings, waiting for real-estate speculation. To cope with this, a growing tax rate (IPTU) policy should be implemented, pressuring land- and building owners to develop or occupy. The policy also allows the municipality to purchase the property after a period of 5 years, if not occupied. A similar strategy is currently being adopted in Sao Paulo, setting the Brazilian precedent.

figure 6.38 | **Typologies and guidelines for the expanding and densifying urban fabric**
urban allotments | private allotments | watefront development | infrastructure & nodes



The map shows the application of the guidelines for the implementation of the typologies, projects, and programs in the urban fabric of Altamira. The proposal already acknowledges future growth of the urban fabric, considering the different 'population' key factor scenario investigations, conducted in the spatial- and scenario analysis chapter of the graduation thesis. This is done in an attempt to guide growth within the selected sites, preventing additional deforestation or irregular occupations and allotments.

The map also displays the proposal for the waterfront densification guidelines, mainly in the margins of the Xingu river and Altamira stream, aiming to enrich the urban quality in alignment with the high potential of the water resources of the region. The main roads of the consolidated center of the city become the framework for an axial densification model, exploring the existing infrastructure for promoting a mixed-use and accessible urban typology. The intersections of these axis' are also delimited as a potential for a node development.

Legend:

- **expanding urban fabric:** inner-ring of development. Assuming current and future expansion and occupation.
- **private residential allotments:** outer-ring of expanding urban fabric.
- **special intervention:** for transformation of privately occupied waterfront.
- existing rural properties or urban farms
- parks, forests and preserved landscapes

expanding typologies

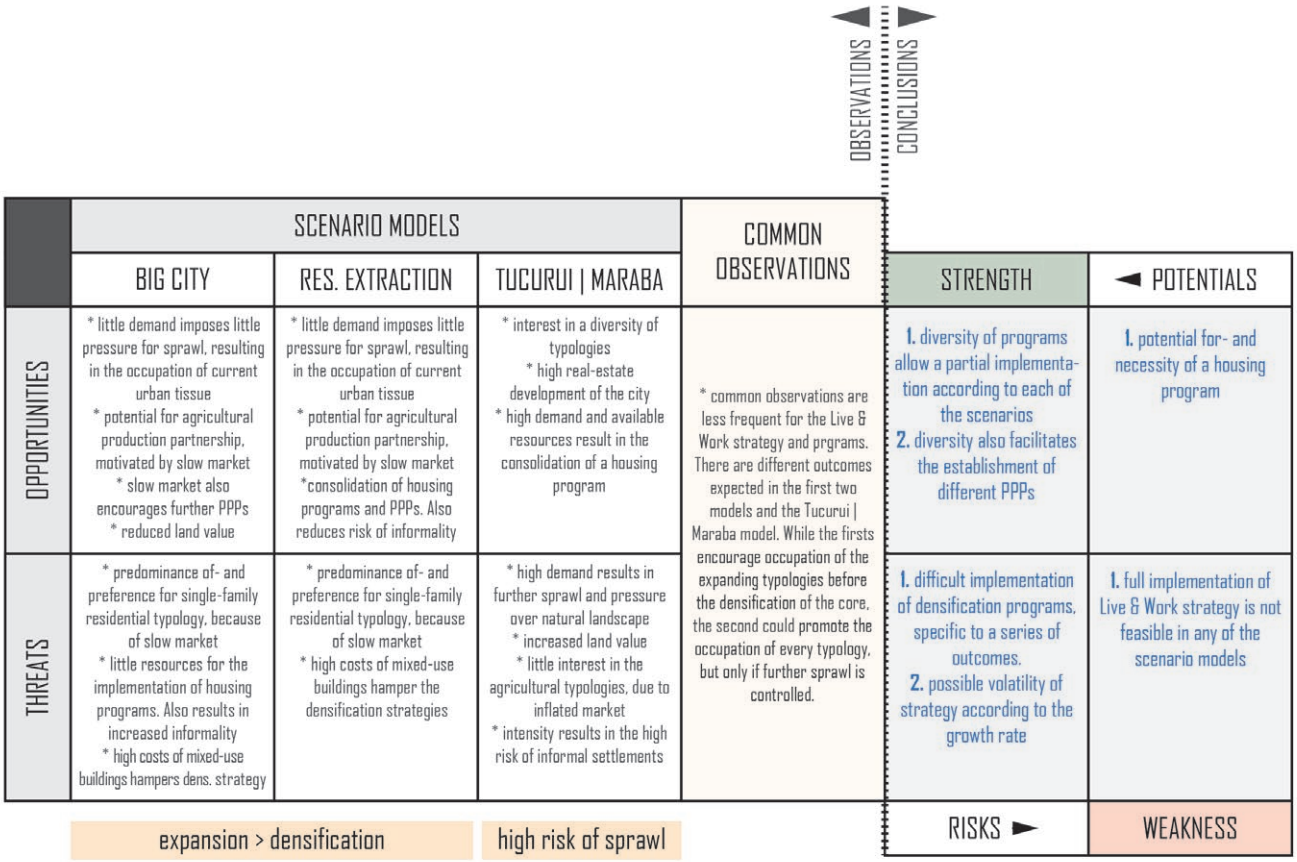
- predominance of **low density residential** typology
- clusters or nodes of **low density residential** typology
- predominance of **medium density mixed-use** typology
- corridor development of **medium density mixed-use** typology
- clusters of **medium density mixed-use** typology
- node (intersection) oriented development
- predominance of **medium density commercial** typology
- corridor development of **medium density commercial** typology
- commercial or industrial clusters
- rural occupation of the urban fabric **(short cycle crops)**
- rural occupation of the urban fabric **(long cycle crops)**
- expansion of typologies

densifying typologies

- densification according to waterfront urban typologies
- historic city center, preservation of urban characteristics
- axial densification, of the main roads of the urban network
- **node densification:** special occupation on the main articulations
- existing mixed-use typologies (residential predominance)
- axis of expansion, predicted in the vision plan
- existing mixed-use typologies (commercial predominance)
- axis of expansion, predicted in the vision plan

figure 6.39 | **Pluri-family housing project under construction**
photo by the author

figure 6.40 | **Evaluation of the strategy according to possible future outcomes** (threats and opportunities)



The evaluation of the strategy according to the three future models lead to different observations regarding the implementation and possible outcomes of the different programs. The first and most obvious one is the realization that there is no scenario ideal for a full implementation of the strategy. Instead, the observations expose some programs to be more sensitive to specific models, due to particular characteristics and demands expected. But, with this notion that 'no glove fits all hands' in mind, the diversity of the block typologies and program proposed also embolden a partial implementation regardless of the development scenario outcome, ensuring an urban development aligned with the vision proposed by the strategic vision plan. Furthermore, the same diversity also aims to attract the interest of different stakeholders, facilitating the establishment of partnerships in each of the models.

The conclusions of the observations and point out to the fact that, in case of development according to the first two models, the emphasis of the market and the spatial transformations would rely more on the expanding typologies rather than on the consolidated core of the city, This would probably happen because of the low demand for housing expected and the higher costs and risks for the construction of mixed-use higher density typologies. In addition to that, when evaluating the strategy according to the Tucurui | Maraba model, the observations lead to the perception that even with a high housing demand the development of the densification programs become quite challenging, assuming the risk further sprawl of the urban fabric before densification. In this regard, one solution to be explored could be the implementation of fiscal benefits encouraging the construction of mixed-use typologies in the central areas of Altamira.

Finally, the evaluation also highlights the risk of formation of informal settlements and the challenges for implementing a housing secretary in all the different outcomes. The implementation of housing programs in Altamira is imperative, however, even with the proposal of public-private partnerships a successful implementation of the strategy still relies on the availability of public resources. And even though there might not be an ideal model to overcome this issue, the necessity of a housing strategy should be emphasized as a priority in the action plan of the strategic vision plan.

strategy 4/4

SPECIAL PROJECTS

figure 6.41 | **Fisherman, the Zingu river and the Amazon forest**
photo by the author

The potentials of tourism and education

When investigating alternatives for promoting the economic growth of Altamira and the diversification of job and income opportunities, the development of (eco) tourism and the expansion of the educational institutions inevitably comes to mind. The touristic industry, considering the abundance and beauty of the natural landscape and a prospective implementation of new sustainable practices, is still very limited and could (and should) be further explored. As for the education, the existing institutions and infrastructure should be expanded along with the current city growth, especially considering the consolidation of Altamira as a regional sub-center. This perception was also shared by several of the stakeholders interviewed during the site visit.

The fourth strategy, however, does not aim to structure an economic model facilitating the implementation or development of those industries. Within the planning perspective, the following design investigates the potentials and influence such industries could have in the built environment, looking for ways of encouraging their development and exploring the resources they might bring. In this regard, and differently than the previous three strategies, the Special Projects proposal focuses on one specific section of the urban tissue of Altamira. The site, along the margins of the Xingu river, has become challenging for its consolidated private occupation of the riverfront, preventing public access to the water. Assuming the proportions of possible projects and amount of investment required for their implementation, the strategy explores how a growing tourism industry and strong educational institutions could contribute to facilitating the envisioned spatial transformations.

Again, the strategy is expected to tackle challenges found in the spatial analysis of all the four key factors, with an emphasis on jobs & income, for the development of the industries in itself. Assuming a probable weak governance scenario, the proposals are also supported by a transdisciplinary approach, relying on public-private partnerships for the development of the programs.

Figure 6.42 | **Socio-spatial issues tackled**

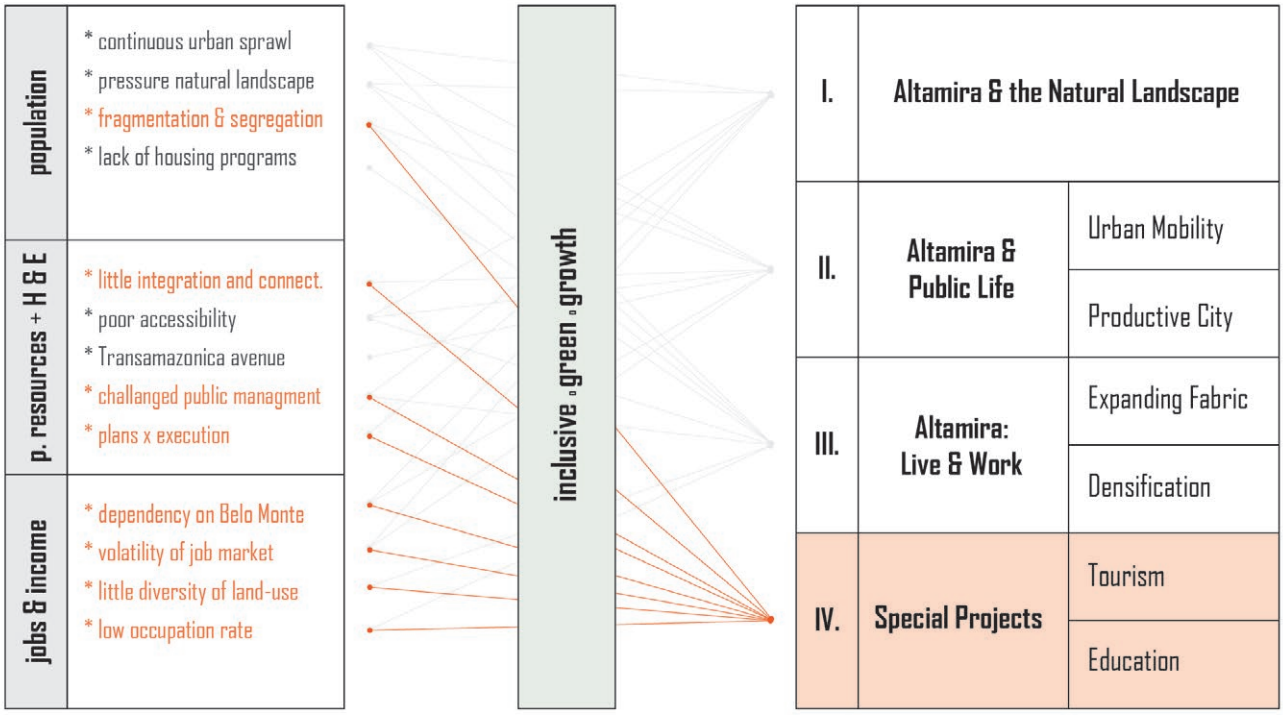
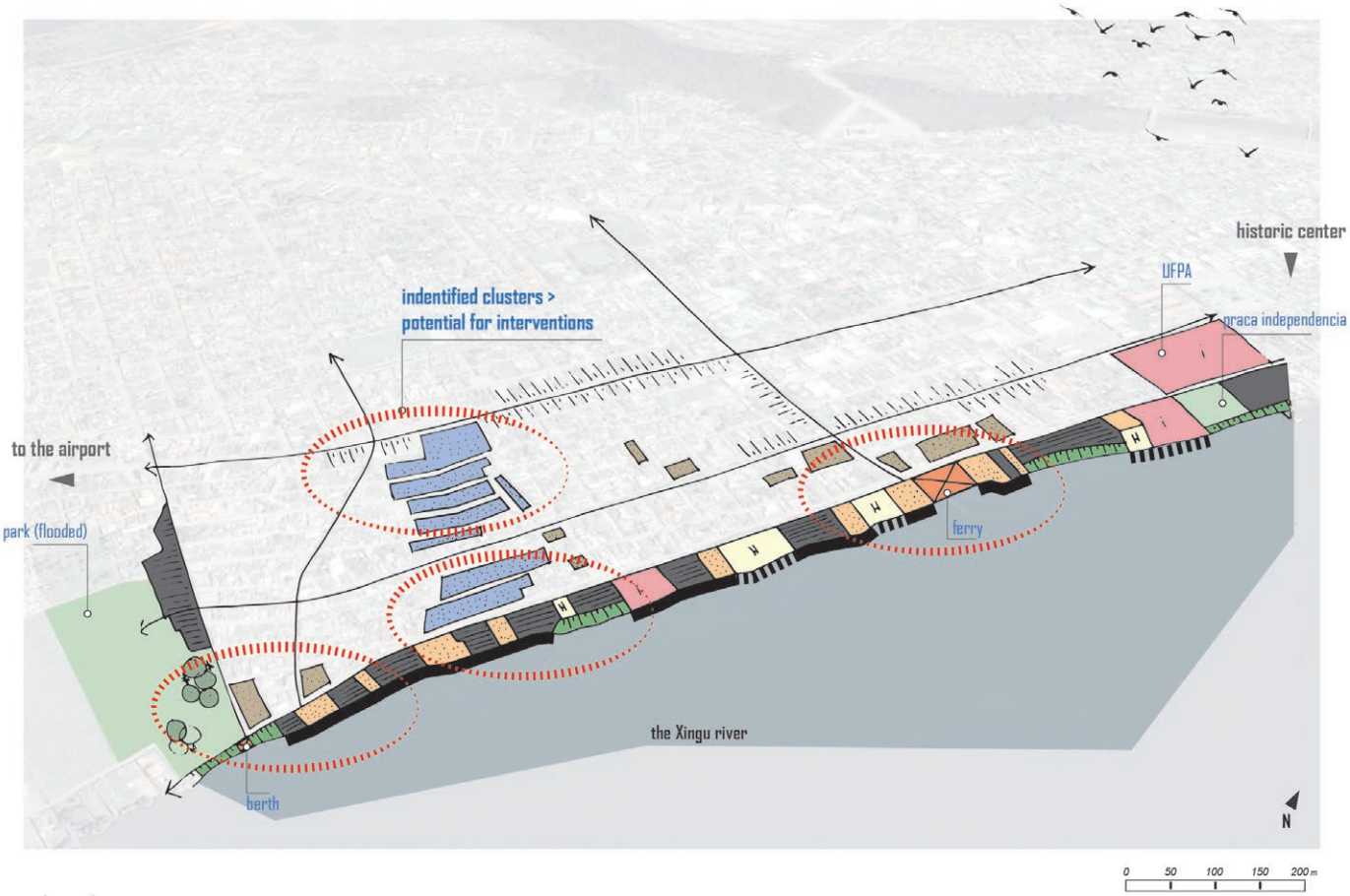


figure 6.43 | **Coronel Jose Porfirio (marginal) street, separated by private property**
photo by the author

figure 6.44 | **Spatial analysis of the site**

The image, picturing the Coronel Jose Porfirio street, highlights the scrutinized urban condition seen in a large strip of the Xingu river margins, right next to the historic center. The condition is simple, the city lacks public access to the riverfront. The development of the urban fabric without a marginal avenue allowed the occupation of private properties between public spaces and the Xingu river. With this, the access to the water, one of the main natural resources of the region, is exclusive to a few properties. The map below displays the current occupation pattern identified in the site and explores some of the main spatial characteristics encountered in the territory. Amongst the findings, the concentration of wealth and vast amounts of vacant plots are worth emphasizing. Assuming a consolidated occupation of the waterfront and the probable limitation of public resources, it would be unfeasible to imagine the opening of a new marginal road granting access to the river. With this in mind, the question becomes: how to develop an already consolidated neighborhood, exploiting all its potentials, with the possible limitations of public resources?

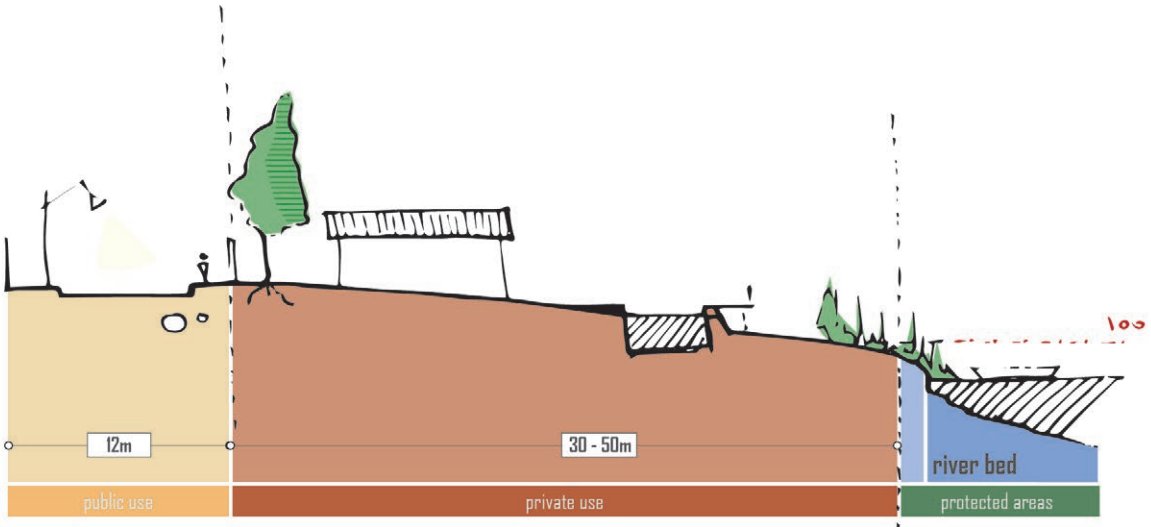


legend:

- water equipment
- private occupation of the waterfront
- vacant private lots in the waterfront
- evicted properties, municipal owned land
- empty lots
- public access to waterfront
- parks
- commercial axis
- HORECA (hotels, restaurants, cafes)
- institutional and educational

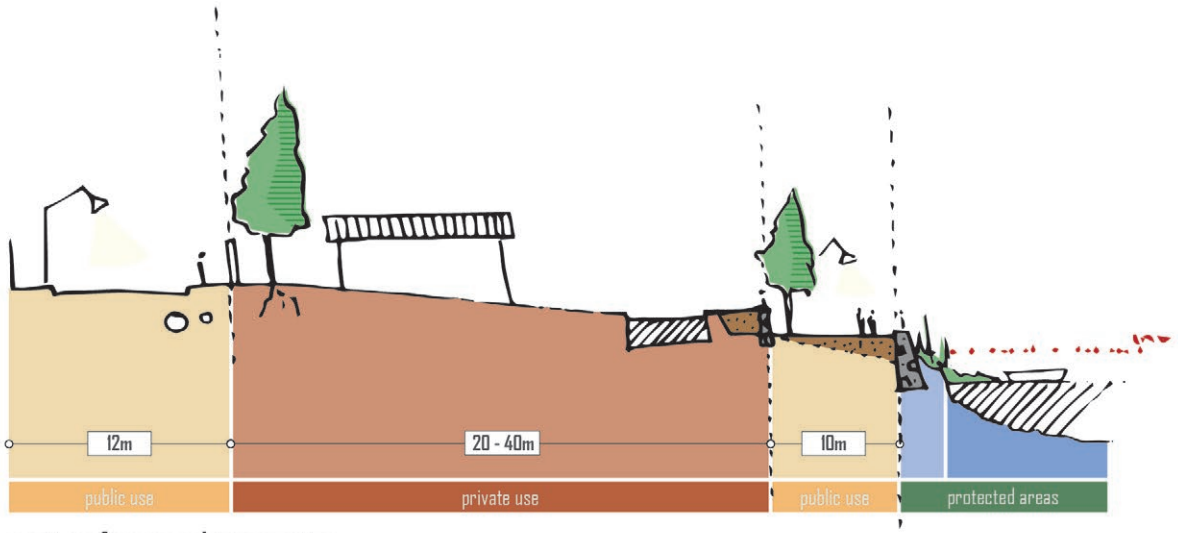
figure 6.45 | **Existing occupation and proposal**

The sections show the existing occupation pattern and the proposed intervention, introducing a new pedestrian (and possibly cyclist) promenade between the back of private properties and the Xingu river. Rather than proposing a marginal road, as done in the Altamira & Public Life strategy, the design suggests the construction of a narrow linear park granting the access to the water. Furthermore, besides its social and leisure functions, the construction of the promenade is also important for the consolidation of a flood-resistant infrastructure. The intervention faces, of course, the same challenges a new road would. With this in mind, the design assumes the challenging acquisition of land and development processes (described in the diagram next page) and recognizes that a full implementation would take decades or not be feasible at all, allowing a gradual and fragmented constitution.



section of existing occupation pattern

private properties between the Xingu river and the Coronel Jose Porfirio street, blocking public access to the waterfront



section of proposed intervention

acquisition of a 10m strip of each property, used for the implementation of a public promenade facing the Xingu river. The design is also important for flood control strategies.

Figure 6.46 | **Ownership and occupation of land**

The following diagram shows the implications identified for a possible implementation of the new public space. The first step was to understand the different land-use occupation of the private properties and to recognize their different characteristics. The starting point of the strategy focuses on vacant lots, assuming the vast amount encountered in the site. The definition of new policies (restricting and encouraging occupation) is the main planning tool adopted for advocating the spatial transformations. The intervention on occupied property is more complicated and relies on fiscal encouragement provided the purchase of necessary land is granted.

Another issue becomes the economic feasibility of the proposal, especially assuming the possible limitation of public funds. This is the point where the priveledged location of the neighborhood, combined with the existing infrastructure, availability of land and proximity to the Xingu river are used as a potential for clustering the development of economic activities. The high potential- and increasing demand for tourism, for example, could be explored in a public-private partnership for financing part of the implementation of the proposed public infrastructures. The spatial definition of the possible clusters is showned in the vision map on the next page.

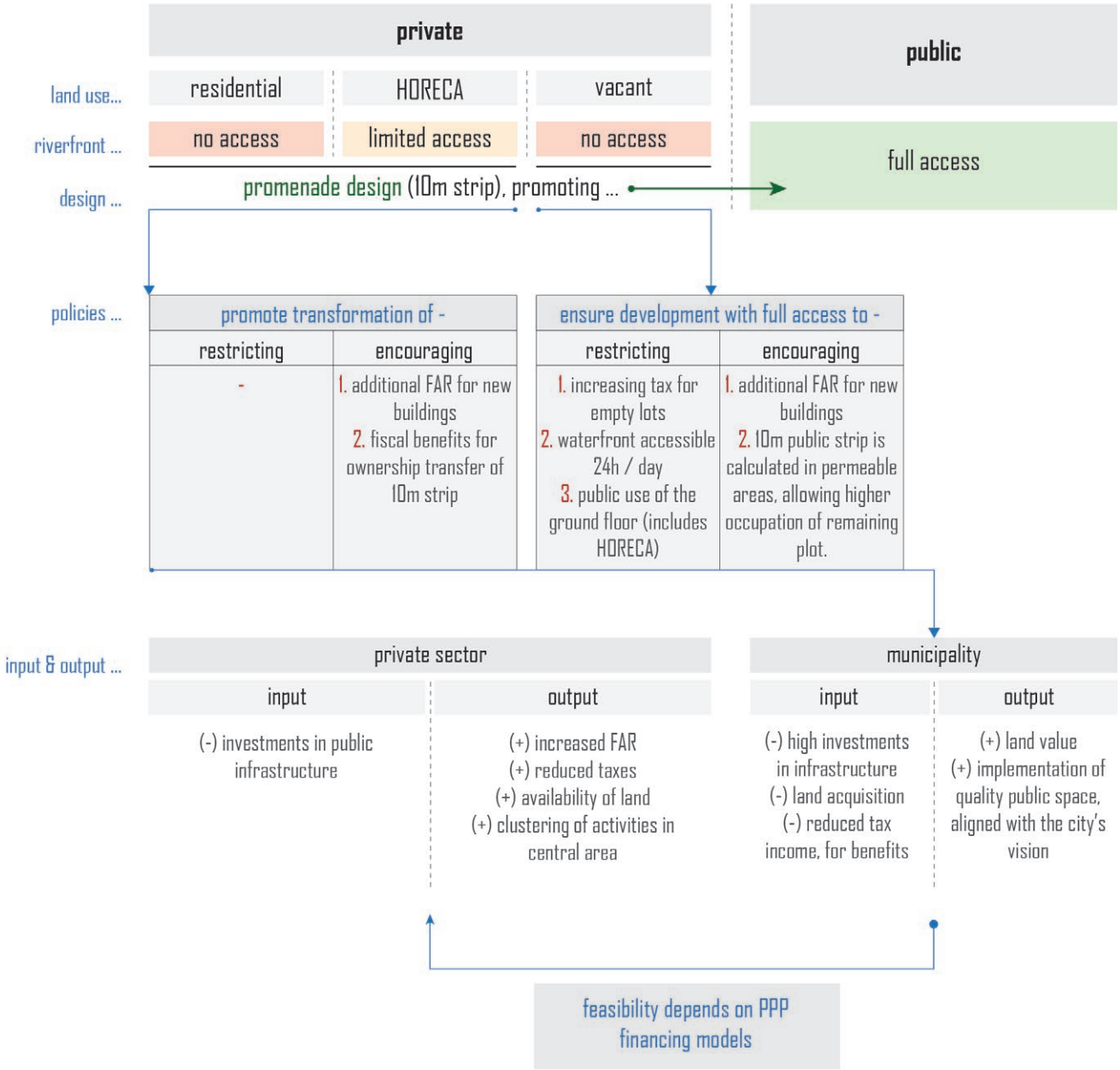
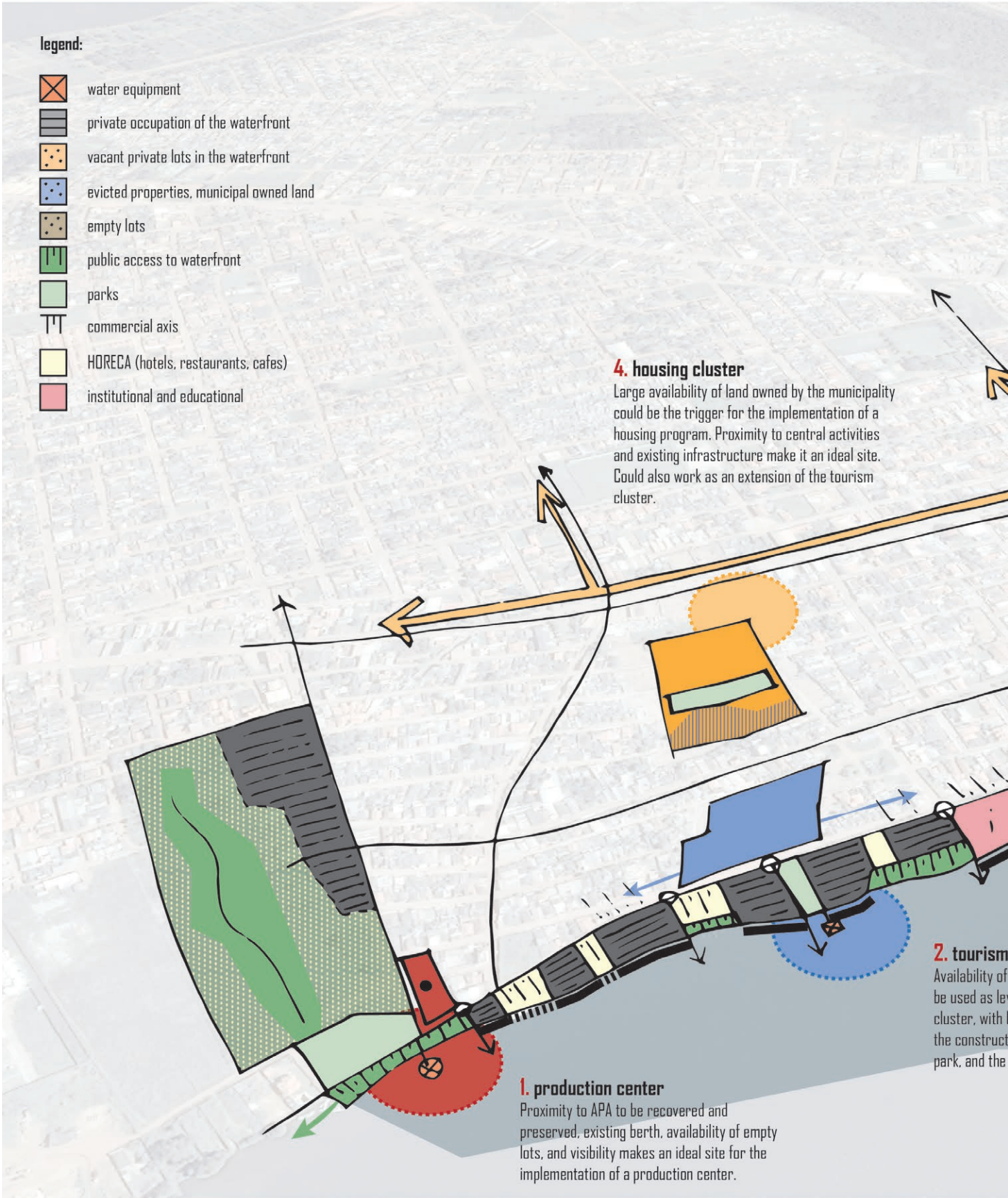
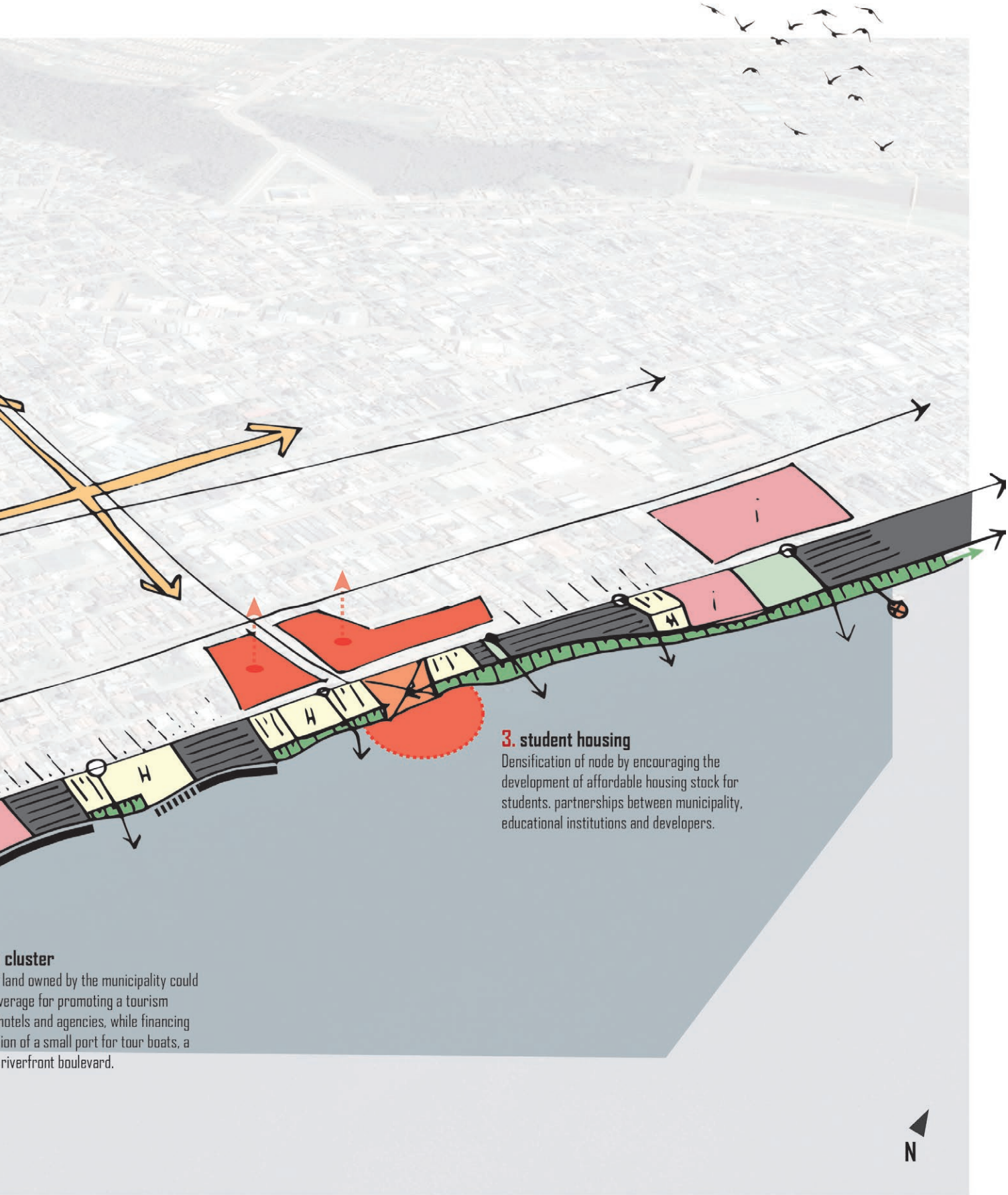


figure 6.47 | **Waterfront densification typology**

Guidelines for the densification of the waterfront boundaries of





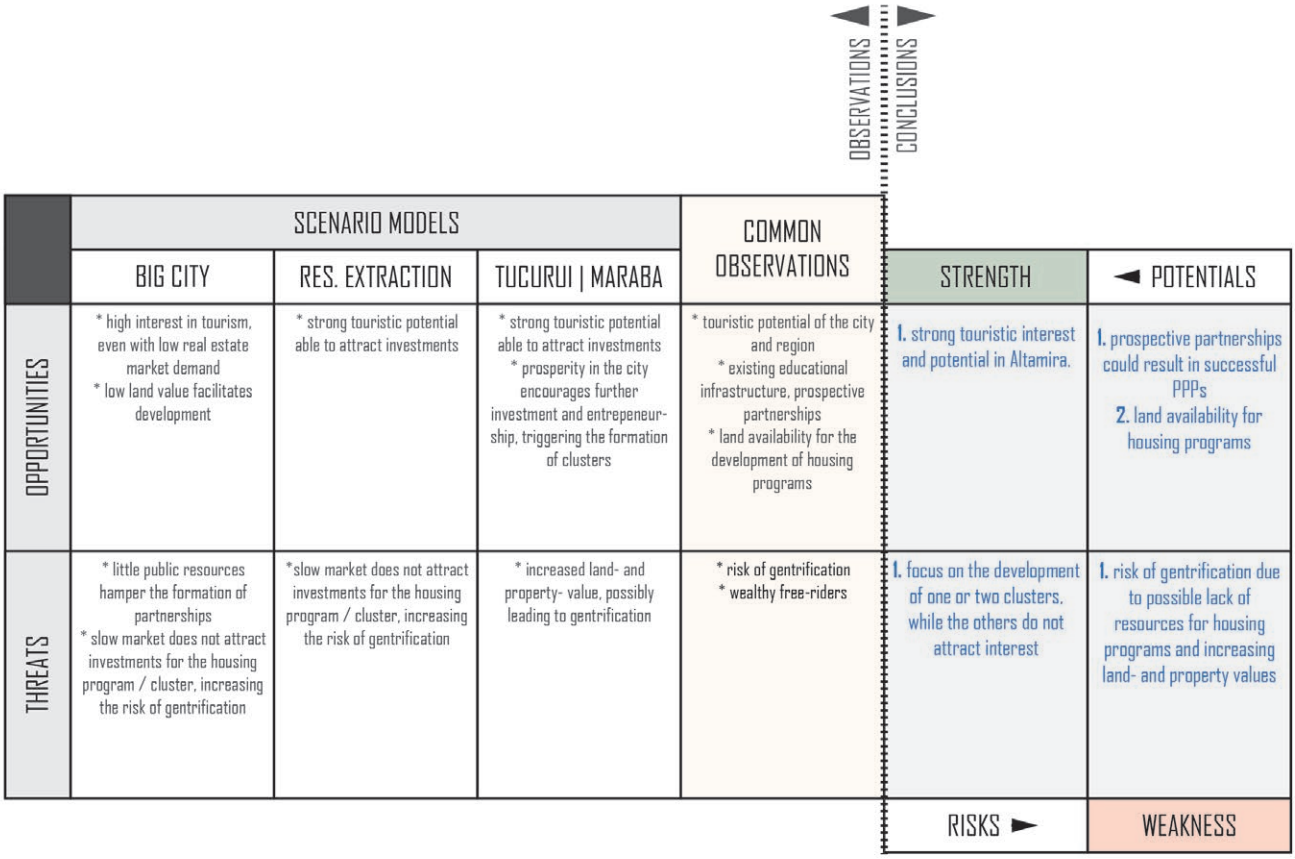
3. student housing
Densification of node by encouraging the development of affordable housing stock for students. partnerships between municipality, educational institutions and developers.

cluster
land owned by the municipality could
verage for promoting a tourism
notels and agencies, while financing
ion of a small port for tour boats, a
riverfront boulevard.

N

0 50 100 150 200 m

figure 6.48 | **Evaluation of the strategy according to possible future outcomes** (threats and opportunities)



The evaluation of the 'special projects' strategy shows fewer variations than seen in the other strategies, mainly due to the fact that the development of tourism and the promotion of education is not entirely constrained to the possible variations of population figures. Another reason for explaining the little variation seen in the scenario extrapolation exercise is the common interest in the potential for both touristic and educational activities, identified in all of the models. This common interest, necessary to trigger the spatial transformation proposed, becomes fundamental for a successful establishment of public-private partnerships, becoming the principal strength of the strategy. The expectation of engaging with multiple stakeholders can also guarantee a collaborative approach, ensuring an adequate implementation assuming possible scenarios with a challenged public management.

Another potential factor contributing to a fruitful socio-spatial transformation of the neighborhood is the availability of empty lots, many already owned by the municipality. Land ownership should be used as leverage to promote the transformations designed for the public spaces and to trigger the implementation of the new affordable housing programs proposed for Altamira.

On the risk analysis, the evaluation exercise point to the chance of an uneven development of the clusters, resulting in the poor implementation of the housing programs, due to possible lack of interest of investors. The little availability of affordable housing stock, combined with the likely to be increasing land values, might bolster the gentrification of this central neighborhood, pushing part of the population to the outskirts of the city. The outcome would be a benefited wealthy- and a harmed lower-income populations, a model which is contradictory to the inclusiveness proposed by the vision. To prevent this, the construction of social and affordable housing units should be included in all of the clusters and part of the resources of the public-private partnership should be directed to the housing secretary for the development of these units.

figure 6.49 | **Public promenade and the Xingu river**
photo by the author

figure 6.50 | **Worker and brick fabrication**
image by Dario Bosio
source: https://dariobosio.com/at-the-end-of-the-river/

6.3 ACTION PLAN

From plan to territory

The following section of the thesis summarizes the four strategies and the projects designed and explores the necessary actions to be taken in order to successfully implement them in Altamira. As concluded by analyzing the current plans and policies of the city, there is always a large gap between urban development and proposed guidelines, mainly due to a poor or inadequate management of the public sector. The action plan is intended to organize the main programs, projects, and the involved stakeholders into a single plan, to be followed by public management, government, the private sector and the civic society, facilitating a proper implementation and operation.

The first step was the definition of the fundamental actions to be taken, before, during and after the implementation of the strategic vision plan. The actions start with the awareness and motivation, exposing and adapting the vision plan with the multiple stakeholders involved, guaranteeing a collaborative and transparent process. The exposure also becomes vital for attracting possible investors to Altamira, triggering the establishment of partnerships and the fulfillment of the programs. After initiating, the definition and alignment of roles amongst the stakeholders are key for an aligned process, ensuring a realization coherent to the plans. Moreover, thinking about the long-term implementation plan, investment in research is imperative for building up knowledge, promoting frequent innovation in the process. Lastly, monitoring and evaluating tools should be used in facilitating the adaptiveness of the plan and supporting the decision-making process.

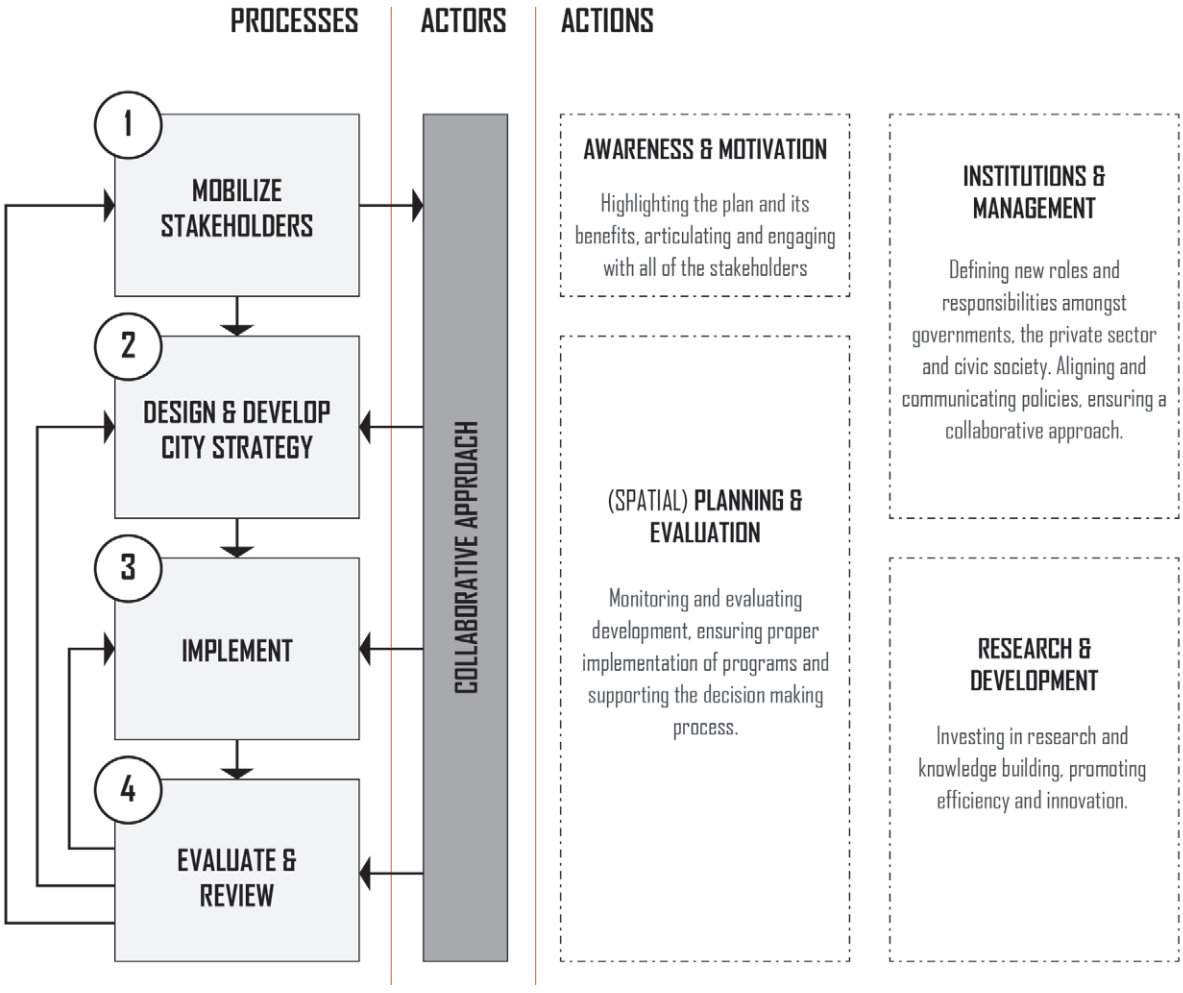


figure 6.51 | **Implementation process, actors, and actions**

Policy suggestion

Added to the programs and projects. urban development is also shaped by the definition of new policies. Those are present in every strategy, suggesting the creation of new public guidelines for encouraging the outcomes proposed by the vision plan. The diagram below shows the main policies necessary for a possible realization of the desired vision. They are divided into two categories. The first one consists of guidelines for promoting the development of the programs associated with the natural environment, such as reforestation practices and the production centers. The second category delimitates the guidelines for facilitating and limiting future development of the urban fabric, leading Altamira towards the envisioned inclusive- green growth.

The suggested policies are designed with either compliance or restriction purposes. The first one aims to attract investors and facilitate the envisioned development by creating a friendly environment encouraging and motivating the participation of multiple stakeholders. Restricting policies, on the other hand, aim to prevent the continuity of irregular occupation of the urban fabric, by setting new rules and penalties for determined occupation patterns identified throughout the spatial analysis.

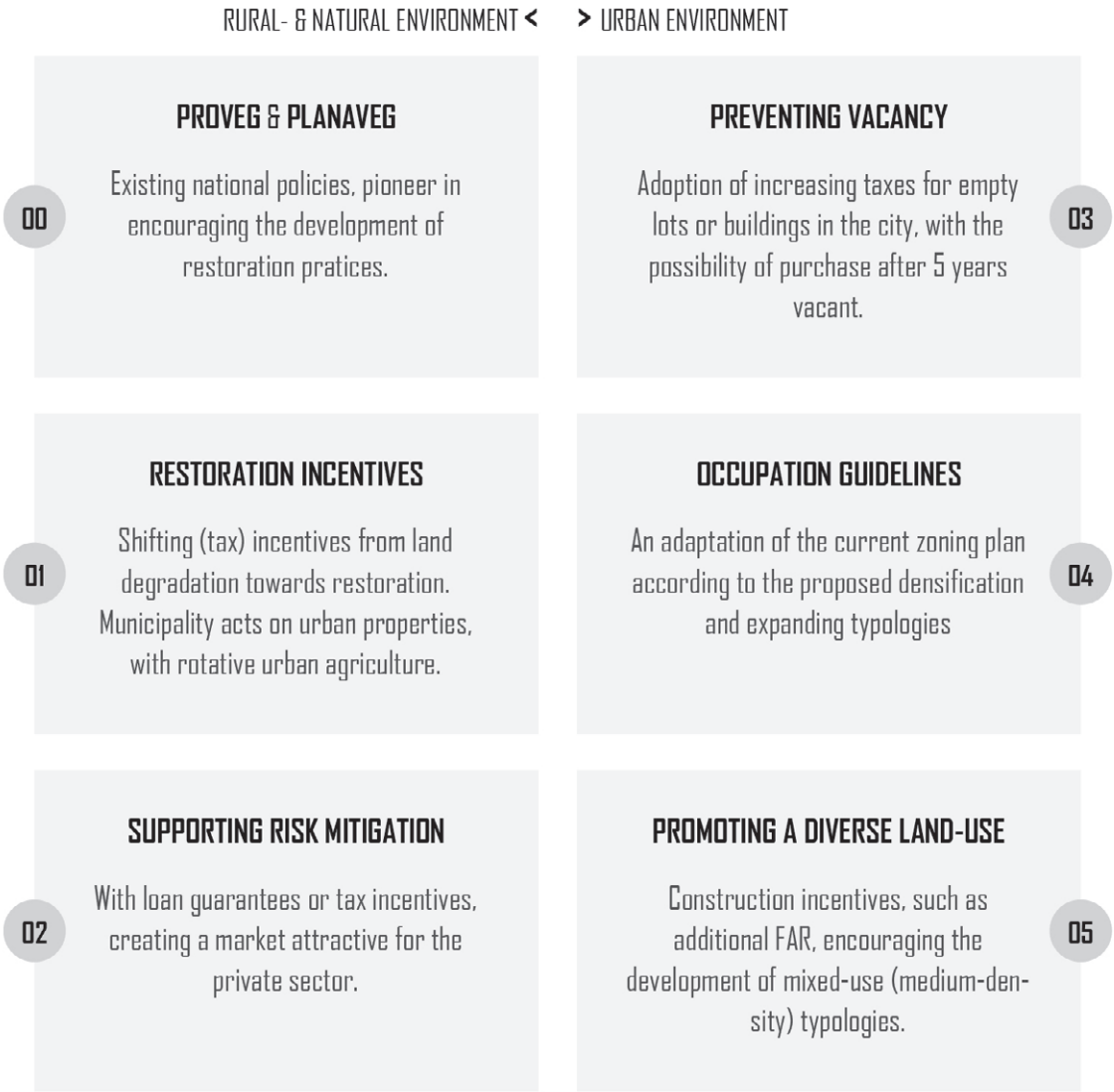


figure 6.52 | **Main policies suggested**

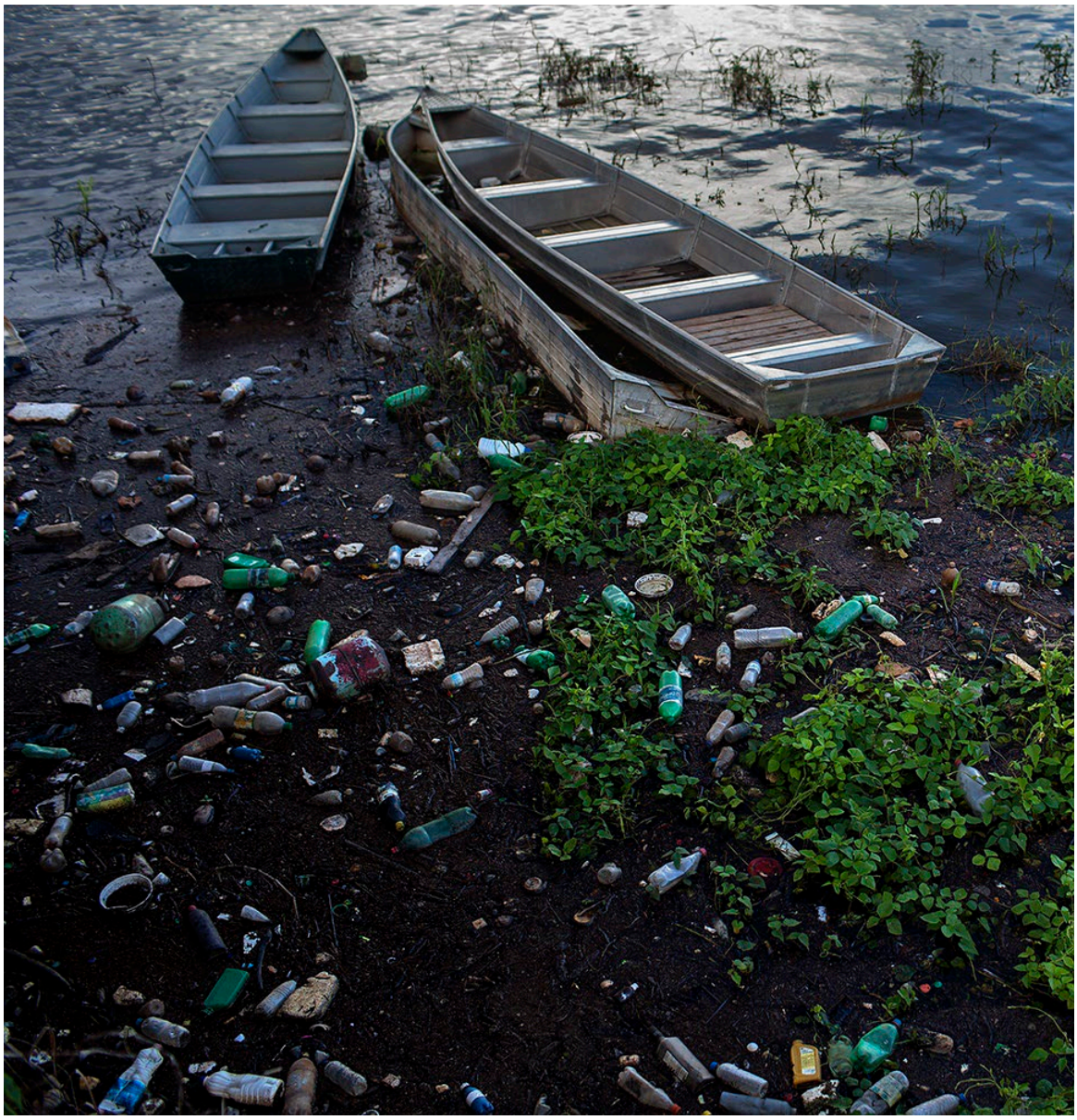


figure 6.53 | **Garbage being disposed in the Xingu river, in Altamira**
image by Marizilda Cruppe
source: https://racismoambiental.net.br/2016/03/30/fim-de-festa-em-belo-monte/

Overview of projects, programs and stakeholders

As scrutinized before, a critical issue to be tackled for future development of Altamira, present in every scenario, is the challenged public management capacity of many Amazonian municipalities. This issue is likely to lead to an inefficient application of current resources and a poor implementation of the strategic vision plan proposed by the graduation thesis. To cope with this, a multisector and collaborative approach needs to be adopted, ensuring an inclusive decision-making process and promoting a fair management of the built- and natural environments.

The first step is to understand what are the specific programs and projects designed for each of the strategies. The diagram on the following page exhibits an overview of the main proposals and the stakeholders considered in- and for strategic vision plan. The drawing associates which of the actors play an important role in the specific projects, which have an important input and which will be significantly benefited by the implementation. The actors are divided into four categories (or sectors). The local organizations and educational institutes were categorized as 'institutional' in this exercise, for their strong presence and position in the development of the urban and natural landscapes. Within the civic society, it is important to highlight the presence of indigenous and traditional (ribeirinhos) communities, currently neglected by the planning structure of Altamira.

Another observation is the participation of the municipality in every project or program. Even with the intent of relieving the pressure from the public management, it is still not possible to exclude their presence in the implementation process of urban strategies, especially in the Brazilian context. The responsibility, however, is always divided between several groups, avoiding the accumulation of responsibilities on a single stakeholder and increasing visibility and the monitoring capacity, thus reducing the risk of a poor public management.

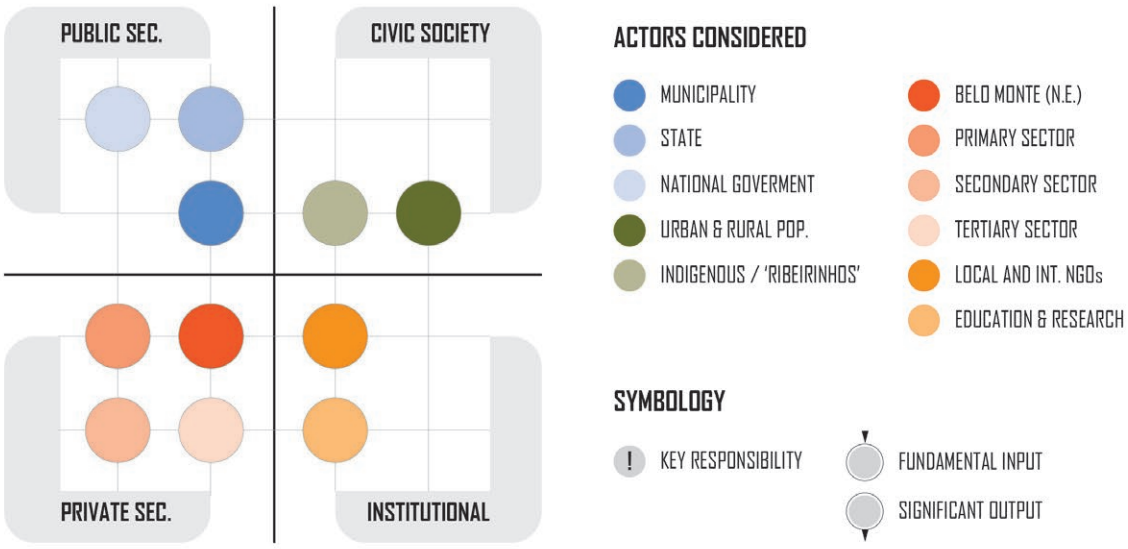


figure 6.54 | **Projects, programs, actors and responsibilities**

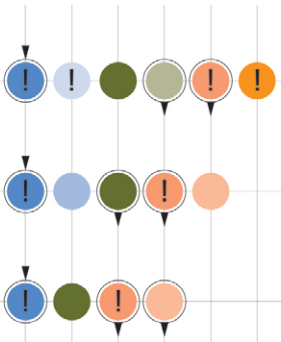
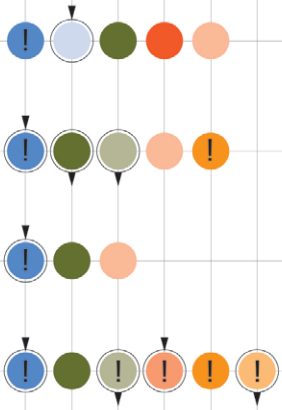
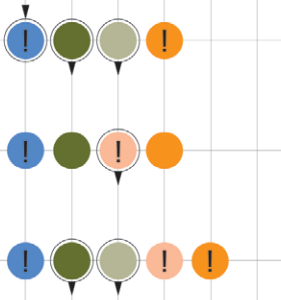
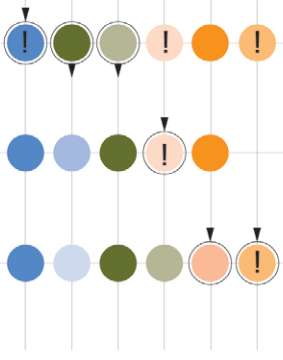
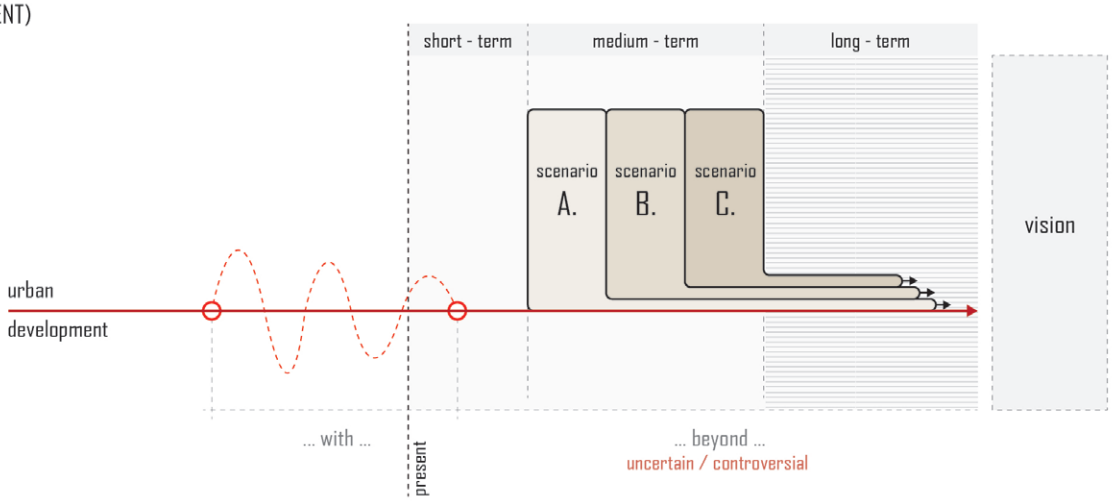
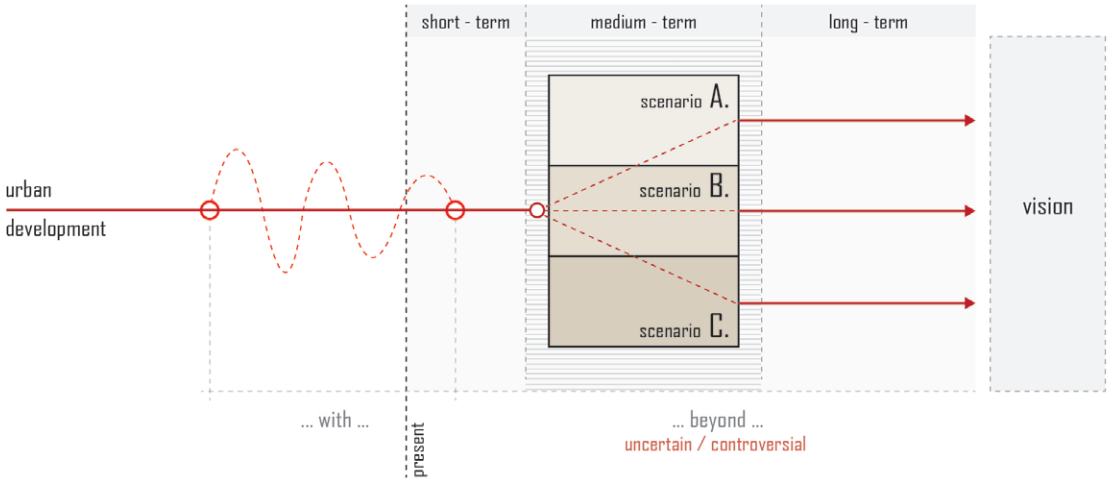
STRATEGIES	PROJECTS | PROGRAMS	KEY ACTORS	DESCRIPTION
1. ALTAMIRA & THE **NATURAL LANDSCAPE**	1a. Preservation Practices (extractivism, agroforestry, rotative agriculture) 1b. Construction of Harbor 1c. Implementation of Industrial Parks		The public sector plays an important role in creating policies and facilitating the implementation process. The private sector is fundamental for the financial feasibility and sustainability of the strategy. Civic society, especially local communities, carry the know-how and are empowered with the proposal.
2. ALTAMIRA & **PUBLIC LIFE**	2a. Transamazonica Interventions 2b. Accessible Waterfront 2c. Connected City 2d. Productive City		Again the public sector holds some responsibility of facilitating the implementation, even though the 'productive city' program could also be decentralized. The private sector and Belo Monte dam have a great interest in the economic potential of the strategy. Different groups of the civic society play a role in the proposal and the participation and support of institutions is fundamental.
3. ALTAMIRA, **LIVE & WORK**	3a. Housing Secretary 3b. Housing PPPs 3c. Urban Typologies		High dependency on the public sector. The private sector is engaged through PPP's, aiming to assist in the financing of the projects. Institutions are important for articulating (and including) the civic society with the public and private sectors. Knowledge building is vital for a successful implementation.
4. **SPECIAL PROJECTS**	4a. Waterfront Promenade 4b. Tourism Cluster 4c. Education Cluster		The final strategy relies on the engagement with- and participation of the private sector. Both public sectors and institutions are responsible for evaluating and monitoring the process, ensuring the inclusiveness and accessibility of the promoted development.

figure 6.55 | **Planning terms and the uncertain 'beyond'**

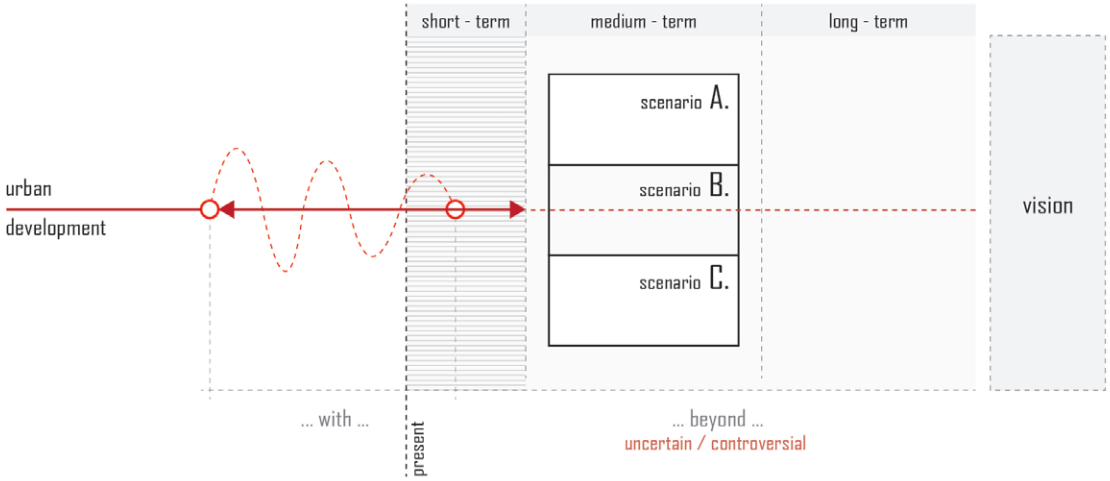
LONG-TERM | ENDURING
(SELF SUFFICIENT)



GUIDED DEVELOPMENT
(FLEXIBLE TO SCENARIOS)



SHORT-TERM INTERVENTIONS
(IMMEDIATE SOLUTIONS)



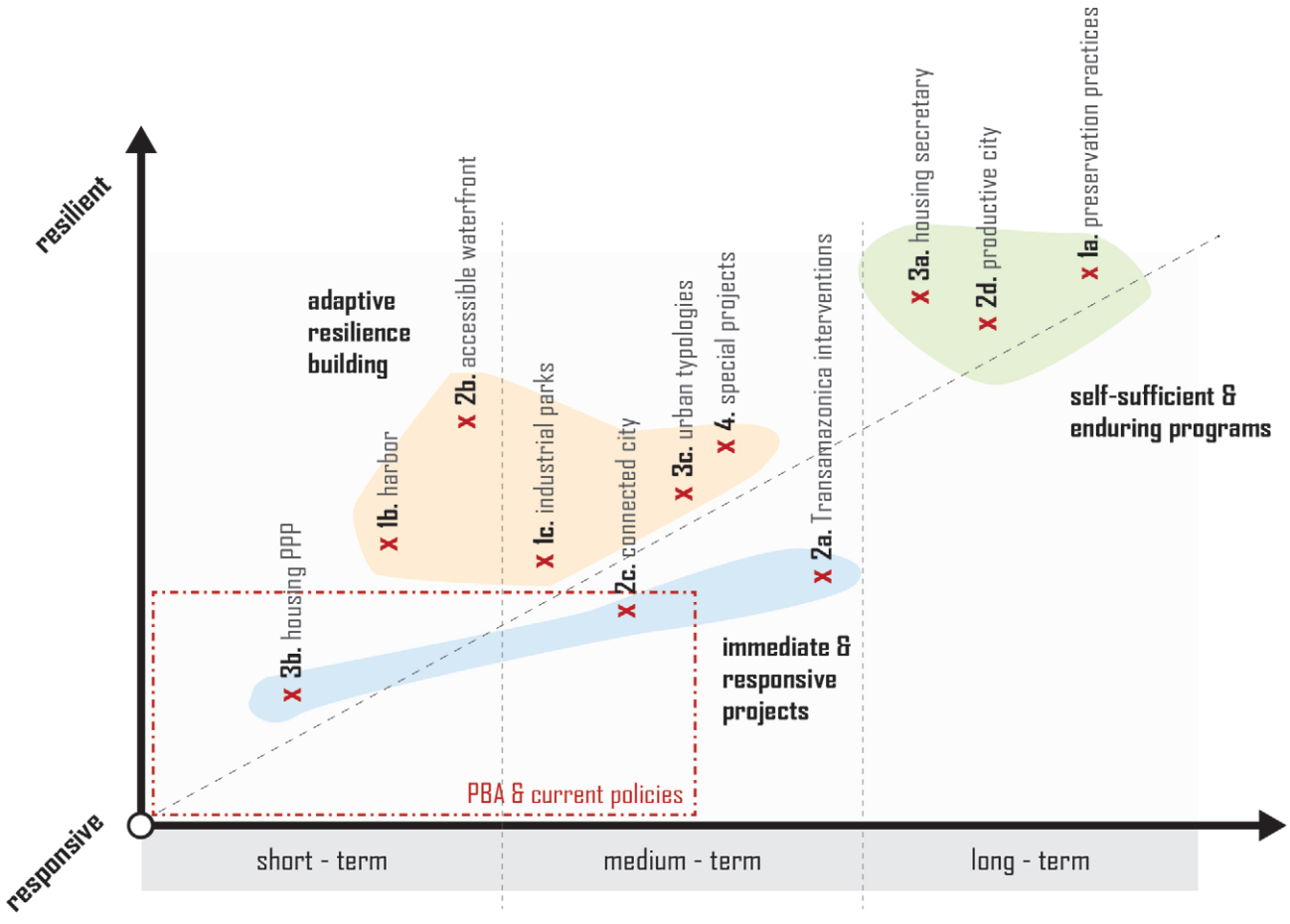
Uncertainties and frequencies

One of the main challenges of adopting of the proposed planning framework is the uncertainties concerning future growth of Altamira. The research highlighted possible outcomes according to three different scenarios, each of which could heavily influence the development of the built environment in the city. The scenarios, as evaluated by the strategies, are expected to determine the implementation of the proposals. To cope with different futures, the projects and programs were designed according to a variety of planning-terms, as described in figure 6.55.

Long-term programs are expected to have an enduring influence on the city of Altamira, regardless of the scenario outcome. The proposals structure on-going developments and aim for self-sufficiency in any envisioned future. Medium-term planning tools set the guidelines for a stirred development, flexible to the different scenarios. For the success of medium-term programs, it is fundamental to the implementation of an adaptive planning framework, through a collaborative management team and a knowledge building platform. Lastly, the short-term interventions aim for immediate solutions for the main issues identified in the spatial analysis, consequences of the growth associated with the construction of the Belo Monte dam.

The diagram below categorizes all the programs and projects according to the described planning terms. Furthermore, the drawing evaluates the strategies on a scale of responsive to resilience building. The guidelines of the PBA are also highlighted, being categorized mainly as responsive and short-term measures, directly tackling the impacts related to the construction of the big infrastructure project.

figure 6.56 | **Frequency and operability of projects and programs**



Implementation strategy

The feasibility of the strategic vision plan faces then two main challenges, as already described in this section. The first one is a challenged public management, which demands the adoption of a collaborative approach, engaging different stakeholders in the design and decision-making process, promoting a fair and inclusive development of the urban fabric. The second one is the very uncertain future of Altaira, explored throughout the scenario oriented methodology of the research, that should be tackled by an adaptive planning framework, especially when looking into a medium-term horizon.

The diagram on the following page organizes a possible implementation of the strategies according to a time horizon. The structuring element of the drawing is the core management of a multi-sector collaborative team. This management has the responsibility of articulating, implementing and evaluating the different programs and projects and should result in the building of knowledge and experience, facilitating the flexible adaptation in a medium- and long- term horizon.

The first two years, until 2020, are designated mainly for planning, negotiating and policymaking. It is a vital period for mobilizing stakeholders, aligning the strategies and further designing the proposals. Most of the projects are expected to start after this period. The division of actions is carefully distributed based on a 4-year interval framework, aligning a few milestones with the election years in Altamira, encouraging the participation of politicians and the continuity of the programs.

figure 6.57 | **time-line of the strategic vision plan for Altamira**

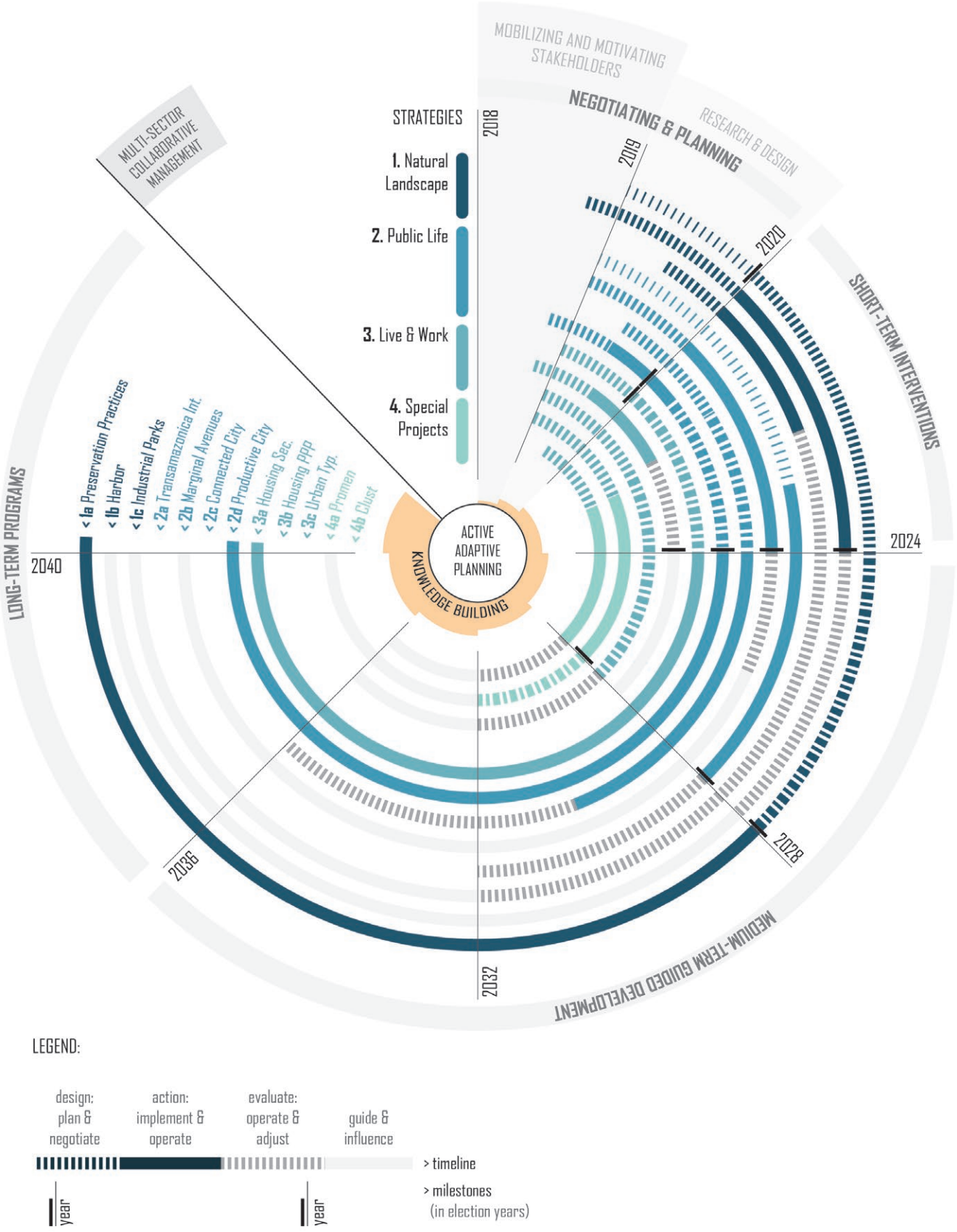


figure 7.1 | **Local boy running his errand**
image by the author

chapter **7.**

CONCLUSIONS

7.1 FINAL REMARKS ON ALTAMIRA

From its starting point, the identification of a symbiosis between a hydroelectric power plant and a city in the Brazilian Amazon, the research investigated the main socio-spatial implications of the relationship between big-infrastructure and urban development. Through the impacts associated with the construction process and the many mitigation and compensation guidelines designed to cope with them, the Belo Monte dam has led to significant transformations in the built environment of Altamira. And, even though many of the implemented programs lead to a positive outcome, as seen throughout the research, the presence and influence of the dam were unable to promote sustainable development of the city.

Looking beyond the construction of the dam, the proposed strategic vision plan aims to stir future growth of the city towards a sustainable direction. To achieve this, the adoption of a long-term planning tool and the definition of a vision unifying the different strategies is suggested to the current public management toolbox of the city. With an emphasis on the unique territory in which the city lies, the vision proposes to better articulate the relationship between the natural- and the built environments, breaking the existing boundaries between men and nature. Oriented by a collaborative approach, four strategies were designed with the intention of leading urban development towards the inclusive and green future envisioned.

By evaluating the strategies and imagining the possibility of implementing them, one can realize a few limitations of the proposals, especially considering some of the technical and juridical challenges of the region, such as land ownership and regularization. However, the broadness and diversity of the design ensure that, even without a full implementation, the strategies could promote a sustainable development in Altamira.

Another very important factor to consider is the constant uncertainty concerning the future of the city. Even though the graduation thesis explores and acknowledges different scenarios, the implementation of the Belo Sun mining complex, for example, could alter the growth dynamic of the city once again, compromising the effectiveness of some of the program and projects designed. In this regard, it becomes indispensable to ensure an alignment of new mitigation and compensation guidelines with the vision proposed, adapting it to the new urban dynamic and exploiting the potentials the big-infrastructure project might bring. Furthermore, assuming the long-term life cycle of the natural environment solutions, it also becomes vital to ensure the continuity of the programs.

Finally, and most importantly, the graduation thesis is able to raise the discussion on possible solutions and alternatives for the development of Altamira. Apart from the debate on its feasibility, the results evidence what were the main transformations in the urban fabric, what futures could be expected and what possible solutions could (and should) be implemented. The body of knowledge constructed could be used as a framework for local stakeholders, offering them a new perspective on urban development, beyond the construction of the Belo Monte dam.

figure 7.2 | **Alacid Nunes Avenue**
image by the author

7.2 PERSONAL REFLECTION

Within a planning perspective, the approach of this graduation thesis proposed to articulate the urban- to the rural- and natural environments. Acknowledging the recent urban transformations, influenced by the construction of Belo Monte dam, and the inevitable growth associated to it, the strategies were designed with the intent to guide the development of the city towards an inclusive- green future. The following section is used to reflect on the processes adopted in the research and design and their alignment with the raised academic and ethical values. The exercise is divided into three parts. The first one looks back into the methodological framework conducted, observing on the advantages and limitations of the tools adopted for achieving the proposed outcomes. The second part reflects on the alignment of the work with the research group and the contribution of the results to its specific body of knowledge. Finally, the last part scrutinizes the ethical and societal relevance of the conclusions, evaluating the proposals according to the values of the territory investigated.

1. A reflection on the advantages and limitations of the chosen methods

Considering the number of large issues concerning the construction of the dam and the influence it had in its surroundings, defining a scope and a methodological framework was quite a challenge in itself. The proportions of the territorial conflicts encountered and the polarized and controversial discussions on the impacts and benefits of the dam set a broad range of issues and scales to be tackled. In this regard, the comparative precedent studies conducted and the determination of the four key factors and criteria were fundamental for the definition of an objective investigative process, not only guiding the research but also strengthening its coherence with the specific context. The key factors became the backbone of the process, defining parameters for both past and future investigations of the main socio-spatial characteristics of Altamira.

The methodology was also successful for its overlapping process, again encouraged by the definition of the key factors. The inclusion of a future-oriented investigation method within the spatial analysis framework allowed for the superposition of research and design, exploring not only past transformations but also future developments, allowing for the definition of the design principles. The chosen methods overlapped again while evaluating the strategies according to the scenario models, verifying the alignment of the proposed design with the research conducted and testing the feasibility of the strategic vision plan based on the precedent studies.

The use of scenarios, on the other hand, had its limitations throughout the investigation. After determining criteria and probable future models, scenarios were used exclusively as an evaluation tool. And even though they were fundamental for structuring the proposals, the initial intent to explore them spatially, allowing for a qualitative evaluation of the design, was not completely fulfilled. This fact can be associated with the time limitation of a 9-month long graduation project. Another challenge worth mentioning is concerning the spatial- and scenario analysis section. The process, focused on the key factors, became too anchored to a technical perspective, resulting in the loss of sensibility towards the environmental and societal issues raised in the introduction of the research. This fact was compensated with the definition of the vision and principles in the strategic plan, re-aligning the design with the ethical and societal values of the fragile landscape under investigation.

2. A reflection on the academic value of the project and its relation with the research group

The graduation project is very much associated with the mission of the complex cities studio, especially when considering a territory where poverty, extreme environmental threats, and weak governance are within the main challenges to be tackled. In this regard, the investigation conducted on the socio-spatial influence of big infrastructure projects and the solutions designed to address such issues can deeply contribute to the body of knowledge of the urban and regional planning discipline. The research was careful in understanding the existing planning tools and processes of the city, exploring sensitive and feasible interventions able to advocate significant transformations. The knowledge of the Dutch experience was also introduced, when applicable, as part of the toolbox necessary for the conclusion of the research.

Assuming the Brazilian context, the research pointed out the lack of a unified and long-term planning tool as a crucial reason for the challenged development taking place in Altamira. With this in mind, the outcome of the graduation project, a strategic vision plan, emphasizes the necessity of introducing new transdisciplinary planning methodologies. The proposed strategies, even though bold, are able to raise the discussion on the importance of innovative solutions, aiming to stir the development of the city towards an inclusive- green future.

figure 7.3 | **Boys playing in a stream**
image by Lalo de Almeida
source: http://lalodealmeida.com.br/site_pt/editorial/belo-monte-2/#!prettyPhoto

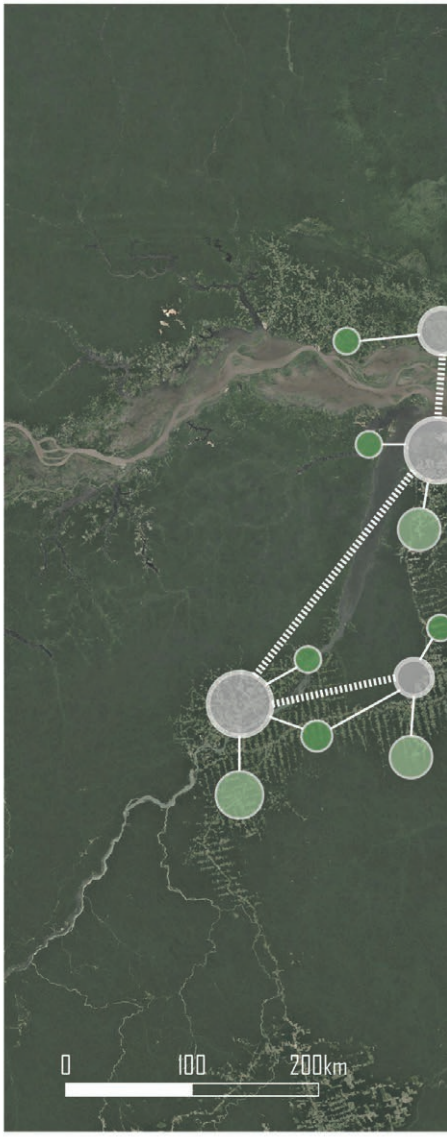
3. A reflection on the ethical issues encountered and the potential application of the results

Critically positioning myself in the controversial discussion on the exploitation of natural resources and the development of cities in the Amazonian region was no easy task, especially considering the polarization of opinions and facts surrounding the topic. Avoiding a biased approach, the investigation stayed away from the "right or wrong" debate and aimed for an impartial analysis of all available facts and data. However, as a designer, there is the need to assume a critical standpoint before coming up with plausible solutions for the territory. With this in mind, the following paragraphs express the position embraced by this graduation project.

The research does not condemn the implementation of the Belo Monte dam or other big infrastructure projects. The exploitation of natural resources can be beneficial for the development of the region and is necessary for the growth of the country, especially when considering the increasing global demands, and should not be understood as a negative outcome. However, the implementation processes have shown to be too intensive and aggressive and, historically, have not promoted an ideal development in the region. In this regard, the strong role that local and global organizations have played in demanding a proper implementation of the projects, constantly fighting for the rights of the natural landscape and its local communities have become fundamental for the maintenance of the Amazon. But, instead of avoiding the conception of future projects, there is the need of finding ways to amend the challenged processes, leading to an optimized exploration of the potentials they are expected to bring. As mentioned in the research, the existing boundary between production and resources, between men and nature, needs to be overcome.

The strategic vision plan was designed according to this point of view, investigating alternatives capable of sustainably exploring the natural resources and the local knowledge the Amazonian region has to offer. The focus, evidently, relies on the development of the built environment. Urban settlements, instead of adding further pressure to the natural environment, should be able to articulate the two worlds, ensuring its productivity and preservation.

Aiming beyond the specific case study, the final outcome is expected to create a model to be applicable in other Amazonian cities. Triggered by Altamira, the implementation of similar practices in other municipalities could encourage the development of a new industry, promoting the employment of inclusive and sustainable practices, providing an alternative for the current development and exploitation models. Moreover, instead of simply focusing on the compensation and mitigation of impacts, the construction of dams and other big infrastructure should be explored to support the implementation of this new inclusive- green model.



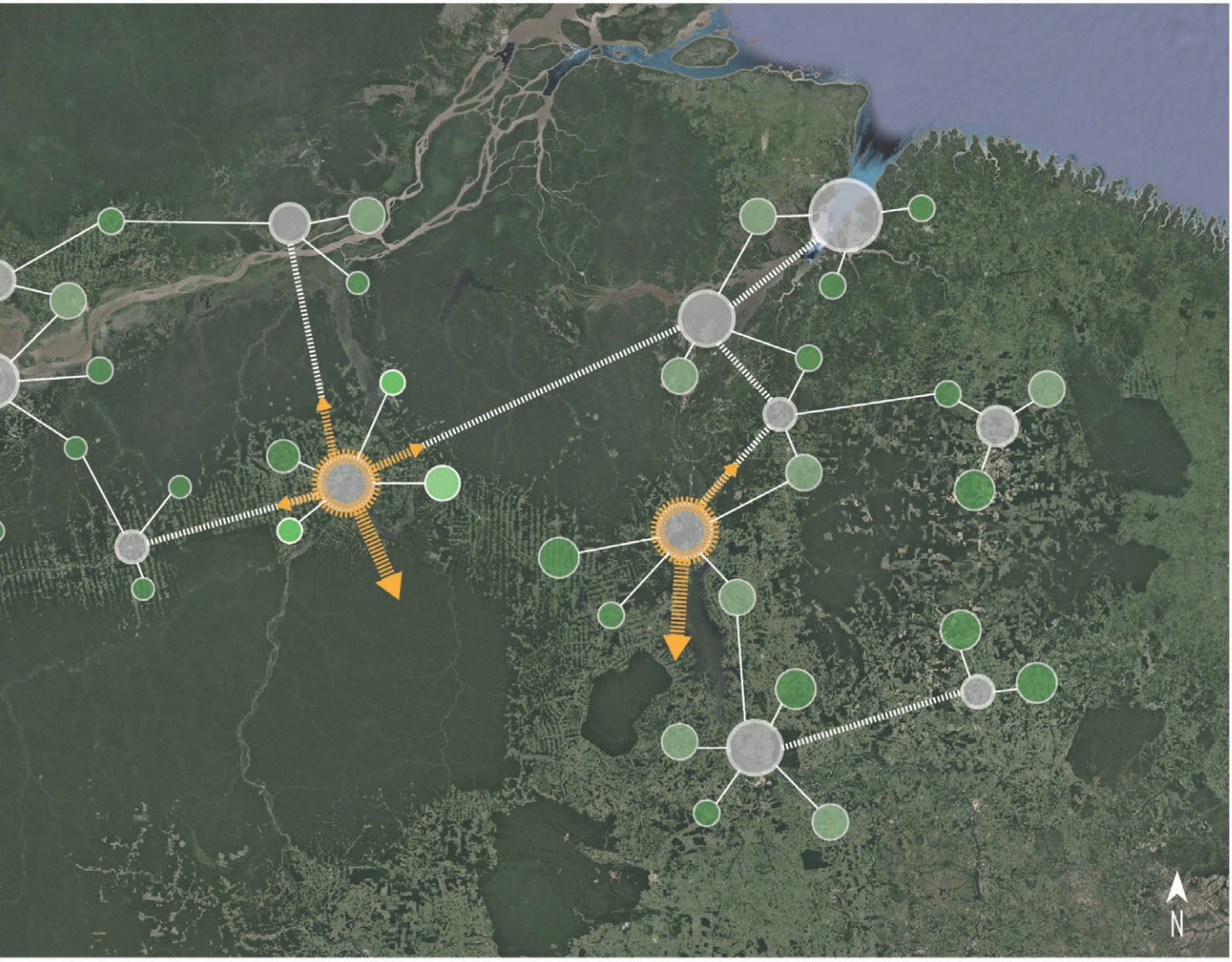


figure 7.4 | **Transferability of the model in the Amazon**
base map: GOOGLE EARTH

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