BETWEEN MOUNTAINS AND MANGROVES

Designing a Gradient City

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DESIGNING WITH LANDSCAPE GRADIENTS FOR SOCIO-ECOLOGICAL URBAN DEVELOPMENT IN NUSANTARA, THE NEW CAPITAL OF INDONESIA

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All images by author unless stated otherwise





Image 1: In the administrative center of Nusantara, February 2025.

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Image 2: The construction of Sepaku River dam for the water supply of Nusantara (Sitompul, 2024).

ABSTRACT

This research explores how landscape gradients can shape a new urbanisation framework for Nusantara, Indonesia's planned capital city. As Jakarta struggles with rising sea levels and the pressures of climate change, the creation of Nusantara offers a rare opportunity to rethink the relationship between urban development and ecological systems on a grand scale.

Nusantara's development site is located on the island of Borneo, between mountainous rainforests and estuarine mangroves. Much of the lowland rainforest in the area was converted into agricultural land and production forest in the 1900s, resulting in the fragmented landscape seen today. The natural gradient transitions between landscape typologies, which allow species movement, foster biodiversity, and carry cultural significance, have been disrupted by logging, agriculture, infrastructure, and mining. Since Nusantara is situated along a broad spatial gradient from the hilly rainforest to the mangroves, an alternative planning approach is required to preserve and regenerate these landscape structures.

This research explores whether landscape gradients can serve as a formative force in Nusantara's development. The study begins with an analysis of the historical, spatial, ecological, and cultural characteristics of the site to uncover its underlying logic for subsequent design exploration. A collection of principles for designing with landscape gradients emerges from fieldwork and research, offering potential for future research. Key locations identified in the vision are developed in greater detail to illustrate the spatial quality of the proposed framework.

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01 - INTRODUCTION

In this chapter, the project location is introduced, and the scope of the research is defined. An initial analysis of current and potential issues regarding the construction of a new capital city in the bio-diversity hub, on the island of Borneo, establishes the research theme. A case study on planned capital cities supports the argument for the necessity of an alternative approach to designing large-scale urban developments. Important concepts such as landscape gradients and fragmentation are explained and their relevance to the project and study location is outlined. The research objective and questions help structure and direct the project. The introduction concludes by emphasising the importance of exploring the landscape-based approach to urbanism, ultimately highlighting the relevance of this research for the design of future-proof cities.



1.1 WRITING A NEW STORY

Personal Fascination

I have always been fascinated by the unique relationship between people and landscape, and how this relationship translates into modern urban life. The story of people and landscape runs deep in history, as “cultures have either withered or flourished as a result of how they lived with land and water or per, McHarg how they designed with nature” (Weller et al., 2019). When observing the current urban reality, the city and landscape often seem like mutually exclusive concepts in conflict with one another. This conflict has become ordinary in many places, as we have come to “take for granted the natural and cultural, land and water, urban and rural” (Mathur, 2019). Yet, “the longing for landscape” is becoming a universal trend –a “natural reaction to that which is disappearing” (De Wit, 2019). This longing inspires a rediscovery and reinvention of the relationship between the people and the land in an urban environment. I believe landscape architects can play a key role in continuing the story of people and landscape and imagining a future city where the two come together.



Image 3: Nusantara under construction (Robin Zwartsenberg, 2025)

1.2 NEW CAPITAL OF INDONESIA

The island country of Indonesia is currently building a new capital city called Nusantara. The motivation to replace Jakarta, the current capital, with a brand-new city stems from various political, environmental, and economic reasons. For one, Jakarta is facing the effects of climate change with the threat of submerging under the rising sea (Renaldi & Program, 2022). Nusantara, meaning archipelago, is supposed to alleviate some of Jakarta's pressures and symbolise a new opportunity for the future. The location, on the island of Borneo, has been selected based on its central location relative to the other islands and a comparative safety from climate change challenges, such as the rising sea level (Ibu Kota Nusantara, 2021). It is important to acknowledge that the plan evokes mixed feelings, with reasonable concerns for environmental impact and social inclusion. This research approaches Nusantara as a possibility to experiment with a landscape-based approach to urbanism and create an example of how this design framework can lead to positive development.



1.3 ON THE ISLAND OF BORNEO

The future capital is located in the East Kalimantan province, between two major cities, Balikpapan and Samarinda. The region is rich in natural resources such as gas, oil, coal, and forest (Kusuma et al., 2023). For that reason, the mining, oil, and logging industries have a strong presence in the study location.

The natural landscape in the larger development area is incredibly diverse and valuable. To the west, the city is bordered by a stretch of steep hills covered in rainforest. In Balikpapan Bay, a fringe of mangroves outlines the coast. Much of the land between the mangroves and the protected forests of Mount Beratus was originally covered by precious lowland rainforest. However, today large parts of the forest have been converted to oil palm plantations and eucalyptus production forests.

An intricate water network of streams and rivers, that bring freshwater toward the bay, runs through the development area. There, the fresh and the salty water mix creating a brackish zone; home to the mangroves.
Other than the two large cities, smaller villages are scattered along production roads between plantations and along major infrastructure connections. Many of these villages emerged in the 1970's as people from Java Island were relocated to Borneo as a part of Indonesia's transmigration program (Fauzi et al., 2023). Additionally, multiple Indigenous communities, such as the Balik, have their homes in the development area.

The construction of Nusantara began in 2022 and is planned to be finished by 2045. In that period, the city's population is predicted to reach roughly 2 million people (Bambang, 2019). The implications of such rapid development in an already ecologically vulnerable environment will be discussed in the following pages of the report.



1.4 CURRENT PLANNING

Problem Field

To identify the problem field of the project, it is important to consider both the potential effects of building a new city and how these effects may play out in the site-specific context. The predicted effects are related to the general influence of urbanization on landscapes and ecosystems, as well as the current planning strategy.

Urbanization generally has a negative impact on the natural environment, contributing to biodiversity loss by altering existing land use (Nijhuis, 2024). The degradation of coastal mangroves near Samarinda, one of Nusantara's neighboring cities, is a relevant example of how population and economic pressure can impact even the most valuable natural habitats (Jariah et al., 2024). This raises an important question: how does the current planning of Nusantara address these issues?

The vision for Nusantara revolves around the concept of a future "forest city for all". Many current urbanism trends such as the 10-minute city and biophilic design are mentioned as core principles of the design. These strategies intend to mitigate the negative effects of urbanization and ensure high living standards for all inhabitants. For example, the project aims to integrate reforestation strategies to regenerate large sections of the eucalyptus plantations (Ibu Kota Nusantara, 2021). These concepts indeed offer an opportunity to test how urban development can go hand in hand with ecosystem rehabilitation.

However, since construction began, several issues regarding damage to protected ecosystems and injustices toward local communities have been reported. For instance, stretches of mangroves have been cut down to construct electricity lines and infrastructure roads (Ratcliffe, 2024). Mangroves in particular are a part of the biodiversity management plan which aims to avoid, minimise or compensate for any ecological destruction (Deputy Environment, 2024). Such reports reveal a certain discrepancy between the plan and reality. To understand why this is happening, examples of other planned capitals have been analyzed and compared to the current planning of Nusantara.



Image 4: : Contrasting perspectives: current planning strategies alongside media coverage of the ongoing development.

PLANNED CAPITALS

Nusantara is not the first capital city to be built from scratch, precedents include Brasilia, Islamabad, Naypyidaw, Putrajaya, and many others. These cities often serve a primarily administrative function, similar to Nusantara. These examples can provide valuable insight into the possibilities and challenges of designing a new urban environment.

I have selected the cases of Brasilia, Abuja, and Islamabad to study in more detail, since they have comparable functions and population sizes. Interestingly, the three examples emphasize urban experimentation and green urban spaces in their planning. Yet, looking at these cities after completion, issues with ecological degradation, functionality, and social dynamics are prevalent. I have identified that rigid planning, a lack of consideration for cultural and natural processes, and rapid development, lead to these discrepancies between the desired result and the eventual outcome (see Annex I).

By comparing the current planning of Nusantara with the studied examples of other planned capitals, numerous similarities rise to the surface. The plan follows a top-down approach with limited room for flexibility, reducing its potential for future adaptation to natural and cultural processes. This approach leads to challenges with landscape degradation and lack of social development in the studied examples. Therefore, to explore the potential of this project, a new planning approach rooted in landscape-cultural characteristics is necessary.

NUSANTARA



Image 5: Current masterplan of Nusantara
(Ministry of public works and public housing, Republic of Indonesia).

BRASÌLIA-BRAZIL

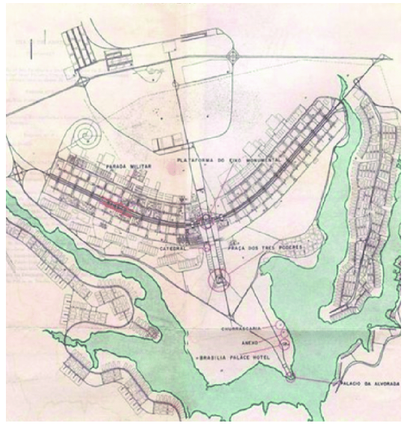


Image 6: Masterplan of Brasilia 1960s (Alwehab & Juvara, 2018).

ABUJA-NIGERIA



Image 7: Masterplan of Abuja 1980s (Abuja by Kenzo Tange 1981, 2014).

ISLAMABAD- PAKISTAN

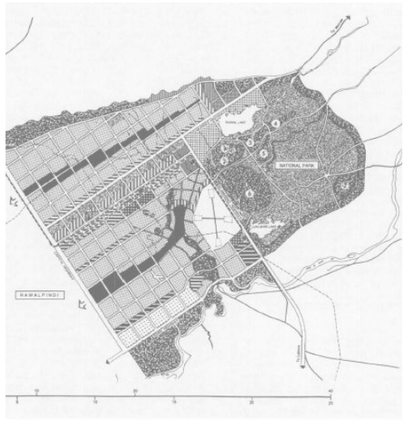


Image 8: Masterplan of Islamabad 1960 (Imran, 2003).

LANDSCAPE FRAGMENTATION

Beyond the general issues of urbanization and flaws in the current planning, the project location has been subjected to extensive landscape fragmentation caused by logging, agriculture, and mining activities. Landscape fragmentation refers to the loss and breaking apart of continuous landscapes into isolated habitat patches. This process not only disrupts landscape connectivity but also leads to a gradual decline in biodiversity (Fahrig, 2003). The study site has been heavily fragmented since the onset of industrial-scale extractive operations on the island of Borneo in the early 1970s (Gaveau et al., 2014).

At the project site, estuarine and coastal mangroves, as well as protected areas of secondary and primary forest, are now separated from one another and from the larger primary forest of Mt. Beratus. Between these landscape patches stretch vast areas of eucalyptus and palm oil plantations, along with several coal mines. These extend across the steep hills west of Nusantara toward the city of Samarinda, significantly limiting access to the primary forest of Mt. Beratus from most of the coastal and bay areas. This connection is especially critical, as the forest of Mt. Beratus links to the Heart of Borneo, one of the oldest and most biodiverse rainforests in the world (Moate, 2023). Larger protected areas, such as Sungai Wain and Bukit Soeharto, also lack direct connections to the mangroves. This ultimately isolates different habitat typologies by restricting species movement between them and erasing transitional zones within the landscape.

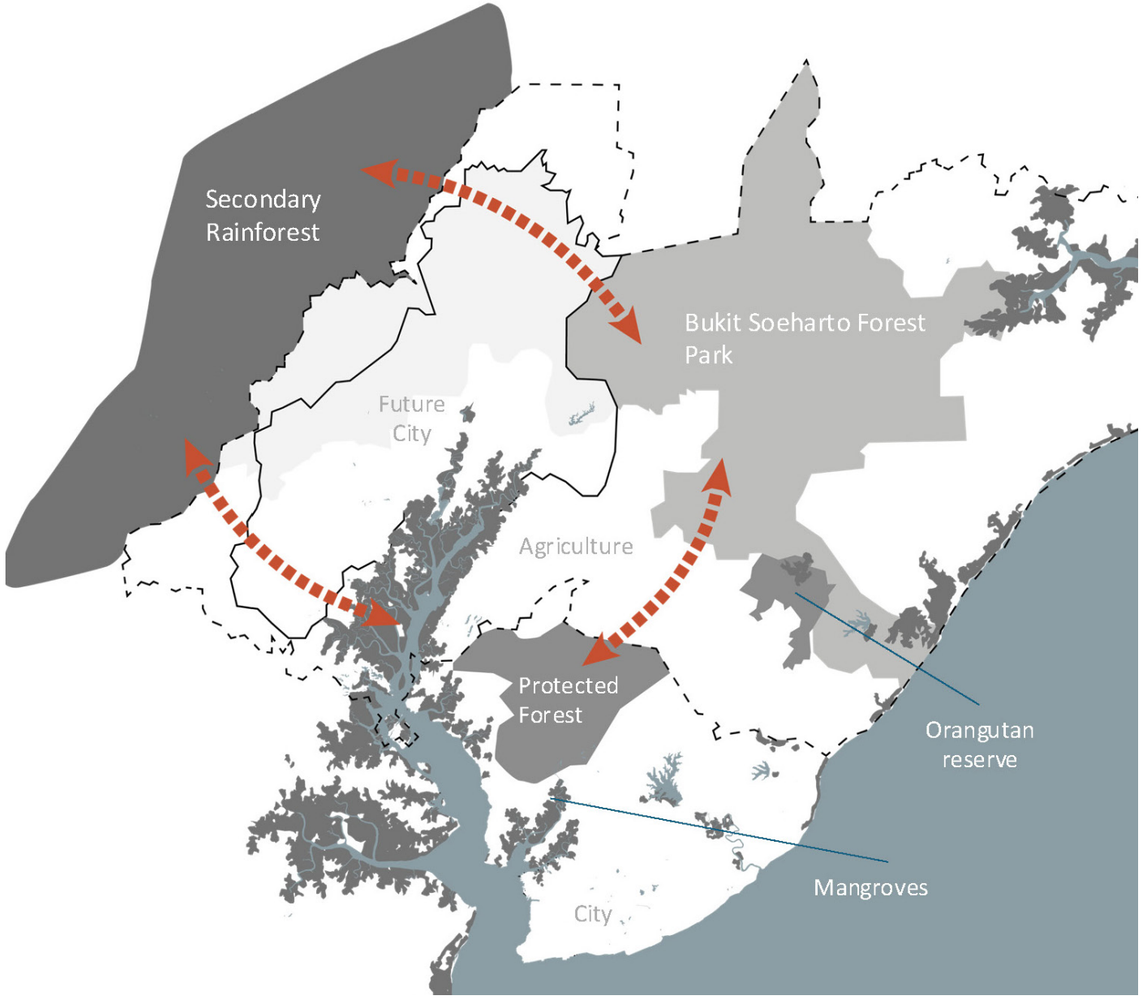




Image 9: Eucalyptus plantations near Nusantara



Image 10: Palm oil plantations near Nusantara

DISRUPTION OF LANDSCAPE GRADIENTS

The loss of transitional zones, or gradients, in the landscape is another significant issue at the research site, which may be further intensified by the construction of Nusantara. Landscape gradients occur in response to changing characteristics such as elevation, climate, water, soil, and human activity. The overlap or transition between different landscape typologies often exhibits especially high levels of biodiversity, making these areas extremely valuable (Kark, 2012). In Nusantara, many of these gradient transitions have been disrupted through the conversion of lowland rainforest into plantations.

The main natural gradients on-site are closely related to water and elevation. The transition between the wet zone, where mangroves thrive, and the lowland rainforest is barely present, as most of the mangrove edges have been transformed into palm oil plantations. Another gradient that has been severely disrupted is the transition between lowland and hilly rainforest, where eucalyptus plantations have created a harsh boundary. Riparian gradients, which stretch throughout the landscape and create large-scale ecological connections, are still partially intact. Each of these gradients offers a unique ecological value and corresponds with distinct cultural practices.

Nusantara's position plays a major role in the large-scale gradient transition from mountains to mangroves. This gradient is already heavily disrupted, and a large urbanisation project may only intensify the barrier effect. Therefore, given the ecological and cultural richness of landscape gradients, it is essential to develop a design framework that both preserves and responds to them in a meaningful way.

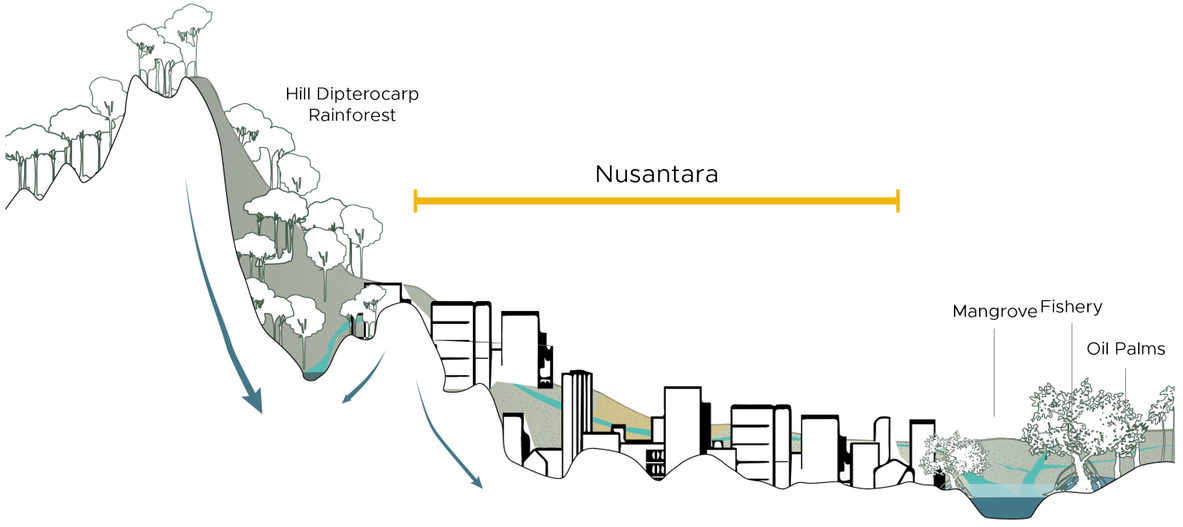




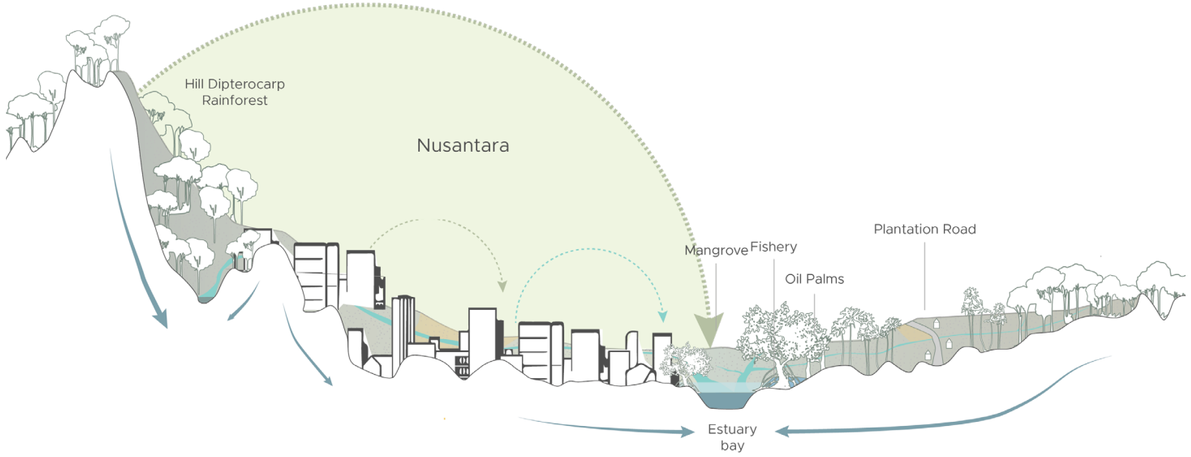
Image 11: Infrastructure development near the city cetner 2025.



Image 12: Construction of a road to the Balikpapan Bay through existing mangroves 2025.

1.5 RESEARCH OBJECTIVE

The issues with the current planning, as well as existing landscape fragmentation and the disruption of ecological gradients, highlight the importance of implementing an alternative design approach—one that can guide the urbanisation process in a way that helps regenerate and stimulate the landscape while integrating local communities. To achieve such an ambitious objective, this research will focus on the landscape-based approach and the potential of gradient landscape transitions in terms of their ecological and cultural significance. The following research questions outline the main objective of the study and provide a structured framework for the research.



RESEARCH QUESTION

How to design an integrative landscape framework that regenerates natural gradients and supports the socio-ecological urban development of the new capital Nusantara?

SRQ1: Understanding and Analysis

What are the ecological and cultural landscape characteristics and gradients of the region and what opportunities and challenges can be identified regarding its current state and its transformation into an urban landscape?

SRQ2: Design Strategy

What spatial design strategies and principles can be derived from the concept of landscape gradients to enhance landscape ecological connectivity and socio-culturally inclusive urban development?

SRQ3: Design Application

How can the design of an integrative landscape framework be applied at multiple scale levels to regenerate natural gradients and support the realization of an eco-culturally diverse new capital?

SRQ4: Reflection

What lessons can be learned from the application of a landscape-gradient-based urbanization approach?

1.6 METHODS

This overview highlights the variety of research methods used at different stages of the research. Each stage requires methods tailored to the sub-research question in mind. A more in-depth discussion of the methodology in relation to theory and research approach will follow in chapter two.

Understanding and Analysis

Mapping

Gaining an understanding of the landscape and its systems by making synthetic maps. A structure map will be created to highlight defining landscape elements. A challenge map will pinpoint areas of attention and provide initial design clues.

Layer Analysis

The analysis of the landscape structure will make use of the landscape layer approach to study the relationship between landscape elements. The analysis layers look at water, ecology and culture.

Sections and Transect

To visualise gradient landscape transitions sections will be used. When visiting the site a transect of each ecological zone will be drawn to better understand gradient landscape transitions.

Multi-Scalar Analysis

The mapping and drawing of sections will represent different scales. First the regional scale will be studied to recognise underlying landscape systems. Then the gradients will be studied in a zoomed in scale. Lastly the processes and conditions for the gradients will be studied in the local scale..

Analysis through time

To understand the conditions for landscape restoration a look back at the undisturbed ecological system in comparison to today's situation.

Design Principles and Strategy

Case study

The study of relevant examples on landscape connectivity, landscape gradients and water sensitive design can provide valuable design principles.

Indigenous Practices

The understanding of how indigenous people live with the landscape can provide a basis to developing design principles that are ecologically and culturally sensitive.

Literature Review

To find further design principles literature on landscape connectivity, designing with gradients and water will be studied and interpreted to the project's context.

Design Explorations

Multi-scalar design

The design will be applied to multiple scale levels to tests it feasibility and spatial quality.

Flexible Masterplan

The large scale masterplan will leave room for change and growth. Seen from the study of other purpose-built capitals a fixed masterplan often fails to adapt to future population demand.

1.7 SOCIETAL AND ACADEMIC RELEVANCE

The case of Nusantara addresses many current issues related to urbanisation worldwide, such as landscape fragmentation, habitat loss, and social inclusion. It offers a highly relevant research context with broad potential for future application. The framework of landscape-based urbanism allows for the exploration of opportunities to design with the landscape, rather than focusing solely on the negative impacts of urbanisation. As Edward T. McMahon aptly states: “Growth is inevitable and desirable, but destruction of community character is not. The question is not whether your part of the world is going to change. The question is how.”

By integrating the concept of landscape gradients, this research introduces a new and unique perspective on working with transitional zones in both ecological and social contexts. While the importance of ecological gradients is a well-established concept, their concrete application in urban-scale design remains limited. This project therefore addresses an important research gap and offers valuable insights into the potential of a gradient-based design approach. Exploring landscape gradients as a guiding design principle opens up a compelling interface between ecological processes and cultural expression.



Image 13: Restored mangroves in Balikpapan 2025.

1.8 READING GUIDE

This research is structured into a series of chapters that reflect the progression of the research process. Each chapter corresponds to one of the research sub-questions or a key component of the design development, providing a logical and coherent narrative from theory to design exploration.

Chapter 2 – Research Approach

This chapter explores key theoretical concepts and integrates them into a cohesive framework that informs the methodology. It introduces the ideas of landscape gradients, landscape connectivity, and landscape-based urbanism, linking them directly to the research. The insights drawn from these theories form the foundation for the project's methodology, establishing a clear, theory-driven approach.

Chapter 3 – Analysis and Understanding

This chapter focuses on understanding the natural, cultural, historical, and spatial dimensions of the landscape in relation to the gradient concept. Examining "original" landscape conditions in contrast with the present state highlights the evolving human–landscape relationship through a historical lens. This analysis also reveals the richness and potential of the site. By overlaying various landscape layers, relationships between different types of gradients become evident. These findings help define the landscape logic of the site, outlining its key challenges and opportunities, and building a strong foundation for the design phase.

Chapter 4 – Design Principles and Strategy

This chapter develops the design framework by gathering relevant principles through case studies and fieldwork, applying them to a regional vision. These guidelines establish the design logic behind the project. The regional design illustrates this logic spatially, using the concept of landscape connectivity to propose a network of ecologically and spatially valuable blue-green structures. This chapter demonstrates how gradient-based thinking translates into spatial design strategies.

Chapter 5 – Design Explorations

Guided by the regional vision, this chapter focuses on selected areas that exemplify the gradient concept. The first design exploration investigates how existing villages can be integrated into the urban fabric of Nusantara while preserving their rural identity. Various interventions demonstrate how local communities can adopt nature-inclusive solutions tailored to different gradient conditions. A second design focus examines the development of urban green corridors, with particular attention to edge conditions. These explorations provide a practical application of the research framework.

Chapter 6 – Discussion and Conclusion

The final chapter reflects on the outcomes of the proposed design framework and evaluates the overall research process. It discusses the implications of the findings and outlines opportunities for future development of the gradient-based design approach.

02 - RESEARCH APPROACH

The concepts of landscape gradients, landscape connectivity, and landscape-based urbanism shape the theoretical framework of this research. Each concept contributes ideas for analytical and design which are interpreted and synthesised into a cohesive research approach for this project. This stage engages with existing literature, lending validity to the study while also exploring new opportunities for the application of these concepts. The research approach and methods are developed in alignment with the theoretical framework. Ultimately, this chapter outlines the core structure and approach of the research.



2.1 LANDSCAPE GRADIENTS

Theoretical Background

The gradient paradigm of landscape structure offers a comprehensive framework for understanding and representing landscapes.

Ecological gradients describe transitional areas between landscape typologies, which “are created as a result of spatial shifts in elevation, climate, soil, and many other environmental factors” (Kark, 2012). These gradual transition zones often exhibit remarkable biodiversity, as species from neighboring typologies overlap and interact, creating unique ecological conditions (Araújo, 2002).

Additionally, the gradient view of the landscape complements and expands upon traditional landscape mosaic theory. While the mosaic model has been valuable in categorizing landscapes into distinct typologies, it can sometimes oversimplify complex spatial dynamics by emphasizing discrete boundaries. In contrast, the gradient paradigm introduces a continuous perspective,

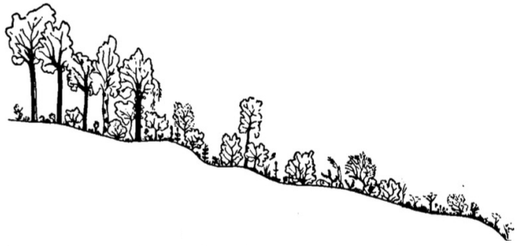


Figure 14: Vegetation Gradient (Van Leeuwen, 1965).

allowing for a more nuanced representation of spatial transitions and ecological processes (McGarigal & Cushman, 2005).This approach facilitates the analysis of relationships, continuity, and heterogeneity within across landscapes.

The idea of gradients is especially relevant to this project because it encourages a mindset that challenges conventional planning strategies and highlights the richness of the research site. The location presents several important



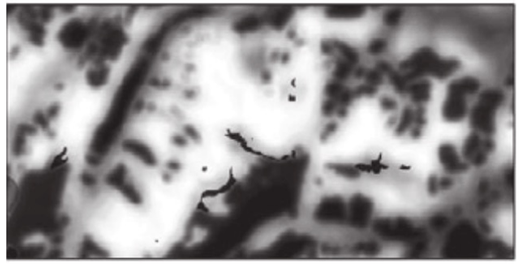


Image 15: Example of gradient representation (McGarigal & Cushman, 2005).

gradient transitions that require a specialized approach to uncover their potential. Notably, the concept of landscape gradients also extends to transition zones shaped by cultural processes (Kark, 2012). This opens up new possibilities for engaging with urban edge conditions and traditional landscape cultivation practices. By integrating both cultural and natural dynamics, the gradient concept offers a compelling alternative to rigid, conventional planning methods.

Finally, the gradient concept calls for suitable representation techniques across different scales. Maps with strict lines between landscape typologies often misrepresent the reality of gradual transitions (McGarigal & Cushman, 2005). Since landscape gradients can reflect both large-scale structural patterns and localized transitional zones, their representation must be flexible and context specific. Therefore, this theoretical framework necessitates mapping and drawing methods that can effectively capture the fluid and dynamic nature of gradients.

LANDSCAPE CONNECTIVITY

Landscape connectivity offers a valuable counterbalance to fragmentation by providing clear planning principles aimed at mitigating its negative impacts. It refers to the degree of spatial continuity within a landscape whether in terms of infrastructure, ecological flows, or movement. Connectivity can be assessed structurally or functionally: structural connectivity concerns the physical distribution of landscape features such as patches, corridors, and waterways, while functional connectivity relates to how species or materials move in response to that structure (Crooks & Sanjayan, 2006). Three key components shape landscape connectivity: species movement patterns and behaviors, the size and arrangement of habitat patches, and the character of the surrounding matrix (Crooks & Sanjayan, 2006). Numerous methods exist to design and assess connectivity, each with varying emphasis on these elements.

Given the high degree of fragmentation at the design site, the concept of landscape connectivity provides a

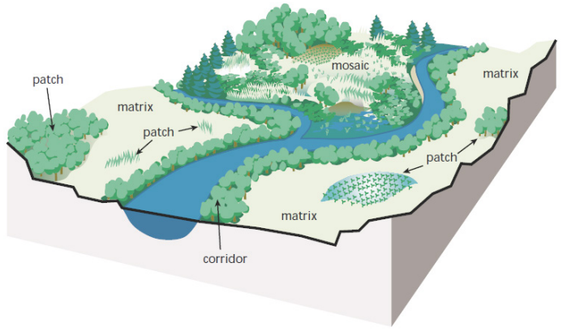


Figure 16: Components of landscape strucutre (FISGRW 1998)

range of potential strategies. Some focus on quantitatively assessing connectivity—structural or functional, and propose measurable interventions, such as green corridors (Zhang et al., 2018). Others emphasize the often-overlooked role of the matrix in maintaining biodiversity. As Prugh et al. (2008) note, “Improving matrix quality may lead to higher conservation returns than manipulating the size and configuration of remnant patches for many of the

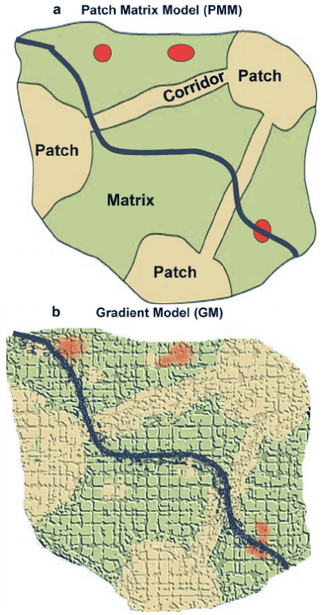


Image 17: Representation of landscape structure (Lausch et al., 2014)

species that persist in the aftermath of habitat destruction.” These different perspectives both offer valuable methodologies for regenerating or preserving landscape connectivity.

In this research, the matrix-based approach aligns closely with the gradient theory, enabling integration of connectivity principles in varied conditions. This approach shifts focus away from species-specific requirements and toward the broader quality of the matrix, particularly relevant in agricultural landscapes (Franklin & Lindenmayer, 2009). Conversely, the structural approach supports the design of green corridors, which are especially effective in enhancing both structural and functional connectivity in urban areas (Zhang et al., 2018). Furthermore, linking ecological corridors with social functions can help activate underutilized urban space (Hernandez-Santin et al., 2020).

Accordingly, this research will draw from both approaches, enhancing matrix quality in less dense areas while implementing targeted corridor interventions, where necessary, to create a resilient and connected landscape structure.

LANDSCAPE-BASED URBANISM

Landscape-based urbanism is a landscape architecture theory rooted in the idea of placing landscape logic at the center stage of future-proof urban developments. The idea of landscape logic refers to the notion of designing with nature, humans, and history. It interprets landscape as a combination of these elements, which form a complex “mosaic of land, soil, vegetation, and land use” (Nijhuis, 2024). The landscape forms a complex system of logical relationships between natural features such as soil, relief, and water, and cultural elements which historically often developed from the natural ones. By incorporating these elements, the discipline creates a relationship between the urban fabric and the natural and cultural features of landscapes (Gray, 2017).

This approach is particularly relevant considering the current pace of urbanisation worldwide. Growing urban areas often consume precious pieces of natural landscapes. The case of Nusantara is a perfect example of the urbanisation trend at the expense of landscape and local culture. Landscape-based urbanism provides a means to balance the scales through the implementation of nature-inclusive interventions such as “nature-based solutions” and “eco-engineering” (Nijhuis, 2024). Such methods not only successfully integrate natural features of the landscape into urban environments but also provide greater value for local communities and the economy. This renders landscape-based urbanism a highly relevant theory in terms of this research project.



Image 18: Landscape as the basis for social and economic development (Stockholm Resilience Centre).

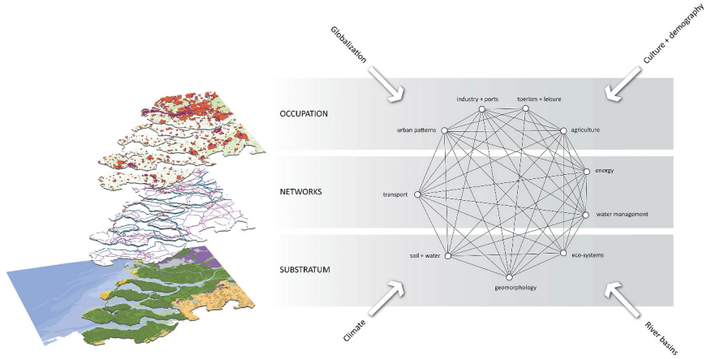


Image 19: Understanding the urban landscape as a layered and complex system (Steffen Nijhuis).

Landscape-based urbanism cultivates a multidisciplinary, multi-scalar, and flexible design approach that encompasses four perspectives: nature, people, history, and space (Nijhuis, 2024).

1. The natural perspective emphasizes the formative role of abiotic factors in shaping urban development. It highlights the importance of landscape gradients and the use of gradual transitions between typologies—linking this to the gradient theory discussed earlier in the report.
2. The human perspective stresses designing green urban spaces for people. These spaces, across various scales, can offer recreational, health, and climate-adaptive benefits. Human needs must remain central to landscape design.
3. The historical perspective involves incorporating historical landscape features. For instance, integrating indigenous knowledge can reveal time-tested cultivation and landscape management strategies (Nijhuis, 2024).
4. The spatial perspective focuses on the experiential and aesthetic quality of a well-composed landscape design.

Combining these perspectives eventually leads to developing a design grounded in landscape logic.

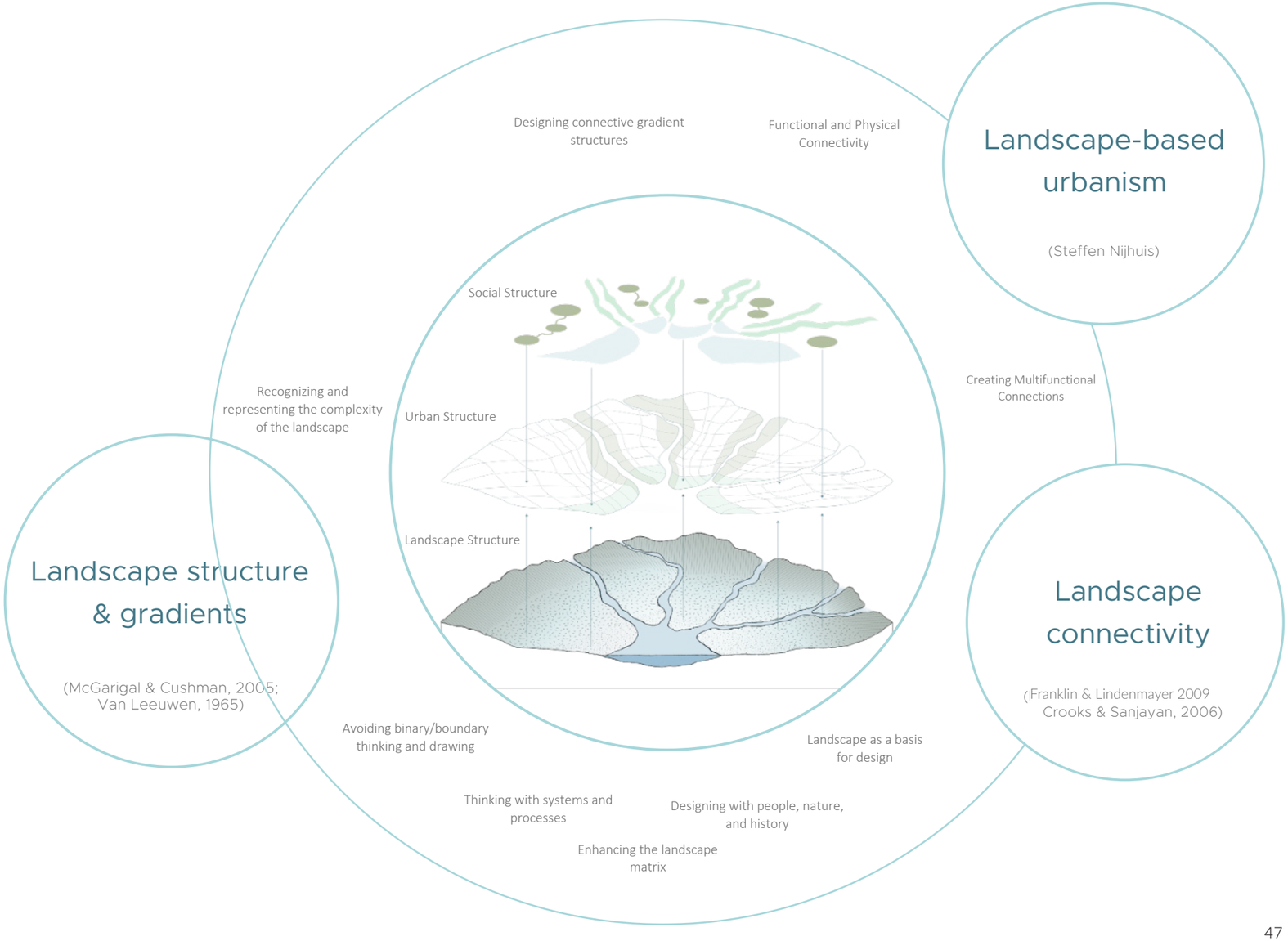
The design framework of landscape-based urbanism also outlines a certain design methodology, which includes the steps of understanding the landscape logic, collecting design principles, outlining a design strategy on the regional scale, and conducting design experiments on specific key design locations.

2.2 THEORETICAL FRAMEWORK

The previously discussed theories each contribute valuable concepts to the overarching theoretical framework of this research. The resulting framework positions natural and social systems as the foundation for designing the urban fabric, following the principles of landscape-based urbanism. Within this approach, understanding the natural systems and the logic of the landscape is primarily informed by the theory of gradients. The landscape analysis will focus on identifying the qualities, conditions, and potentials of site-specific landscape gradients to build a strong knowledge base for design.

The historical perspective of landscape-based urbanism allows for an exploration of the interactions between ecological and social gradients, offering insights into traditional practices and indigenous knowledge. The principles of landscape connectivity support the design phase of the project by guiding the development of gradient-based matrix networks and large-scale connective corridors. These structures will be addressed in the design strategy and regional vision phases of the landscape-based approach.

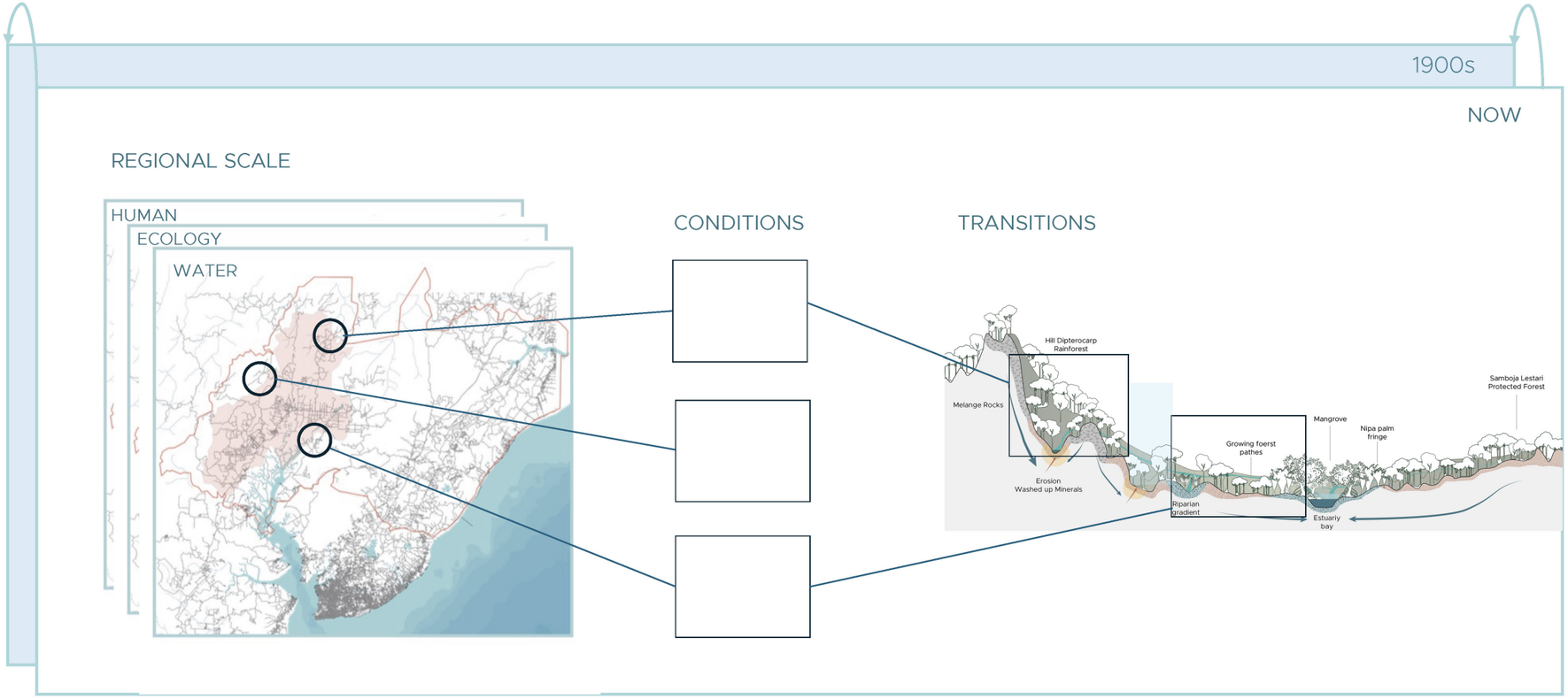
Together, the integration of these theories forms a coherent and grounded framework that informs both the methodology and the design goals of the research.



2.3 ANALYSIS STRUCTURE

Research framework

The theoretical framework influences all aspects of the research, including landscape analysis and interpretation. A historical perspective is central to this process, enabling comparisons between “original” landscape conditions and the present state. This approach highlights how human interaction with the environment has evolved over time and draws attention to the loss of gradient transitions due to changes in cultivation practices. The use of layered analysis to examine both natural and cultural dimensions aligns with the landscape-based approach and helps reveal relationships between gradient-forming elements. To effectively represent these transitions, the study applies a range of visual techniques, including sections, diagrams, and smooth gradations in maps. Together, these methods create a strong link between gradient theory and landscape-based urbanism.



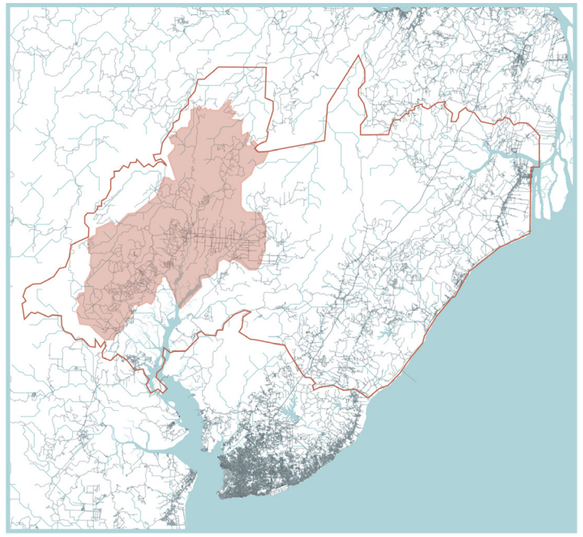
DESIGN APPROACH

The design methodology carries the theoretical framework forward, applying its principles throughout the project. A key theme across all three theories is the emphasis on working across scales. Different scales reveal the variability of gradients and strucutral connectionscreating a link to the landscape-based approach. Accordingly, the design will operate at three levels: regional, gradient, and local.

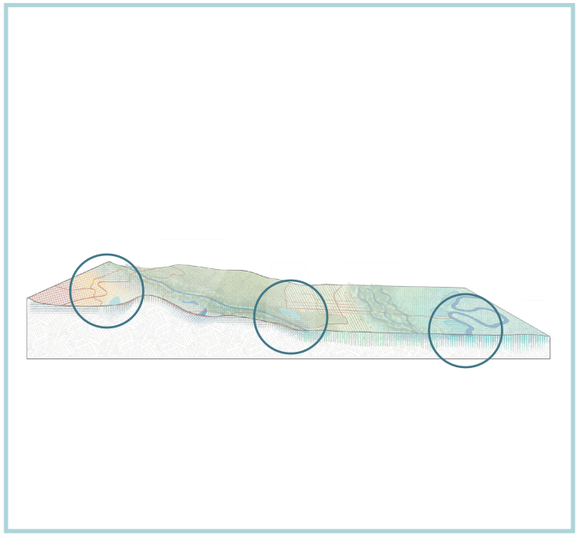
At the regional scale, the focus lies on establishing large-scale connections through ecological corridors and enhancing the matrix with more diverse agricultural and agroforestry practices. The gradient scale addresses transitions that span multiple ecological typologies, illustrating how broader patterns of change can inform spatial strategies. Finally, the local scale explores specific spatial adaptations that support fine-grained gradient connections.

As in the analysis phase, the design process will continue to experiment with methods for representing gradients, helping to reinforce the conceptual coherence of the project across all levels.

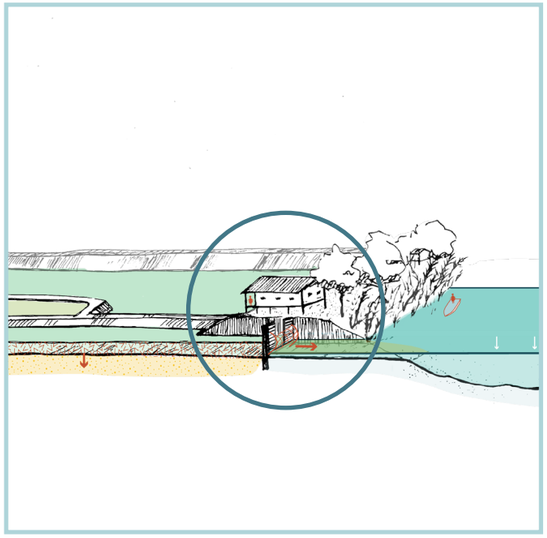
REGIONAL SCALE



GRADIENT SCALE



LOCAL SCALE



Processes

KEY GRADIENTS
- Preserve
- Regenerate
- Connect

URBAN STRUCTURE
- Connection to gradients
- Cultural integration

Selecting key transitional areas

KEY GRADIENTS
- Urban development
- Existing communities

ZOOM INN DESIGNS
- Site-specific
- Spatiality
- Practices

03 - ANALYSIS AND UNDERSTANDING

In this chapter the main characterisitcs and systems of the landscape are analysed to create a knowledge base for the seign. The logic of the landscape is explored through the lense natural, cultural and historical aspects. These aspects are further interpreted in terms of the gradeint theory . The resulting landscape strucutre, challenge and opportunity maps provide a clear basis for design.

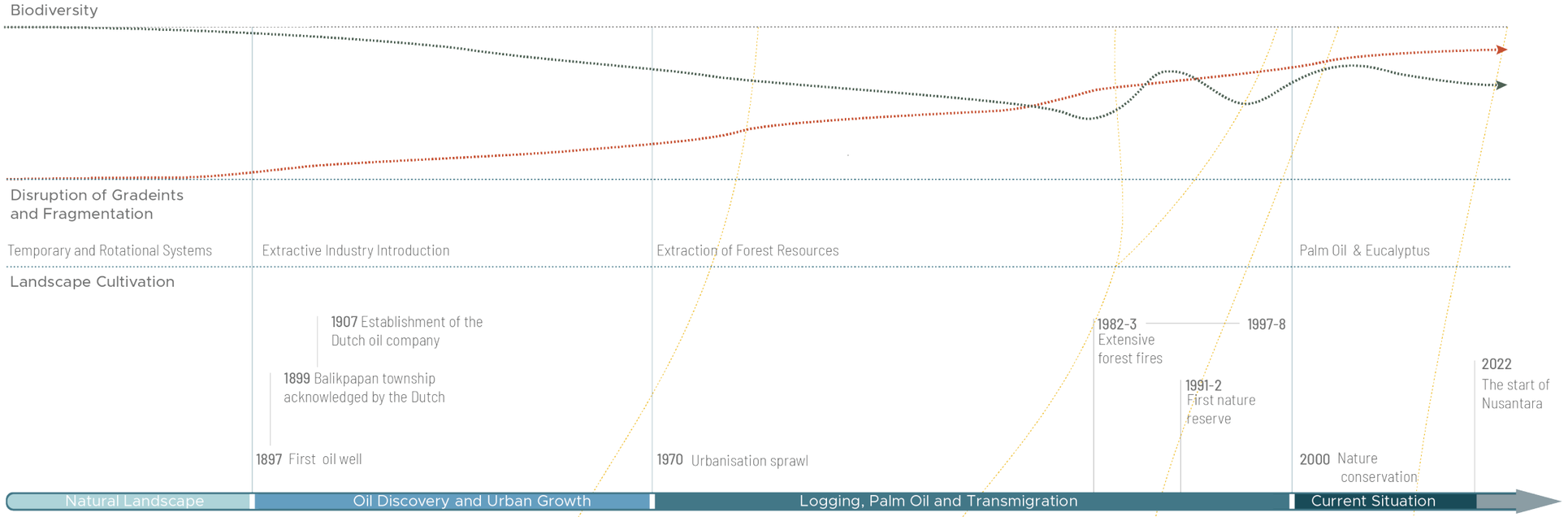


3.1 HISTORICAL DEVELOPMENT

The research site has undergone several transformations that not only explain its current state but also provide insights into local cultural practices and natural systems. The timeline highlights four main development stages of the site, marked by pivotal moments in landscape transformation.

The first phase, prior to the 1900s, refers to a time when the landscape was mostly untouched, except for local village communities. In 1897, the phase of oil extraction in Balikpapan began, marking the start of industrial extraction of natural resouces under colonial rule. During this phase, oil palm plantations were introduced to the site. In the 1970s, another phase of urban growth and further landscape exploitation began, with the expansion of the logging industry. The current phase is still dominated by logging and palm oil plantations, yet ecological conservation efforts have also gained importance. The construction of Nusantara will inevitably mark the next chapter in the site's development.

The different phases tell a story of how the relationship between people and the landscape shifted—from a balanced co-existence to a more detached form of exploitation. Along with this shift came fragmentation and the disruption of landscape gradients. The historical overview of the site provides a more complete understanding of its landscape logic and highlights the importance of the relationship between people and landscape.

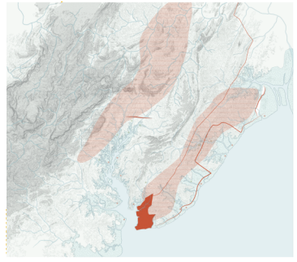




The area remains largely natural, characterized by local indigenous villages, with Balikpapan nearby as an expanding urban center.



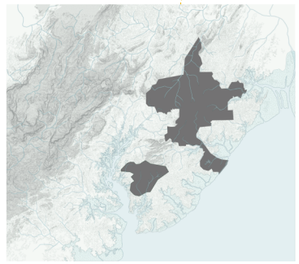
Balikpapan becomes an important industrial site with the construction of the first oil well. This accelerates the growth of the village and its transformation into the city.



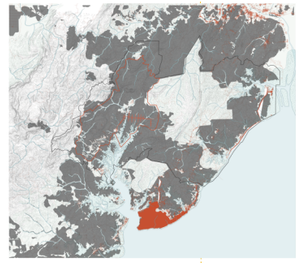
After the expansion of the oil industry, logging has become an increasingly widespread industry.



The fires affected most of the development site, including the existing nature reserves. These fires led to the formation of secondary rainforests, which are less mature and lack slow-growing species such as ironwood.



Following the expansion of logging and the spread of fires, the first nature conservation areas were established. These reserves represent the majority of the remaining lowland rainforest on the site today.



The site today is still heavily reliant on the extraction of natural resources, such as logging and mining, but the construction of Nusantara offers a chance to reverse this approach and promote more sustainable practices.

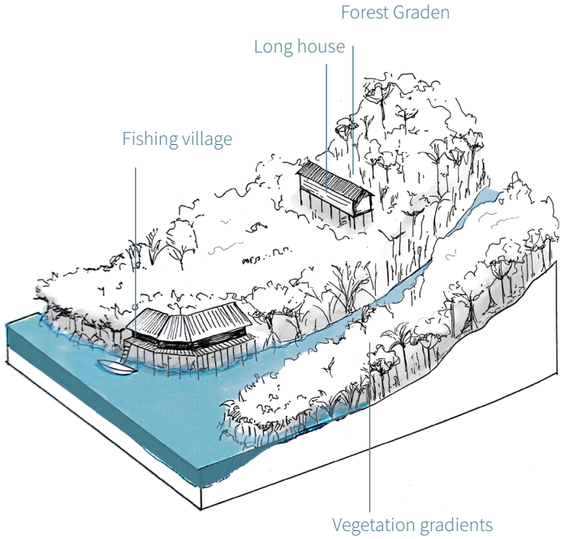
3.1 HISTORICAL DEVELOPMENT

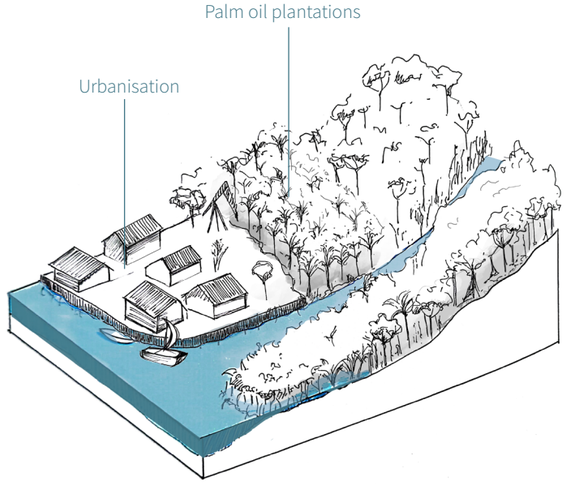
Natural Landscape

People have occupied the research site for thousands of years, with recent archaeological research uncovering artifacts dating back to the early Holocene (Fauzi et al., 2023). The rich diversity of ethnic communities on the island of Borneo is reflected at the study site, with various groups such as the Dayak, Malays, Bugis, and Kutai people present (MacKinnon, 1996). These different ethnic communities specialized in various cultural landscape practices. For example, the Malays commonly settled along the coast and rivers, focusing on fishing and trade, whereas the Dayak tended to settle in hilly locations and practiced forest cultivation techniques (MacKinnon, 1996). A number of these local communities still exist on site, despite the changes to the landscape and ongoing struggles over land ownership.

1897-1970

The first major changes in the area occurred with the discovery of oil reserves in the mid-19th century. Before the discovery, the area was mainly inhabited by local fishing communities. Under Dutch colonial rule, the first oil well in Balikpapan was opened in 1897 (Tarigan et al., 2016). This led to the transformation of Balikpapan into an industrial urban center and an “oil city” during the 20th century, inevitably impacting the development of the surrounding area and accelerating urbanization and industrial growth.

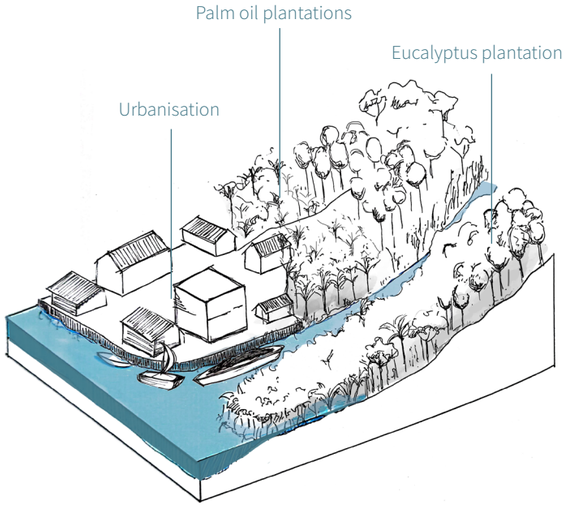




1970-Now

Another major transformation of the natural and cultural landscape systems began around fifty years ago with the intensification of the logging industry, combined with the implementation of the transmigration policy. “Large-scale cutting of timber in Kalimantan began in 1967 when all Indonesian forests were declared the property of the state” (MacKinnon, 1996, p. 398). The development site was no exception, experiencing a significant reduction in forest cover between the 1970s and the present day (Gaveau et al., 2014). During this time, transmigration villages were established, altering local settlement patterns and introducing new ethnic groups to the region (Clauss et al., 1988). The protected areas of Sungai Wain and Bukit Soeharto were designated for forest conservation in the early 1980s. However, both areas were severely affected by the forest

fires of 1982–83 and 1997–98 (Kobayashi, 2001), leading to the development of secondary rainforests. More recently, conservation initiatives such as the Samboja Lestari orangutan rehabilitation project and the Graha Indah mangrove restoration project have been established. This phase has had a major impact on the current state of the natural and cultural systems in the study site, explaining much of the existing landscape fragmentation and shifts in local community structures.

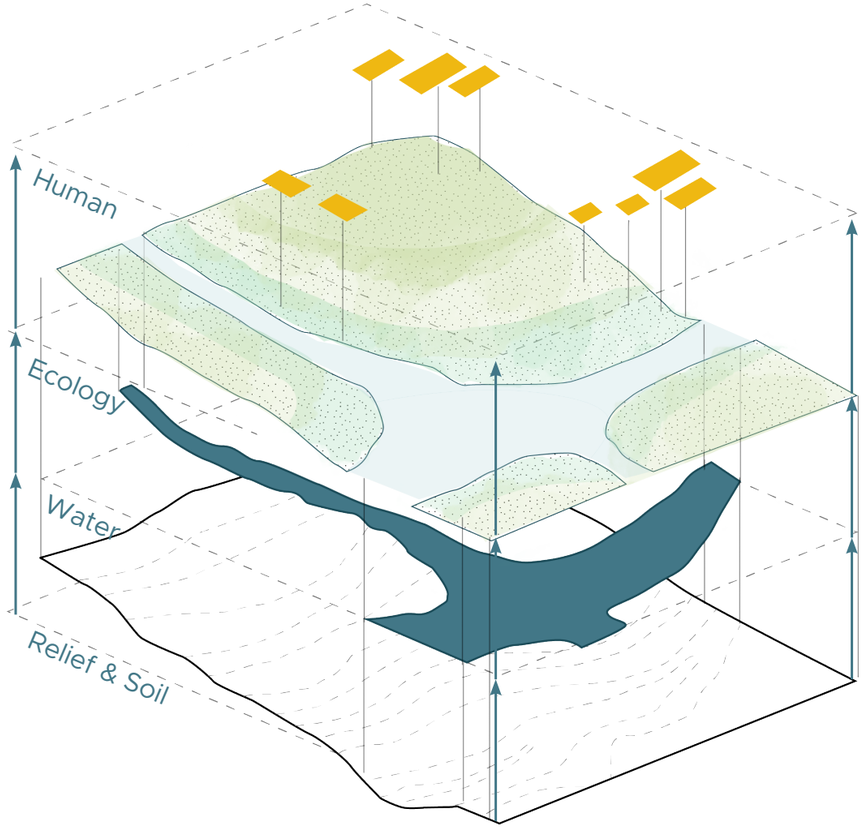


3.2 LANDSCAPE BEFORE

After examining the historical development of the site, it becomes clear that not long ago the landscape system was primarily shaped by natural processes, which were reflected in the cultural practices of local communities. The interconnection between relief, water, ecological communities, and human activity defined multiple landscape typologies, such as the wet zone, riparian zone, lowland rainforest, and hilly rainforest. Each of these zones exhibits unique ecological and cultural characteristics.

Transitions between these typologies are where gradient zones occur. By analysing individual layers of the landscape such as water, ecology, and human activity, the defining characteristics of each landscape typology can be identified. In the case of the natural landscape the cultural level is largely shaped by the other layers. From this analysis, a mapping and characterisation of the gradient zones can be developed.

By then examining the same layers in the present-day situation, a comprehensive overview of the remaining and lost gradients can be created. This comparison will help identify the current challenges and potentials of the site.



WATER SYSTEM

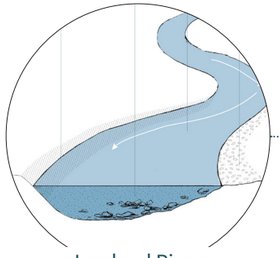
The water system primarily consists of the Balikpapan Bay catchment. The main catchment is subdivided into smaller sub-catchments of individual rivers: Sepaku, Tengin, Pemaluan, and Wain. The largest waterway in the catchment that runs directly through the development area is the Sepaku River (Wahid et al., 2024). The freshwater from these rivers eventually flows into Balikpapan Bay, where it mixes with the saltwater of the Makassar Strait, creating a brackish water zone known as an estuary. Waterways to the east of the hilly range running through Bukit Soeharto Forest Park drain directly into the Makassar Strait, forming another smaller catchment.

The natural water system of the design site can be divided into three main typologies: estuary, lowland rivers, and upland streams. These zones are primarily defined by differences in relief, sediment, flow velocity, water temperature, and salinity. Each zone is closely linked to various ecological typologies which will be discussed later in the report. The smooth transitions between different water zones create a large-scale gradient across the landscape.

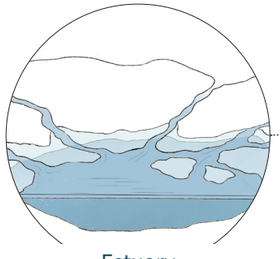
The brackish water zone is a dynamic gradient landscape that is highly relevant to the project. The hydrological relationship between freshwater supply and the condition of the brackish water zone, where mangroves thrive, is particularly important for the overall water system. Freshwater inflows not only maintain the salt balance in the estuary but also regulate the amount of nutrients and sediment essential for mangrove vitality and their resilience to climate change (Ward et al., 2016). Sediment buildup contributes to the formation of alluvial clay soils in the wet zone. The fluctuation of water levels due to tidal action creates a variety of conditions that allow different plant species to develop. Therefore, the estuary is a critical gradient landscape that depends on the health of the water system as a whole and supports unique ecological conditions.



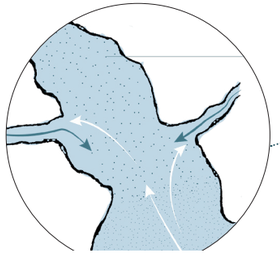
Upland Streams



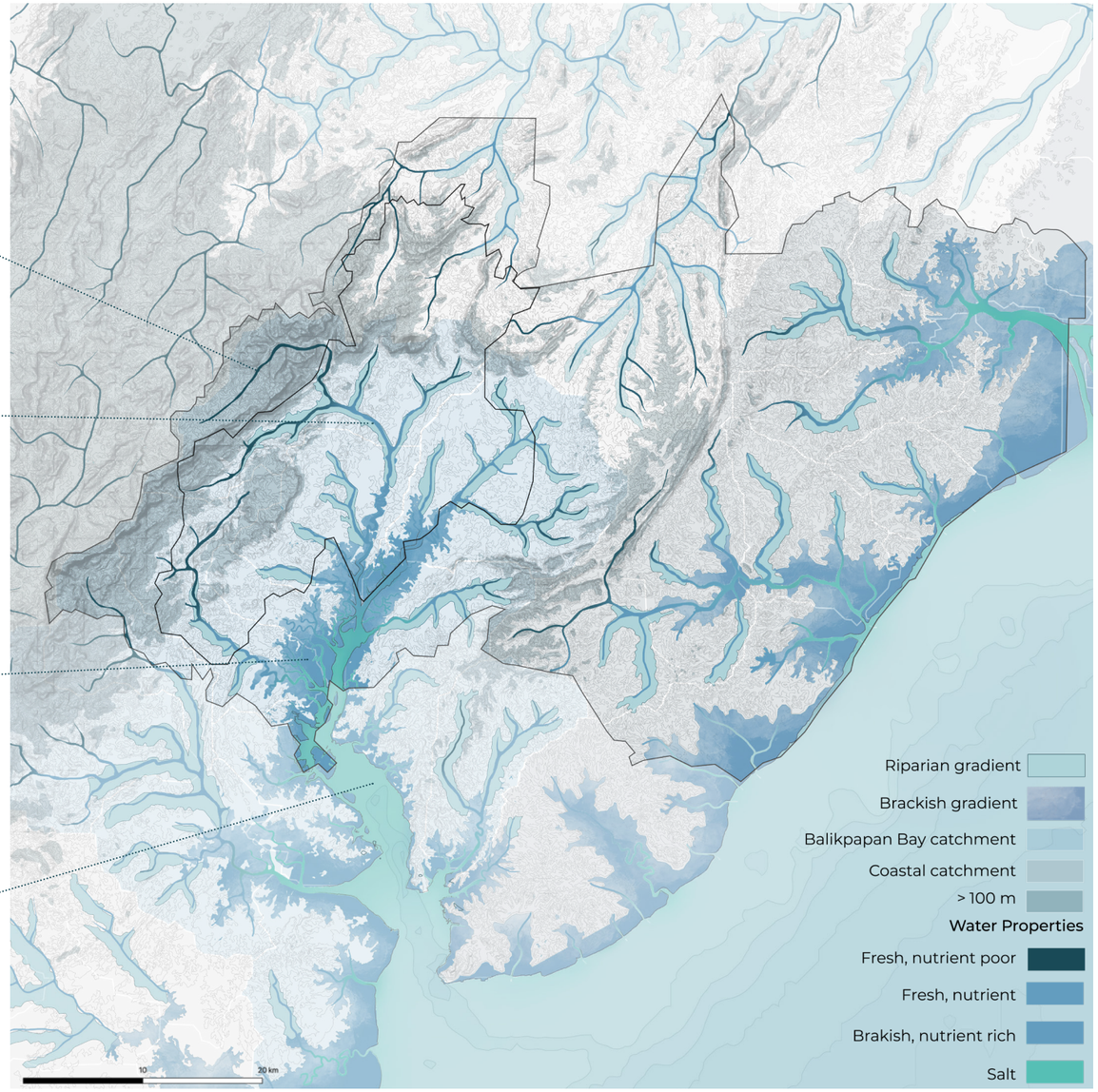
Lowland Rivers



Estuary



Brackish Water



ECOLOGY

The ecological typologies and vegetation communities are closely linked to water, soil, and topographic conditions. The four main typologies found on site are mangrove forests, lowland rainforest, upland rainforest, and heath rainforest.

Mangroves, as previously mentioned, grow in the brackish water zone and support a unique estuarine ecosystem. The structural diversity of mangrove vegetation, along with the abundance of nutrients, creates ideal conditions for numerous animal, fish, and bird species. Additionally, mangroves contribute to coastal stabilization by trapping sediment and thereby reducing erosion (Kristiningrum et al., 2020).

The lowland dipterocarp forest is the dominant natural forest type on site and is also the most characteristic rainforest type on the island of Borneo. Due to the high diversity of plant species, this forest is incredibly valuable in terms of biodiversity. Trees in this ecosystem typically grow between 45 and 60 meters tall, forming a dense canopy that provides habitat for many animal species (MacKinnon, 1996). The edges of the lowland rainforest define many of the ecological gradients found on the site.

Upland rainforest and heath forest are found just west of the research site, where elevations exceed 200 meters. Elevation significantly influences light availability and soil characteristics in these forests. While upland rainforest is generally similar to lowland rainforest, heath forest is distinctly different in structure, texture, and color (MacKinnon, 1996). Heath forests grow on nutrient-poor soils, which likely contributes to the characteristically small trees, usually less than 15 meters tall (MacKinnon, 1996). The hilly range west of Nusantara thus forms another gradient zone, where lowland, upland, and heath forests blend into one another, creating fascinating ecological transitions.

Although not a separate forest typology, riparian gradients form another significant ecological transition zone. The edges of rivers and streams create specific light and moisture conditions that allow riparian vegetation to establish (MacKinnon, 1996). These gradients not only form dynamic ecological edge conditions but also generate distinctive structural features across the landscape.



Upland Rainforest



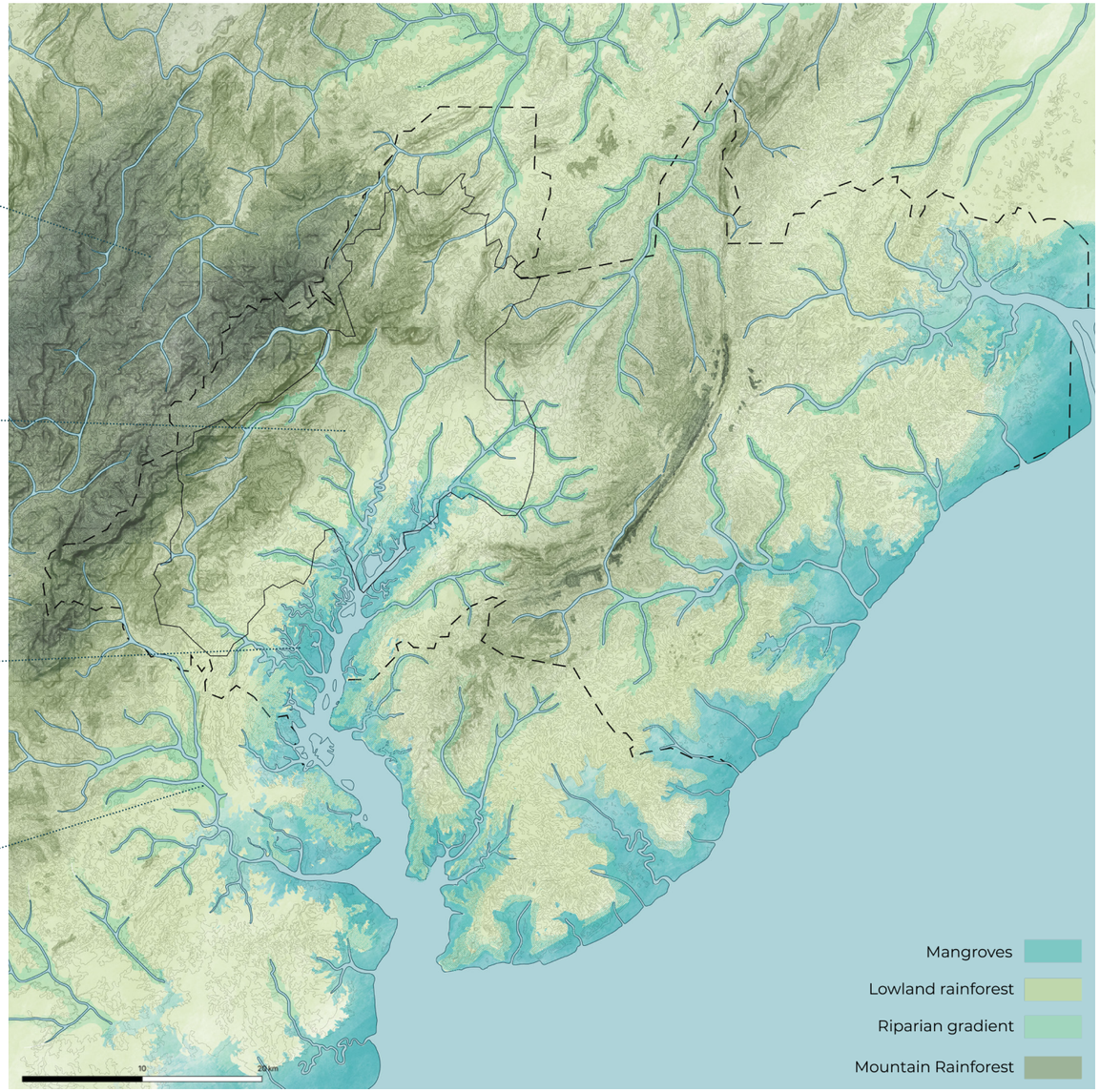
Lowland Rainforest



Mangroves



Riparian Gradient



SEASONALITY

It is important to mention that the water system and ecology of the site are closely related to the existing climate. The area has a hot and humid tropical climate where rainfall plays a significant role in shaping local conditions (MacKinnon, 1996). A distinctive feature of the region is the occurrence of both a wet and a dry season throughout the year. The design location is situated in an area considerably drier than the rest of the island, with rainfall often lower than 200 mm per month during the wet season (MacKinnon, 1996). The relatively nutrient-poor soil conditions can be attributed to the washing away of nutrients due to frequent rainfall. Therefore, organic soil layers play an important role in the nutrient cycle. Rainfall patterns largely determine the availability of freshwater and influence the flowering and fruiting of plants. The climate supports the formation of evergreen rainforests and creates the conditions necessary for extensive biodiversity.

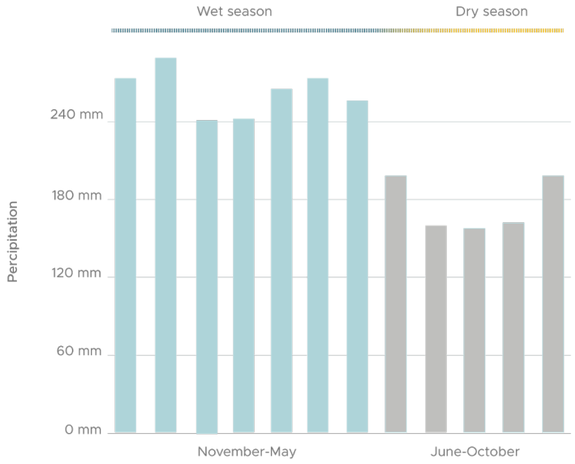
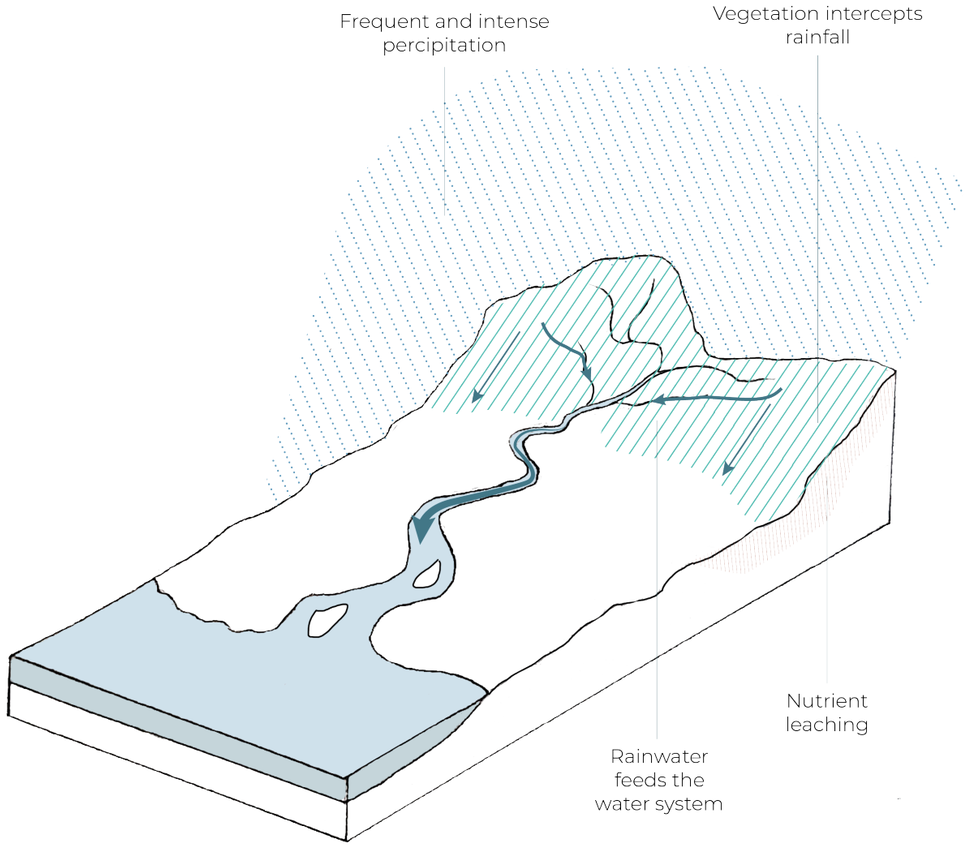


Image 20: Climate on site (Wolrd Bank)



HUMAN ACTIVITY

Indigenous communities were highly adapted to the local landscape and often made use of existing natural gradients. The region has long been ethnically diverse, as is typical of much of East Kalimantan's coastal areas, with Malay and Sulawesi sailors forming new settlements. These groups typically relied on small-scale trade and fishing (MacKinnon, 1996). To this day, local fishermen demonstrate deep knowledge of seasonal shifts in fishing conditions (Gunawan, 2016). The richness of mangrove ecosystems has supported local livelihoods for centuries.

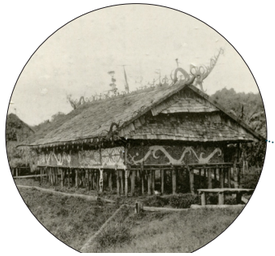
Certain local practices even contributed to the creation of small-scale gradients. This is especially true of temporary forest cultivation methods used by Dayak tribes, who traditionally inhabit upland areas of the island. Their cultivation techniques range from forest gardens to controlled slash and burn agriculture. In both cases, the rotational and temporary nature of these practices helps minimize ecological impact (Murhaini & Achmadi, 2021). By cultivating small forest plots and allowing them to regenerate after use, a mosaic of fine-scale ecological gradients is created (Kark, 2012). These patterns are valuable to explore for both their ecological and cultural significance.

Housing typologies also reflect adaptation to both the landscape and climate. For example, stilt houses in fishing villages are designed to accommodate tidal fluctuations. Traditional Dayak longhouses offer an-other example of climate-responsive architecture. These communal dwellings incorporate several biocli-matic features that help mitigate heat and promote ventilation, making them well-suited to the region's hot and humid conditions (Victoria et al., 2017).
Indigenous communities maintained a close relationship with the land and frequently engaged with gradient ecologies. Their understanding of local systems allowed them to live in balance with natural processes and even foster new gradient transitions. Therefore, it is essential to acknowledge the value of learning from indigenous knowledge systems explore potential design adaptations.



Forest Garden
(Sumarni Laman)

(Wellcome Collection)



Long House
(Nationaal museum wereldculturen)



River House
(Arnoud H. Klokke)

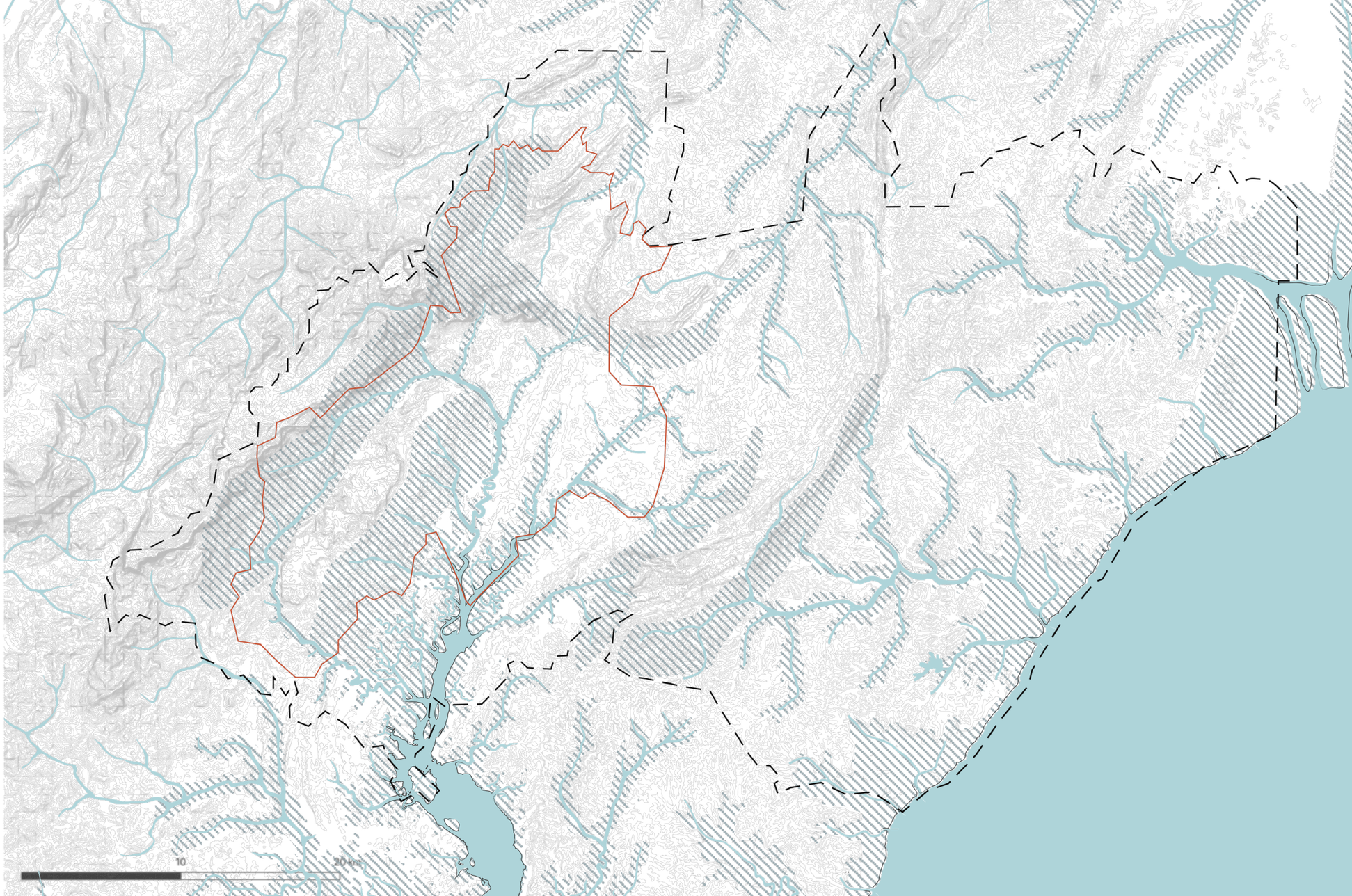


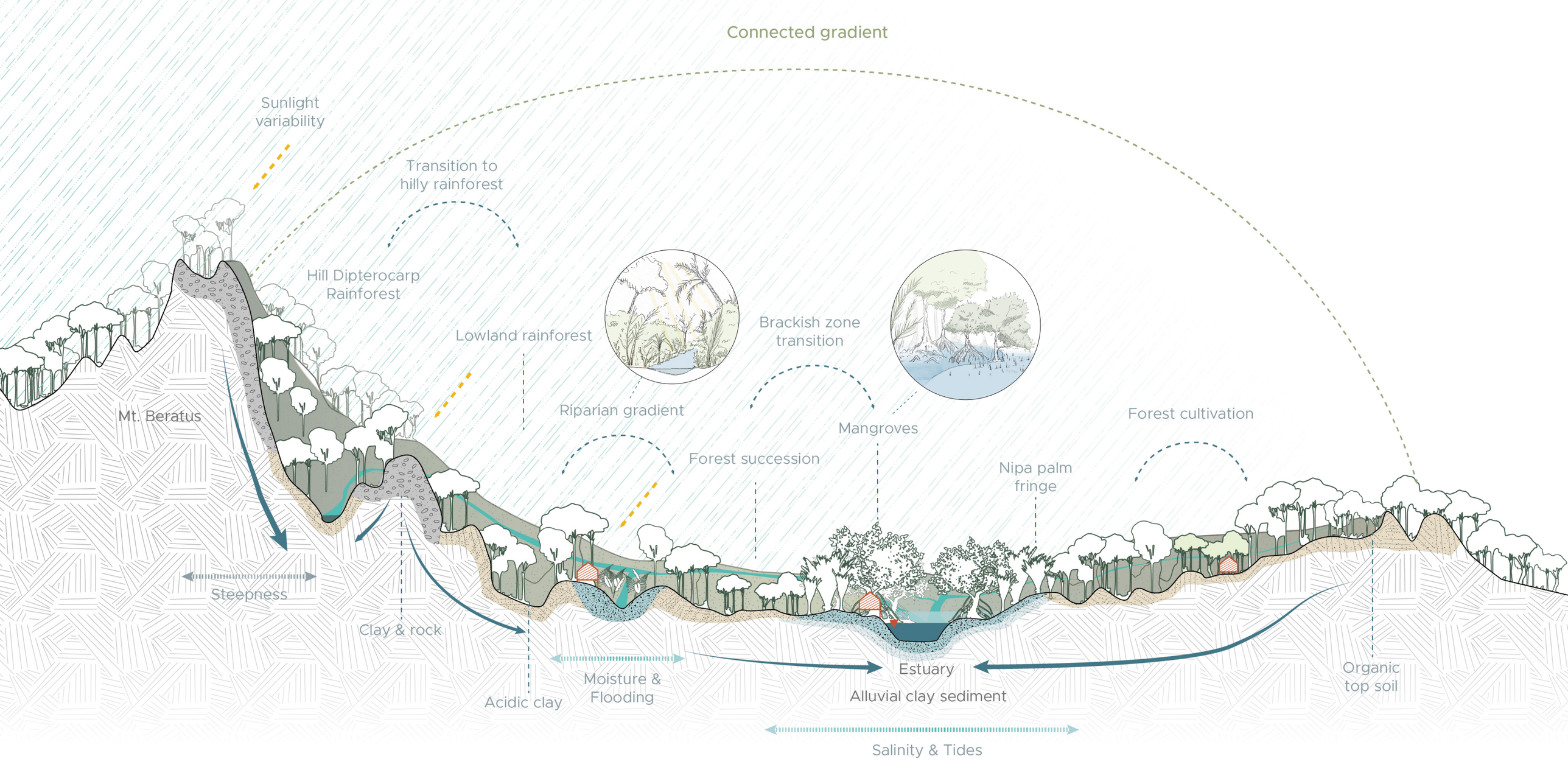
Coastal Village



GRADIENTS

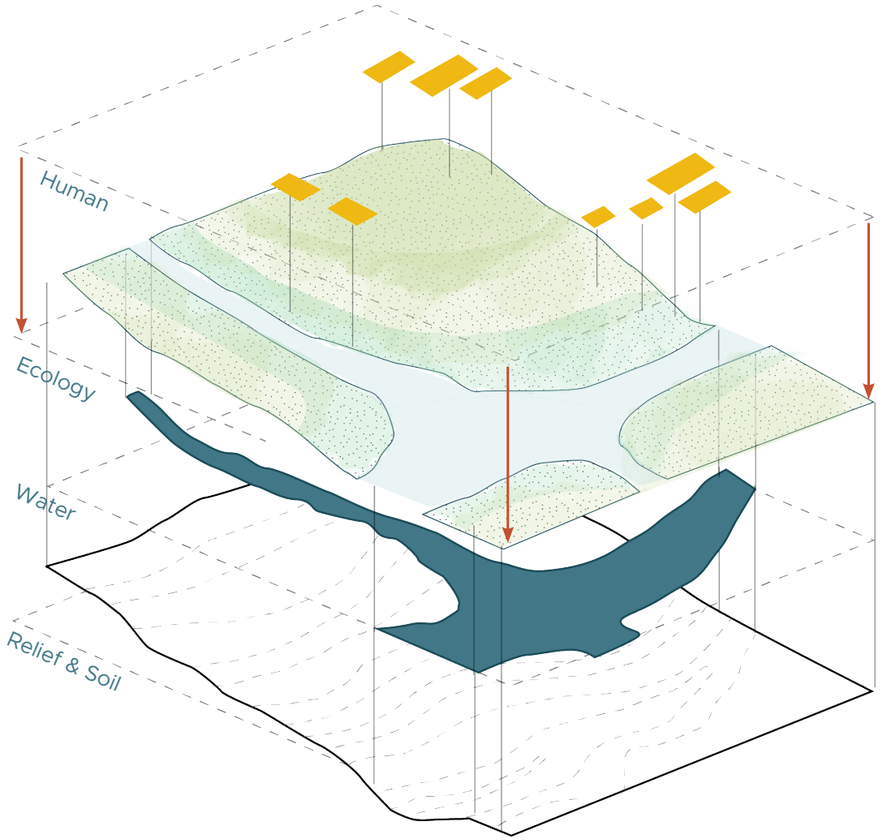
To conclude the exploration of the landscape in its pre-cultivated state, an overview of significant landscape gradients reveals several opportunities for this project. The layer analysis demonstrates a strong connection between ecological transitions, geomorphology, hydrology, and cultural patterns. Key gradients that significantly influence the site's cultural and biological diversity include the mangrove zone, riparian corridors, and the ecotone between lowland and upland rainforest. Notably, water plays a central role in all of these gradients, underscoring its formative influence. Riparian zones establish large-scale connections across the landscape and present opportunities to reinforce both structural and functional connectivity. The mangroves offer valuable potential in terms of biodiversity, coastal protection, and local livelihoods. The upland rainforest edges, located near the boundaries of Nusantara's urban expansion, present unique conditions and opportunities for design experimentation. Overall, these gradients bring together natural and cultural processes, offering a wide range of benefits and design possibilities.




Connected gradient
Sunlight variability
Transition to hilly rainforest
Hill Dipterocarp Rainforest
Lowland rainforest
Riparian gradient
Brackish zone transition
Mangroves
Forest succession
Nipa palm fringe
Forest cultivation
Mt. Beratus
Steepness
Clay & rock
Acidic clay
Moisture & Flooding
Estuary
Alluvial clay sediment
Organic top soil
Salinity & Tides

3.3 LANDSCAPE NOW

After examining the landscape conditions before the onset of major cultivation, it is now important to assess the current situation. In the case of the “original” landscape, layers such as topography, water systems, and ecology significantly shaped local communities and their cultivation techniques. Today, this relationship has shifted, as human activity has an overpowering influence on water systems, soil, and ecological patterns. By revisiting the same landscape layers and considering the transformations over time, a clearer understanding of the current gradient conditions can be developed.

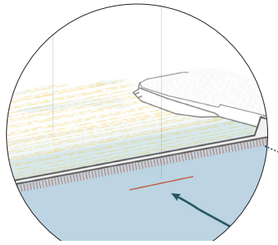


WATER SYSTEM

The general structure of the water system still follows the same logic as before; however, several aspects are under pressure due to increasing water demand, pollution, and imbalances between fresh and saltwater. The growing population in the region requires water for drinking, domestic use, and agriculture. To meet this demand, multiple dams have been constructed. For instance, a new dam was built in the midstream section of the Tengin River to supply water to Nusantara, which has reduced the freshwater flow to the bay area (Simbolon et al., 2025). As previously discussed in this report, the balance between freshwater and saltwater, along with sediment supply, is crucial for the health of the estuarine ecosystem. Damming and river modifications can therefore have significant negative impacts on mangrove habitats (Ward et al., 2016b).

Another major change to the water system stems from industrial water pollution, increased shipping activity, and widespread mangrove removal, particularly in and around Balikpapan. In 2018, for example, a major oil spill in Balikpapan Bay caused severe damage to the aquatic ecosystem and led to the destruction of large mangrove areas (Daton, 2020). Additionally, extensive sections of coastline have been cleared for urban development, industrial activities, or aquaculture, removing the natural buffer that protects against coastal erosion. These changes have serious consequences for biodiversity, climate resilience, and local communities.

With the construction of Nusantara, pressure on the water system is expected to increase. Many of the issues currently affecting Balikpapan, such as pollution and mangrove loss, may eventually extend further up the estuary. The valuable brackish water zone, located at the end of the hydrological cycle, is especially vulnerable to these changes. Therefore, it is essential for Nusantara to manage its water resources in a balanced and sustainable way.



River Damming



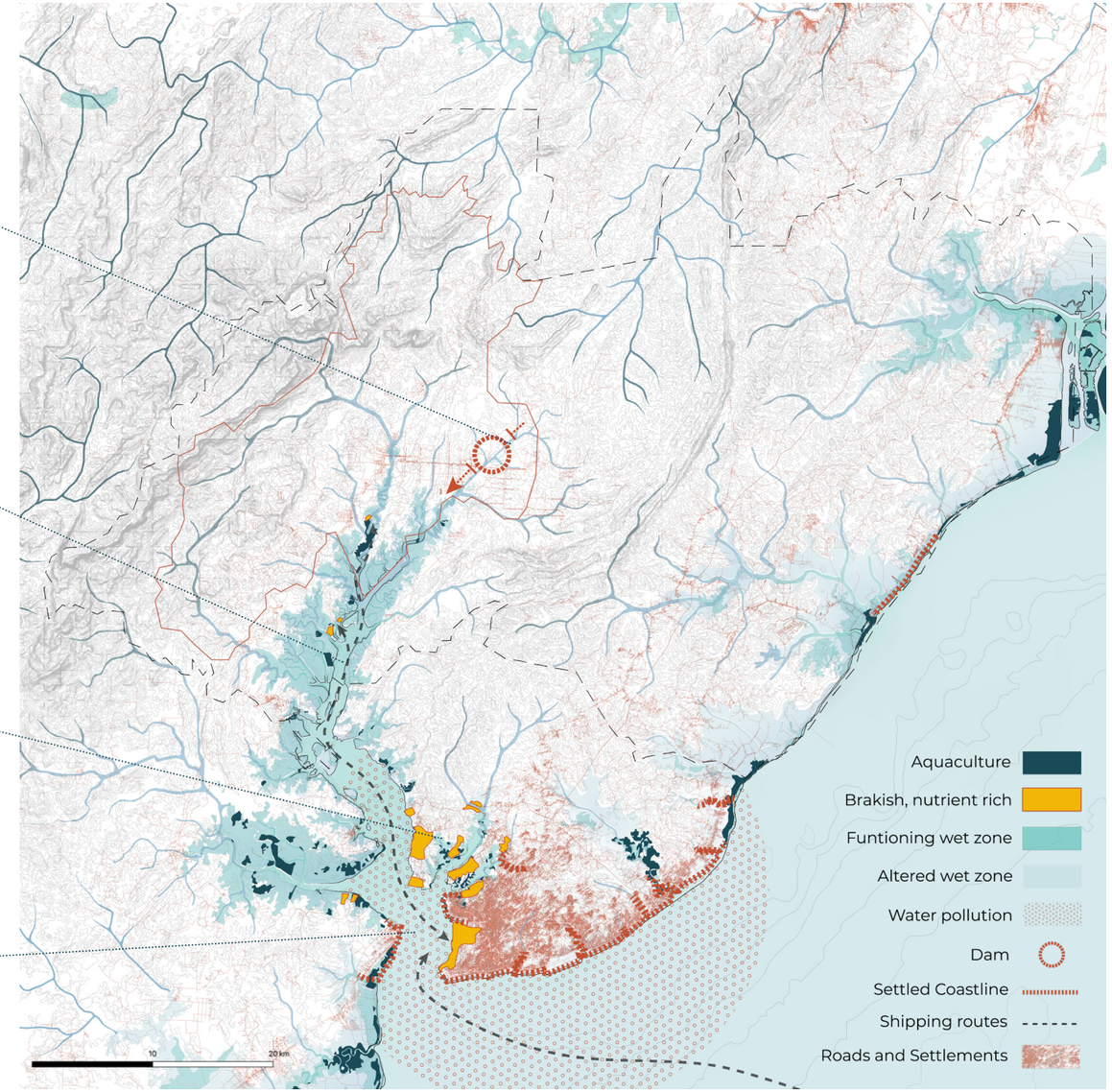
Aquaculture



Industry



Mangorve Loss



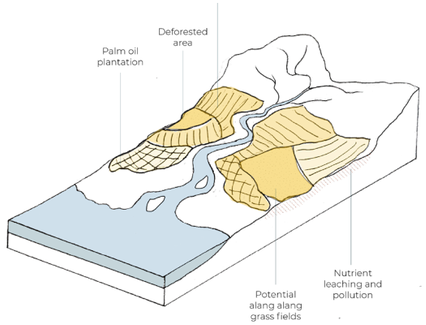
ECOLOGY

The ecological structures of the site have undergone major alteration over the years, particularly with the loss of lowland rainforest. Monocultural palm oil plantations and eucalyptus logging concessions now dominate areas that were once covered in lowland forest. This rainforest once served as connective tissue between different ecosystems, creating vital gradient transitions. Today, protected ecosystems such as the mangroves, Samboja Lestari, Sungai Wain, and Bukit Soeharto remain as isolated habitat patches, separated by sharp boundaries. This fragmentation has serious consequences for the region's biodiversity. For instance, in the mangroves, the conversion of adjacent areas into palm oil plantations has led to a decline in habitat for the proboscis monkey, a species endemic to Borneo (Toulec et al., 2019). Similarly, the edge of the upland rainforest on Mt. Beratus is bordered by extensive eucalyptus plantations, isolating it from other habitat zones. The loss of large-scale gradeint transtions is therfore an important challenge.

It is also noteworthy that even within protected areas, most remaining forest is secondary. Large fires in 1983 and 1998 reduced primary forest cover, and recovery has been slow due to the nature of rainforest species (Kobayashi, 2001b). During a visit to Sungai Wain, which was partially affected by these fires, the contrast between secondary and primary forest was still clearly visible. This underlines the importance of time as a critical factor in gradient formation.

Another key impact of converting lowland rainforest to agriculture and mining is soil erosion. The lack of ground vegetation in oil palm and eucalyptus plantations contributes to topsoil degradation and nutrient leaching (Smits, 2025). Mining also accelerates soil erosion by disturbing and mixing soil layers (Smits, 2025). Eventually, degraded soils struggle to absorb rainfall, leading to increased flooding. These challenges further underscore the need to restore ecological connectivity and landscape integrity.

The urban core of Nusantara is located precisely between the upland rainforest and the mangroves, in an area currently used for eucalyptus production. This positioning makes it especially vulnerable to erosion and flooding. As a result, designing a robust blue-green network that can restore lost gradient transitions presents both a challenge and an opportunity.

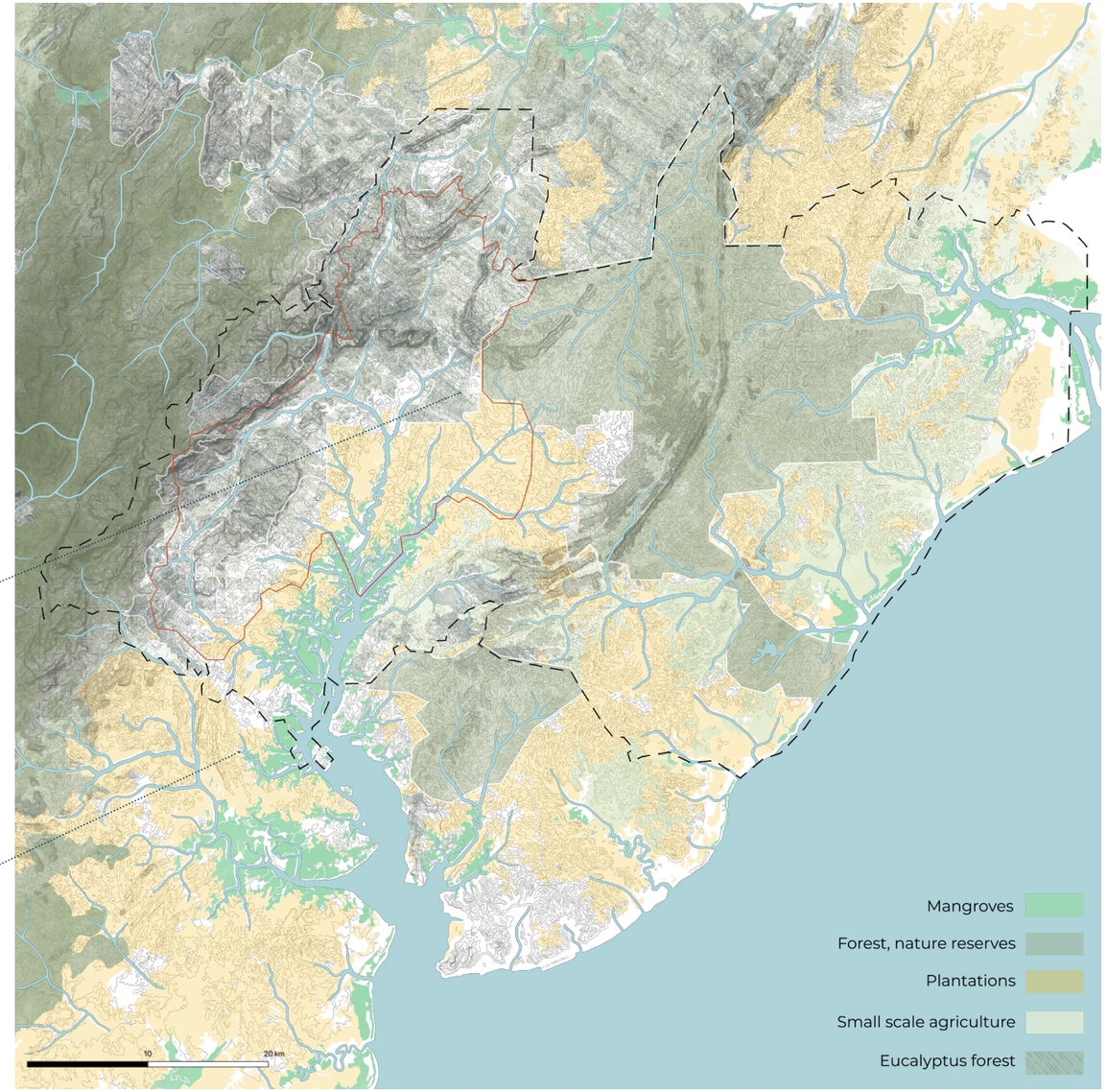




Eucalyptus Plantation



Oil Palm Plantation



CLIMATE CHANGE

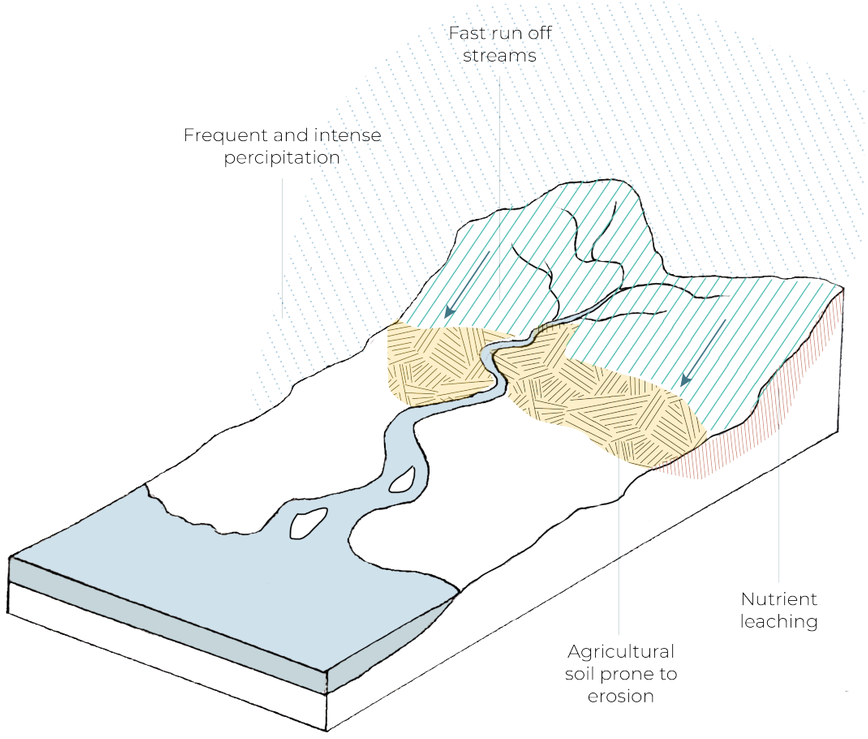
An additional challenge affecting the current water and ecological systems is climate change. Shifting rainfall patterns and the increasing intensity of the El Niño–Southern Oscillation (ENSO) lead to recurring floods and droughts. For example, the forest fires of 1997–1998 were linked to an ENSO-related extended drought (Kobayashi, 2001b). The spread of these fires, primarily across open grassland, highlights how the reduction of forest cover has weakened the site's climate resilience. Similarly, flooding during the wet season is often caused by soil erosion and river damming (Smits, 2025). As climate change is expected to intensify extreme weather events, strengthening the site's adaptive capacity is essential.

Another consequence of climate change is sea-level rise, which poses a threat to mangrove ecosystems. While mangroves can adapt to rising sea levels by trapping sediment, this requires a sufficient sediment supply (Ward et al., 2016b). This issue connects to the reduced sediment flow caused by increasing water demand and river modifications, discussed previously.

Overall, the loss of critical ecosystems on the site not only increases its vulnerability to climate-related risks but also contributes to climate change by reducing its capacity to store CO_2 (Yulandhika & Nugrahanti, 2014).



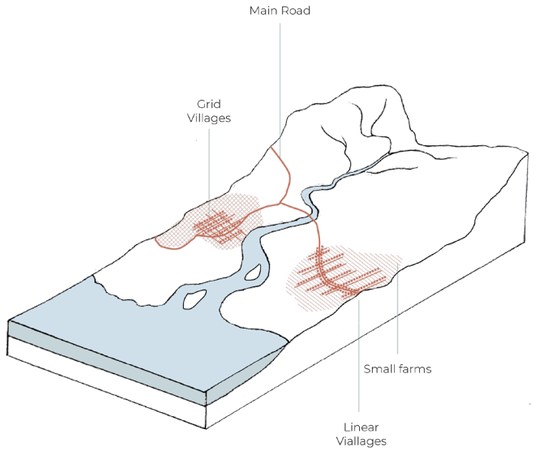
Image 21: Forest fires in East Kalimnatan (ANTARA/HO Pusdalops Kabupaten PPU)



HUMAN ACTIVITY

The urban population around the site has grown significantly over the past 100 years. The two major urban centers nearby, Balikpapan and Samarinda, each have populations of around 800,000. In contrast, the site itself is currently home only to villages, with construction of the new city, Nusantara, now underway. These villages are often linear, following infrastructure corridors, although some adopt a grid-like structure. Several of them originated from the transmigration policies of the 1970s, which explains their organized layouts and, at times, unusual locations in the landscape (Clauss et al., 1988). Integrating these areas into the broader vision for Nusantara is an important consideration.

Indigenous communities also continue to inhabit the development zone. While they have adapted to modern conditions, many maintain a close relationship with the landscape. For example, villagers often engage in small-scale farming, creating transitional landscape edges. In the mangrove areas, fishing communities still live in stilted villages and rely on crabbing and fishing for their livelihoods. As Nusantara develops, debates around the future of these communities have intensified. Reports of potential displacement and contested land ownership raise concerns about their security (Ratcliffe, 2024). Meaningful inclusion of indigenous communities in the planning process could bring valuable insights into traditional cultivation techniques and housing strategies, while also ensuring that these communities benefit from future development.

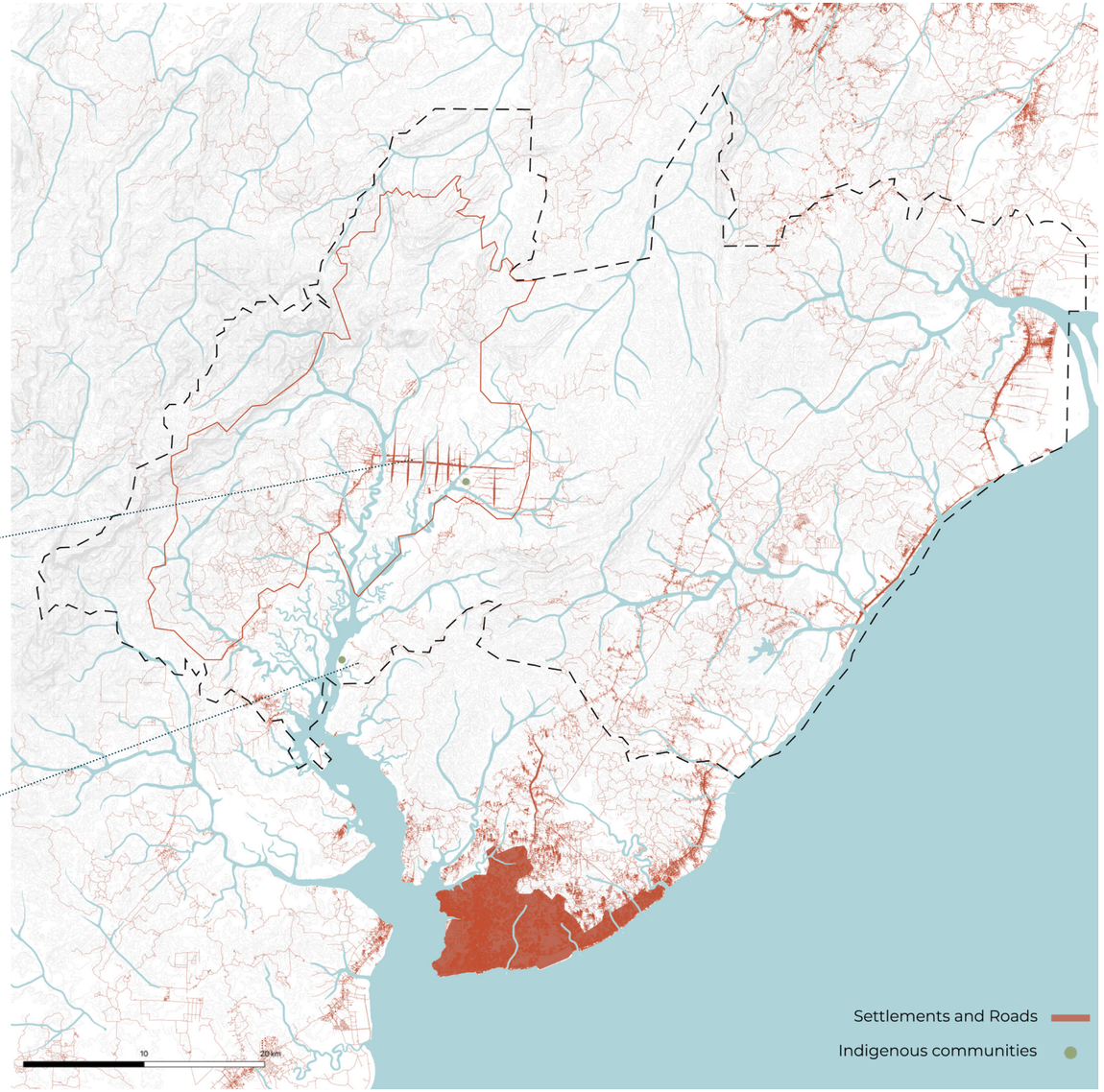




Linear Village



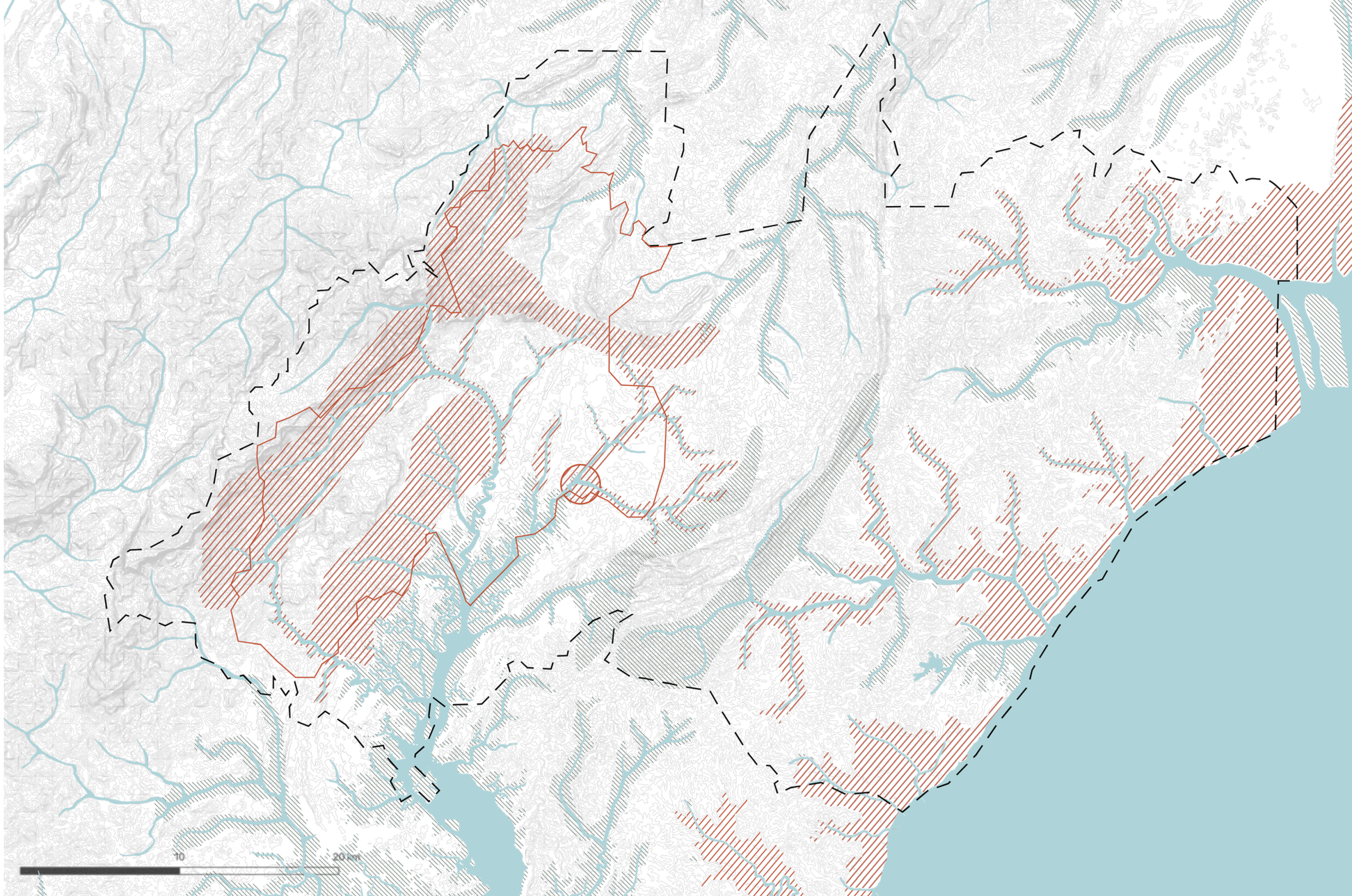
Small-Scale Cultivation

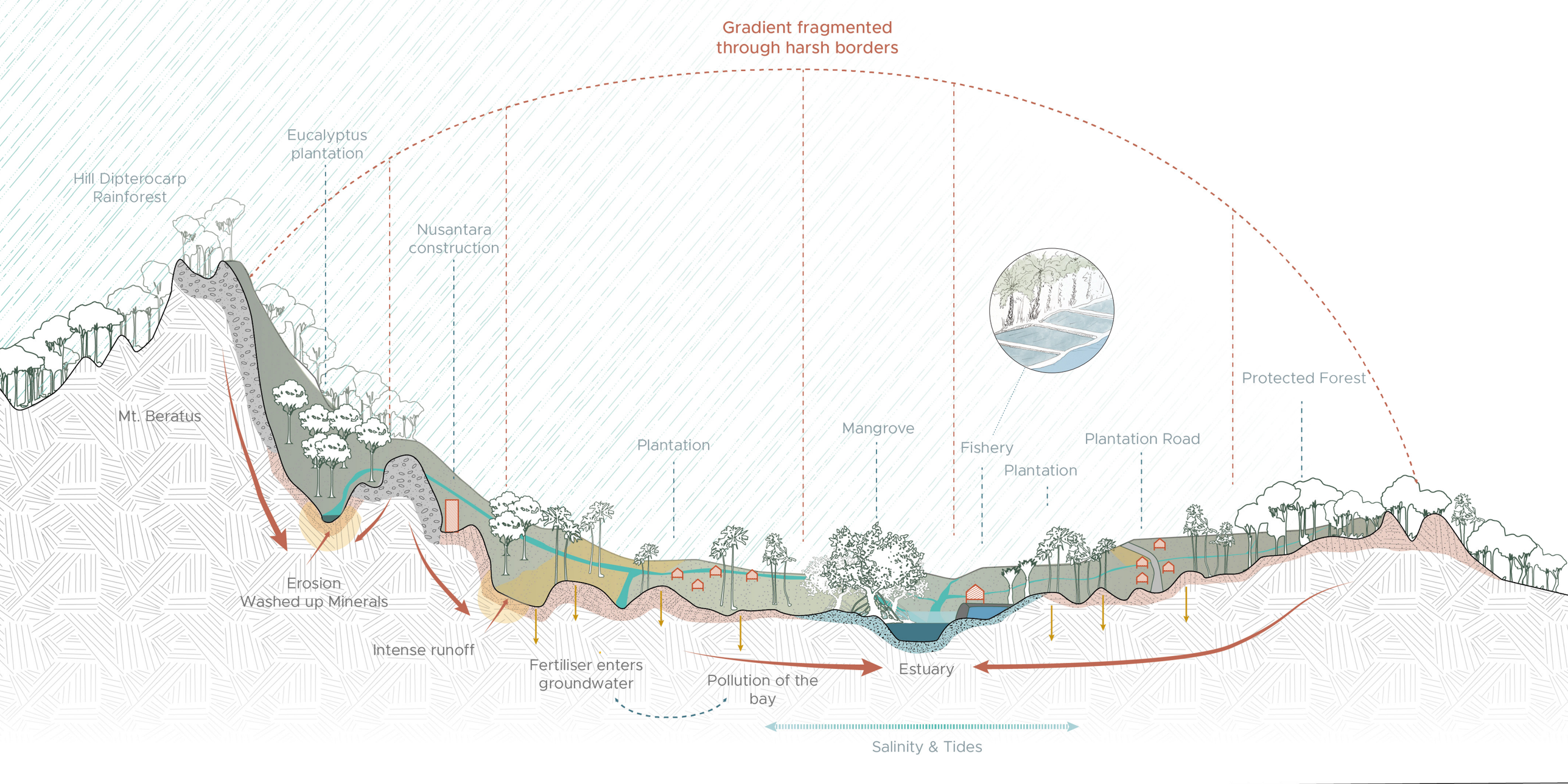


GRADIENTS

After analyzing the current state of the landscape layers, it becomes clear that many ecological and cultural gradients have been disrupted. The most significant loss of gradients is due to the replacement of lowland rainforest with palm oil plantations, eucalyptus logging, and mining activities. The remaining ecological zones are now marked by sharp, rigid boundaries instead of gradual transitions. This fragmentation and the loss of connective structures present major challenges for the site, including reduced biodiversity, increased erosion, flooding, and greater vulnerability to climate risks.

Cultural gradients have also diminished as the relationship between people and the landscape has shifted. Many of the current residents were relocated through government policies and have not developed a strong connection to the land. Once again, a significant influx of Javanese citizens is anticipated as part of Nusantara's development strategy. However, by integrating cultural processes and recognizing indigenous knowledge, this relocation could instead foster a more meaningful relationship between people and the landscape.

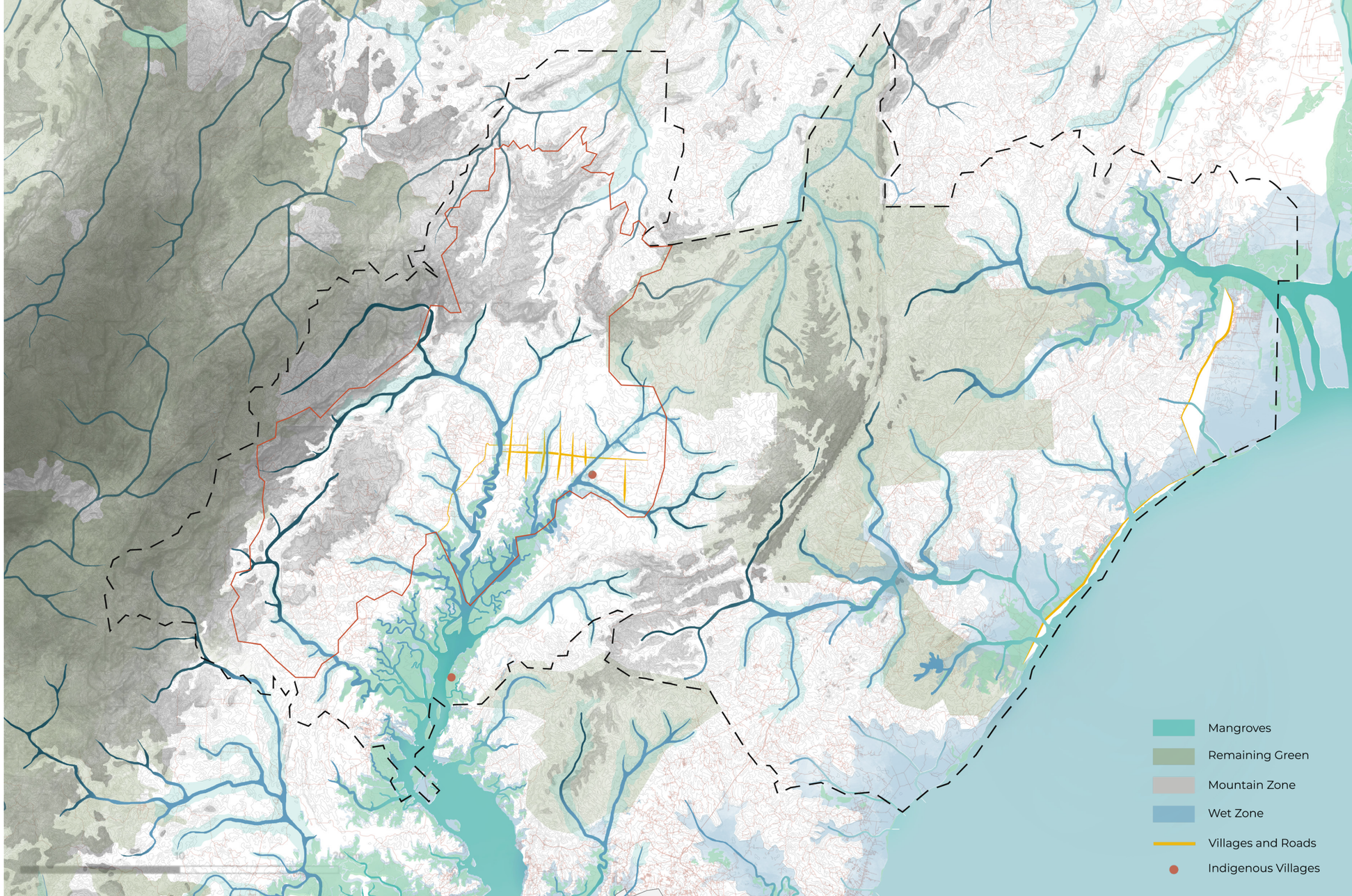



Gradient fragmented
through harsh borders
Hill Dipterocarp
Rainforest
Eucalyptus
plantation
Nusantara
construction
Mt. Beratus
Erosion
Washed up Minerals
Intense runoff
Plantation
Fertiliser enters
groundwater
Pollution of the
bay
Mangrove
Estuary
Fishery
Plantation
Plantation Road
Protected Forest
Salinity & Tides

3.4 LANDSCAPE STRUCTURES

To summarise the results of the analysis and bring findings from both time layers together a structure map capturing main landscape characteristics was created. The main formative elements of the landscape attributed to elevation, soil and water define four major typologies. The estuarine ecosystem remains an defining feature of the landscape and supports much of the biodiversity. Upland rainforest of Mt. Beratus is an important zone of primary forest connected to the heart of Borneo. Riparian gradients create unique conditions and build connections through the site. The remaining patches of primary and secondary lowland rainforest in protected areas are important conservation, biodiversity and eco-tourism locations. These elements ultimately build the structural backbone of the landscape and provide opportunities for connectivity and growth.

Cultural patterns also play a defining role in the landscape structure. The villages and indigenous communities within the site should be meaningfully integrated into the planning of Nusantara. Their connection to the land and potential relationship with the future city can help shape new and valuable gradient conditions. Furthermore, the infrastructural connections between Nusantara, Balikpapan and Samarinda play a key role in regional development.



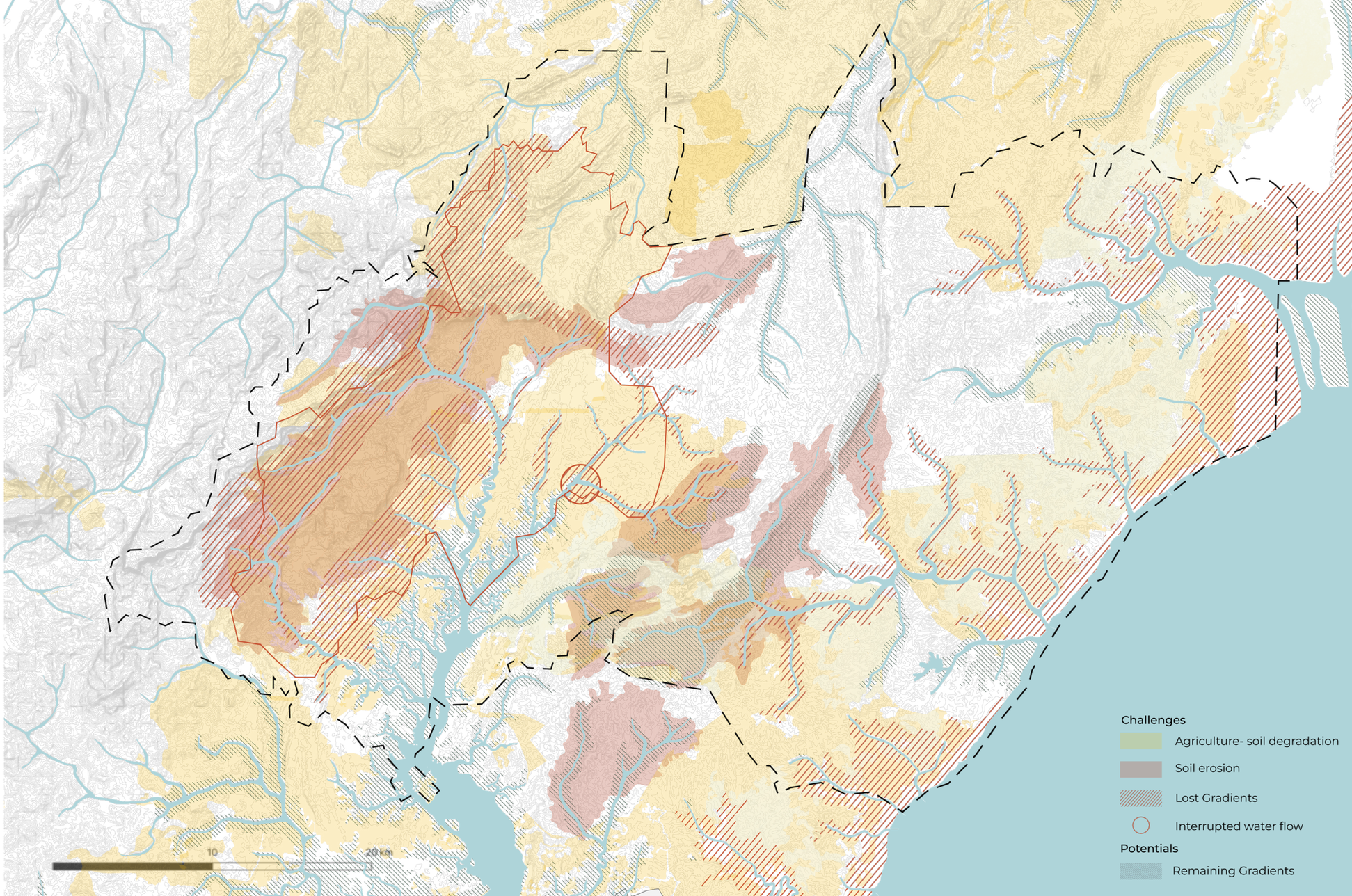
3.5 CHALLENGES & POTENTIALS

To conclude the analysis and set the stage for the design phase, this section outlines the key challenges and opportunities of the site.

The main challenges on site stem from the disruption of landscape gradients and increasing fragmentation. The connective structure once formed by lowland rainforest has largely been replaced by unsustainable monocultures, creating stark separations between ecological typologies. Erosion, flooding, and ecological degradation caused by changing land use patterns threaten Nusantara's future climate resilience. However, a landscape-based planning approach offers an opportunity to address these issues by gradually regenerating gradient transitions and reestablishing ecological connections.

Another major challenge lies in integrating existing villages and infrastructural networks in a way that promotes cultural diversity and social inclusion. Developing recreational links, adapting cultivation strategies, and encouraging deeper relationships with the landscape will be crucial for sustainable development.

Overall, the landscape is highly diverse, rich, and resilient, shaped by dynamic gradient transitions that hold both cultural and ecological value. It has sustained local livelihoods, recovered from large-scale fires, and supported exceptional biodiversity over centuries. This history demonstrates the immense potential of the region and highlights the future opportunities that could emerge from a process-oriented, adaptive planning approach.



04 - DESIGN PRINCIPLES AND STRATEGY

In this chapter, design principles are developed through case studies, indigenous knowledge, and fieldwork. These principles represent the core ideas behind the design and translate conceptual thinking into spatial strategies. Each principle acts as a tool for addressing specific landscape challenges or opportunities. Together, they form the basis for a regional vision that builds on the landscape logic discussed in the previous chapter. The vision is structured in three main phases, taking time and process into account to guide long-term, adaptive development.

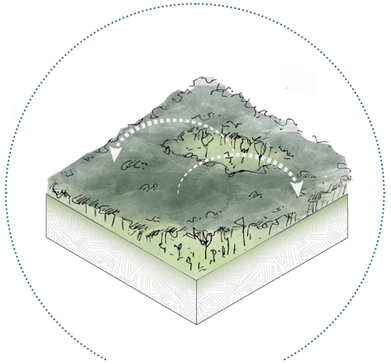


4.1 INDIGENOUS PRACTICES

A part of the landscape-based approach encourages the integration of local indigenous knowledge for the development of design principles. As the analysis shows, local communities indeed can provide interesting ideas regarding cultivation practices, seasonality and housing typologies.

Temporary Forest Cultivation

The Dayak tribes of Borneo have multiple sustainable rainforest cultivation techniques woven into their livelihoods and belief systems. One of the most interesting practices is “simpukng”, a type of temporary forest cultivation described as a form of forest gardening (Mulyoutami et al., 2009). These gardens are family-owned plots of primary or secondary rainforest that preserve much of the forest’s appearance and structure but have been deliberately cultivated to produce specific crops such as rattan, fruit, honey, timber, or vegetables.
A family can own up to 30 different gardens, each targeted towards a specific crop, which allows for a year-round harvest. Some crops require more intensive clearing and at times controlled land burning than others, resulting in a wide variety of garden typologies. These gardens are an important part of local culture, not only as a source of income, food, and materials, but also spiritually.
Since the Dayak tribes typically relocate every 8–10 years, the gardens eventually regenerate and become part of the rainforest again (Mulyoutami et al., 2009). This process creates interesting small-scale gradients within the landscape. The practice highlights the natural productivity and crop diversity that rainforest cultivation can offer. Ultimately, the temporality, careful and purposeful cultivation, and respect for the forest are key takeaways from this traditional method.



Rotational Forest Cultivation



Image 22: Dayak forest-garden system (Sumarni Laman).

Sustainable Fishing Practices

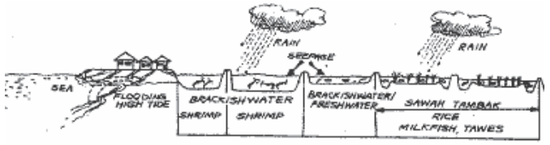
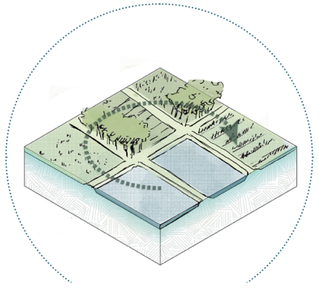


Image 23: Diagram of sawah tambak system (Dela Cruz, 2001).

Another interesting practice that originates from fishing communities is the tambak pond system. Tambak ponds are a form of fish and shrimp aquaculture rooted in the hydrological cycles of the brackish water zone. Several variations of this practice, with different pond and crop typologies, exist throughout Indonesia and Southeast Asia. An interesting adaptation of the aquaculture system from Java is the sawah tambak, a system of rice-fish cultivation. The ponds use an alternating cultivation strategy depending on the season and water supply (Dela Cruz, 2001). Crop types depend on water availability and salinity. This system allows for year-round cultivation and harvest of different crops while relying solely on rainfall.
It is important to note that similar practices can have negative environmental impacts when applied on an industrial scale, as seen in Samarinda. For this reason, modern adaptations of these practices that involve mangrove integration will be explored in more detail later.



Seasonal Agricutlture

Bioclimatic Architecture



Image 24: Traditional Lamin - Longhouse near Samarinda

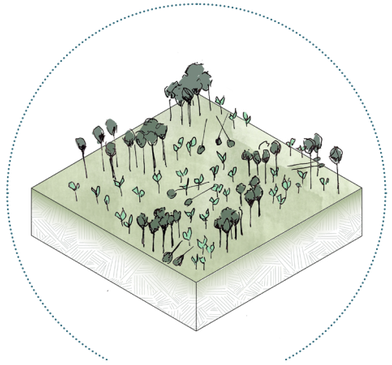
With the expected rate of urbanisation, it is also important to consider the characteristics of future housing typologies. The local communities have developed several bioclimatic architectural adaptations suited to the hot and humid climate. One of the most characteristic housing types of the Dayak is the Lamin longhouse. These communal houses use local materials such as bamboo, ironwood, and sago palm leaves, which support air circulation and have low heat absorption (Victoria et al., 2017). The elongated shape, combined with a high roof and ventilation openings, promotes airflow and aids thermal regulation. Modern adaptations of these techniques could be incorporated into suitable housing typologies in Nusantara to encourage ecologically adaptive architecture.

4.2 REFORESTATION

With the high degree of landscape fragmentation and the loss of many gradients, reforestation will play a crucial role in re-establishing ecological connections across the site. Due to the current level of soil degradation in some areas, specific techniques are required to initiate ecological succession. The Samboja Lestari orangutan conservation center, one of the protected areas within the site, serves as an example of successful reforestation on degraded land.
I had the opportunity to visit Samboja in February 2025 and conducted an interview with founder Willie Smits to learn more about their reforestation processes and techniques. Before restoration began, the land had been severely degraded by palm oil cultivation and mining activities. A belt of sugar palms was planted first to protect and define the area's boundaries. Local communities were involved from the beginning, benefiting from sugar palm tapping. To prepare the land for forest regeneration, resilient and tolerant species like Acacia mangium were introduced initially. These were followed by fast-growing local pioneer species to provide shade and enrich the soil with organic material (Smits, 2025). Once these pioneers matured, fruit-bearing and slow-growing hardwood species were planted to complete the forest layers. Today, Samboja has become an established secondary rainforest and a site for orangutan conservation.

An equally important aspect of the project is the involvement of local communities. Surrounding villages have been engaged in agroforestry practices, supplying fruits and vegetables to the reserve and gaining income in return. Many residents have also found employment at the center. Regular educational programs introduce both locals and visitors to forest restoration techniques and the importance of conservation.

This project provides valuable insights into species selection, phasing strategies for reforestation, and the benefits of community participation. These lessons hold strong potential for application in various parts of the development site.



Initiate Succession





Images 25 -26: Samboja Lestari reforestation state

4.3 AGROFORESTRY

Agroforestry techniques have a lot of potential to improve the ecological conditions of palm oil and eucalyptus plantations while retaining economic value. During the site visit, I attended an agroforestry workshop organised by Mulawarman University at a local coffee plantation. In this example, coffee trees were planted between mature fruit trees. The fruit trees were planted first to loosen the eroded soil and provide shade for the coffee plants. Although the fruit trees do not contribute directly to the economic value, they provide food for the farmers and help improve ecological conditions. The coffee plants begin to produce berries soon after planting and yield a more valuable crop. The farm relies on rainfall for irrigation. The type of coffee planted depends highly on the site's elevation, with Liberica being the only variety that grows below 600 metres, making it more suitable for the lowland conditions on site.

In addition to coffee, numerous other crops are suitable for agroforestry in the area, including mixed forms of palm oil diversification. These agri-silviculture systems can resemble indigenous forest cultivation by interplanting forest trees with crops (Olofson, 2008). Such systems support a diverse range of crops including banana, papaya, cassava, jackfruit, durian, legumes, sweet potato, cacao, cinnamon, rattan, and various types of timber. This type of forest cultivation can support most of a farmer's income, although education programmes on cultivation techniques may help to increase profits (Roslinda et al., 2023). A phased strategy could be introduced to support the transition from monoculture plantations to agroforestry systems.

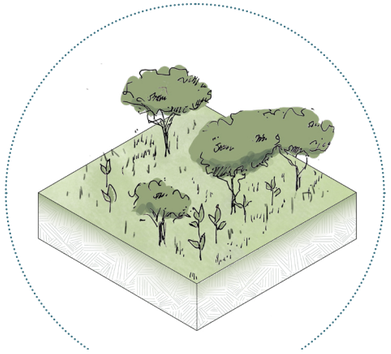




Image 27: Agroforestry strucutres (From Aumeeruddy 1994, 28–29).

Agroforestry adaptation has the potential to regenerate lost landscape gradients and encourage a stronger relationship between farmers and their land. The high biodiversity of the site allows for the cultivation of many different crops, securing local livelihoods. The integration of indigenous knowledge could also play a valuable role in transferring forest cultivation techniques.

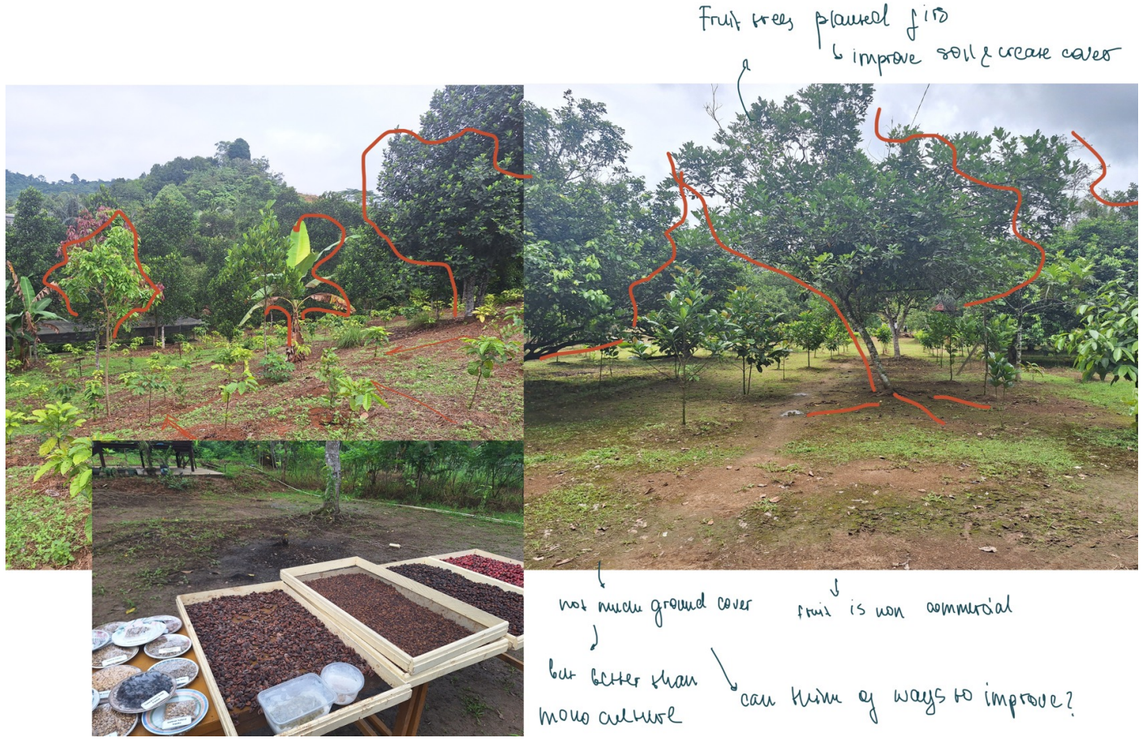


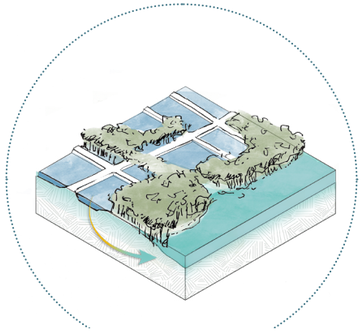
Image 28: Coffee - fruit plantation

4.4 MANGROVE RESTORATION & AQUACULTURE

As mentioned during the analysis, the mangroves are one of the most important and simultaneously most threatened gradients on site. It is therefore essential to consider potential mangrove restoration techniques and their integration into local systems such as aquaculture.

During the site visit, I travelled to two mangrove restoration sites. Replanting mangroves is a highly specific process, with many unsuccessful examples around the world. The process begins by collecting mangrove seeds and growing them in a nursery; otherwise, the seedlings risk being washed away by the tides. Biodegradable planting sacks are placed together with the young plants to stabilise them and protect the roots. The trees then require at least five years to develop a sufficient and stable root system.Rhizophora species are most often selected for restoration due to their higher tolerance. However, to support the natural tree diversity of mangrove ecosystems, other species such as Avicennia, Bruguiera, and Nypa should also be included.

Mangroves can also contribute to the local economy through the adoption of Integrated Mangrove Aquaculture (IMA). This strategy incorporates mangroves into aquaculture ponds to improve water filtration, reduce pollution, and enhance biodiversity (Bosma et al., 2023). The system is particularly promising for the area, as many aquaculture ponds on site have strayed from sustainable local practices over time. A potential combination of the IMA approach with indigenous pond systems offers an opportunity to regenerate ecological gradients in aquaculture zones.



Integrate Mangorves

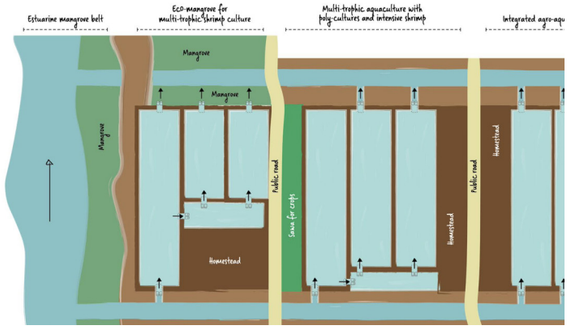
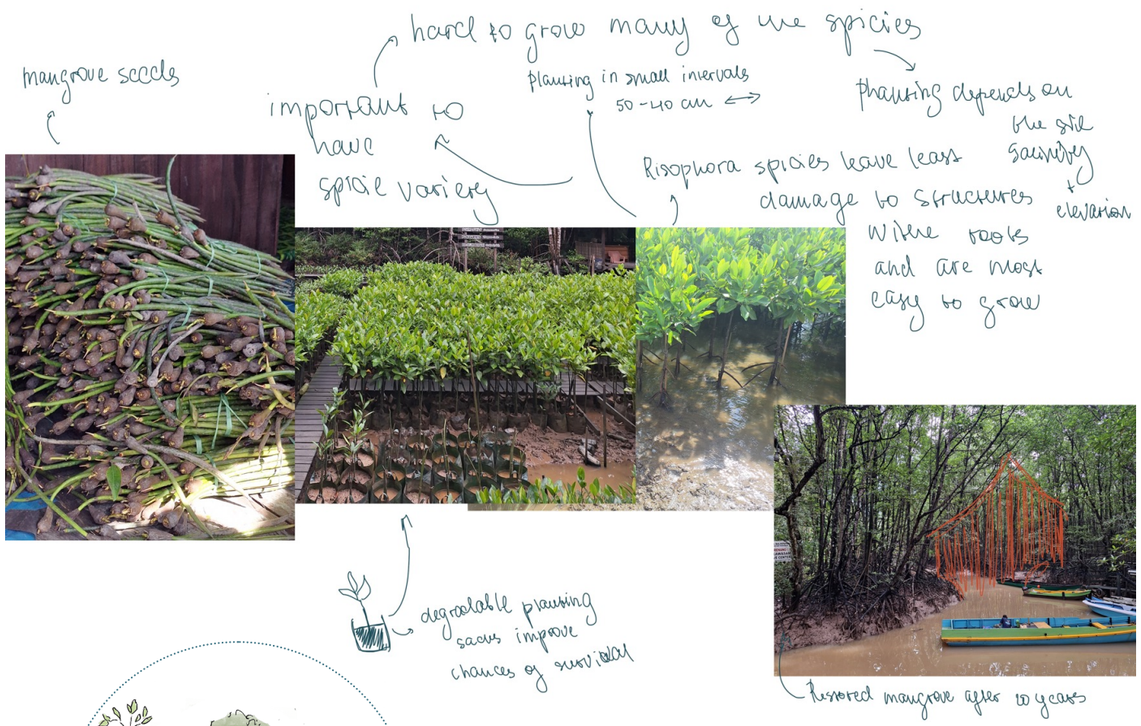
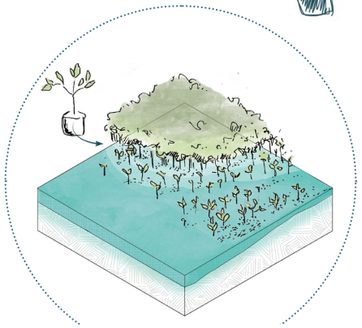


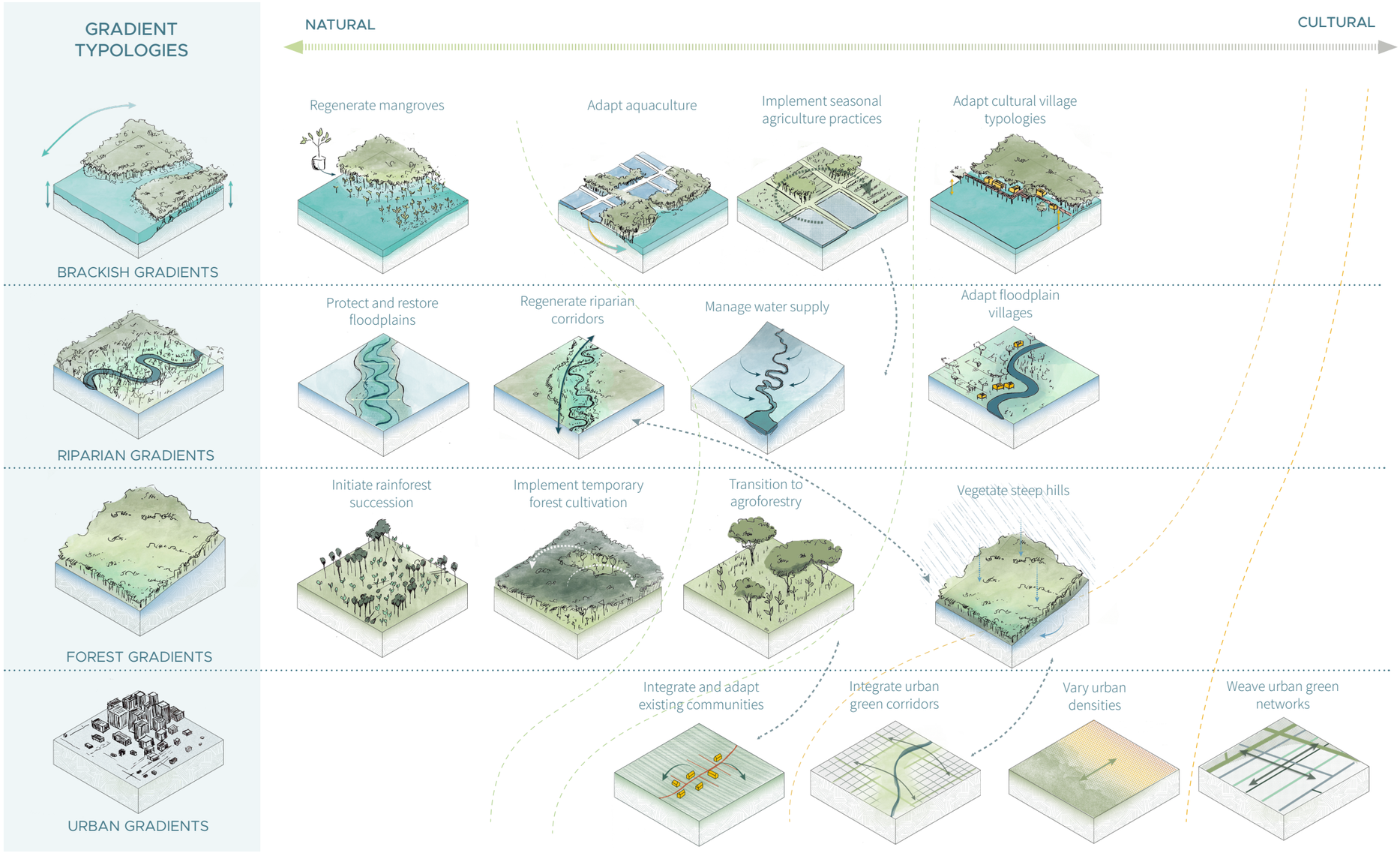
Image 29: IMA diagram (Roel Bosma)





Regenerate Mangorves

Image 30: Mangorve regeneration study on site



4.5 DESIGN PRINCIPLES

After collecting the design principles through case studies, indigenous knowledge exploration, and fieldwork, a framework for their application can be established. The identified principles target the main gradient zones, which will either be recovered, developed, or protected. They can also be classified according to whether they focus more on ecological or cultural aspects of the design.

The ecologically oriented principles concentrate on the regeneration and recovery of landscape gradients and the creation of ecological connections. These principles require time to take effect and should therefore be implemented in the early stages of development to establish a resilient green network. Principles that lie between the ecological and cultural spectrum mainly address agricultural adaptations and the integration of existing communities. These serve as a bridge between natural and cultural systems by aligning cultivation methods with landscape conditions and using its potential sustainably. Indigenous knowledge systems play an important role in forming this connection. Finally, principles that primarily address the cultural dimension of the design are closely tied to patterns of urban and rural development. These may indicate potential densities or village structures.

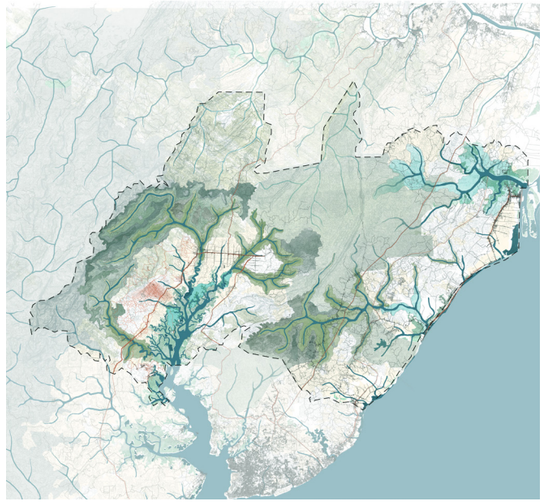
Classifying the principles along a gradient from natural to cultural helps guide their application across the research site. This approach offers a strategy for generating gradual transitions between different landscape typologies and levels of urbanisation.

4.6 DESIGN PHASING

As outlined on the previous page, several design principles require time to fully develop. A phased implementation strategy helps set clear priorities and establish a hierarchy of actions. Gradual development also ensures that both natural and cultural processes are better integrated into the evolving landscape. This phasing approach places the landscape as the primary shaping force behind urban design, allowing elements to grow and blend seamlessly over time.

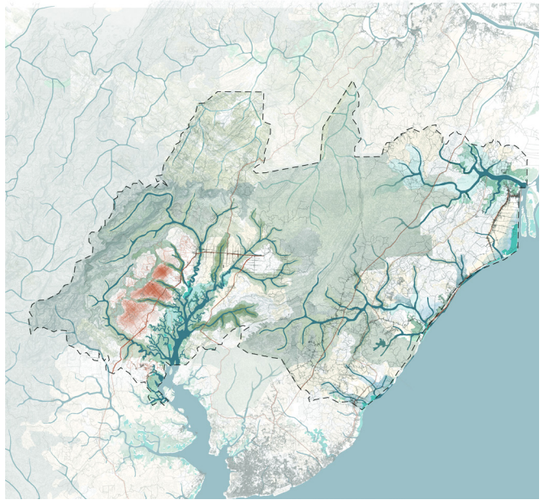
The current development plan envisions a complete ‘forest city’ within just twenty years, a timeline that does not realistically account for the regeneration needs of today’s degraded landscapes. To support ecological recovery and the development of social structures, the proposed third phase of the plan intentionally extends beyond this deadline, enabling slower, organic growth into the future.

PHASE 1: RECOVER AND RECONNECT
2025-2035 -CONTINUOUS GROWTH



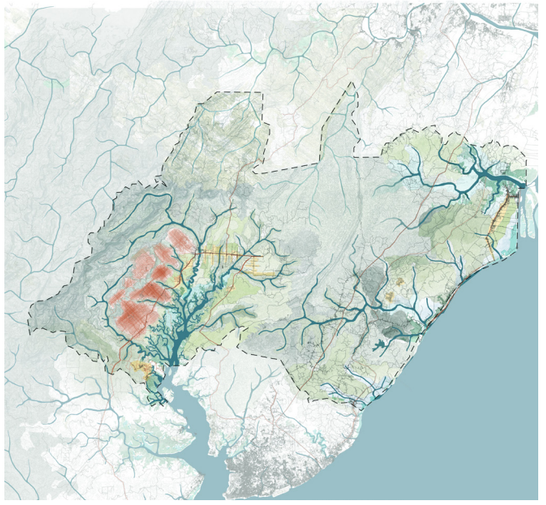
Focus on restoring missing landscape gradients and creating strong connections between fragmented habitat patches, following the logic of landscape-based urbanism. Prioritising the reconnection of the landscape system early on gives it time to grow alongside urban development. These key green structures also define zones that should remain free of intensive urbanisation. In essence, this phase establishes the structural gradient backbone of the design.

PHASE 2: STRENGTHEN AND GROW
2035-2045 -CONTINUOUS GROWTH



Build on the established green and urban structures, allowing them to expand and interact with one another. Agricultural transformations can begin to take place, forming smoother transitions between villages and major ecological areas. Within the city, additional green corridors can take shape, gradually blending into the urban fabric. At this stage, the design becomes a more refined network of diverse green and urban typologies.

PHASE 3: EXPERIMENT AND ADAPT
2045 -CONTINUOUS GROWTH



Shift towards improving the quality of the broader landscape matrix by transforming remaining agricultural zones. Urban areas are now mostly complete and transition fluidly into the established green corridors. With these green structures fully developed and local materials more readily available, new agricultural and housing typologies can be explored and refined. While further development may take place in the future, the key ecological structures should remain intact.

4.7 PHASE I:
RECOVER AND RECONNECT

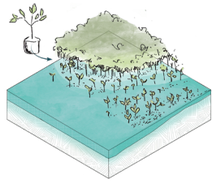
Desing Startegy

This phase focuses on the transformation and protection of important landscape gradients that have been disrupted, are under pressure from surrounding land use, or may be directly affected by the development of Nusantara. These gradients include the western edge of Nusantara, where the upland forest of Mount Beratus is isolated from other green areas, the riparian zones along the main rivers, mangrove edges, and the missing links between protected forest areas.

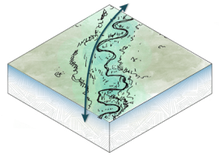
These zones will be prioritised through a series of restoration practices. For example, mangrove planting will primarily take place along the coastline, where most of the original mangrove cover has been lost. Buffer zones surrounding riparian gradients will be established, forming the larger ecological corridors—these should ideally have a minimum width of 200 meters on each side of the river. Between major conservation patches, natural succession processes can be initiated and degraded soils rehabilitated.

In parallel, the urban core of Nusantara will be established. Existing construction will serve as the starting point for further concentric development. The urban area of Nusantara should remain as compact as possible, with density gradually decreasing in transitional zones. Existing villages are to preserve their character while gaining access to new opportunities.

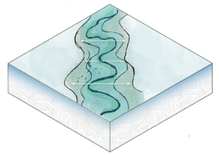
Regenerate mangroves



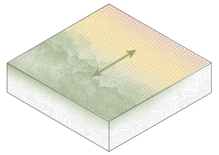
Regenerate riparian corridors



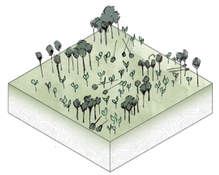
Protect and restore floodplains

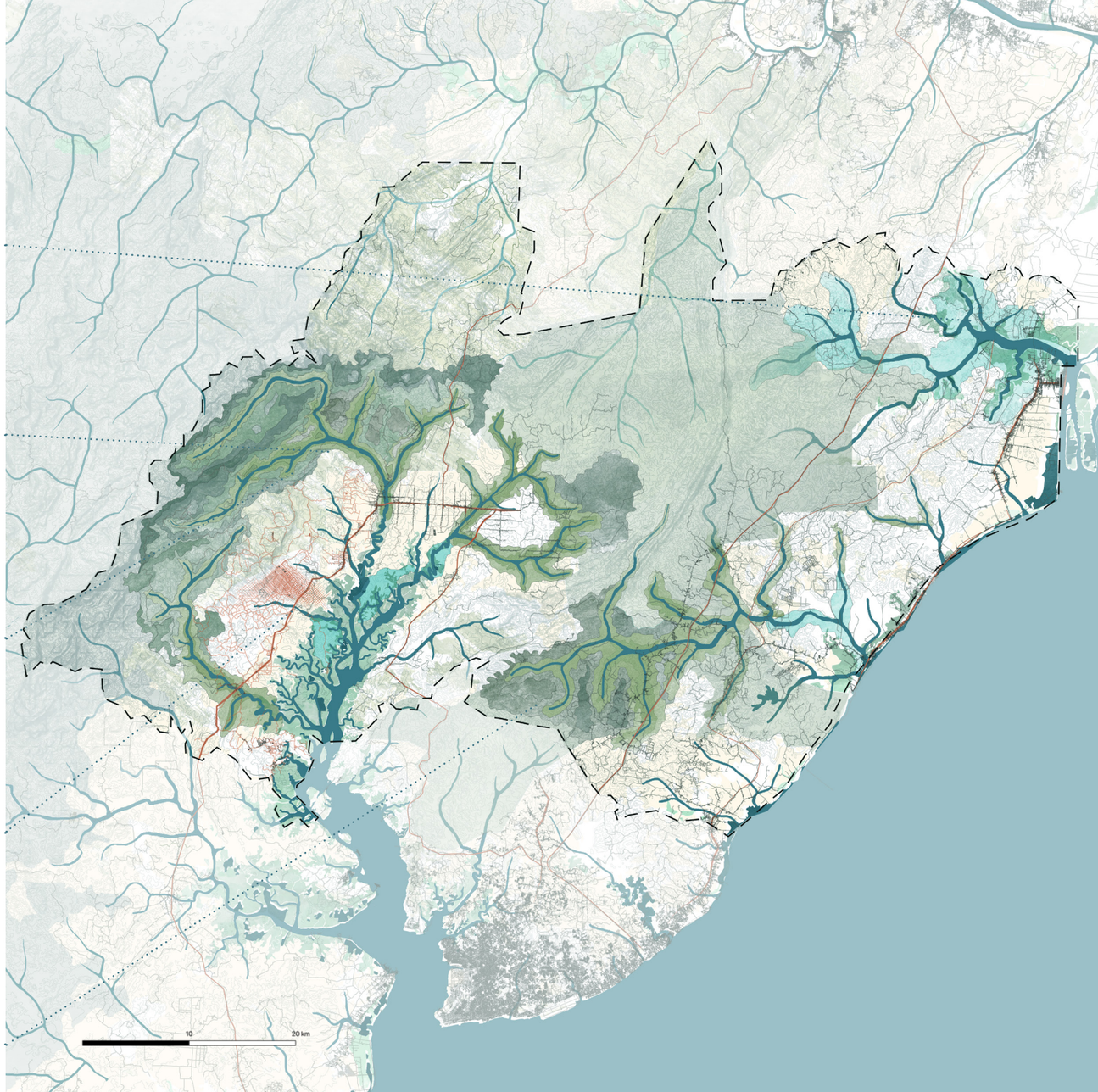


Establish and vary urban densities



Initiate rainforest succession



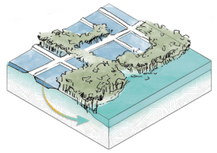


4.7 PHASE II
STRENGTHEN AND GROW

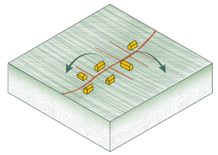
At this stage, important adaptations in the agricultural sector will take place alongside urban development and the creation of a more refined green structure. Strategies such as Integrated Mangrove Aquaculture can begin to support alternative local practices and generate more nuanced ecological transitions. Agroforestry strategies can help soften the edges of palm oil and eucalyptus plantations, creating more diverse and interconnected rural gradients. These actions initiate a shift in the relationship between people and the landscape, encouraging long-term, positive change.

Many of these strategies also require time to establish and evolve, supporting the incremental development of the landscape system. In urban areas, additional green corridors following riparian zones and steep elevation changes will begin to shape the urban green network. These areas offer cooling and erosion protection within the city and may be more accessible for recreation than the larger green structures from the previous phase.

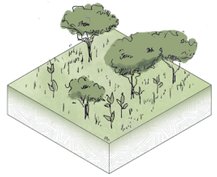
Adapt aquaculture



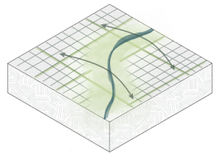
Integrate and adapt existing communities



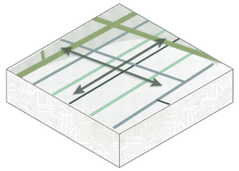
Transition to agroforestry

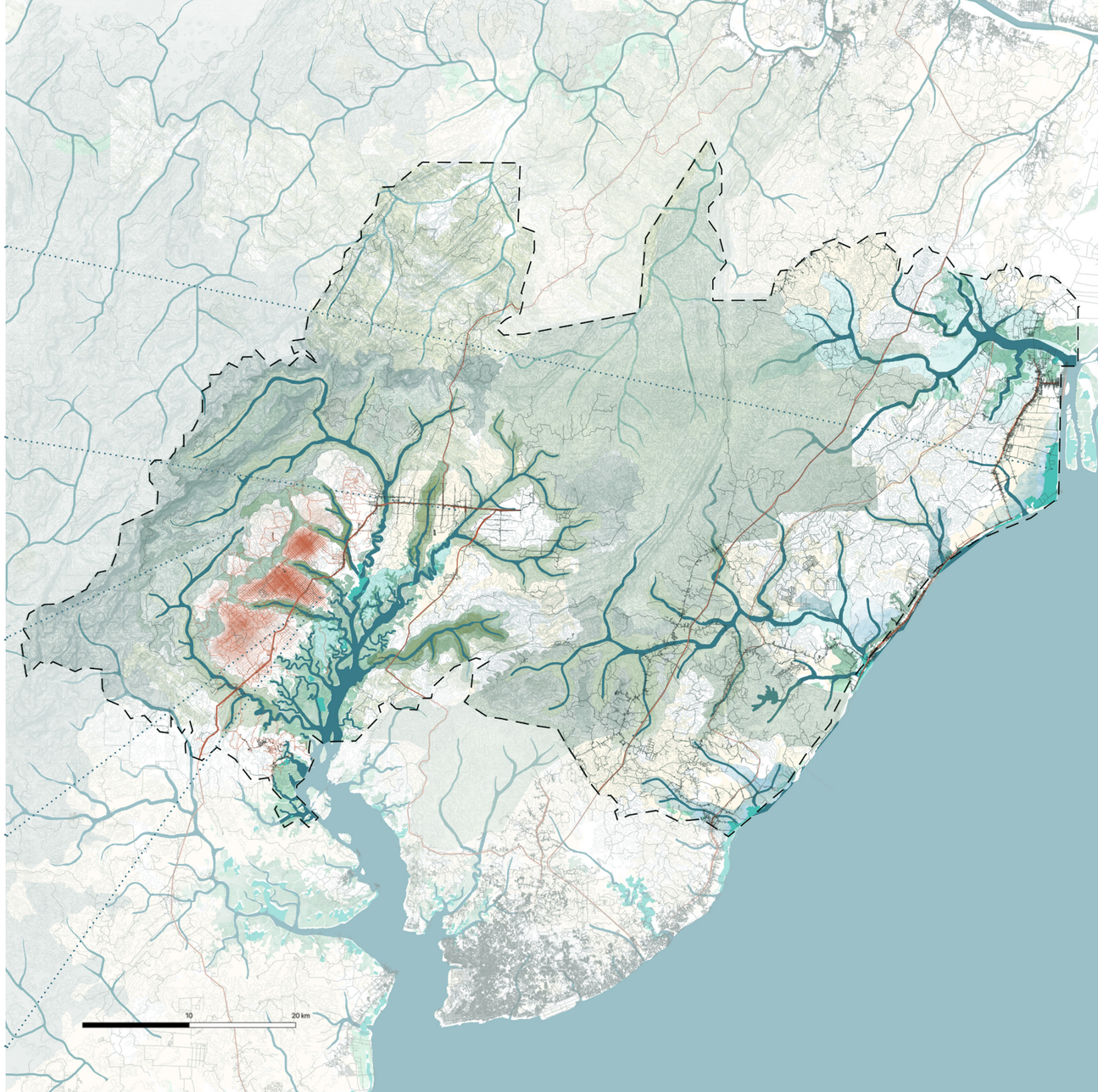


Integrate urban green corridors



Weave urban green networks





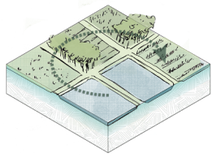
4.7 PHASE III
Experiment and adapt

In the final stages of the design, the fine-grained network of green, urban, and agricultural areas comes together and continues to adapt and evolve based on future needs. The last steps of agricultural transformation focus on remaining patches of unsustainable agriculture, introducing seasonal and rotational cropping systems to regenerate soil and address climate-related water challenges. At this stage, local knowledge and practices can lead to particularly innovative results. This phase plays a key role in shaping the landscape matrix, adding another layer of connectivity to the design.

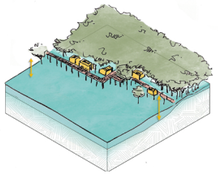
The now-established city can also begin to adapt its water supply system, moving away from large-scale damming toward more sustainable alternatives. According to Willie Smits, Nusantara could achieve a more resilient water supply by restoring natural recharge systems upstream, once these areas are reforested with native vegetation. This could help return some of the freshwater flow to the bay.

By this point, the future direction of Nusantara will be clearer, allowing new design phases to guide its continued development while protecting the carefully structured gradient network.

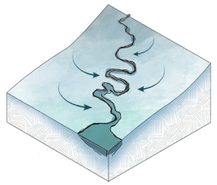
Implement seasonal agriculture practices



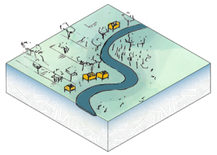
Adapt mangrove villages



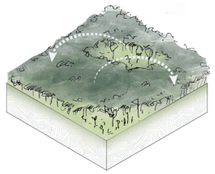
Manage water supply

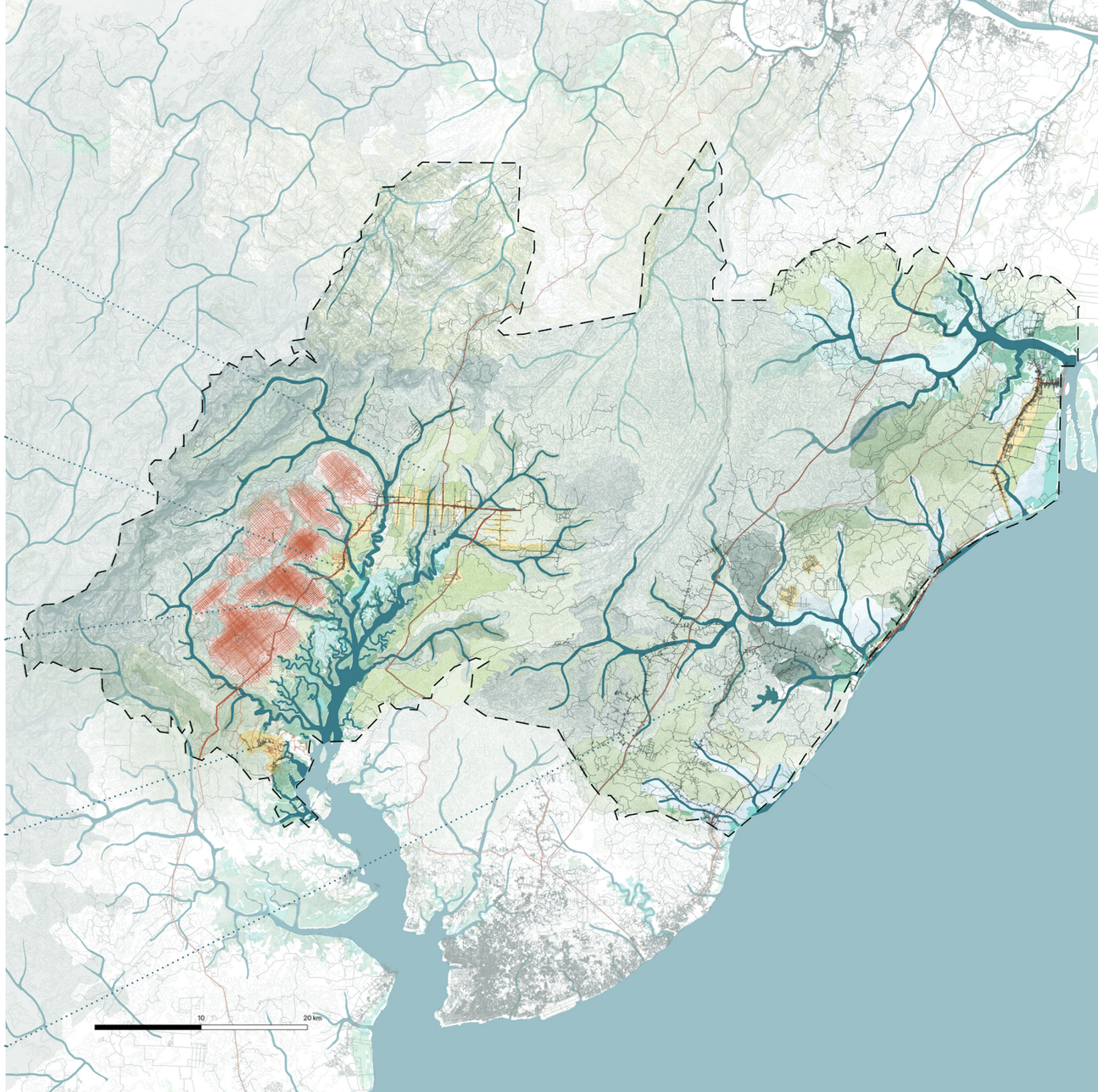


Adapt floodplain villages



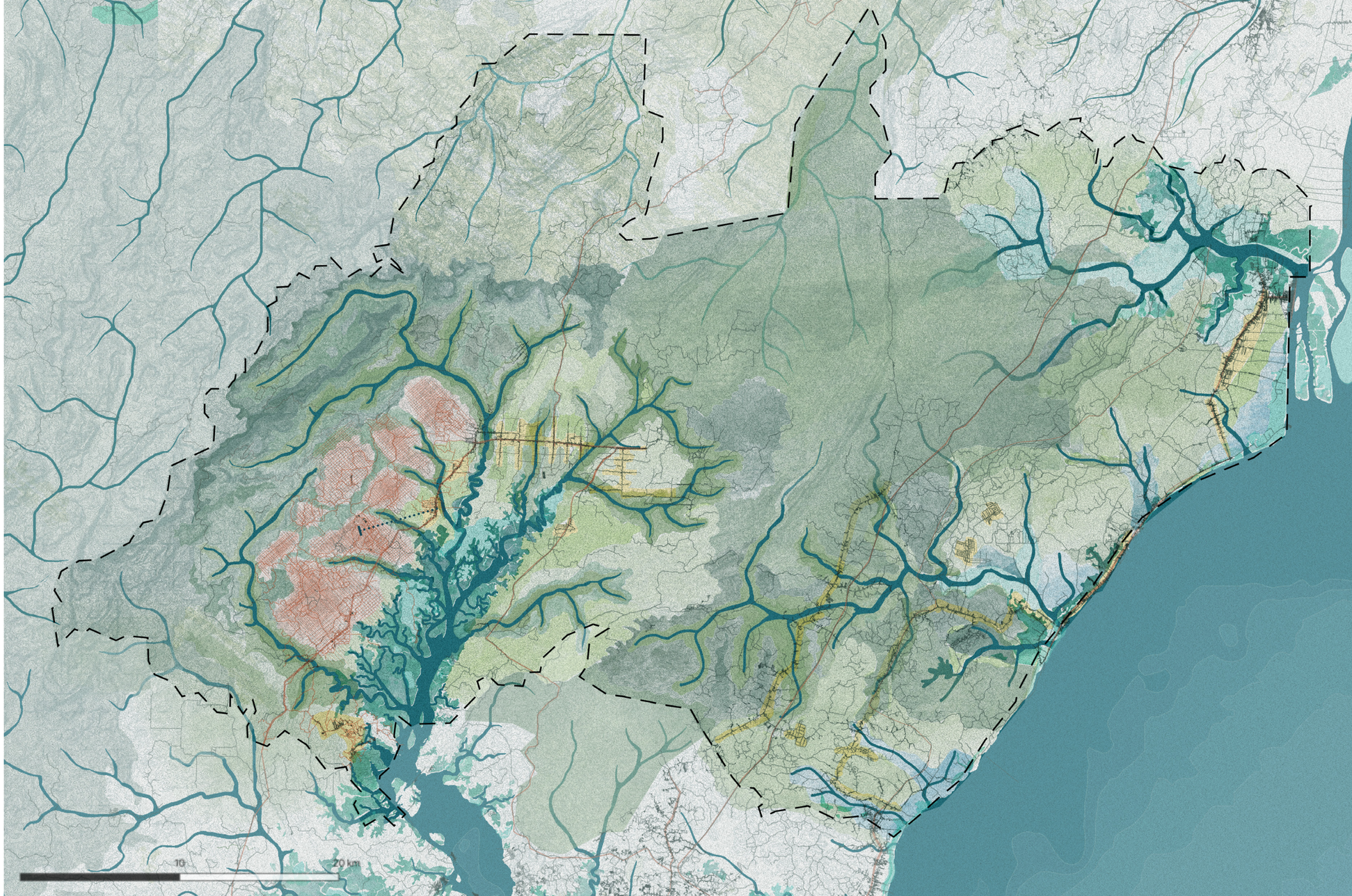
Implement temporary forest cultivation





4.8 VISION

The three phases together form a cohesive regional vision for the future of Nusantara. With this vision in place, a more detailed, zoomed-in design process can begin. The selected area spans several key gradient transition zones and illustrates many of the design principles developed so far. It includes transitions from mangroves to existing village areas, into palm oil plantations, and toward the urban core of Nusantara. By focusing on strategic designs within this area, the overall concept can be communicated more effectively. These zoomed-in designs will be explored at multiple scales to highlight the qualities and dynamics of gradient transitions within the landscape.



05 - DESIGN EXPLORATIONS

The design explorations further develop the vision by expressing its qualities across different scales. The selected gradient is divided into two sub-areas to allow for more detailed spatial design and the exploration of both existing communities and newly established urban areas. The first zoom-in focuses on the adaptation of an existing village, emphasizing edge conditions such as aquaculture and agroforestry. The second zoom-in investigates the creation of urban green networks through street and urban green space typologies. Together, these zoom-ins provide insight into concrete design strategies and highlight the spatial articulation of the gradient concept.

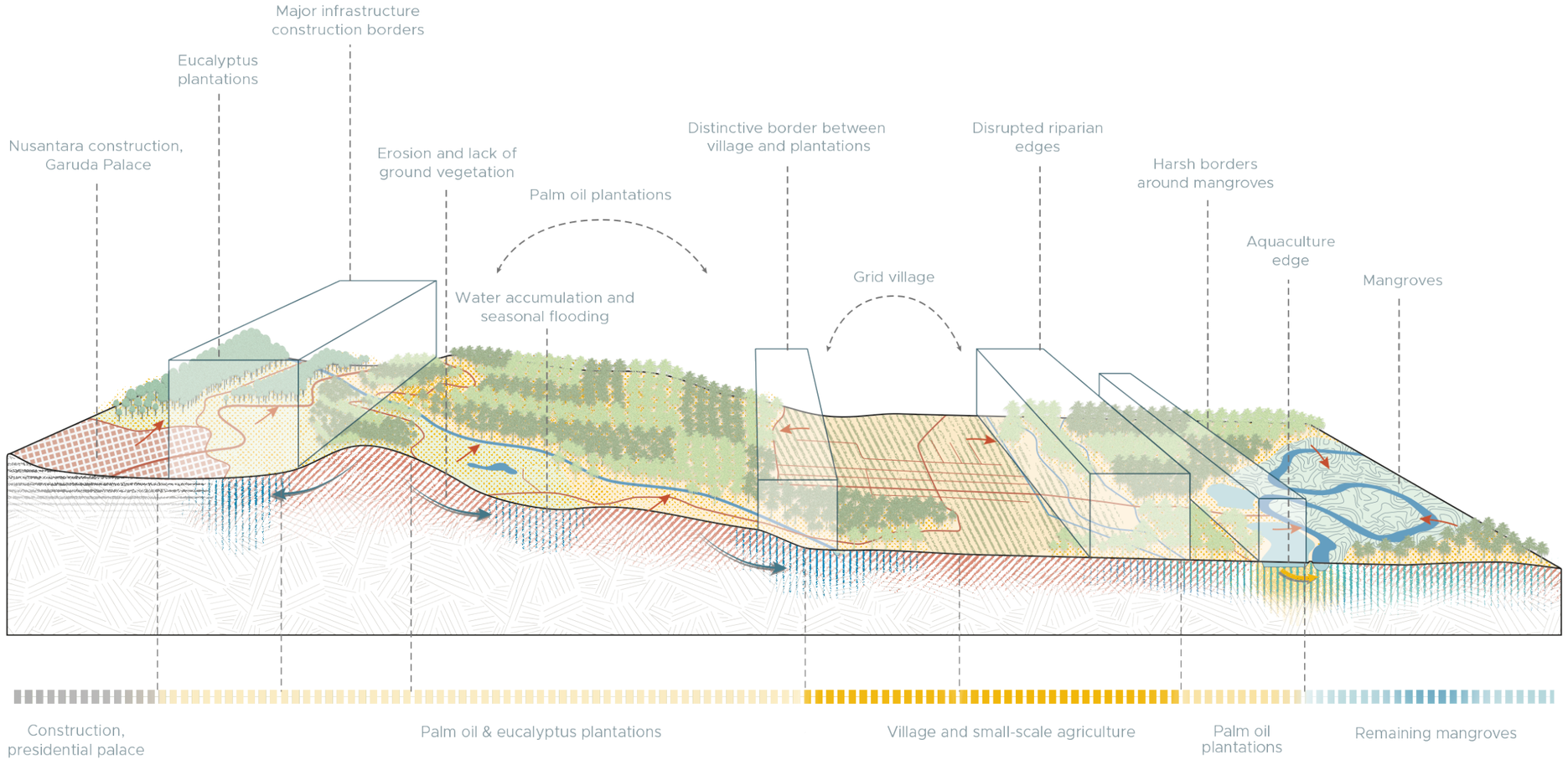


5.1 GRADIENT SCALE DESIGN

The selected design zoom encompasses the transition from a large-scale green corridor to the city center, offering an opportunity to explore the concept of landscape gradients in various contexts. These include connections between mangrove ecosystems and rural settlements, agricultural edges, and the integration of urban green corridors. Particularly interesting is the exploration of the evolving relationship between new urban development and existing communities.

In the current situation, the development of the new capital city cuts through existing eucalyptus plantations. The challenging topography of the area contributes to issues such as flooding and landslides. As a result, the construction of the presidential palace and its surroundings has involved extensive excavation, the damming of existing streams, and significant reshaping of the terrain.

The nearby grid village is encircled by palm oil plantations, which create distinct border conditions. These plantations separate the community from both the ongoing construction activities and the surrounding mangrove ecosystem. The emerging urban environment introduces new opportunities as well as challenges for the local population.

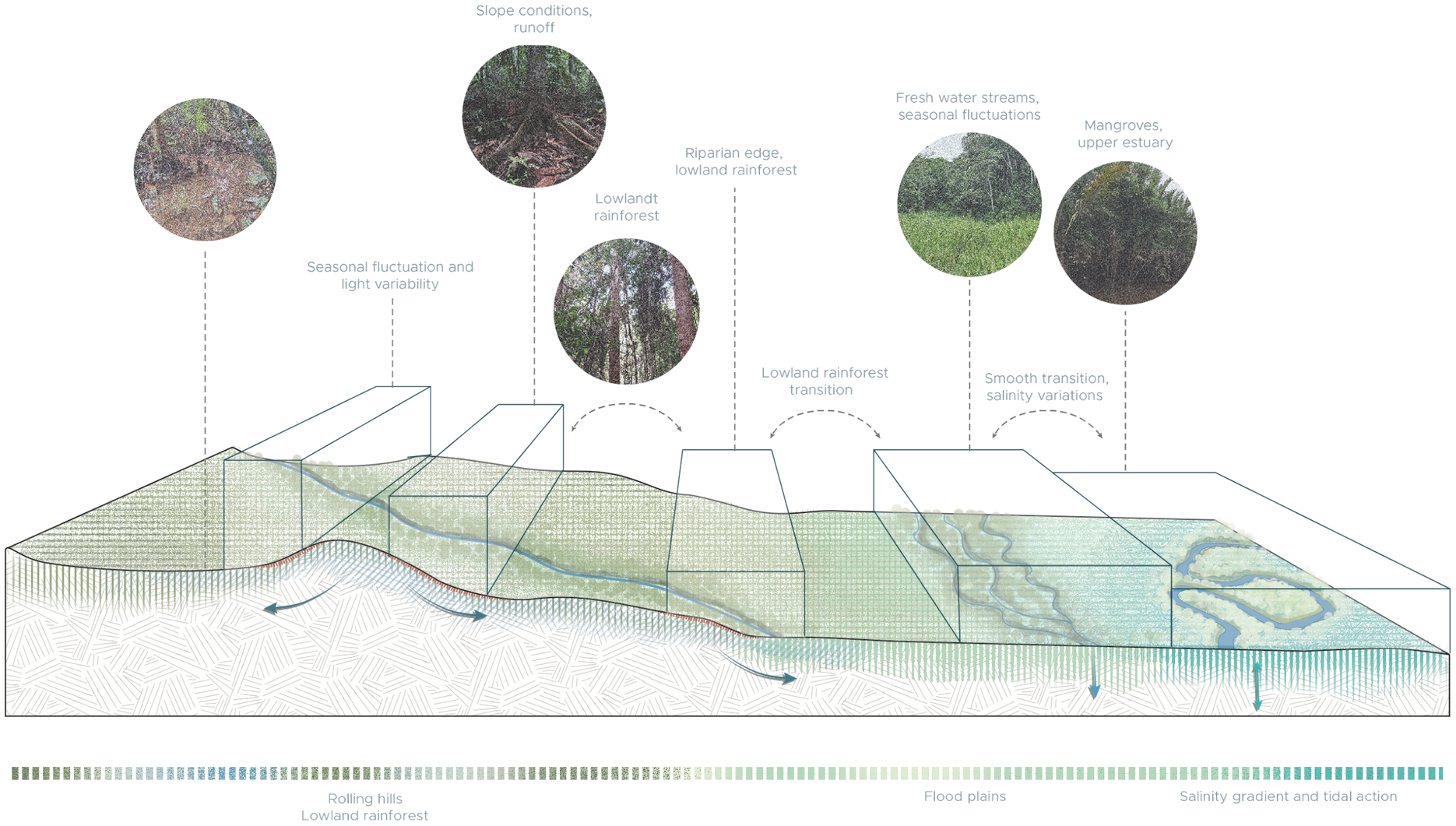


NATURAL SITUATION

During the design process, revisiting the original landscape conditions to identify the locations of natural gradient transitions and ecological patterns supports the principle of designing in harmony with landscape logic.

The mangroves and adjacent streams form a major gradient zone on the right side of the section. This area is characterised by fluctuating water levels, variable salinity, seasonal flooding, and diverse vegetation structures. Its proximity to the existing village suggests both a high risk of flooding and unique opportunities for adapted agricultural practices. At present, palm oil plantations impose hard edges where natural riparian gradients and transitions from wet to lowland conditions would otherwise occur.

The hilly terrain on the left side of the section introduces a variety of small-scale forest gradients and dynamic water conditions. These create rich vegetation transitions and support high levels of biodiversity. Seasonally floodable areas at the base of the hills further enhance ecological diversity. However, these unique gradient qualities are currently perceived as obstacles in the planning of Nusantara, as they complicate conventional urban development approaches. Applying the gradient concept offers the potential to reverse this perception by integrating these natural characteristics as valuable assets within the urban fabric.



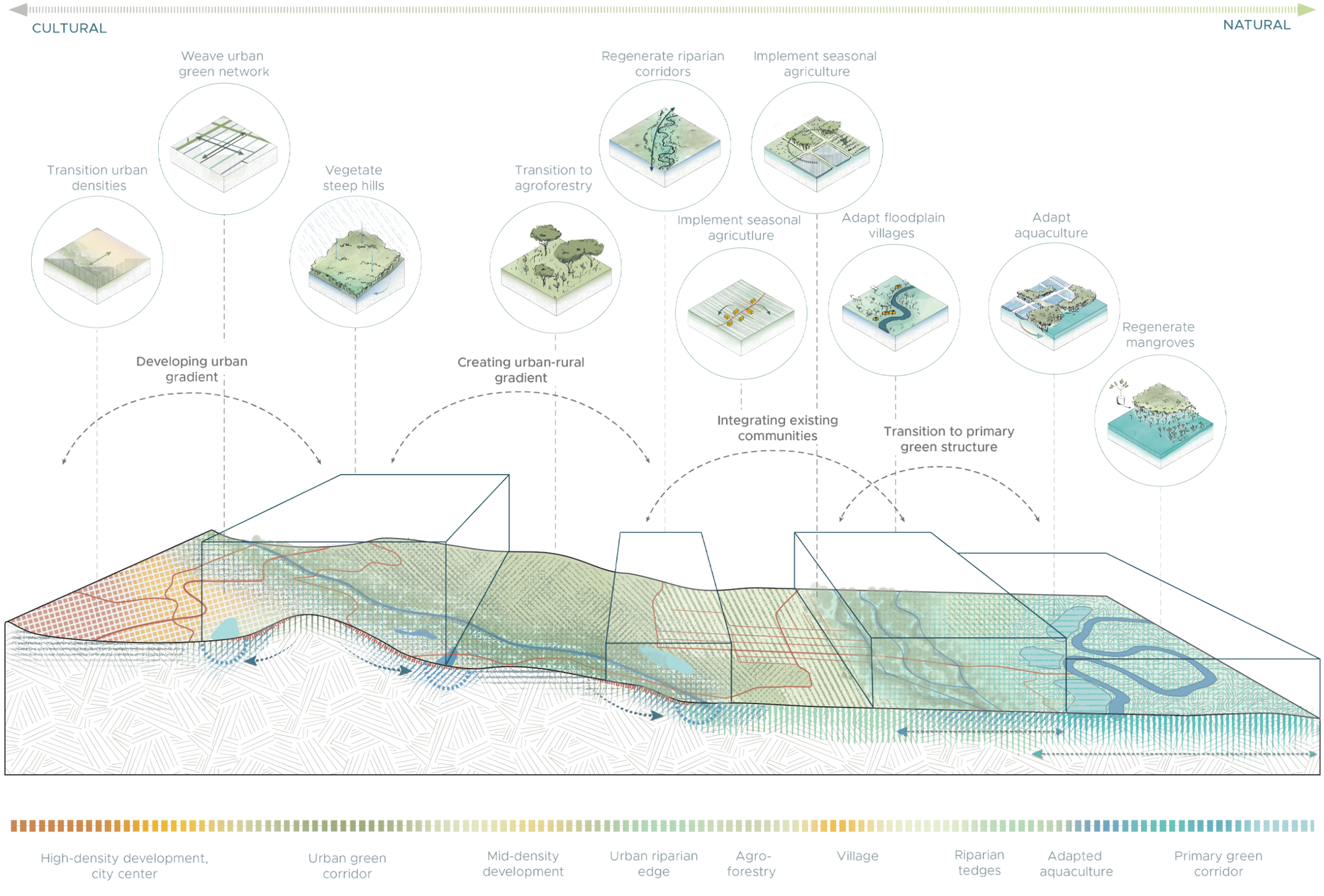
DESIGN PROPOSAL

To utilise the natural potential of the area while simultaneously enabling urban development and integrating existing local communities, the principles of working with landscape gradients can offer a coherent design approach.

The restoration of mangroves and the transition towards integrated aquaculture methods serve to regenerate and protect the large-scale water system while also opening new socio-economic opportunities. By considering naturally occurring wet conditions, additional seasonal agricultural adaptations can be introduced to further diversify land use and support local livelihoods.

Urban green corridors that preserve and enhance natural gradients not only create accessible recreational spaces but also provide multiple benefits for both urban and rural environments. Forested hills, for example, can slow down surface runoff, reducing erosion and the risk of flooding. Temporary and flexible water accumulation areas can meet agricultural water demands during dry periods. Furthermore, cool air flowing from the hills into the urban fabric can help to moderate temperatures and reduce the urban heat island effect.

Agroforestry transitions can facilitate soil regeneration and offer new economic opportunities for village communities. At the same time, these systems allow settlements to maintain familiar social structures while promoting ecological diversity. By preserving site-specific cultural characteristics, these areas also hold the potential to become attractive recreational destinations for urban residents.



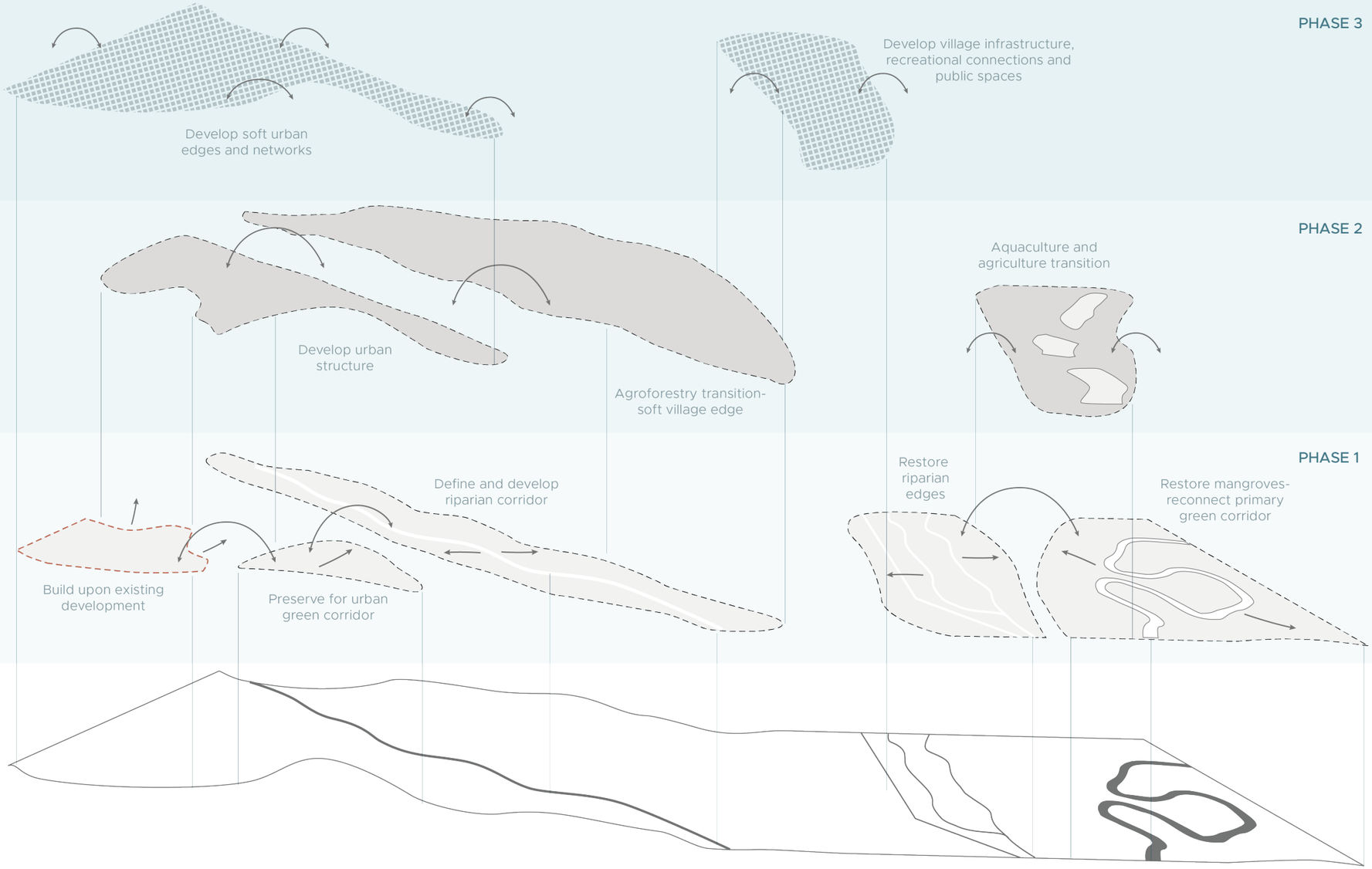
DESIGN PHASING

Referring to the three design phases enables a gradual transformation of the site, with each step contributing to the softening of harsh boundaries and the creation of smooth transitions between landscape typologies.

Phase one focuses on securing sufficient space for green structures and initiating their restoration. The regeneration of mangroves is essential for rebuilding one of the primary ecological systems identified in the regional vision. Protecting and restoring nearby streams supports this system by allowing for seasonal water recharge. In addition, the steep hills near the urban core of Nusantara should remain undeveloped to reduce flooding and erosion, where natural succession processes can be encouraged to restore ground vegetation.

In the second phase, transitions between ecological zones begin to soften through agricultural and urban adaptations. Agroforestry and aquaculture establish gradual shifts between urban areas and green spaces. At the same time, the city itself grows with a gradient of densities that carefully respond to and integrate with the surrounding landscape.

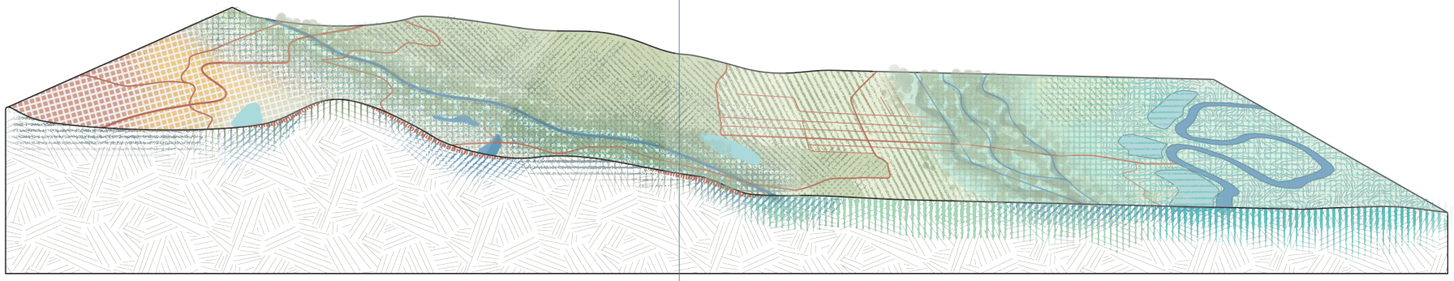
Finally, the village and the city become more closely woven into the developed framework, forming finer-grained ecological and cultural networks that enhance both environmental resilience and community life.



5.2 - GRADIENT I

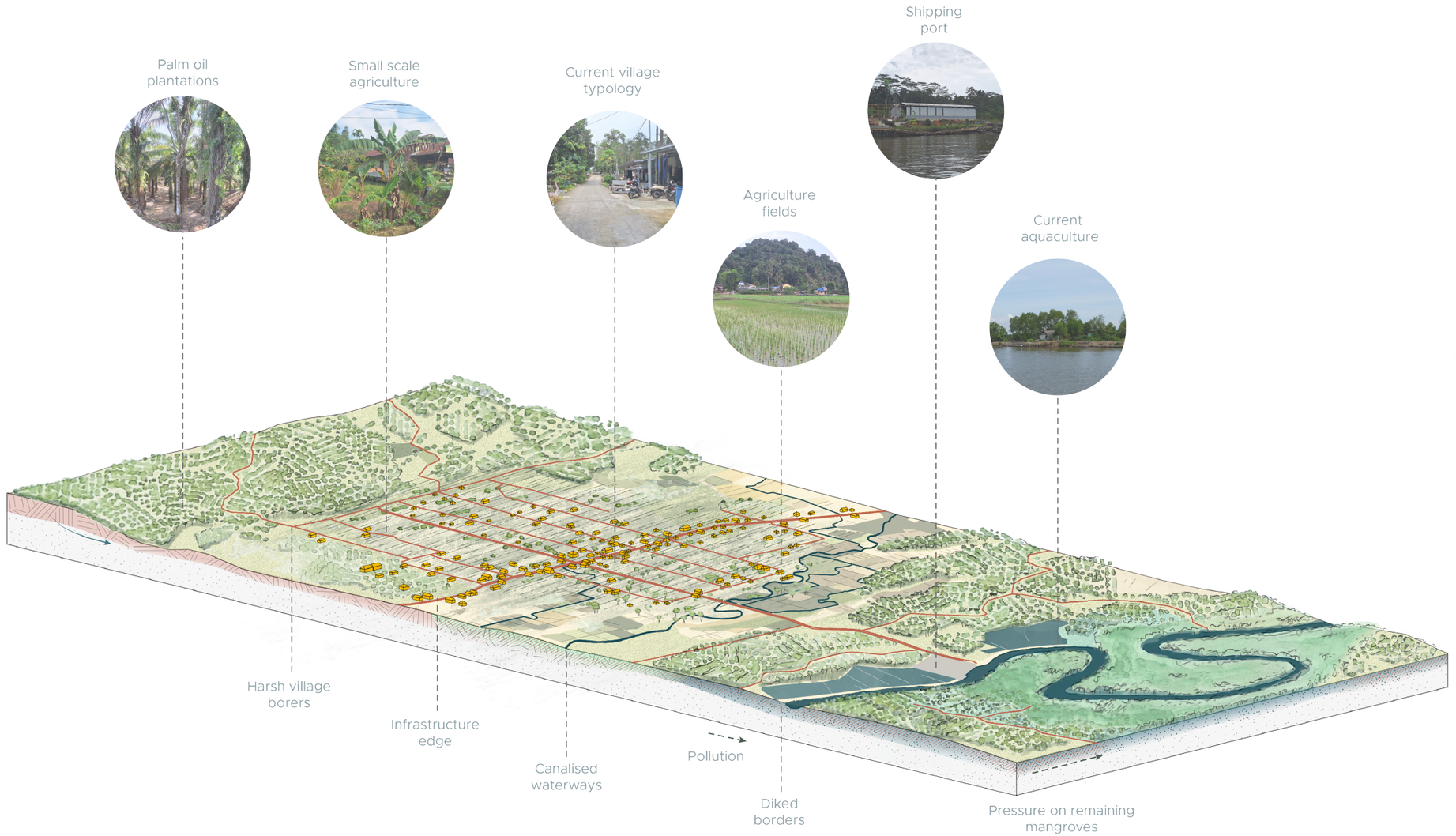
INTEGRATING & DEVELOPING EXISTING COMMUNITIES

To explore the design in greater spatial detail, the following sections focus on developing the gradient in two parts. The first part examines the adaptation and integration of existing local communities into the design of Nusantara.



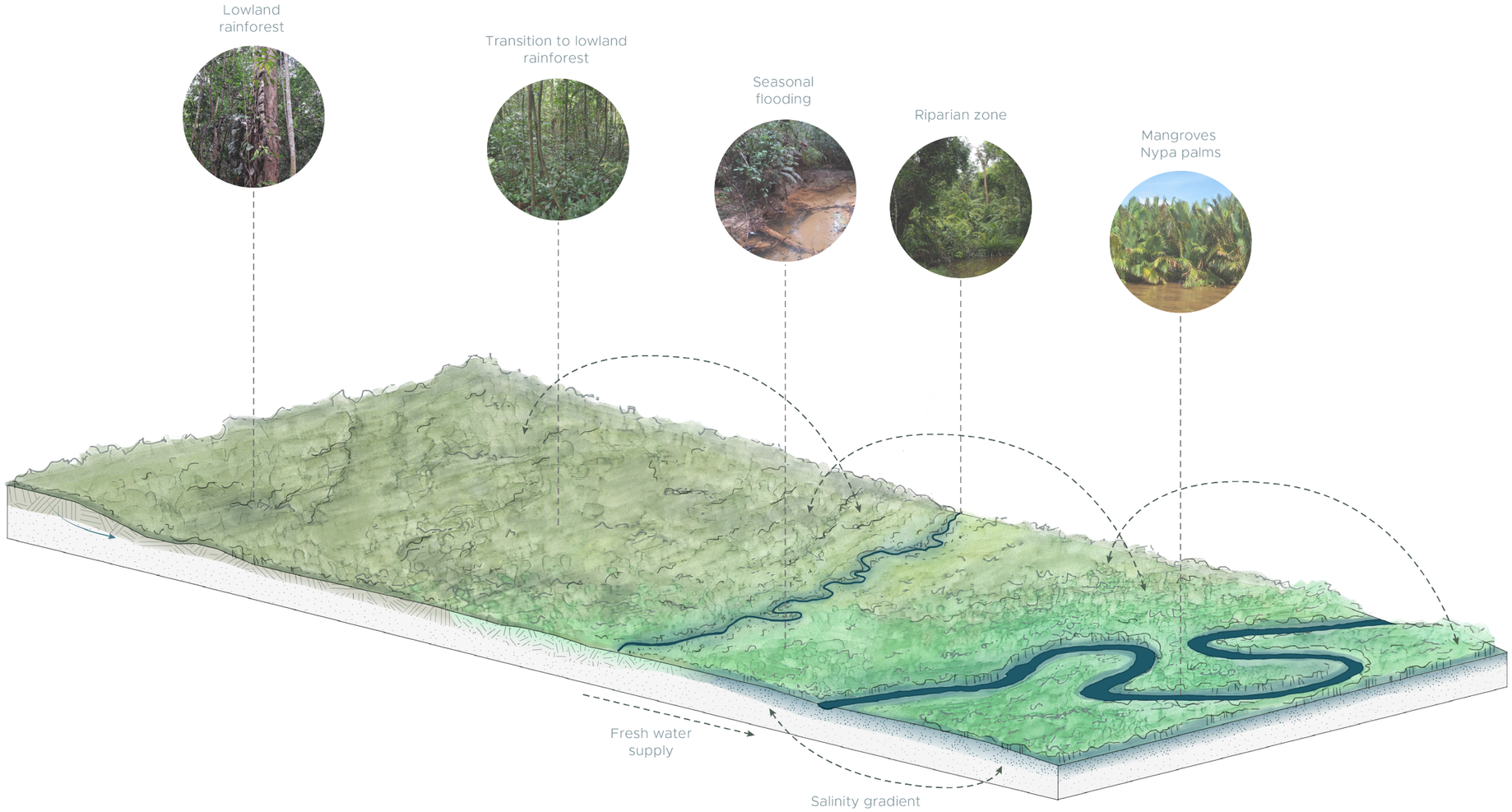
CURRENT SITUATION

The village is situated near the future capital city of Nusantara, on relatively flat terrain crossed by numerous streams. The surrounding landscape has been heavily shaped by agricultural expansion. Mangrove areas have been drastically reduced, replaced by aquaculture and palm oil plantations. Small-scale plantations are scattered within and around the village; these plots, often managed by local families, still offer pockets of biodiversity and ecological value. In contrast, large commercial plantations dominate the wider area, creating vast monocultures with little ecological diversity.
The village itself follows a simple grid layout and is connected to Nusantara by a main road. A small port supports the transport of materials to the new capital. This connection currently serves mainly as a transit route but is beginning to attract new people to the area.



NATURAL SITUATION

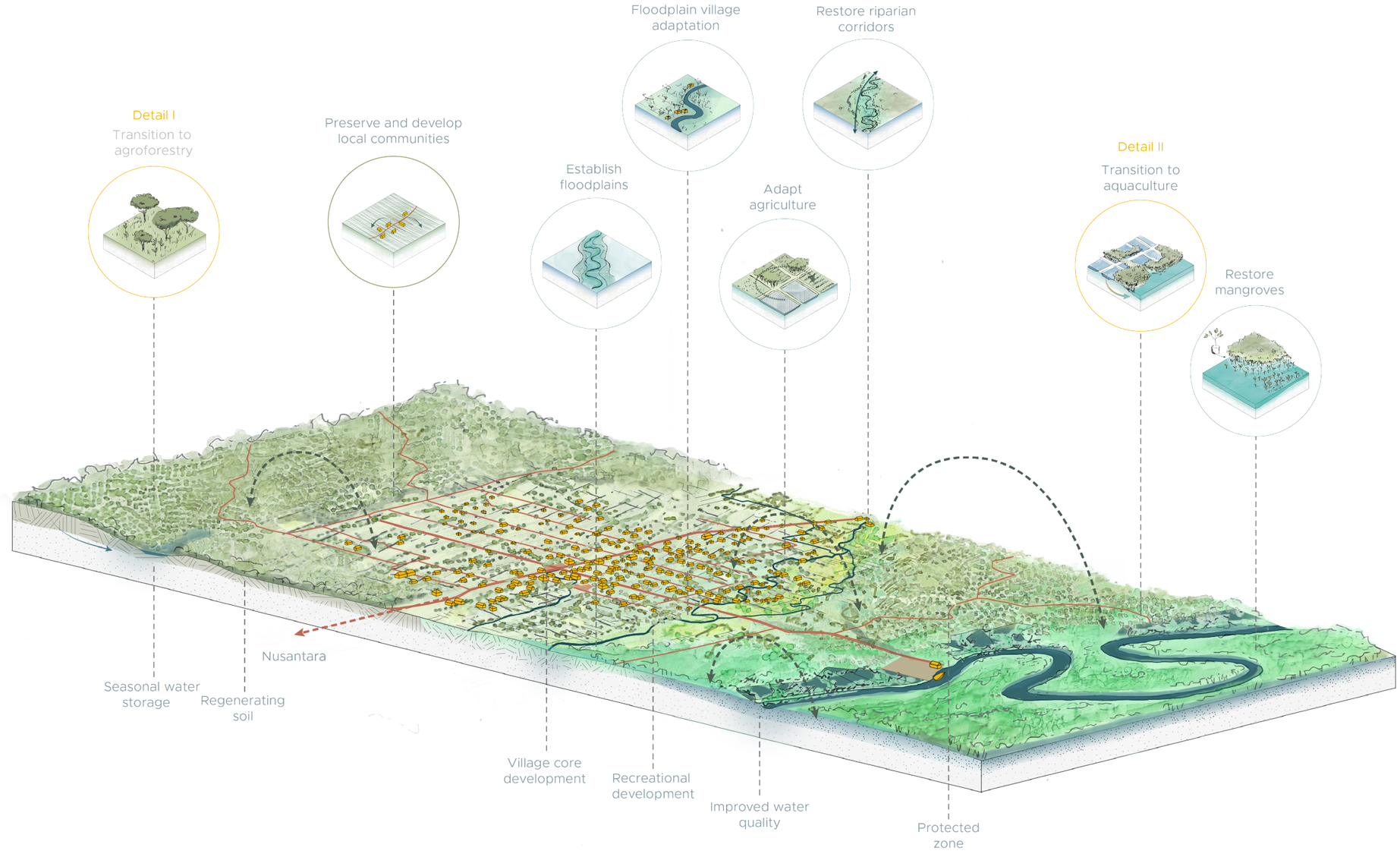
In its natural state, the area featured a dynamic and ecologically rich landscape defined by a series of interconnected gradients. Along the main river, a dense mangrove edge marked the upper estuarine zone of relatively low salinity, providing vital habitat and buffering the inland areas. Further inland, numerous smaller streams flowed towards the river, expanding the wet zone and shaping distinct riparian conditions influenced by seasonal flooding. These transitional areas formed a mosaic of wetland ecologies that gradually gave way to lowland rainforest covering the western portion of the site. The richness of these natural conditions offers valuable design guidance, revealing flood-prone zones, areas of high biodiversity, and natural transition spaces. Notably, the current village sits at the intersection of several ecological gradients.



DESIGN

The design prioritises ecological restoration and sustainable rural development, while fostering a healthy relationship between the emerging urban centre and the village by preserving existing ecological qualities and introducing new livelihood opportunities. A key strategy involves the restoration of the mangrove belt to enhance ecological connectivity along existing stream corridors. This is complemented by integrated mangrove-based aquaculture systems that link the restored mangroves with adjacent riparian gradients, reinforcing both biodiversity and local livelihoods. Restoration efforts also extend to the riparian zones along waterways, leveraging naturally wet conditions to support water storage, wetland agriculture, and the development of river-oriented settlements. The village core is strategically located at infrastructural intersections to foster communal interaction and support small-scale enterprises. The design further promotes small-scale farming initiatives and incorporates agroforestry systems at the periphery of the settlement, creating productive buffer zones that mediate the transition between dense built and rural environments.

The following sections explore two key conditions in detail: mangrove-based aquaculture and agroforestry systems on dryland.

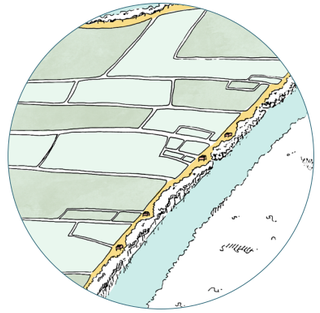


CURRENT CONDITIONS

Detail I

The current aquaculture practices on site are characterized by a static, pond-based system that has expanded over time to maximize profit and streamline production. Originally small ponds measuring 20 to 30 meters in length have been scaled up to over 100 meters. This expansion has led to ecological degradation of both the pond system and the adjacent mangroves. The accumulation of organic waste and the resulting decline in overall water quality have reduced long-term productivity. In contrast, the surrounding mangrove ecosystems remain highly dynamic and biodiverse, providing valuable habitats. Integrating elements of this natural dynamics into the aquaculture system presents an opportunity to improve ecological function, resilience, and productivity, while also softening the sharp boundary between these landscape elements.

Current pond structure

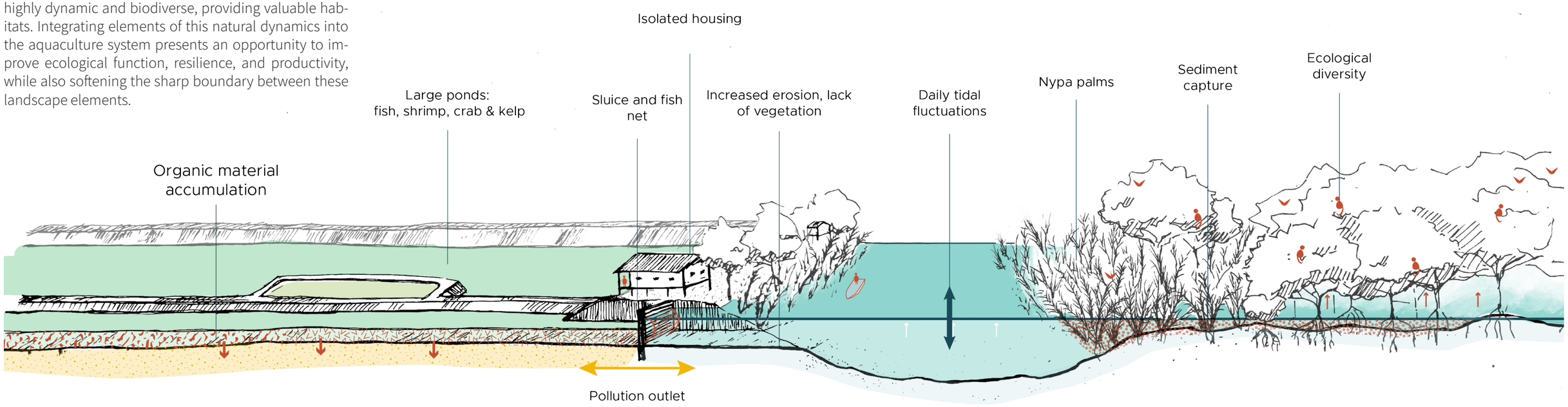


Narrow dikes



Large open ponds, limiteded vegetation

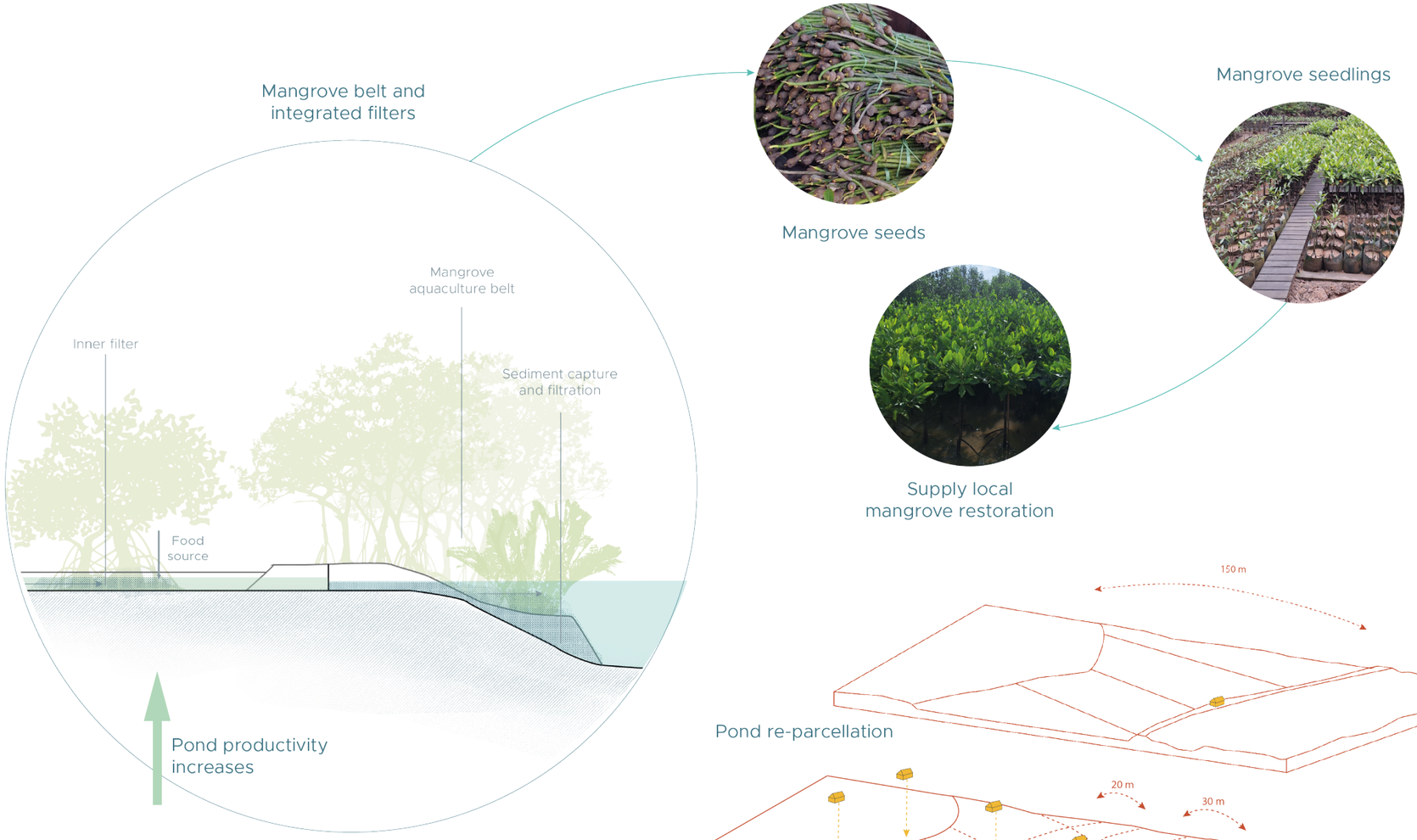




CONCEPT

To improve the current aquaculture system, a set of principles has been developed based on the study of Integrated Mangrove Aquaculture practices and indigenous cultivation methods. A key principle involves incorporating mangroves into the pond structure to enhance natural filtration and water quality. While various spatial configurations are possible, one effective approach combines a mangrove belt along the outer edge of the ponds with additional trees planted inside the system near the water outlet. This not only supports ecological functions but also creates connective habitats by providing corridors for species movement. As observed on site, even narrow strips of mangroves attract numerous birds and even Proboscis monkeys, a key endemic species.
Furthermore, the mangroves themselves can be harvested and cultivated for additional benefits. Species like the Nypa palm, which is well suited to the site's low-salinity conditions, can be harvested for ethanol production as well as for roofing and weaving materials. In addition, mangrove seeds and seedlings are a valuable product, especially in light of the planned large-scale restoration of mangroves along the coast and near Nusantara.

Along with the integration of mangroves, another important adaptation is the reduction of pond size to decrease pollution and diversify crop output, thereby improving the system's resilience. In many traditional systems, smaller farm sizes allowed for greater flexibility in integrating the water system with seasonal conditions. For example, incorporating shallow rain-fed rice fields into the pond structure can diversify crop production during the wet season. Moreover, smaller farm sizes provide opportunities to strengthen the local community, which is currently underdeveloped. In this context, learning from indigenous practices about sustainable cultivation practices offers valuable insight for maintaining and enhancing the system.

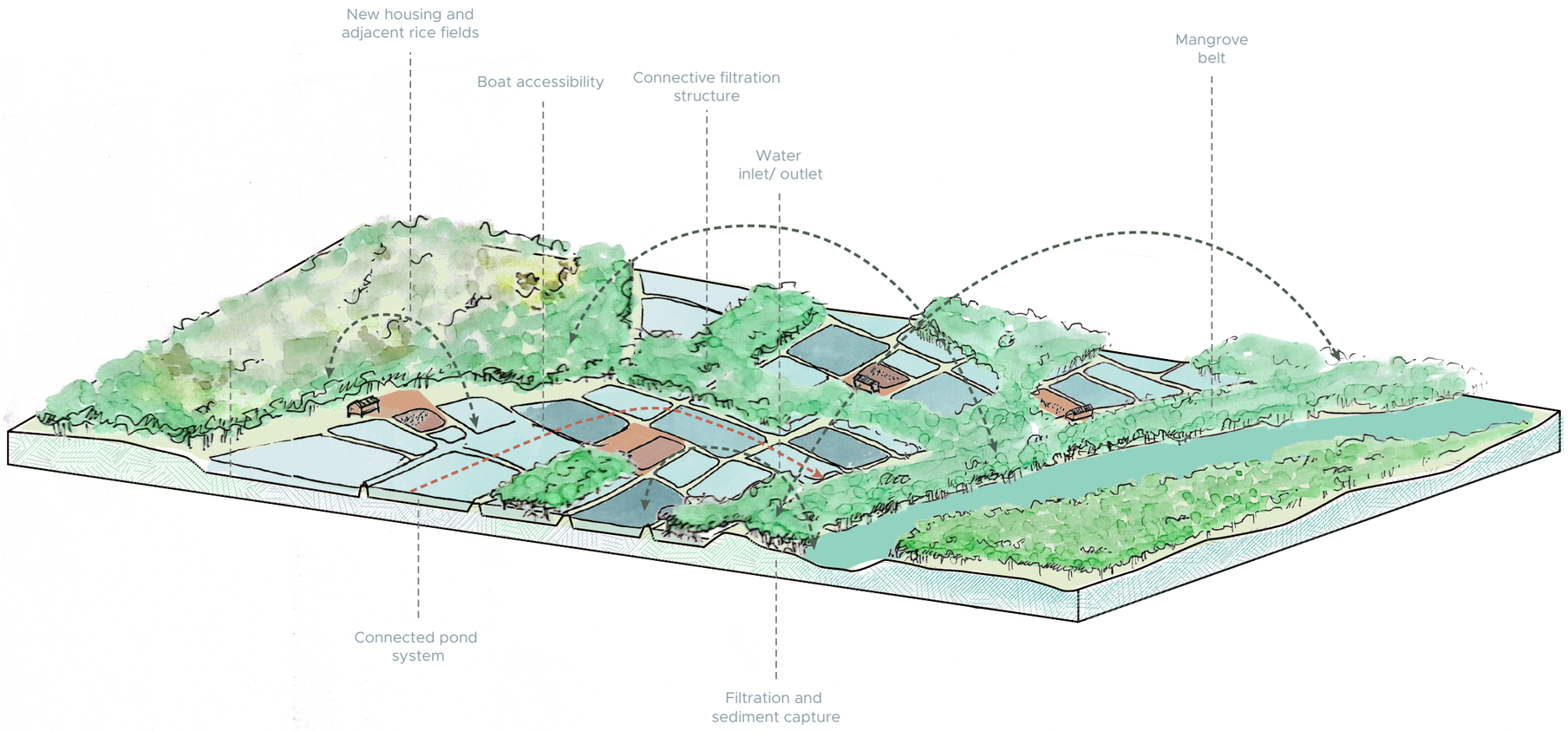


DESIGN

Applying these principles to an existing aquaculture site has resulted in a restructured system that balances ecological function with productive use. The redesigned ponds are reduced in size to units of approximately 20 to 30 meters, with mangrove patches introduced along the edges and as buffers near the water outlets. To enhance species movement and ecological connectivity, continuous mangrove corridors link the aquaculture area to the adjacent riparian zone. The spatial arrangement enables each farmer to manage three to four ponds alongside a plot for rice or vegetable cultivation, with boat access ensuring ease of use. This approach fosters gradual transitions between the mangrove habitat and surrounding ecosystems, creating a mosaic of productive and ecologically resilient spaces. The spatial structure also supports movement for both people and wildlife throughout the system.

Beyond ecological improvements, the design also fosters stronger social ties and a more intimate relationship between farmers and their environment. Vegetable and rice plots are strategically arranged to benefit from the shade and cooling effects of adjacent mangrove plantings, enriching the spatial experience and supporting microclimatic comfort. Located close to the homes, these plots create a garden-like setting that combines cultivation with opportunities for social interaction and relaxation.

This design exploration is especially relevant for broader application across other parts of Nusantara's development, such as the coastal zones, where salinity shifts with proximity to the sea. In these areas, species composition and ecological strategies will naturally vary, presenting further opportunities for site-specific adaptations that integrate productive use with ecological resilience.



Space

Nypa, Rhizophora, Avicenia etc.



Seeds, building material

Shrimp, fish and kelp



Rice

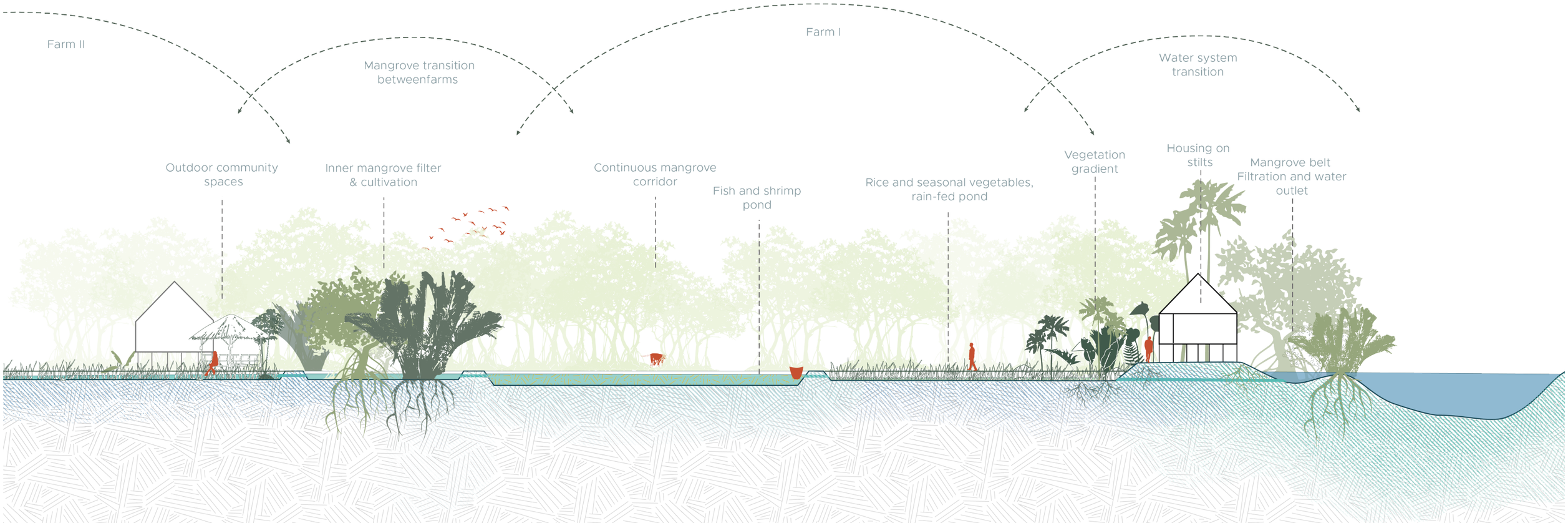


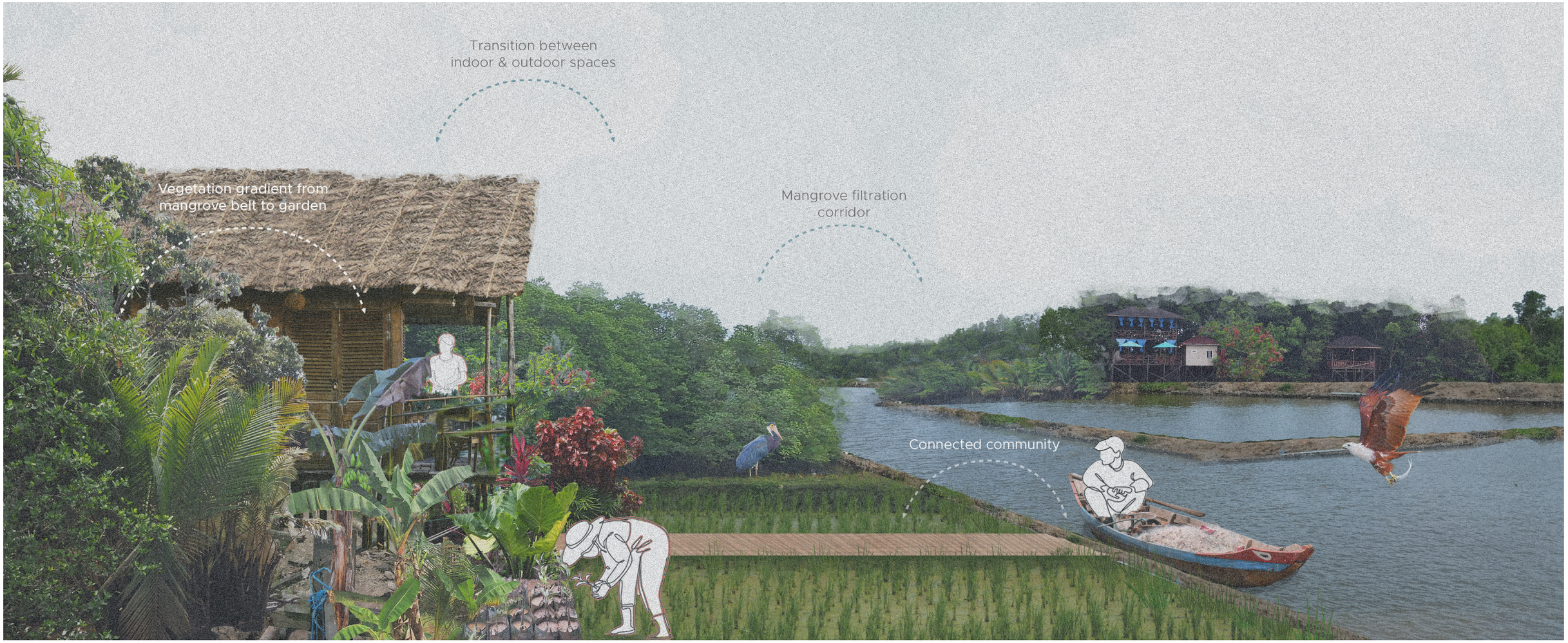
Fruits and vegetables



Nypa & Rhizophora

Production and vegetation




Transition between
indoor & outdoor spaces
Vegetation gradient from
mangrove belt to garden
Mangrove filtration
corridor
Connected community

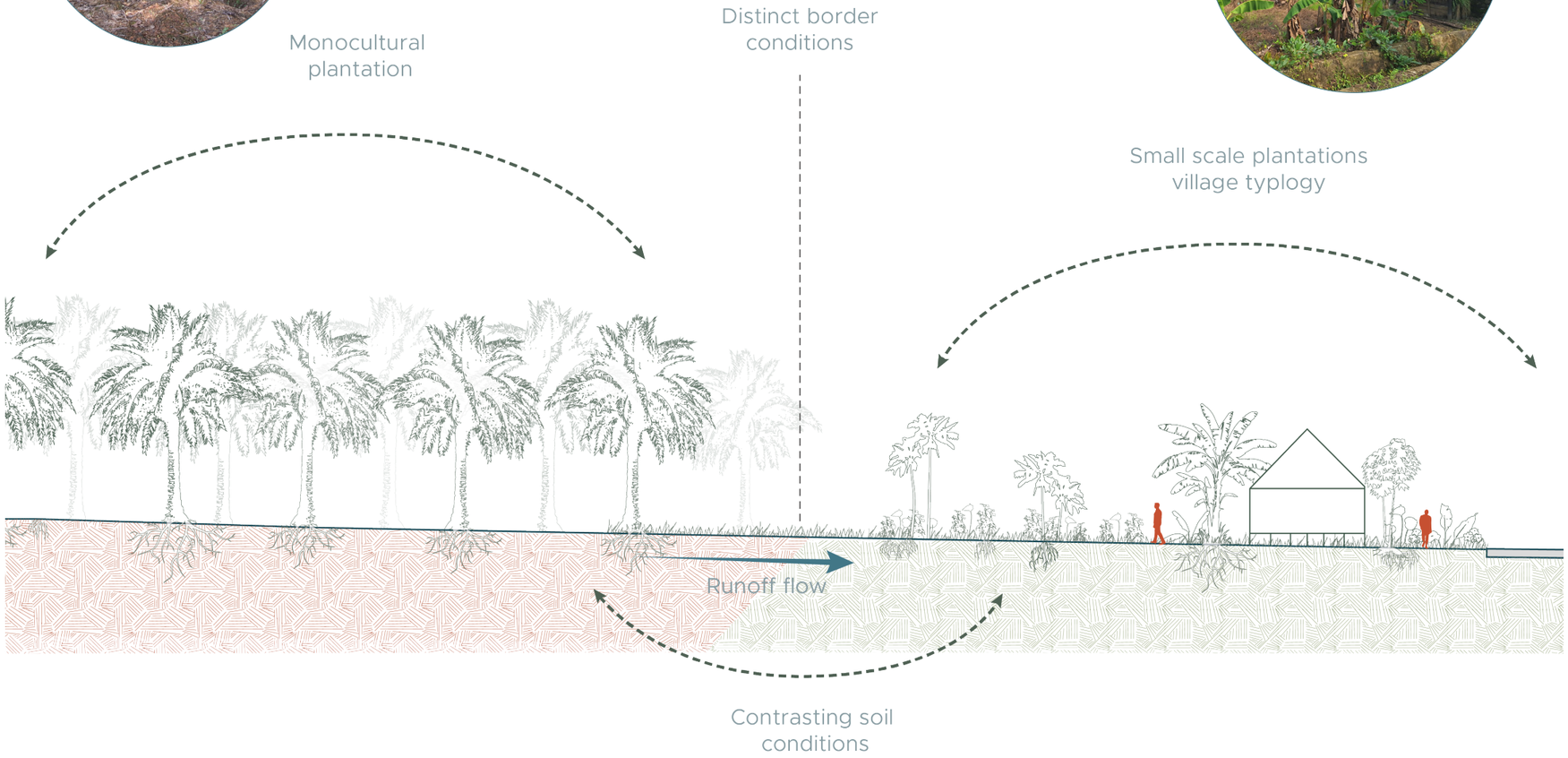
CURRENT CONDITIONS

Detail II

Currently, the village is surrounded by monocultural palm oil plantations. These plantations, operated by large concessions, create abrupt and harsh boundaries in the landscape as a result of land ownership patterns. The village edge is therefore sharply defined, often marked by transportation routes. One of the main issues associated with palm oil monocultures is the lack of ground cover, which leads to soil erosion. Given the village's location in a lowland area, this exacerbates the risk of flooding. At the same time, oil palms require a substantial and consistent water supply, which poses additional challenges in the face of increasing drought conditions. Therefore, transitioning to agroforestry is not only valuable for restoring landscape gradients but is also becoming an ecological necessity.





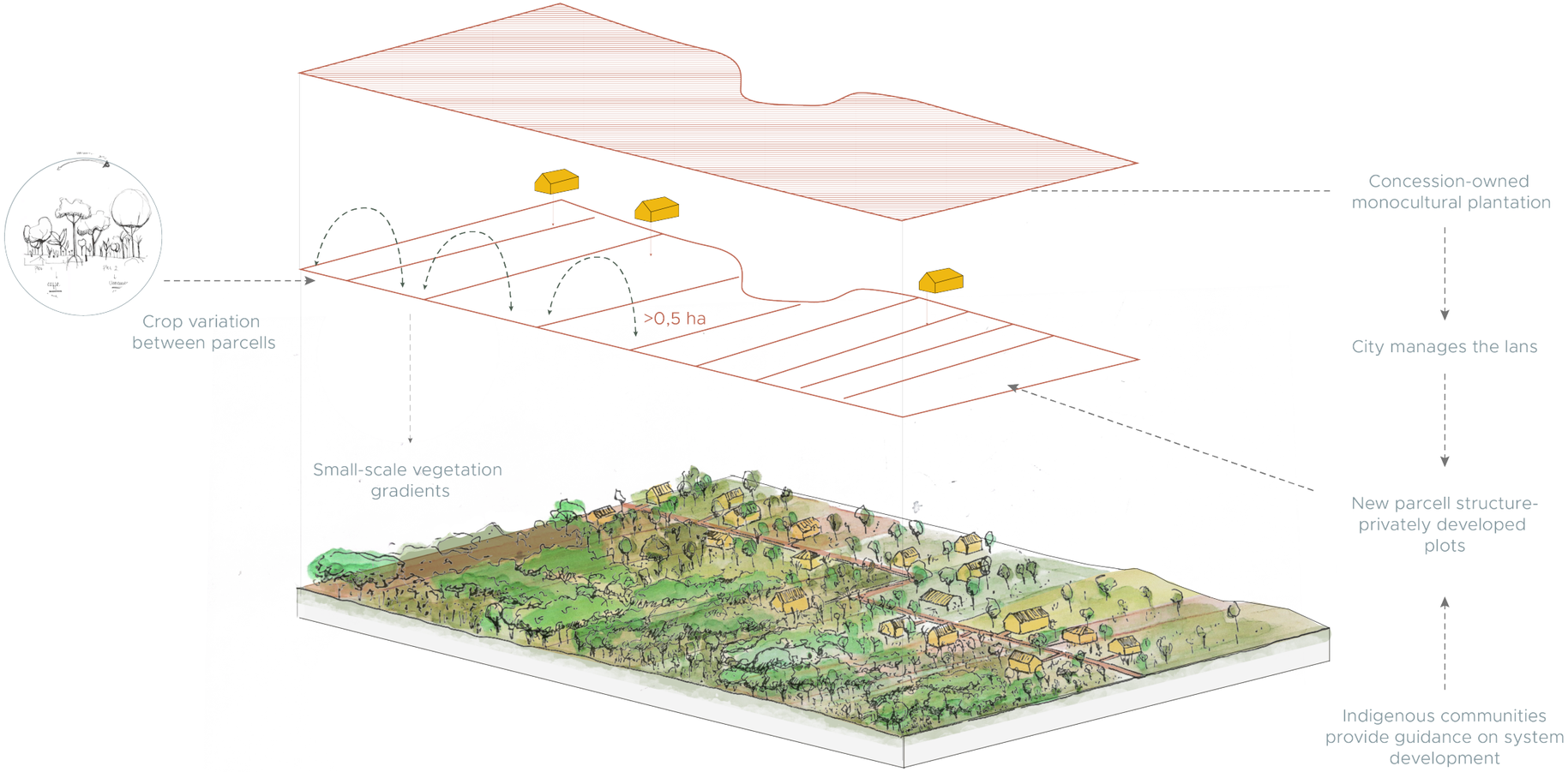


AGROFORESTRY PRINCIPLES

The proposed agroforestry adaptation draws on precedent studies and site-specific observations, with the aim of enabling a smooth transition from oil palm monoculture to more diverse systems without causing financial disruption for local farmers. A key strategy involves re-parcelling the land, shifting from large, uniform plantation blocks to a mosaic of privately cultivated farms. This restructuring is made feasible by the development of the new city, which oversees the urban expansion zone and can allocate land for alternative uses.

The new parcels can integrate into the existing village pattern and should ideally be at least half a hectare in size. This subdivision not only breaks up the rigid plantation structure but also creates opportunities for new forms of rural development, allowing for a gradual transition between the village and the emerging agroforestry systems.

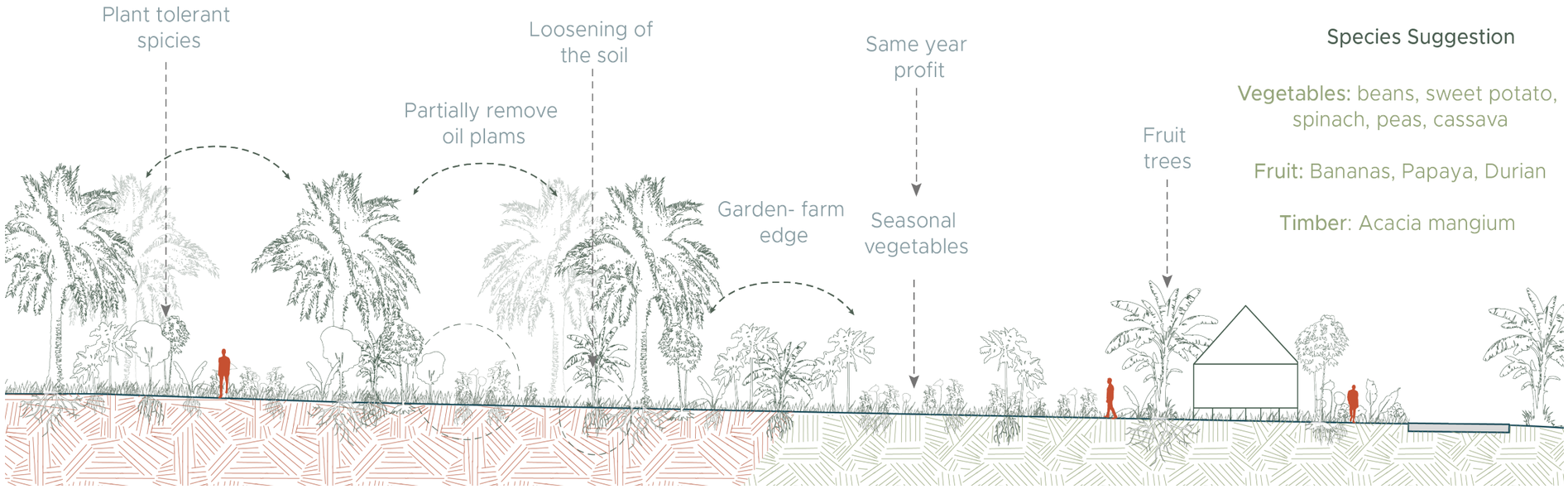
To enhance cultivation practices, the involvement of indigenous communities is encouraged, as they possess valuable expertise in lowland forest cultivation. This exchange of knowledge can foster a mutually beneficial relationship between the ongoing urban development and the local population. By promoting the cultivation of diverse crops across farms, the system can become more resilient to climate stressors while generating small-scale vegetation gradients that offer additional ecological benefits.



PHASING

To achieve a smooth transformation it is essential to develop the system in stages. Initially, only a portion of the palm trees is removed, allowing new trees to be planted alongside seasonal vegetables that can be harvested within the first year, providing short-term income. As the agroforestry trees mature, additional crops are introduced to strengthen economic resilience. Over time, soil conditions are improved, allowing for the cultivation of less tolerant, higher-value species. In the final stage, the oil palms may be fully replaced by a diverse plant community. This landscape supports a wide variety of plausible crops, offering flexibility and adaptability in response to market demands and environmental conditions.

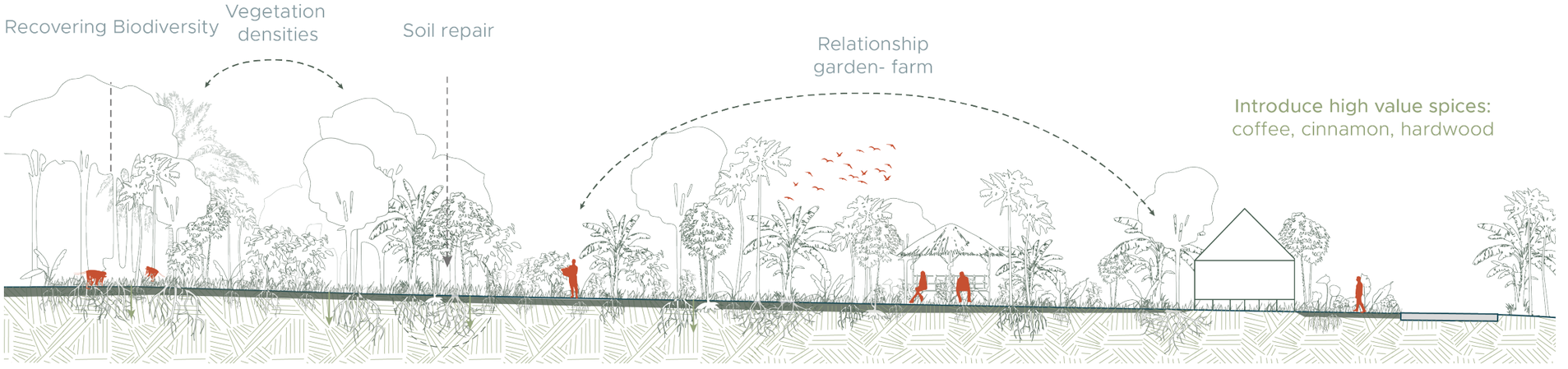
STAGE I



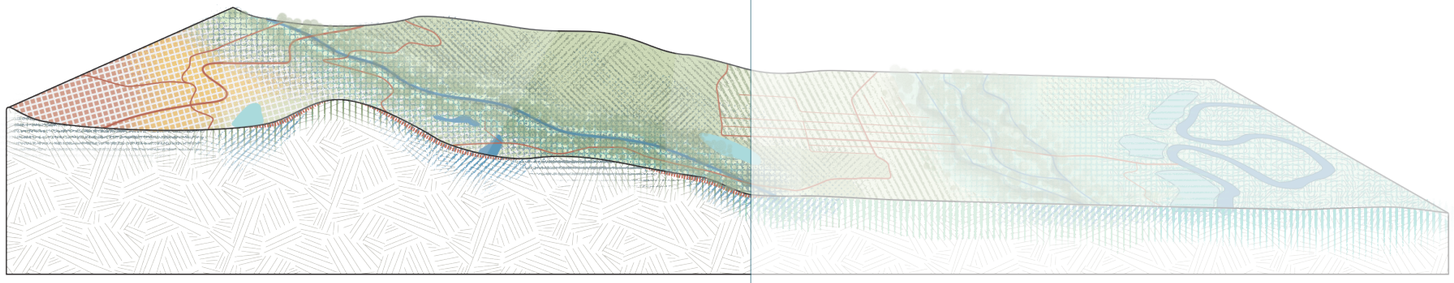
STAGE II



STAGE III




Vegetation densifies in the agroforest
Transition from home to garden
Forming a relationship with the system
From garden to plantation



5.3 - GRADIENT II

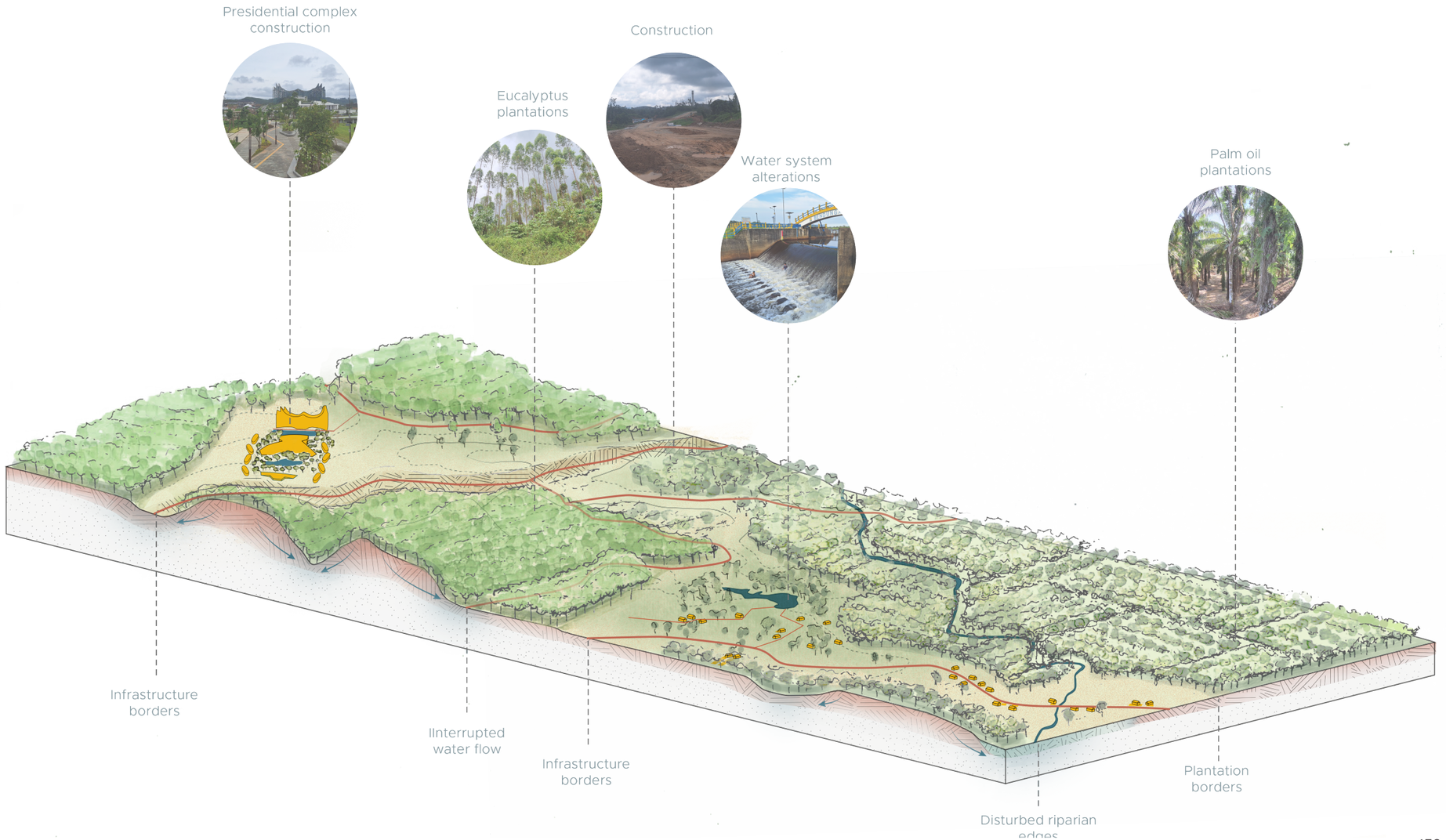
DEVELPING THE URBAN FABRIC AND GREEN NETWORKS

The second gradient design explores strategies for new urban development, with a focus on integrating green structures. By employing varied street typologies and building densities, the design generates gradual transitions between urban and ecological spaces. A key example illustrates how high-density areas can smoothly transition towards a green corridor, demonstrating the potential of this approach to create functional and interconnected urban landscapes.

CURRENT SITUATION

The current situation reflects the ongoing development of the new city amidst eucalyptus and palm oil plantations. The western area is primarily covered by extensive eucalyptus plantations, which stretch beyond the design site towards Mount Beratus. Most notably, the new presidential palace and the surrounding administrative complex have recently been established. Supporting infrastructure is under development, with major road construction creating barriers across the landscape.

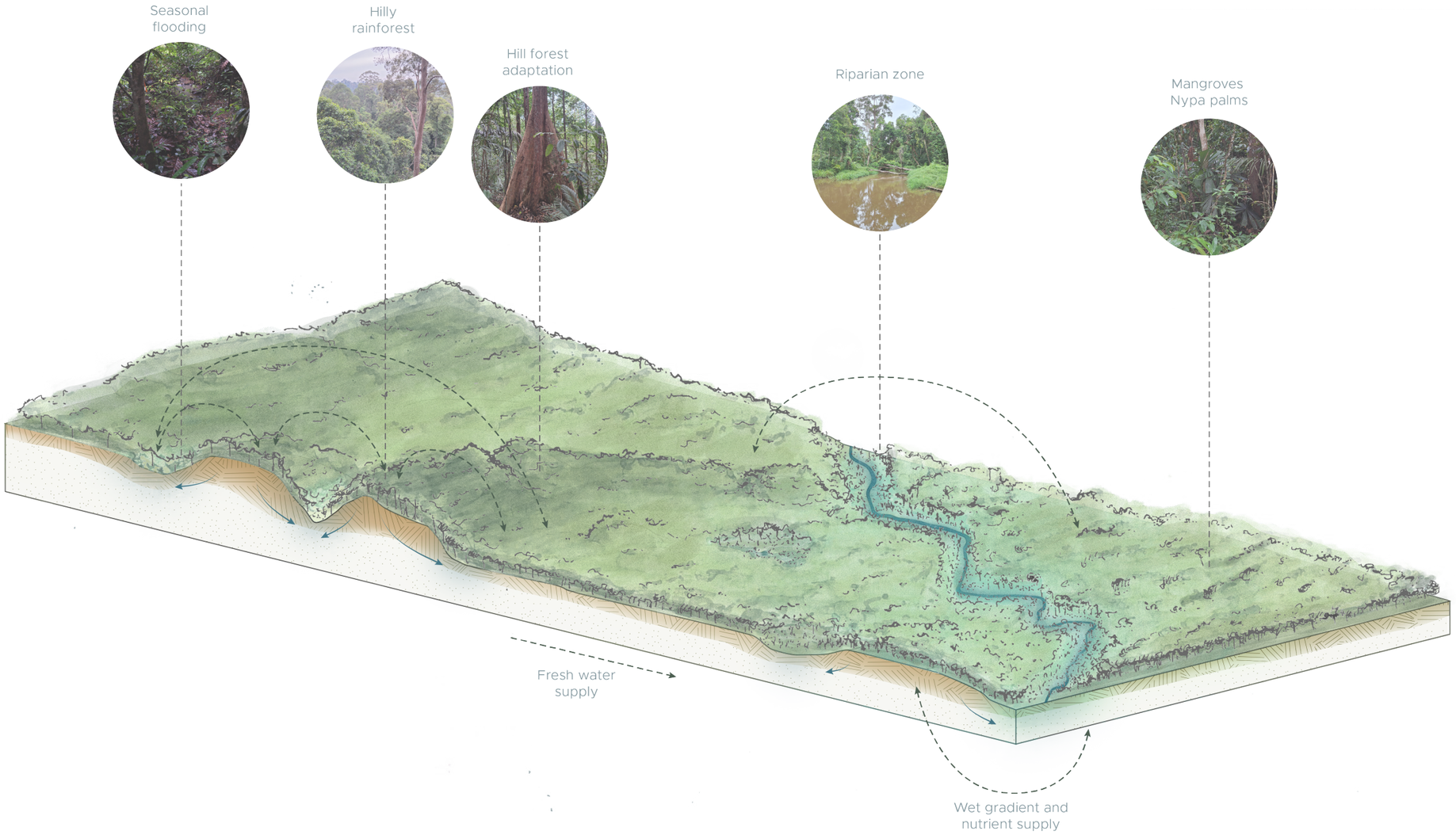
The terrain is hilly and prone to seasonal flooding and erosion. During the site visit, the developers of Nusantara highlighted the challenges of building on steep slopes and emphasized the importance of stabilizing the soil. In addition, modifications to the water system have already been implemented in the form of small dams and artificial lakes.



NATURAL SITUATION

Under natural conditions, the site was covered in lowland rainforest, shaped by small-scale gradients along riparian edges and hills. The hills experience gradual erosion and nutrient leaching, even with ground vegetation present. Combined with variations in light availability, these factors create vegetation gradients that are well adapted to these specific conditions.

The riparian edge forms another important gradient zone on the site. Unlike the streams in the first zoom-in, which interact with mangroves and create broad wetness gradients influenced by tidal fluctuations, this stream supports a relatively narrow riparian zone within the lowland rainforest. It acts as a light corridor and a vital water source for many ground-dwelling species. Additionally, it collects water from the surrounding hills and channels it downstream.

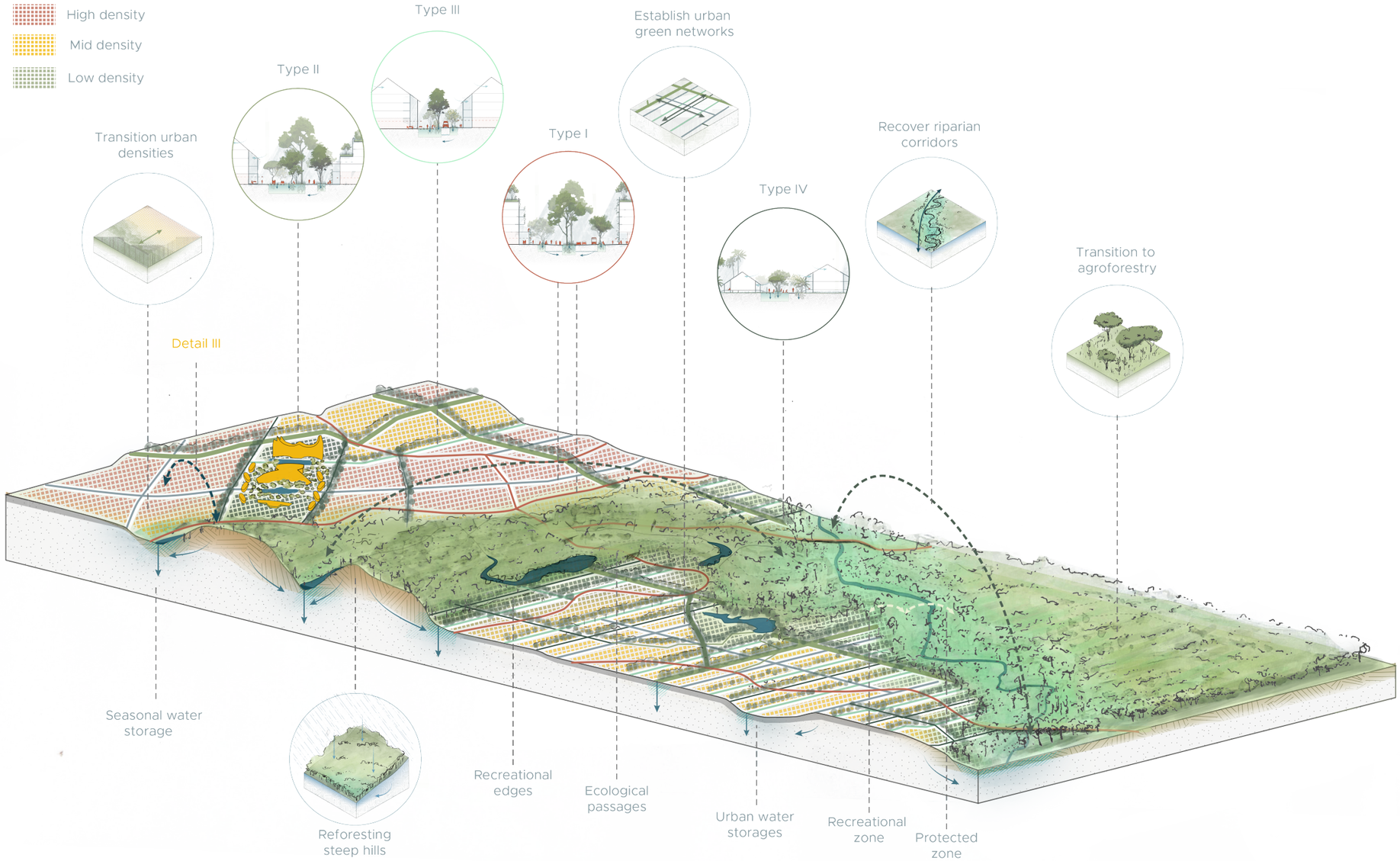


DESIGN PROPOSAL

Drawing inspiration from the site's natural landscape conditions, the design uses gradients as the foundation for urban green structures. The hills form a continuous ecological spine that eventually connects to the riparian edge. This structure helps to mitigate and direct floodwaters while reducing erosion in vulnerable areas. Additionally, it channels fresh, cool air into the city, a crucial factor for thermal comfort in Indonesia's hot and humid climate. At the same time, it creates recreational opportunities across various urban typologies, building a network that connects even densely populated areas to the experience of the surrounding landscape.

Guided by this green framework and the existing infrastructure, the urban matrix is carefully developed. To form soft urban edges, housing density and building typologies gradually decrease in proximity to the green corridors. This soft transition encourages the movement of species and people while improving air circulation throughout the urban fabric.

To further integrate greenery into the city at varying densities, a set of distinct street typologies has been developed. Some prioritize traffic flow, while others are car-free and focus on supporting the green network by establishing continuous canopy cover and ground vegetation. These street typologies adapt to changes in density and are designed to create logical, seamless connections across neighborhoods.

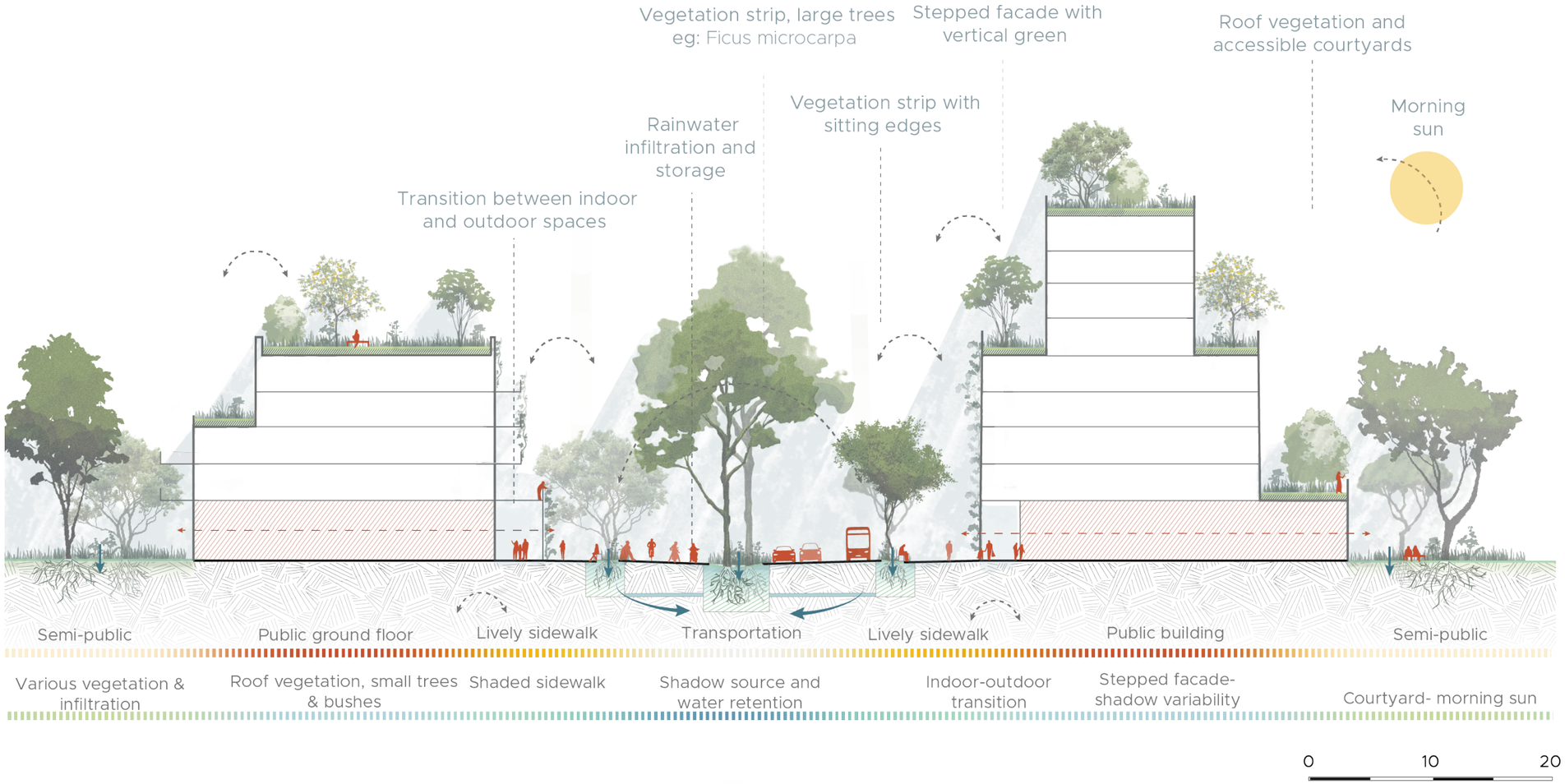


STREET TYPOLOGIES

The streets themselves offer an interesting opportunity to integrate the gradient concept at the small scale by facilitating transitions between outdoor and indoor spaces, vegetation types, and traffic flows. Shade and walkability play a crucial role in shaping the street profiles. During the site visit, these elements were often lacking, resulting in a strong reliance on air-conditioned spaces and reduced outdoor activity, especially during the day. Therefore, shading and vegetation become key factors in defining the street layout.

Type I - Key Infrastructures

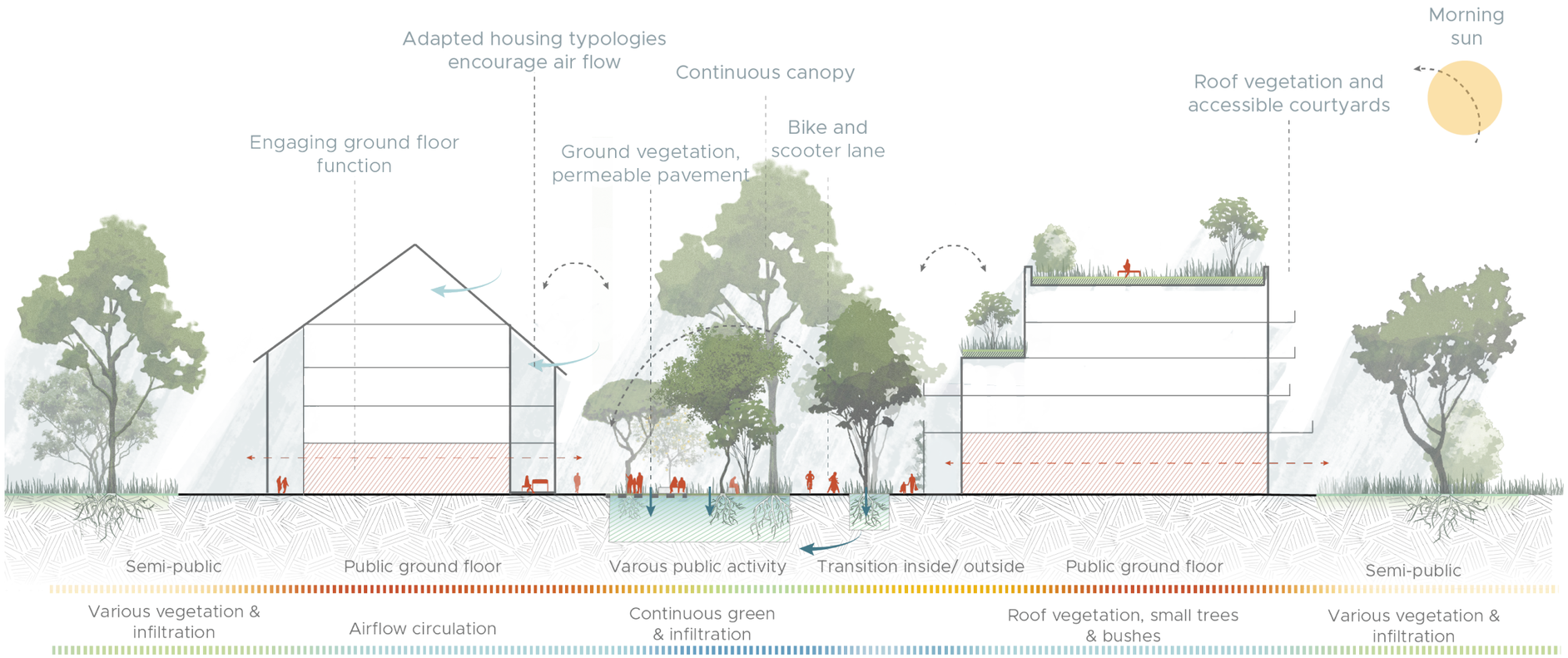
The first street type addresses major traffic routes. These infrastructural connections link different neighborhoods and allow for higher-density development through improved accessibility. Gradients are expressed not only through green structures but also through building adaptations such as colonnades, semi-roofed walkways, staggered facades, vertical greenery, and rooftop planting. The ground floor is designed for mixed-use, encouraging street-level activity. Wide walkways with planted edges of low vegetation create a pleasant microclimate and shading, while larger trees are positioned in the center of the street for sufficient sunlight access. In addition, green, accessible courtyards are integrated into housing blocks to provide semi-private outdoor spaces. Since scooters are a primary mode of transport for many Indonesians, this street type includes clearly defined scooter lanes to improve safety and ease navigation.



Type II - Key Green Connectors

This street typology prioritizes strong pathways and accessible green spaces, linking seamlessly to the larger urban corridors and ensuring comfortable access to the landscape from any part of the city. These streets reclaim space for greenery and public life within the urban fabric. Layered vegetation creates diverse spatial qualities, supporting a variety of activities such as events, markets, street food stalls, playgrounds, and areas for relaxation.

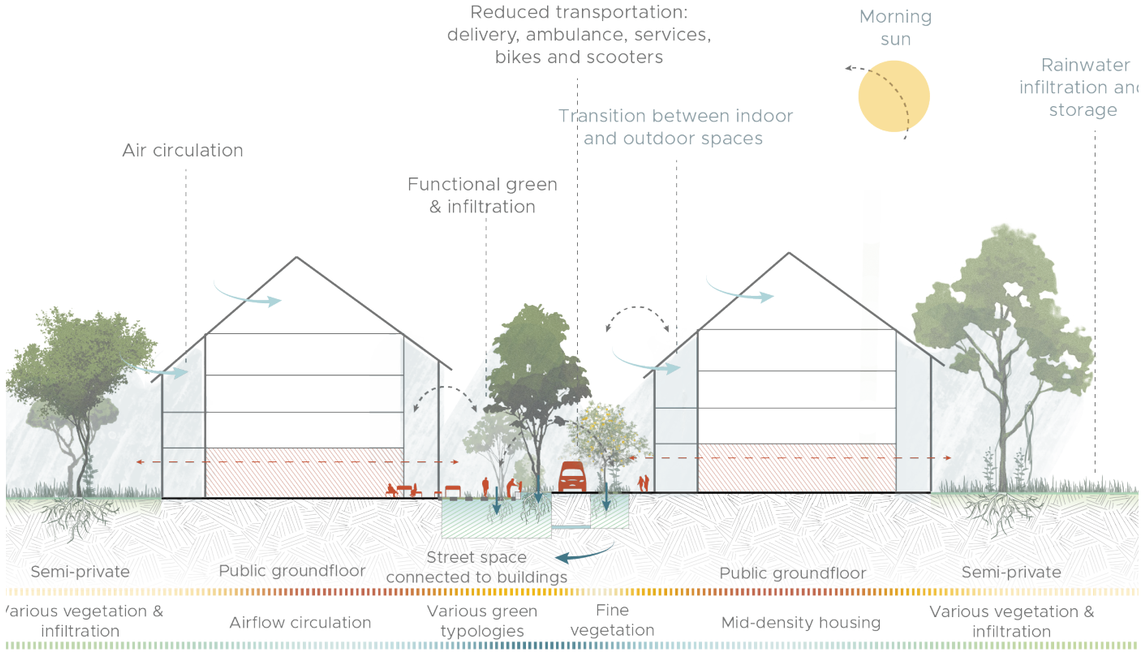
The generous outdoor areas encourage active ground-floor use, fostering a connection between buildings and the street. Integrated water management systems allow for rainwater infiltration, storage, and distribution along these streets, contributing to local cooling, irrigation, and flood mitigation. At the same time, the vegetated canopy and ground cover provide habitat and movement corridors for birds and small animals, enhancing urban biodiversity, while maintaining a compact enough profile to guide larger species along the designated ecological corridors.



Type III - Reduced traffic

The inclusion of streets designed with reduced traffic in mind offers Nusantara the opportunity to avoid many of the common issues seen in large metropolitan areas, such as congestion and a lack of space for pedestrians and greenery. These street types are strategically positioned parallel to main traffic routes, maintaining broader accessibility while prioritizing livability. By allowing only essential traffic, such as service and emergency vehicles, these streets ensure that buildings remain connected to necessary infrastructure, while green structures and public space take center stage.

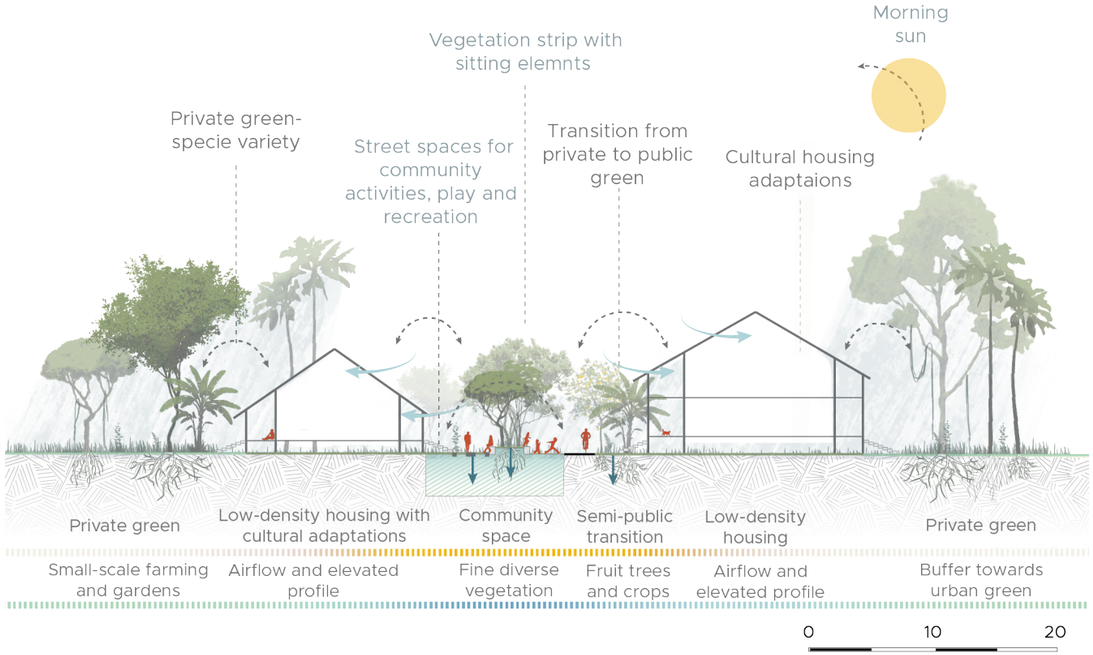
This approach is particularly suitable for areas with medium-density development, where narrower streets create a more intimate and inviting atmosphere. These cozy streets encourage local activity, support the growth of small businesses, and foster vibrant neighborhood life, while enhancing ecological value through integrated planting and green space.



Type IV- Low Density

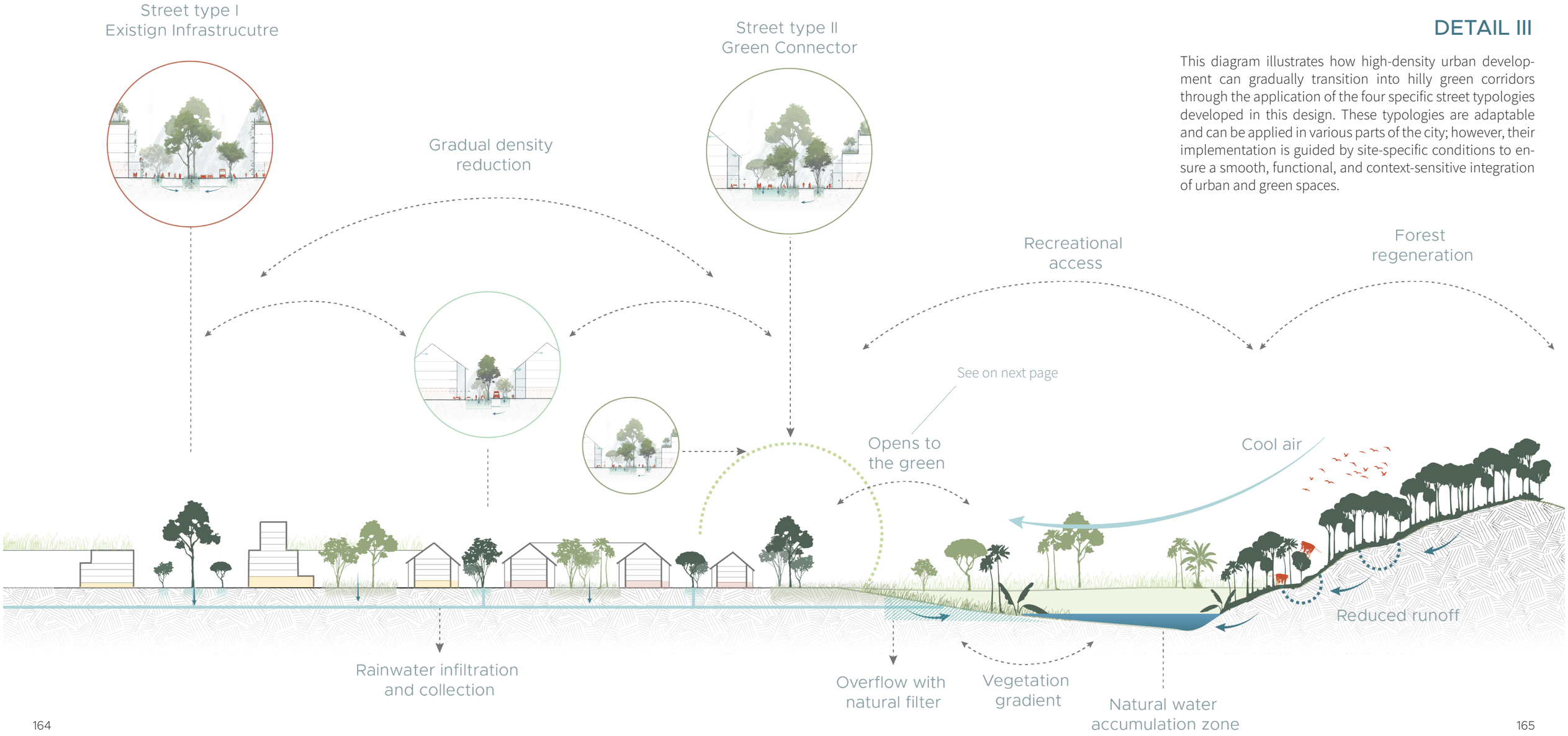
Finally, a street typology focused on low-density urban edges illustrates how the city can gently transition into the surrounding green landscape. In these areas, local housing typologies are complemented by gardens and small-scale cultivation spaces, enriching vegetation diversity and softening the urban boundary.

The street profile here is intentionally narrow, prioritizing scooters and bicycles as primary modes of transport. As observed during the site visit, residents frequently use the open spaces adjacent to their homes — such as front yards, small gardens, and open verandas — for gathering and daily activities. To support this local lifestyle, the street design incorporates gradual transitions between private and public spaces, creating semi-outdoor zones that encourage social interaction and foster a strong sense of community.



DETAIL III

This diagram illustrates how high-density urban development can gradually transition into hilly green corridors through the application of the four specific street typologies developed in this design. These typologies are adaptable and can be applied in various parts of the city; however, their implementation is guided by site-specific conditions to ensure a smooth, functional, and context-sensitive integration of urban and green spaces.



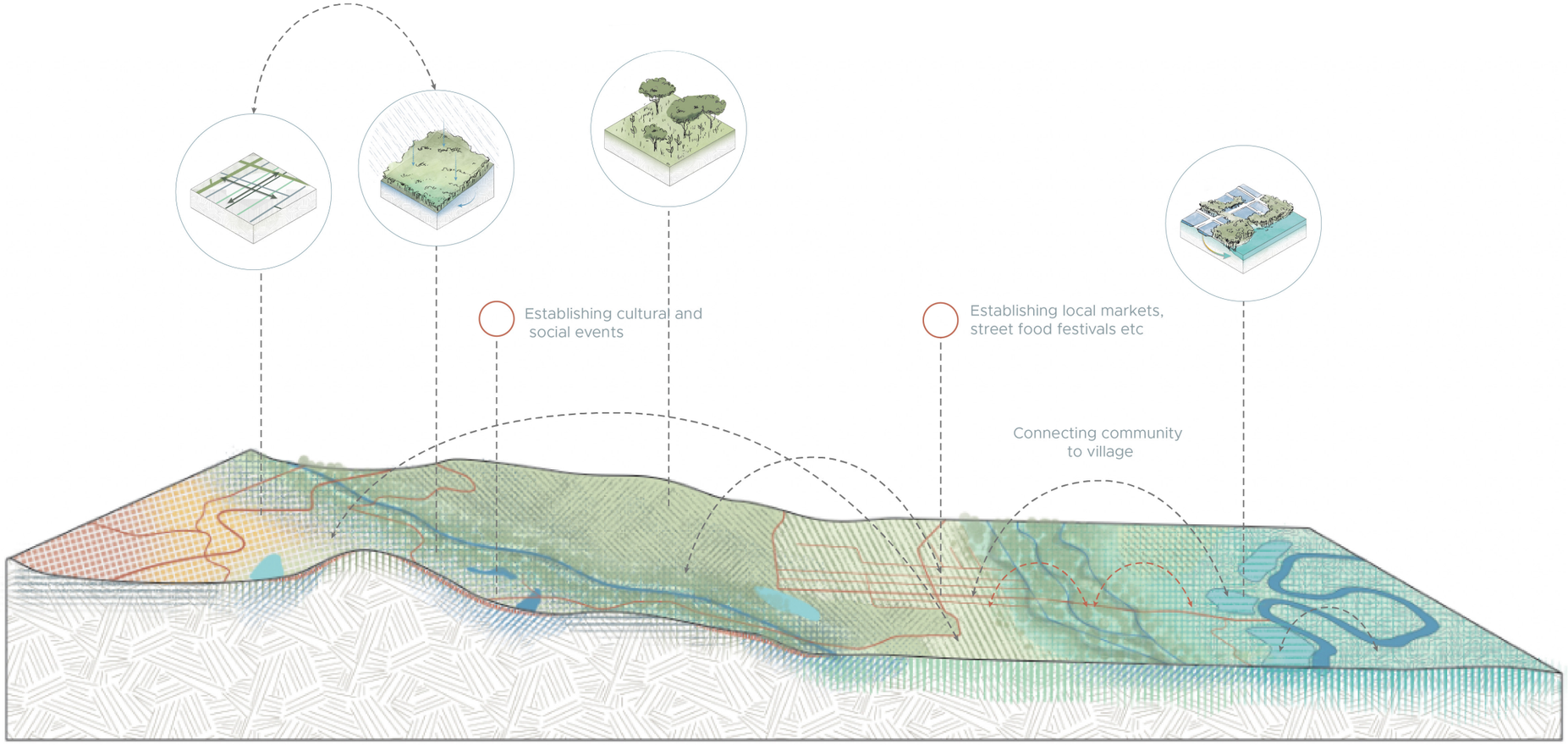

Continuous shade
Vegetation transitions from urban to forested
Connect inside and outside spaces
From city to nature
Connecting to street spaces

5.4 RETURN TO THE GRADIENT

To conclude the design explorations and understand how each piece contributes to the overall development, a return to the large-scale gradient is helpful. Interestingly, each design step raises further questions about how to connect the different parts of the gradient. For example, while developing aquaculture and agroforestry interventions, it became clear that the village needs spaces to sell local goods, linking it to the city by attracting new visitors through markets, events, and cultural activities.

At the same time, the urban design opens up new possibilities for public and cultural spaces that can welcome and engage rural populations, further strengthening the connection between city and countryside.

By focusing on relationships rather than fixed zones and boundaries, the design itself becomes dynamic and alive. This approach encourages thinking beyond static divisions and allows urban and rural systems to blend, evolve, and generate new opportunities for future development.



06 - DISCUSSION AND CONCLUSION



6.1 CONCLUSION

To conclude the report, the sub-questions and the main research question will be addressed. The key findings of each stage provide a concise overview of the research and its outcomes.

RQ1: Understanding and Analysis

What are the ecological and cultural landscape characteristics and gradients of the region and what opportunities and challenges can be identified regarding its current state and its transformation into an urban landscape?

The site analysis highlighted key landscape structures, formative elements, and the role of gradient transitions in supporting both natural and cultural processes. The main ecological typologies are shaped by a combination of relief, water, and soil conditions, giving rise to distinctive vegetation communities such as mangroves, lowland rainforest, and upland rainforest. Riparian gradients further enhance biodiversity by creating unique vegetation corridors along waterways. Numerous Indigenous communities have historically sustained their livelihoods through these gradients and even cultivated their own. Gradient transitions between and within these typologies are biodiversity hotspots and centers for cultural activity due to their richness.
Over time, particularly in the past 100 years, the relationship between people and land has shifted. The introduction of extractive industries in the late 1800s significantly impacted the structural integrity of the landscape. Mining, palm oil cultivation, extensive aquaculture, and eucalyptus logging erased much of the lowland rainforest, fragmenting ecological systems and reducing natural resilience. This has increased vulnerability to climate change, soil erosion, and flooding while decreasing biodiversity. Many Indigenous communities also lost their land to industrial agriculture, leading to the diminishing of traditional cultivation techniques and cultural landscapes. These developments pose major challenges for the future of Nusantara.
An interesting historical development that, to an extent, mirrors the future construction of Nusantara is the continuous transmigration from other islands into the region. The first wave of transmigration led to the establishment of villages and urban centers that were often disconnected from the land. People were purposefully relocated, often as part of broader national strategies to develop local economies or redistribute population pressures. Today, the region is once again experiencing an influx of people, highlighting its perceived value in terms of landscape, resources, and potential. However, this moment presents an opportunity to do things differently: by grounding relocation strategies in the landscape's qualities and the socio-ecological value of gradients, a renewed and meaningful relationship between people and land can flourish.

SRQ2: Design Strategy

What spatial design strategies and principles can be derived from the concept of landscape gradients to enhance landscape ecological connectivity and socio-culturally inclusive urban development?

The outcomes of the analysis phase already suggest a variety of design ideas rooted in ecological restoration and cultural inclusion. These were further developed through research, fieldwork, and the study of indigenous cultivation systems, resulting in a collection of design principles. The exploration of indigenous practices was guided by the close relationship between local communities and landscape gradients. Several techniques and adaptations such as temporary forest cultivation, rotational aquaculture, and bioclimatic architectural features demonstrate a deep understanding of climate, seasonality, materials, and local species. While these practices may not be implemented in exactly the same way today, they offer valuable insights into sustainable and effective approaches.
For instance, a contemporary adaptation of the rotational aquaculture system must function at a larger scale and still provide both ecological and economic value. The study of integrated mangrove aquaculture systems, combined with visits to local restoration programs, demonstrated how traditional knowledge and natural hydrological conditions can be integrated into modern, profitable systems. The incorporation of mangroves into aquaculture ponds and the involvement of local communities are essential to the success of this strategy.
Community participation plays a central role in most of the studied examples, including agroforestry and reforestation initiatives. These practices improve both ecological outcomes and economic resilience when local knowledge is incorporated. Agroforestry, in particular, parallels traditional forest cultivation methods but is adapted to modern contexts. Integrating local knowledge of plants and crops into these systems can enhance their effectiveness, promote engagement, and support educational exchange.
Together, these principles inform a regional development strategy structured in three phases. The phased approach creates a hierarchy of actions and allows for gradual, adaptive growth. Each phase builds and reinforces gradient conditions between landscape and urban elements. The first phase establishes a connective framework based on existing gradients, forming the structural backbone of the design. The second phase elaborates this framework with an expanded network of blue and green structures and introduces agricultural adaptations. The third phase strengthens the landscape matrix by creating social and ecological conditions across the site. These gradients grow and evolve alongside the city, fostering a dynamic and interconnected system.
The strong link between ecological gradients, local cultivation practices, and architectural adaptations makes gradients a powerful foundation for design strategies. Their temporal nature supports process-based development, and a strong landscape analysis is key to identifying spatial configurations and relevant principles. Gradients offer significant potential as a formative force in design.

SRQ3: Design Application

How can the design of an integrative landscape framework be applied at multiple scale levels to regenerate natural gradients and support the realization of an eco-culturally diverse new capital?

Because gradients operate across scales, they serve as a useful tool for initiating design at different levels. The proposed design includes a transition from the urban core to the mangroves, which can be broken down into a sequence of smaller-scale gradient conditions. These finer transitions help build a broader connective system by softening ecological barriers and integrating key typologies.
The first zoom-in demonstrates how the gradient concept can support the integration of existing communities into Nusantara's development. It illustrates a transition from wet to dry rural conditions through a series of spatial and ecological adaptations. Each adaptation reflects a unique gradient condition that blends ecological and cultural elements. A closer look at two of these conditions reveals their distinct spatial qualities and impacts.
Similarly, the second zoom-in focuses on the interface between urban development and ecological systems. It highlights how street typologies of varying densities can be designed to engage with gradient structures. The spatial, ecological, and recreational qualities illustrated in the study of these street typologies provide insight into softening the boundary between city and landscape and explore the gradient concept at a small scale.
Ultimately, these smaller interventions contribute to the larger gradients, gradually dissolving boundaries at different scales and fostering a smooth, interconnected network of urban and green spaces.

Research Question

How to design an integrative landscape framework that regenerates natural gradients and supports the socio-ecological urban development of the new capital Nusantara?

Based on the findings of all sub-questions, a response to the main research question can be formulated. Integrating the gradient concept into the analysis phase revealed its versatility, adaptability, and cultural relevance, making it a strong foundation for design. This approach naturally led to the identification of design principles and process-based strategies. It encourages a layered, multiscale method that supports rich design explorations. Gradients can serve as a formative force in the urban development of Nusantara and other urbanization contexts.

6.2 DISCUSSION

Lessons Learned

Designing with Gradients

One of the most important and interesting lessons of this research was learning to use landscape gradients as a formative design element. I had never worked so closely with transitional areas before and always found them challenging to understand, let alone design with. However, the more I learned about the significance and potential of gradients, the more I appreciated their versatility in design applications. It was still difficult to move away from categorical thinking and drawing. Representing gradients visually remained a challenge throughout the project. Despite this, the concept proved rewarding, as it made transitioning into the design phase smoother and more flexible across different scales and drawing techniques. Ultimately, the potential of gradients outweighs the challenges and allows for an alternative, creative design approach.

Landscape Logic

The notion of landscape logic emerged from the theoretical framework and became a crucial guiding principle throughout the design and analysis process. The integration of history, ecology, culture, and spatial qualities enables a deeper interpretation of the landscape and offers continuous design inspiration. It is a concept that can be applied to any site to foster a more holistic understanding, and one I will certainly carry forward in future work.

Indigenous Knowledge as Design Inspiration

The richness and adaptability of indigenous landscape practices became a truly inspiring source of design ideas. Before this project, I struggled to connect the study of such practices with concrete design applications. Now, I see how indigenous knowledge can be interpreted and meaningfully adapted to contemporary contexts. Moreover, incorporating this knowledge adds value by encouraging cultural exchange between stakeholders and providing opportunities for education and community involvement.

Process Oriented Design

While not a new concept to me, integrating processes into the design from the very beginning allowed for a more meaningful application. Understanding how a project may evolve over time can guide key design decisions. I had often focused more on final outcomes rather than process but using process as an active design tool has helped produce a more thoughtful and layered design.

Designing Connectivity

Connectivity also took on a new meaning during this research. Previously, I mainly understood it through the lens of ecological corridors and specific species. Now, I recognize a broader dimension: the creation of connective networks and the reinforcement of the entire landscape matrix. This adds complexity and richness to the concept, making it a powerful tool for landscape design.

Outcomes

It is important to note that, in terms of future application and relevance, this research produces a set of broadly applicable principles along with a demonstration of their implementation in the context of Nusantara.

Principles of Gradient Design

Since the concept of working with landscape gradients as a guiding design theme has limited precedent in existing design examples, this research contributes to the development of this design framework. As such, the proposed set of principles for gradient design holds potential for future application in alternative urbanisation scenarios. In particular, the categorisation of principles according to gradient typology and the degree of natural-cultural integration can serve as useful guidelines. However, these principles must be adapted to the specific landscape typology in question. For instance, distinct sets of principles could be developed further for designing in mountainous, wetland, or arid environments. Therefore, this outcome has strong potential for further development and elaboration.

Design Explorations

The concrete design explorations not only illustrate an alternative planning scenario for Nusantara but also demonstrate the application of design principles across scales and gradient conditions. By addressing various aspects of large-scale gradients and developing design adaptations suited to different urban contexts, the proposals offer guidance for comparable conditions throughout the development site. For instance, the mangrove-aquaculture adaptation shows strong potential for application in the site's coastal zones, while the agroforestry adaptation could be used to facilitate a transition from Mount Beratus into the urban core. As such, the key zoom-ins are relevant not only to specific site conditions but also at a strategic level.

As mentioned earlier in the conclusion of the design chapter, each exploration naturally leads to the next. This reflects the very nature of working with gradients, which are not meant to begin in one place and end in another but to flow continuously through various conditions. Therefore, it was somewhat challenging to stay focused on each design exploration without feeling the need to develop another part of the gradient to create a complete picture. In a way, this method requires the ability to let certain things evolve naturally over time, which may offer an interesting counterbalance to the current rigid master planning of Nusantara.

Process and Research Approach

Designing and Analysing Through Time

An interesting aspect of this study is the work with different time layers, such as looking to the past for natural landscape conditions, examining the present, and imagining future scenarios. The nature of working with a city that has not yet been built inspired this layered approach from the beginning. By looking back at other planned capitals to assess and predict the future of Nusantara, it was possible to draw meaningful conclusions about the current planning. During the analysis phase, historical research and an understanding of the landscape's earlier functions helped to integrate the concept of the palimpsest into the design. By continuing to incorporate the palimpsest throughout the design, the project gains a quality grounded in the logic of the landscape. This approach served as a continuous reminder of what this landscape is capable of in terms of ecology and culture, and it underscored the importance of rebuilding these relationships.

Gradient Representation

As mentioned earlier, working with gradients calls for appropriate representation techniques. Throughout the report, I have integrated sections and axonometries, especially during the design phase, to visually communicate the gradient effect. Mapping proved to be particularly challenging to adjust, as boundaries and zones are often the dominant elements used. I attempted to implement fading strokes, fills, and hatches to illustrate transitional zones. Nevertheless, I feel that some of the maps could benefit from further adjustments to better express the gradient quality.

DISCUSSION

Limitations

One of the limitations of the research is the lack of available and transparent data, as well as literature on certain aspects. For example, investigating local practices, identifying the precise locations of indigenous settlements, and tracing their historical development proved challenging due to a shortage of English-language sources. In some cases, estimations were based on newspaper reports, historical maps, and fieldwork experience. Additionally, the exploration of local practices was conducted in English, which may have led to the exclusion of relevant practices not documented in that language.
Another limitation arises from the fact that I do not have extensive experience in designing urban environments from scratch. While my background in landscape architecture provided a strong foundation, developing the urban fabric remained a consistent challenge, even with the guiding idea of using landscape as a framework for development. Determining appropriate densities, housing typologies, and urban dimensions was an engaging but complex process. In the end, my focus shifted more toward the landscape-related aspects of the design, leaving some urban questions open-ended. However, this offers a basis for further research and highlights my role as a landscape designer within such projects.

The Role of Landscape Architecture

This research highlights the significance of landscape architecture in the design of urban environments. By using landscape logic as a foundation for development, the importance of understanding and interpreting ecological and social conditions became central to the design process. This underscores the relevance and necessity of landscape architects within interdisciplinary design teams. The ability to reveal underlying landscape structures and translate them into spatial strategies is a distinctive and inspiring aspect of the discipline. Greater collaboration with urban planners, ecologists, policy makers, and local communities can further enhance the quality and impact of such projects.

Future Research

Several opportunities for future research have emerged throughout this study. These include expanding the principles of gradient design for broader application, refining representation techniques, deepening the study of indigenous practices, and further developing the integration of high-density urban fabric within the gradient framework. Addressing these areas could contribute to a more comprehensive design methodology and facilitate the application of this framework in future projects. A particularly promising direction would be the continued exploration of gradient conditions globally, with the goal of compiling a catalogue of design principles across varying degrees of urbanisation, climates, and ecological typologies.

The application of this approach in already established urban settings presents another interesting research opportunity. Does the method work without the flexibility of large landscape areas? While designing the street typologies, the concept remained relevant as it addressed a smaller scale. Whether the benefits of this method can be effectively transferred to the urban scale remains a subject for further research.

Personal Reflection

This project has had a profound impact on my development as a landscape architect. As previously noted, the research challenged many of my initial assumptions about working with transitional areas, process-based design, and the value of local knowledge. Confronting these ideas with openness allowed me not only to broaden my understanding but also to become more receptive to unfamiliar perspectives and challenges. The lessons learned during this process will continue to shape my professional trajectory. In particular, the potential and adaptability of transitional zones, as well as the concept of landscape logic, have become central themes in my approach. Ultimately, this project has deepened my appreciation for the aspects of landscape architecture that I find most compelling and meaningful.

GLOSSARY- CONCEPTUAL

Connectivity

In landscape the degree of spatial connections in terms of infrastructure and ecological continuity can be described as landscape connectivity. Landscape connectivity can be structural or functional. Structural connectivity refers to physical attributes such as landscape patches, corridors and waterways. Functional connectivity relates to the movement of species, materials and processes. Scale plays a big role in understanding and interpreting the connectivity of a landscape.

Fragmentation

Landscape fragmentation is the process of creating isolated landscape patches through urbanisation, agriculture, forestry and other human activities. These isolated patches of remanet landscape often experience landscape degradation and loss of biodiversity over time.

Land Mosaics

The concept of landscape mosaics stems from the field of landscape ecology and provides a theoretical background for classifying landscapes. Three main landscape patterns define landscape mosaics: patches, corridors and matrix. The simplification systems allows to derive design principles based on main characteristics of a landscape type (Forman, 2008)

Landscape Gradient

Landscape gradients refer to the gradual and continuous transitions or changes in environmental, spatial, ecological, or cultural conditions across a landscape. Landscape gradients help to understand intersections and boundaries between landscape types. The concept of gradients further allows for a more accurate, less binary, representation of landscape (McGarigal & Cushman, 2005).

Landscape Typology

Landscape typology is a way of classifying landscapes by identifying differences and similarities in spatial, ecological and cultural patterns and conditions. The identification of landscape typologies allows for the collection of general design principles. It is important to recognise that categorisation may result in a degree of simplification of unique landscape attributes.

Urbanisation

Urbanisation is the process of urban expansion because of rural to urban migration. Urbanisation has both positive and negative aspects on culture, environment and economy. In the case of Nusantara environmental challenges of urbanisation such as habitat loss, pollution and ecosystem disruption pose a serious concern. The cultural implications of the project are also significant considering the relocation of millions of people across the country.

GLOSSARY- CONTEXTUAL

Acidic Soils

Acidic, nutrient poor soils are common at the research site where rainfall is frequent and heavy. Such soils are not well suited for agriculture.

Alluvial Soils

Are nutrient rich soils often found along rivers and in deltas. Fine river sediment is transported down the stream. On site, fertile, alluvial soils can be found mainly in the Balikpapan Bay area.

Indigenous People

Indigenous People are distinct social and cultural groups that share collective ancestral ties to the lands and natural resources where they live, occupy or from which they have been displaced. The land and natural resources on which they depend are inextricably linked to their identities, cultures, livelihoods, as well as their physical and spiritual well-being (Indigenous Peoples, 2023).

Leaching

Leaching is the process of nutrients washing out of the soils, common in the tropics since due to heavy rainfall. Leaching can be further identified through agriculture leading to soil degradation. On Borneo patches of alang-alang grass often remain in place of degraded agricultural fields.

Logging

Logging is the process of cutting down forest for commercial purposes. On the island of Borneo Forest logging is one of the major industries, since the soil is often unsuitable for other forms of agriculture. A large part of the design site is eucalyptus production forest.

Lowland Rainforest

Lowland rainforest, often dipterocarp forest, is the most common type of forest on Borneo. Most of trees in such a forest belong to the Dipterocarpaceae plant family. There is great diversity withing this plant family. Many of the tress are tall and fast growing, blocking out the sunlight beneath. The rainforest has a vertically layered structure. The canopy layer supports much of the animal life. The ground level is often bare with few plants, due to the lack of sunlight. The succession mostly happens in patches where old trees have died, and young trees grow fast (MacKinnon, 1996).

MANGROVE

Mangrove forests exist in the intertidal zone, along coastlines or in estuaries. The fresh to saltwater balance is essential for mangrove species. The roots of mangrove tress often capture sediments and help to filter pollution. Mangrove forests provide protected water habitats where many fish and other aquatic species have their nurseries.

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BRASÌLIA-BRAZIL

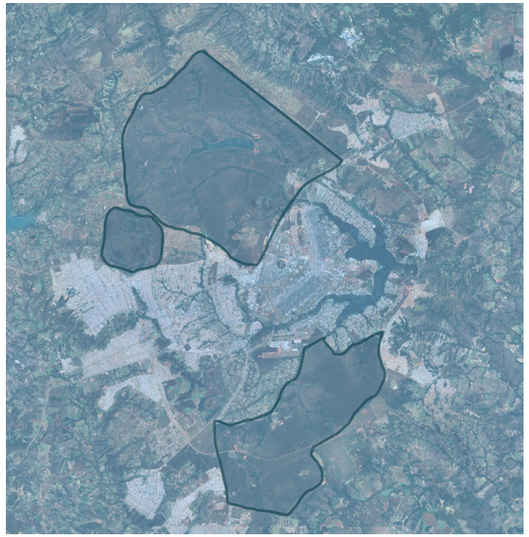

Image 1: Fragemnts of the Cerrado landscape in Brasilia (Peres, 2024)

Brasilia was built in the depth of the Cerredo tropical woodlands, bringing a new urban centre to the interior of the country. The construction of the city not only resulted in the rapid clearing of large forest areas but in the creation of extensive infrastructure connections which opened the land to further deforestation and fragmentation (International Secretariat of WRM, 2023). Deforestation and landscape fragmentation are major issues in Brasilia, with a few disconnected landscape pieces surrounding the capital. The Brasilia National Park has been planned with the purpose of ensuring the city's water supply.

ABUJA-NIGERIA



Image 2: Urban farms in Abuja (Civineer & Civineer, 2020)

Abuja was built in the 1980s, in the centre of Nigeria. The capital was designed to have a representative character and administrative function. In the example Abuja landscape fragmentation and degradation stem from extensive agricultural activity in an around the city. As many citizens seek to make an additional income, much of the natural and initially planned green has been converted to large and small scale agriculture (Saliman, n.d.)

ISLAMABAD- PAKISTAN



Image 3: Expansion of Islamabad into the landscape (Zaidi, 2024)

Islamabad was established in the 1960s taking over parts of the existing Himalayan Forest. Since its initial construction the city grew considerably with a predicted population of 4,4million people by 2050. In the case of Islamabad landscape fragmentation began becoming an issue as result of unplanned urban expansion along main infrastructure connections. The original plan no longer provides a guideline for sustainable urban growth (Asif, 2023).

ANNEX I

Case Study - Planned Capitals

One of the major problems of constructing a new city from scratch is the ecological and spatial degradation of the landscape. Urbanisation in general tends to aggravate issues of landscape fragmentation and ecological degradation due to changes in habitat configuration and connectivity (Elmqvist et al., 2016). The often-rapid construction of planned capitals tends to aggravate the extent of ecological degradation. The effects of urbanisation often affect surrounding landscape as agriculture and industry expand around cities. Furthermore, the initial urban planning often does not account for further growth after completion leading to uncontrolled urbanisation later on.
The impacts of ecological degradation in turn affect the urban environment.

REDUCED CLIMATE RESILIENCE



Image 4: Flooding due to heavy rainfall in Islamabad (DAWN.COM, 2011)

WATER SYSTEM DEGRADATION



Image 5: Degraded water supply in Abuja (Abdulrahman, 2024)

BIODIVERSITY LOSS



Image 6: Forest fires in Brasilia National Park (Peres, 2024)

Main recurring issues associated with ecological degradation in and around rapidly urbanized areas include reduced climate resilience, water system degradation, and loss of biodiversity. As a result of ecological degradation, urban areas become increasingly vulnerable to the impacts of climate change, such as elevated temperatures, air pollution, and heightened susceptibility to extreme weather events (Rowland & Ebuka, 2024).In all three case studies, water system degradation caused by fragmentation and overuse poses a significant challenge, leading to water supply shortages and pollution. For instance, in Brasília, the degradation of natural water recharge systems, combined with climate change-induced drought, caused a critical water shortage in 2016. This crisis led to the depletion of the city's primary water source and the implementation of water rationing measures (Greco & ICLEI World Secretariat, n.d.).Ecological degradation also results in biodiversity loss by physically altering habitats and disrupting landscape connectivity. Ultimately, this diminishes the quality of urban life and undermines ecosystem services.

All three studied capital cities struggle with the effects of ecological degradation on urban living conditions and are attempting to revitalize their landscapes retrospectively.

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