BUILDING THE GAP

a modular toolbox for hybrid floating architecture between technologically advanced systems and informal settlements

mónica garcía & laura echeverri

This thesis is dedicated to all who believed in us and supported us throughout this incredible journey. To our amazing families, loving parents, kind-hearted siblings, supportive partners, and inspiring friends, thank you. To our great mentor, Carlo, for his guidance and vision. And finally, to our home countries Ecuador and Colombia, whose landscapes and realities sparked our curiosity and united our passion for creative, meaningful design in places both familiar and unknown.

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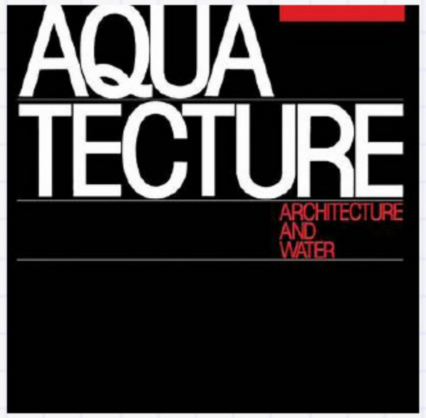
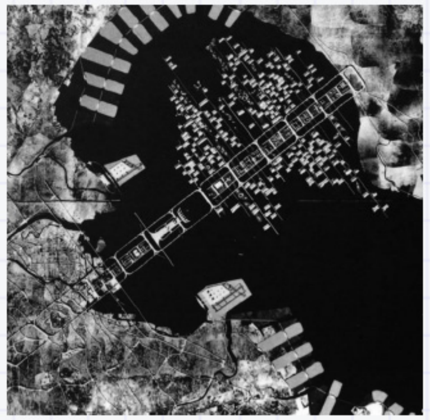
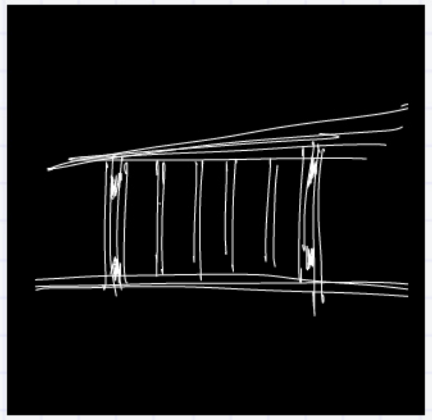






00. introduction

This thesis critically investigates the emerging domain of aquatecture, a field that spans ancient palafitic settlements and contemporary technologically advanced innovations. While "high-tech" is often used to describe the latter, this research refers not necessarily to luxury or high cost but to the application of engineered systems and innovative technologies. However, we want to bring light to the fact that most high-tech floating developments are designed for middle- to high-income contexts, rarely addressing the needs of vulnerable or at-risk populations.

Through this exploration, we identified a critical gap in current discourse and practice: the absence of affordable, community-centered solutions that occupy a "middle ground" between cutting-edge prototypes and traditional Palafitic responses. By examining both ends of the spectrum, this thesis aims to develop a replicable design approach that bridges technological advancements with social equity, promoting climate-responsive, socially rooted, and context-aware aquatic architecture.

The first part of the thesis establishes the broader framework: what aquatecture is, how it has been historically and contemporarily categorized, and what technical and social ambitions it holds today. Through an in-depth review of its typologies, material systems, and socio-environmental contexts, we examine the prevailing rhetoric and limitations of aquatic design, questioning what has been achieved and what remains unimagined. The research emphasizes the need to confront physical and climatic constraints, as well as economic and cultural exclusions, that hinder the democratization of floating solutions.

The second part undertakes a comparative case study between Rotterdam (Netherlands) and Nueva Venecia (Colombia): two "successful" floating environments shaped by vastly different resources, cultures, and priorities. By deconstructing the spatial, material, and social logics of these contrasting realities, we analyze where their strengths converge, where they fall short, and what can be learned from both. This contrastive study forms the analytical core of the thesis.

The final part of the research proposes an alternative vision of floating architecture: a hybrid model informed by traditional and technological knowledge systems. This includes the development of a modular, scalable, and adaptable "toolbox" of architectural parameters capable of addressing diverse geographies, climates, and economic conditions. Rooted in community needs and resilience principles, this model aspires to provide a realistic yet hopeful foundation for inclusive, water-based urban futures applicable to Latin American and European scenarios.

introduction.
why architecture in water?

In recent years, there has been a growing surge of interest in aquatic architecture. The past decade, in particular, has seen an exponential increase in publications, projects, and theoretical explorations centered on living with water, not merely as a technical challenge, but as an evolving cultural and spatial condition. Since 2010, and more noticeably between 2015 and 2024, architects, researchers, and institutions have begun to document floating buildings with greater precision, while new prototypes have emerged across the globe. This growing visibility marks a significant shift: what was once an experimental curiosity is now becoming a legitimate field of architectural inquiry. Yet, while the term floating architecture has gained notoriety, aquatecture (architecture that coincides and coexists with water) encompasses far more than buoyant structures or technological feats. This is what sparked our interest, the deep relation that humans ha It invites a deeper reflection on how humans relate to water as both a habitat and a force. It challenges the terrestrial bias of architectural thought and repositions water as a foundational element of spatial experience, resilience, and adaptation.

Thus, the question naturally arises: why architecture in water? Why is this transition important, and where does it originate? To answer this, throughout this thesis, we had to look beyond the contemporary innovations that have been commonly known in the recent years, and trace the historical, environmental, and cultural impulses that have always driven humanity to build with, rather than against, water. This situates aquatecture as both an ancient practice and a forward-looking response to the challenges of our time. Essentially the decision to focus on aquatecture stems from an urgent need to understand, sort and possibly redefine the relationship between architecture and water.

As sea levels rise and flooding events become more frequent, traditional land-based architectural responses are proving insufficient. In some instances, places where once traditional architecture kept failing from the growing climate change now explore the idea of floating architecture as a futuristic vision. In other instances, traditional aquatic architecture, keeps withstanding the climatic risks.

Floating and amphibious typologies offer a form of resilience that challenges the fixed and static nature of conventional building.

Aquatecture is also uniquely positioned to engage with multiple scales of impact, from the local (community housing and infrastructure) to the global (urban resilience and adaptive planning). It is a spatial manifestation of the global relationship with water: architecture that must negotiate uncertainty, fluidity, and transformation. Studying it allows for a deeper understanding of how human settlements can evolve from resisting water to coexisting with it.

Essentially, we chose to explore aquatecture because it represents a global condition rather than a localized phenomenon. From Rotterdam to Bangkok, from the Mekong Delta to the Ciénaga Grande de Santa Marta, humans have continuously found ways to live with water. This universality allows for meaningful comparative research between technologically advanced and culturally rooted contexts, offering insights that can be replicated worldwide. The Dutch compact city and mixed-use development policies (Dieleman et al., 1999) illustrate how water-based design can integrate density, housing, and ecology within a single system. By studying aquatecture, this research seeks to extract transferable principles that could inform future urban strategies in vulnerable coastal regions.

Through our comparative analysis of 34 floating architecture case studies, whose results will be explored in detail in the following chapters, we identified two dominant typologies shaping the field today: one rooted in high-tech and advanced engineering systems and the other grounded in vernacular community-driven floating settlements. The contrast between these two poles revealed a critical gap: the absence of hybrid solutions that balance affordability, adaptability, and long-term sustainability.

High-tech floating architecture, frequently explored in architectural research and implementation in Europe and Southeast Asia, especially in the Netherlands, Germany, and Singapore, strongly emphasizes innovation, prefabrication, and energy autonomy.

These projects typically serve as experimental prototypes or are developed for private or institutional clients with significant financial resources. Although they successfully integrate strategies to address structural stability, energy performance, and adaptation to climate-related risks, they are generally disconnected from low-income or informal contexts, which are essentially the main at risk population. As revealed by our literature review, the unaffordability of these solutions does not stem from the technology itself but rather from factors such as overdesign, the level of finishing, and the socioeconomic target group. Thus, high-tech does not inherently equal unaffordable, but in practice, it often does when oriented toward elite housing or flagship urban developments.

In contrast, vernacular floating architecture, primarily found in South America, Sub-Saharan Africa, and Southeast Asia, is based on self-construction, ancestral knowledge, and low-cost materials. These settlements reflect strong community engagement and adaptability to local contexts. However, they often exhibit structural vulnerabilities, particularly in terms of climate resilience, sanitation, energy independence, and overall durability. Frequently categorized as “informal,” these systems lack the technical support or policy recognition required for long-term sustainability. While rich in cultural and spatial value, they tend to be perceived as temporary or marginal rather than viable models for replication or institutional endorsement.

This binary opposition between unaffordable innovation and unsustainable informality reveals the urgent need to define and develop a third typology: floating architecture that integrates the strengths of both extremes. While several studies praise the technological advancements of floating housing prototypes and others document the cultural significance of palafitic settlements, few address the possibility of merging the two into a single, adaptable model. There is a clear opportunity to bridge the gap between innovation and accessibility. Instead of forcing vulnerable communities to choose between fragile, improvised structures or prohibitively expensive designs, this third typology could promote an architectural approach that is both participatory and performance-driven.

The absence of this middle ground also raises more profound questions about the allocation of research funding and the values embedded in architectural experimentation. Who is allowed to benefit from innovation? Which communities are included in the future of climate adaptation? These are not merely theoretical concerns, but rather practical design challenges that this thesis aims to address.

problem:

Contemporary solutions concerning floating architecture often fall short when addressing the realities of low- and middle-income urban populations. While high-tech floating architecture is frequently celebrated in academic and professional discourse for its innovation and engineering achievements, such projects tend to be designed for middle- to high-income users and are typically located in stable, resource-rich contexts. On the other hand, floating structures in vulnerable or informal settings are often seen as temporary or rudimentary, lacking recognition as viable long-term housing solutions.

This disparity reveals a critical gap in architectural thinking and practice: the absence of floating typologies that are both technologically informed and socially inclusive. There is a lack of adaptable, affordable, and community-rooted solutions that respond simultaneously to climate change, urban vulnerability, and socio-economic inequality. As cities face increasing risks due to rising water levels and housing shortages, developing hybrid approaches that integrate the strengths of high-tech innovation and vernacular wisdom becomes urgent. This thesis examines the in-between space, designing for dignity, resilience, and adaptability on the water, without excluding the most vulnerable communities.

justification:

As climate change accelerates and urban inequality deepens, floating architecture is increasingly proposed as a viable response to water-related risks and land scarcity. However, most floating solutions currently fall into two extremes: high-tech prototypes developed in resource-abundant settings and tailored for higher-income users or low-cost, informal structures born out of necessity in marginalized communities. The former emphasize technological innovation and sustainability metrics but are often detached from the socio-cultural realities of vulnerable populations. While rooted in local practices and adaptable to context, the latter are commonly overlooked in mainstream architectural discourse and lack technical refinement and institutional support.

This thesis is justified by the urgent need to bridge this divide, both conceptually and practically. The study identifies the architectural, technological, and cultural gaps that limit its broader application by critically analyzing floating architecture across diverse geographies and socio-economic contexts. It challenges the assumption that high-tech necessarily implies high cost or exclusivity, instead proposing that technology can and should be reoriented toward inclusivity, adaptability, and affordability.

Ultimately, this research advocates for a hybrid, modular, and community-based approach to floating architecture that harnesses the innovation of advanced systems and the wisdom of vernacular practices. Such a model can potentially address housing needs in climate-vulnerable urban areas and reposition floating architecture as a legitimate, inclusive, and future-oriented typology in both the Global South and Global North.

questions:

How can technical solutions in building and infrastructure design be made more responsive to the specific social and cultural needs and traditional ways of life of communities?

How does aquatecture integrate into the broader spectrum of urban adaptation strategies implemented in waterfront cities across different temporal scales, geographical regions, and climate zones?

What specific design requirements (parameters) must be considered to ensure the affordability of floating buildings?

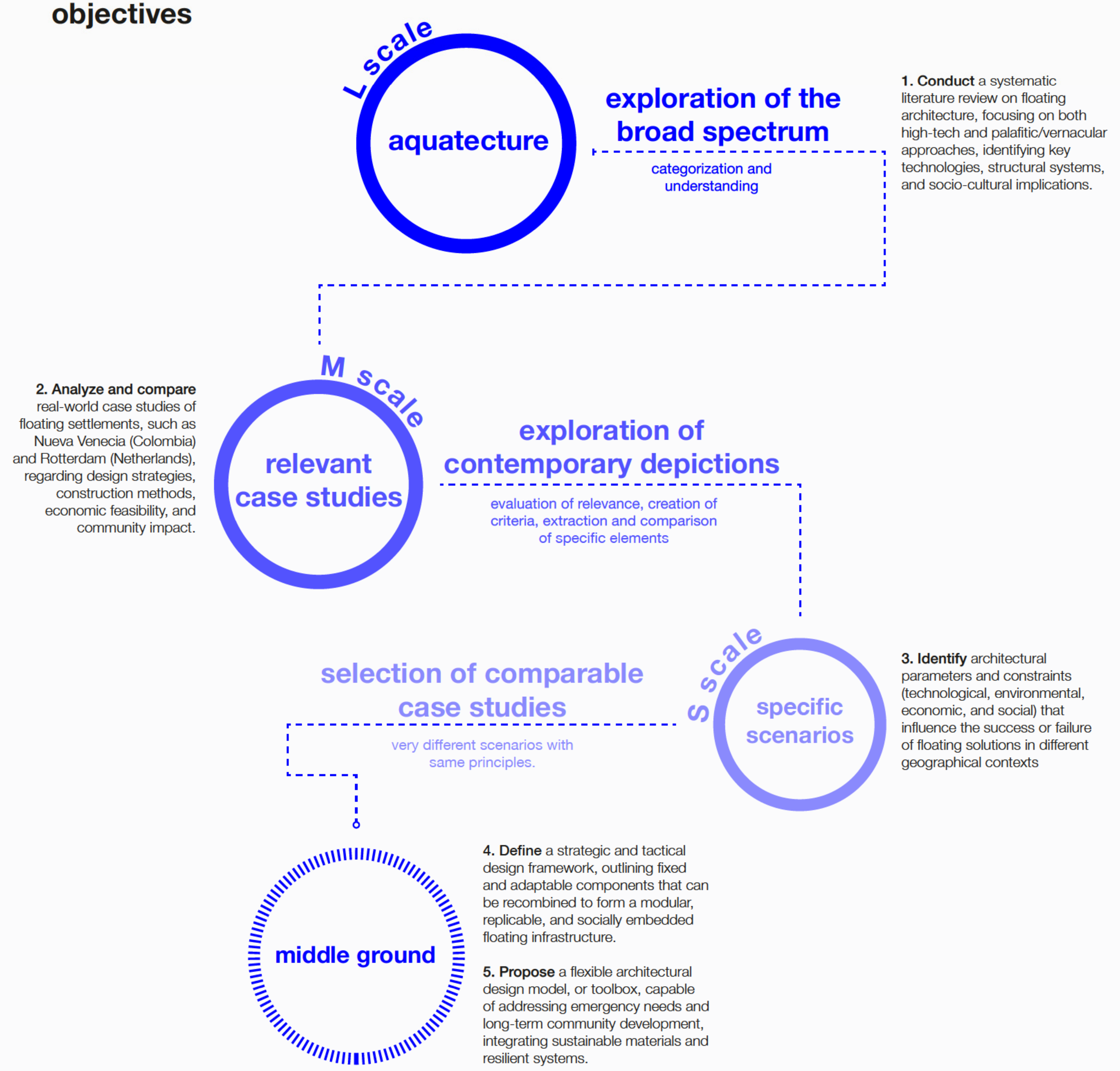
methodology

This study advances the state of the art by first inquiring what the existing aquatecture and then examining a set of case studies to position floating and amphibious architecture within contemporary debates on sustainability and climate adaptation. The analysis pursues three main objectives:

- First, it seeks to demonstrate the relevance of the topic today, at a time when urban settlements are increasingly exposed to the risks of sea-level rise, flooding, and environmental degradation. Floating architecture is no longer a futuristic speculation but a pressing necessity in both high-income and low-income contexts.
- Second, the review aims to identify similarities and points of convergence between vernacular water-based settlements, such as palafitic communities in Latin America, and high-tech floating projects developed in Europe and beyond. Despite their differences in scale, materiality, and technological investment, both respond to the fundamental challenge of living with water.
- Finally, the review investigates whether a meaningful in-between model can be articulated, one that combines the strengths of both paradigms: the affordability, cultural rootedness, and adaptability of vernacular practices, with the resilience, efficiency, and environmental performance of advanced technological solutions. This search for a middle ground, provides the conceptual foundation for the comparative analysis of Rotterdam and Nueva Venecia developed in this thesis.

Building upon the state of the art, the research process required a clear methodological framework to address the questions raised systematically. First, we approached the topic by identifying and categorizing each typology of aquatecture. This classification led us to create a concise and comparable model that could serve as a basis for our conclusion. This was approached in a investigative manner, as we studied not only the existing typologies, but also the proposed comparative categories based on the literary sources. Additionally we conducted a literature review that supports the state of the art based on specific cases of aquatic architecture. The following methodology was adopted: This research employs a qualitative, exploratory approach rooted in architectural theory and design-based inquiry. It seeks to understand the contrasting approaches within floating architecture, from high-tech to palafitic systems, and to define a middle-ground typology suitable for vulnerable, low- to middle-income communities. The methodology integrates theoretical and empirical elements through a Literature Review and comparative case study analysis, culminating in a design proposal based on synthesized parameters.

objectives

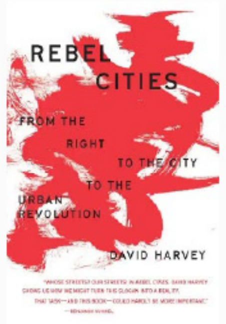


theoretical framework:

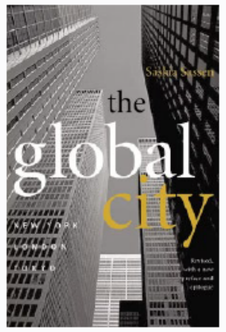
From the research gathered throughout this thesis, the need for a "middle ground" in floating architecture has become increasingly evident. The gap between highly technological, high-cost projects and low-resource, vernacular solutions is not merely one of aesthetics or innovation,it is a structural void that leaves most at-risk communities without viable, sustainable, or affordable options. While cities like Rotterdam have pioneered advanced models of climate-responsive floating architecture, these remain inaccessible to regions with limited resources and fragile economies. Conversely, traditional communities, such as those found in the stilt villages of Colombia or the Amazon, continue to demonstrate remarkable resilience yet lack access to the technological and infrastructural systems that could ensure long-term safety and adaptability.

This recognition extends beyond material or economic constraints,it also reveals a theoretical gap within the current architectural discourse. The field has extensively examined both extremes: high-tech floating cities as symbols of innovation and vernacular stilt settlements as anthropological heritage. However, few frameworks attempt to connect them within a coherent architectural, sociological, and environmental logic. The absence of this bridge highlights a broader challenge: the need to democratize aquatecture and establish a theoretical foundation for a new typology that merges the precision of technology with the adaptability of vernacular intelligence.

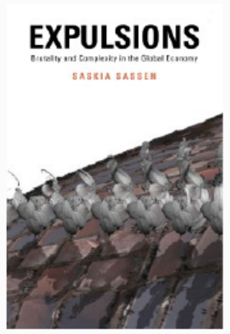
In this first approximation of the "middle ground," our research turned toward key theorists who help justify the urgency and relevance of such an iteration. These authors, spanning sociology, urbanism, and architectural theory, may not focus directly on aquatecture, yet their frameworks provide a critical foundation for understanding how architecture can operate as a mediator between technological capacity and social necessity. Through their lenses, this thesis situates floating architecture within a wider discourse of spatial justice, adaptive urbanism, and environmental coexistence, framing the middle ground not as a compromise but as an evolutionary convergence, a new architectural paradigm for the Anthropocene.



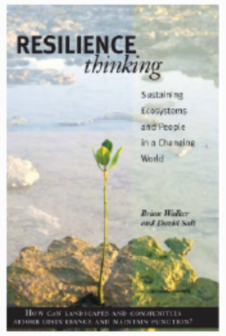
Rebel Cities: From the Right to the City to the Urban Revolution. Verso.



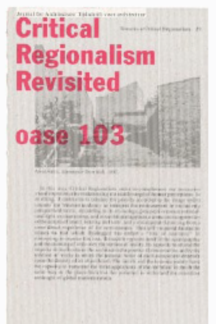
The Global City: New York, London, Tokyo.



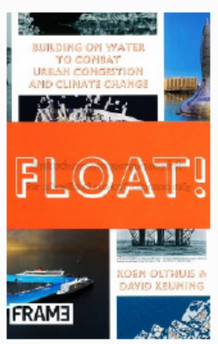
Saskia Sassen — Expulsions (2014) and The Global City (1991)



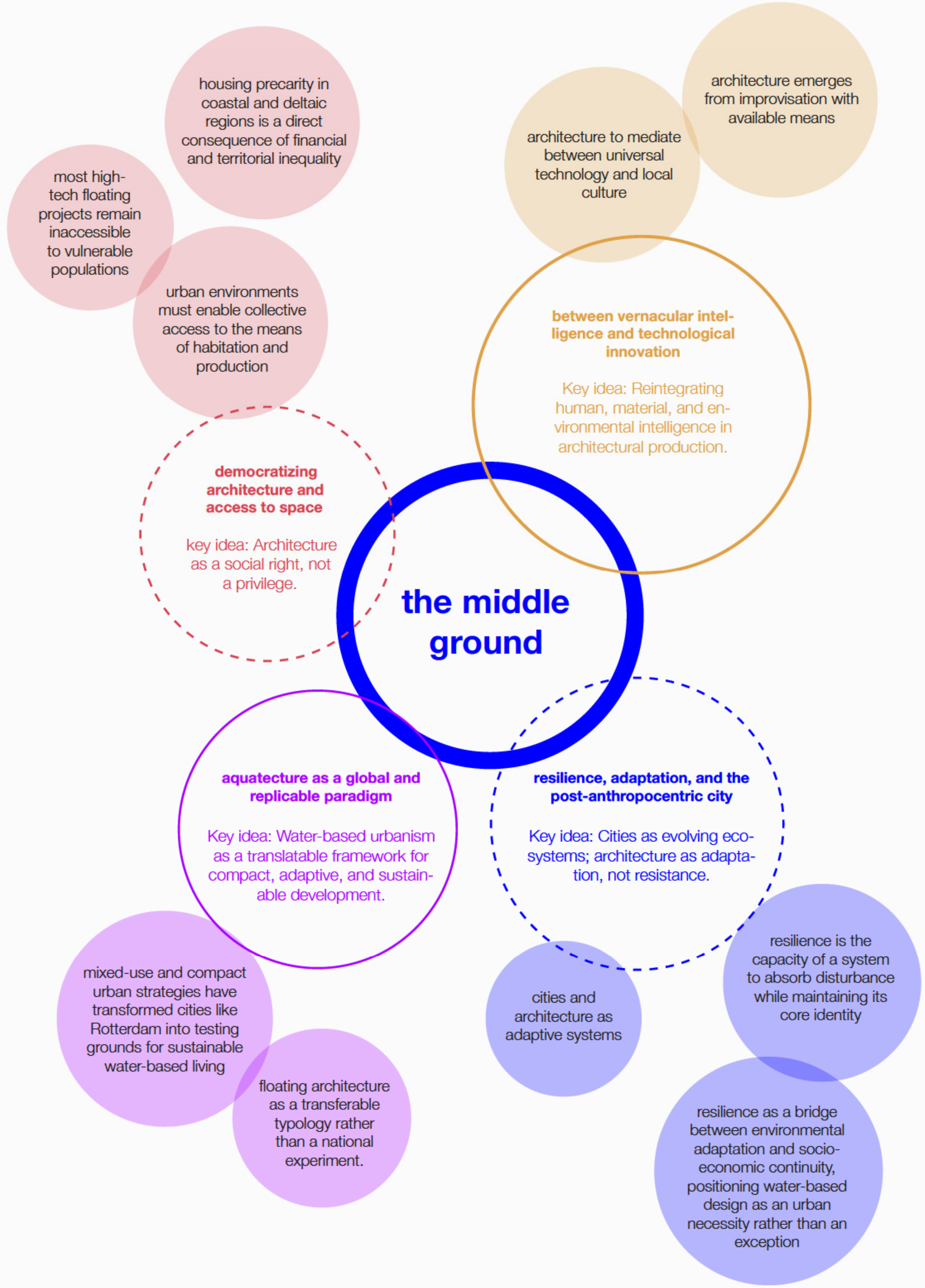
Brian Walker & C.S. Holling — Resilience Thinking (2004)



Kenneth Frampton — Critical Regionalism (1983)



Float! Building on Water to Combat Urban Congestion and Climate Change.



01. aquatecture: buildings and cities designed to live and work with water

In our research on floating architecture, we encountered the broader term **aquatecture**, which encompasses not only buildings that float but also those that are shaped by, dependent on, or coexisting with the water environment. This led us to understand that the topic of aquatic architecture was much broader than only floating architecture. We first came across the term Aquatecture as part of a literary review, which led us down the question of: what falls under the category of aquatecture? How can this typologies complement, contrast and compare to each other? And finally, Is floating architecture the only answer to the topics aquatecture fases?

Flooded deltas like Bangladesh highlight the climate crisis driving resilient aquatecture solutions.

relation of water and architecture

Historically, the relationship between architecture and water has oscillated between domination and symbiosis. Water has been perceived as both a threat to be controlled and a resource to be harnessed. From the construction of dams and canals to the development of land reclamation projects, architectural and infrastructural interventions have sought to solidify the shifting boundary between land and sea. This reveals a fundamental tension: architecture's desire for permanence against water's inherent fluidity. The encounter between the two is never neutral; it is political, ecological, and spatial. In many ways, the history of architecture by the water is the history of humanity's attempt to territorialize the unstable.

Land reclamation from the sea has become a widespread phenomenon in coastal development. It is the preferred solution for land needs in coastal areas and has been implemented for various use cases, including flood control and agriculture. Nowadays, it has become a popular urban response to the rapid increase in coastal urbanization, economic activity, and global population growth. Countries like China and the Netherlands lead the chart for reclaimed land area. However, most reclamation projects today take place within urban centers in the Global South. Cities in West Africa, East Asia, and the Middle East develop these new lands as economic forerunners for their commercial industries and as platforms for luxury residences.

However, the relationship between the design and production of reclaimed lands and the response of water in ocean environments is complex. It requires a symbiotic relationship with water bodies for stability, but can provoke natural forces when negligently imposed on the sea. Ocean water behaviors, including tidal accumulation, sea-level rise, connections to wetlands, and aquatic biodiversity, can question the success or failure of land reclamation projects in different contexts.

Land reclamation has been practiced for centuries using various methods in different settings. Traditionally, cities employed dikes to enclose shallow waters and drain the enclosures to create dry land. An example of this is Zuiderzee in the Netherlands. In the 1900s, dams were built in the North Sea and the water was drained to create land for housing its growing population. In modern times, more concrete practices, such as deep-cement mixing in ocean environments and building seawalls to contain them, have been implemented. The Sino-Singapore Tianjin Eco-city in China is a large-scale example of this modern practice, creating 6.2 miles of land for housing, industrial projects, and port facilities, boosting urban growth and the local economy (Yakubu, 2023).

Coastal reclamation, despite its benefits to cities and the evolution of its methods, will inevitably impact the structure and behavior of ocean environments. Studies have shown that reclamation can alter the profile shape, bed slope, and sediment grain size in ocean environments, influencing local tide dynamics, including amplitude, asymmetry, and tidal currents. When natural ocean currents are obstructed, water can flow by enhancing wave action and tides, naturally shifting in a new direction with greater force. This is the basis for water's response to land reclamation, and it determines the success, environmental impact, and sustainability of the project (Di Carlo, 2020).

Busan, South Korea's Marine City, for instance, exemplifies this paradox. Its sea-facing form and luxury towers were meant to symbolize progress, yet by replacing soft coastlines with hard surfaces, the city became more vulnerable to storm surges and sea-level rise. Similarly, Lagos' Eko Atlantic City, conceived as a solution to flooding, ironically caused new forms of erosion and ecological loss by destroying the wetlands that once served as natural buffers. These examples reveal that architecture's persistent ambition to control water often results in new vulnerabilities.


Aerial landscape of Busan_May, 2017. Image by Panwasin seemala/Shutterstock


Typhoon Chaba flooded the streets of Busan's Marine City 2016. Image by Yonhap/ picture alliance


Eko Atlantic City Reclaimed Land showing new shape of the Coastline. Image by Eko Atlantic city

In contrast, Shanghai's land reclamation strategy shows a more sensitive approach. While expanding its shoreline by over 580 square kilometers, the city also designated portions of the new land for wetlands, parks, and inland lakes, recognizing their ecological role as absorbers of tidal energy. This shift from confronting water to negotiating with it illustrates the direction coastal design must take to remain sustainable.

Through these examples, it becomes evident that the interaction between architecture and water is not merely physical but systemic. Coastal morphology, wetlands, and oceanic flows are not passive backgrounds for human intervention; they are active agents that respond, reshape, and redefine human settlements. When we interrupt these systems without understanding their feedback, water answers back, sometimes violently.

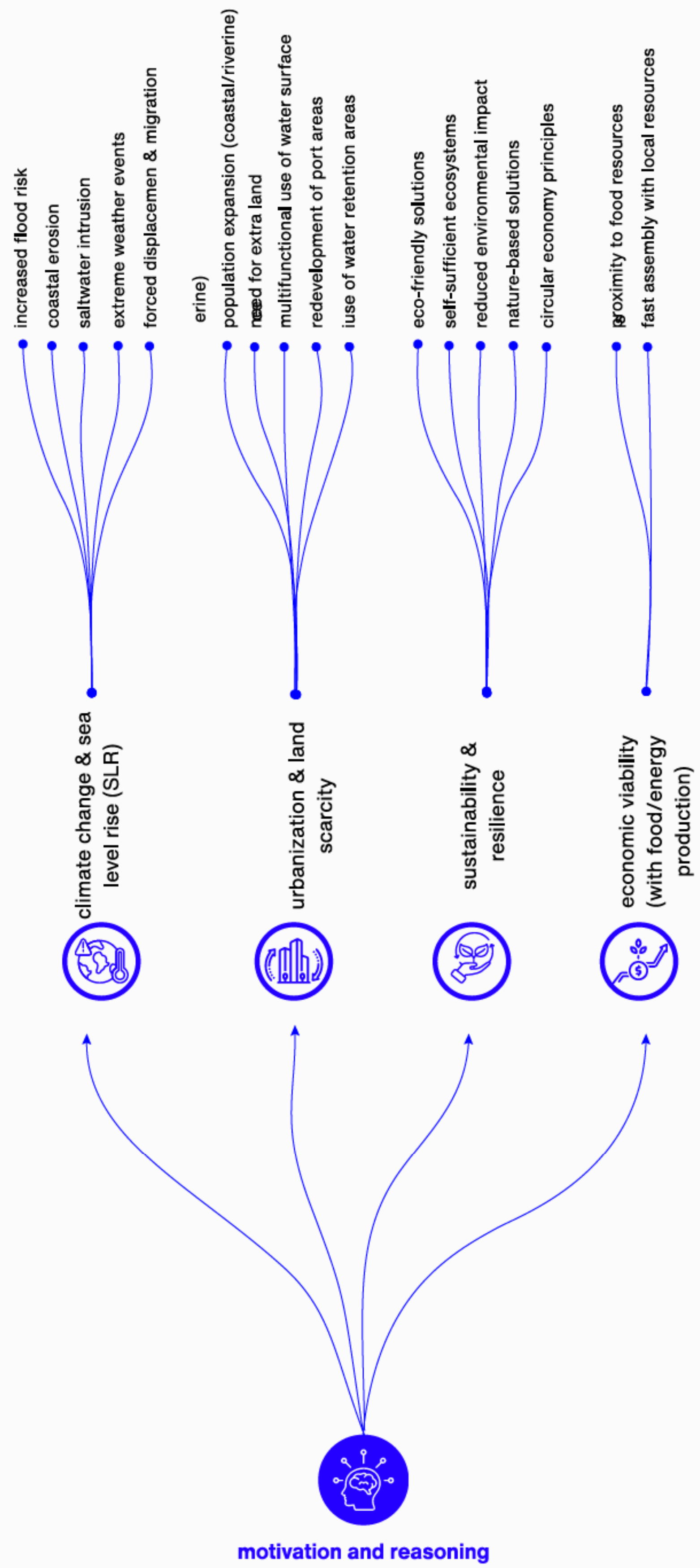
If architecture is, at its core, the art of inhabiting, then we must question what it means to inhabit fluidity itself. The future of architecture in water depends on shifting from the paradigm of control to one of coexistence, acknowledging that the sea cannot be conquered, only understood and designed with.


Park Design of Wetlands. Image by BLVD International

what is aquatecture?

Speaking formally, aquatecture can be defined as architecture that engages directly with water, emerges as both a critical and interesting response to the climate crisis. In the context of rising sea levels, unpredictable rainfall patterns, and the increasing frequency of extreme weather events, aquatecture could represent a growing preemptively adaptive architectural typology. As El-Shihy and Ezquiaga (2019) note, “Aquatecture is not merely about building on or near water, but about embracing water as an integral design element that reshapes both spatial and social dynamics” (p. 3).

During the last few years more and more small publications have been separately analysing aquatecture, without actually acknowledging the common ground that they may have with the similar typologies. Some of them focus on the mear technological characteristics of the individual typologies, like the many publications that the university of waterloo has published on amphibious architecture. Others, like Aquatecture by Richard Coutts, which proposes a very clear categorization of a few aquatic typologies of architecture, or the publication Aquatecture : architecture and water by Wylson, Anthony, which is to our knowledge, the first researcher to globalize the term, focus on a broad perspective and a first glace of what actually pertains to aquatecture. Through these texts, the first author dives more into the simple categorization of some of the typologies, leaving the question of how they can be compared. The second author speaks of the relation of water in architecture, avoiding the actual typologies of the architecture that inhabits water. Leaving a gap in the definition.



We need to consider that there are two distinct branches when it comes to aquatecture, the first is the one previously mentioned, a conscious response to a climate crisis or industrial necessity. Creating a research based, complex and technological aquatecture. And the second one comes naturally from the need of a certain community or cultural heritage. For the second one, essentially, we see the Palafitic and other vernacular water-based typologies demonstrate that aquatecture is also a global architectural condition, not confined to any one culture, geography, or technological framework. Across continents and centuries — from the Uros reed islands on Lake Titicaca, to the Tofinu stilt villages of Ganvié in Benin, the Kampong Ayer settlements of Brunei, the Bajau Laut nomadic boat communities in Southeast Asia, and the palafitos of Colombia and Venezuela — humans have devised remarkably similar architectural responses to living with water. These settlements share universal principles of form and adaptation that emerge from water’s physical demands rather than stylistic trends: elevation, buoyancy, lightness, permeability, and the capacity to grow organically over time. As such, they transcend the morphological constraints of land based architecture.

This is essentially what interests us from aquatecture, the versatility that all instances have, to be explored in the different areas of the world. Aquatecture adapts to diverse needs, environmental variables, and cultural contexts, yet its formal language remains remarkably consistent across regions. This universality of form underscores the importance of understanding and consolidating the programmatic roles, spatial logics, and evolving trends associated with each typology — elements that ultimately define how these water-based architectures function and evolve beyond their physical shape.

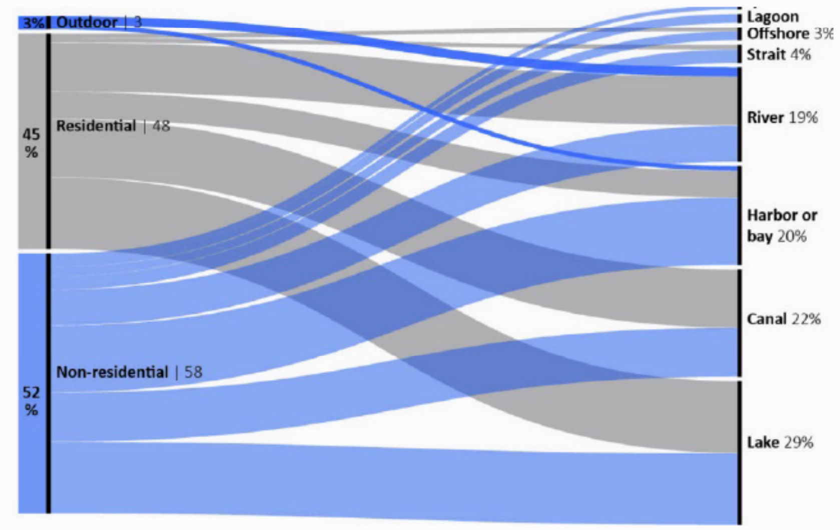


Figure 1. Alluvial diagram showing the correlations between marco-function (residential, non residential and outdoor spaces) and water typology.
Source: Livia Calcagni

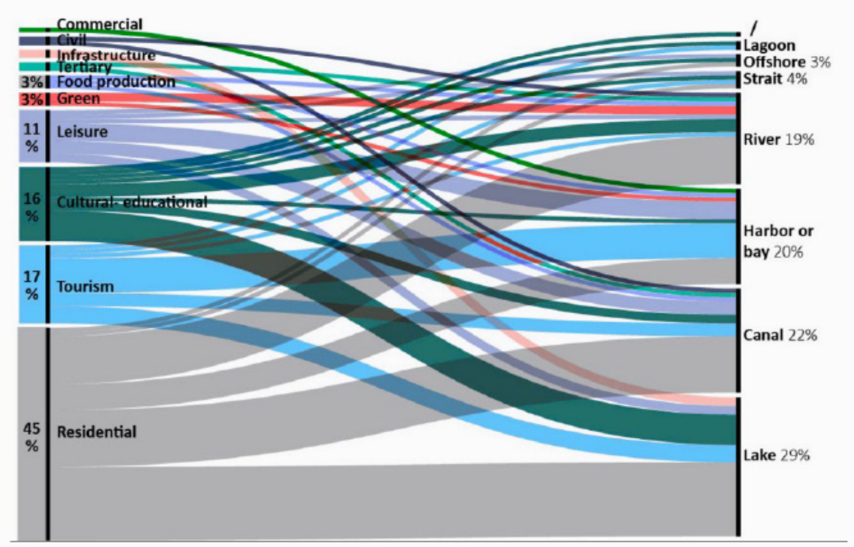
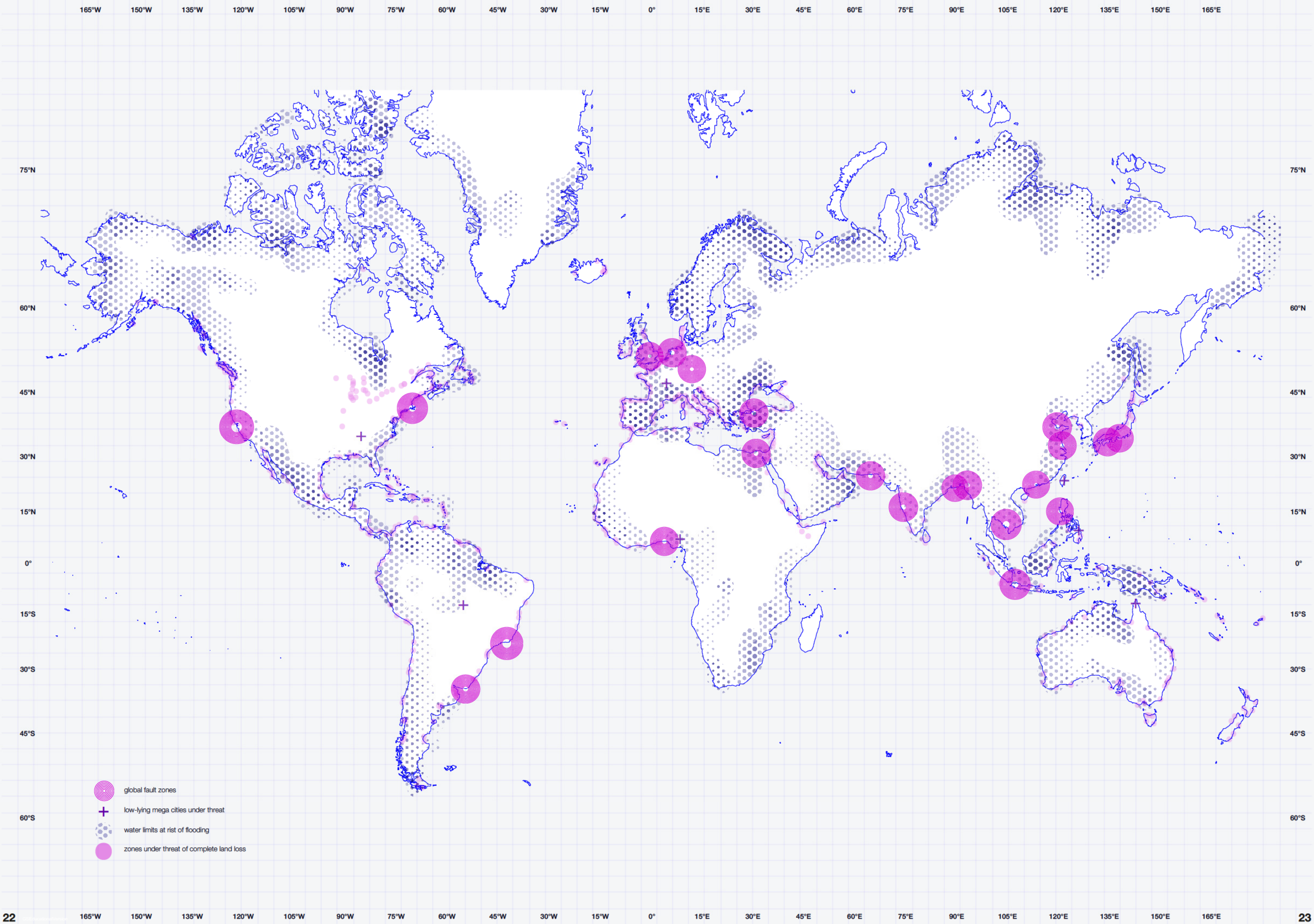


Figure 2. Alluvial diagram showing the correlations between specific function and water typology.
Source: Livia Calcagni



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global fault zones
low-lying mega cities under threat
water limits at rist of flooding
zones under threat of complete land loss

categories of aquatecture

Aquatecture encompasses diverse architectural responses to water, extending far beyond symbolic or aesthetic gestures. It includes practical, structural, and ecological approaches that allow buildings to adapt to the presence, movement, or fluctuation of water. Its most notable typologies are floating and amphibious buildings, which have gained increasing relevance in climate change, rising sea levels, and the need for resilient and adaptable design. Nevertheless, what we found interesting when exploring the limited resources about this architecture typology, is the fact that there are many additional categories that have not yet been fully explored and discussed.

When researching typologies within aquatecture, we were confronted with a fundamental question: What truly defines aquatic architecture? Does it encompass only structures physically in contact with water, or can it also include architectures that respond to, anticipate, or coexist with its presence? The term aquatecture itself implies a fluid disciplinary boundary, one that extends beyond the literal to include symbolic, technological, and ecological relationships with water. This ambiguity shaped the scope of our investigation and the diversity of typologies we sought to represent.

The typologies selected for analysis reflect this gradient of interaction with water, each illustrating a distinct architectural attitude. Floating buildings embody consistent and fully situated aquatecture, existing permanently on water surfaces. Pile or stilt buildings represent ancestral aquatecture, grounded in vernacular wisdom and community-based adaptation. Amphibious buildings express responsive aquatecture, capable of transitioning between land and water conditions. Boat-based dwellings signify movable aquatecture, emphasizing mobility and adaptability to shifting aquatic environments.

Beyond these four core types, we also identified complementary categories that expand the conceptual field: rain gardens and flood-storage systems as strategic urban aquatecture, mediating between hydrological infrastructure and the built environment; and offshore structures as industrial aquatecture, operating at large scales and in extreme marine conditions.

Together, these classifications reveal that aquatecture is not a singular typology but rather a spectrum of coexistence, where water and architecture negotiate their boundaries across social, cultural, and technological contexts.

Esencially we disiscovered was that the roots of Aquatecture are far from futuristic; they are deeply historical and often emerge from traditional responses to water. Discovering in depth the categories, from the palafitic settlements in Lake Titicaca and the Amazon to floating villages in Cambodia and Vietnam, we noticed that communities have long adapted their architecture to aquatic environments through localized knowledge and building practices.This approach informs current sustainable practices and presents a counter-narrative to modernist urban planning, which often sought to exclude or dominate water. According to Calcagni (2017), “Aquatecture frames water not as a threat, but as a connective and narrative element, shaping human rituals, circulation, and spatial belonging” (p. 74). This idea expands the architectural discourse beyond materiality and performance; it calls for emotional, cultural, and symbolic design dimensions.

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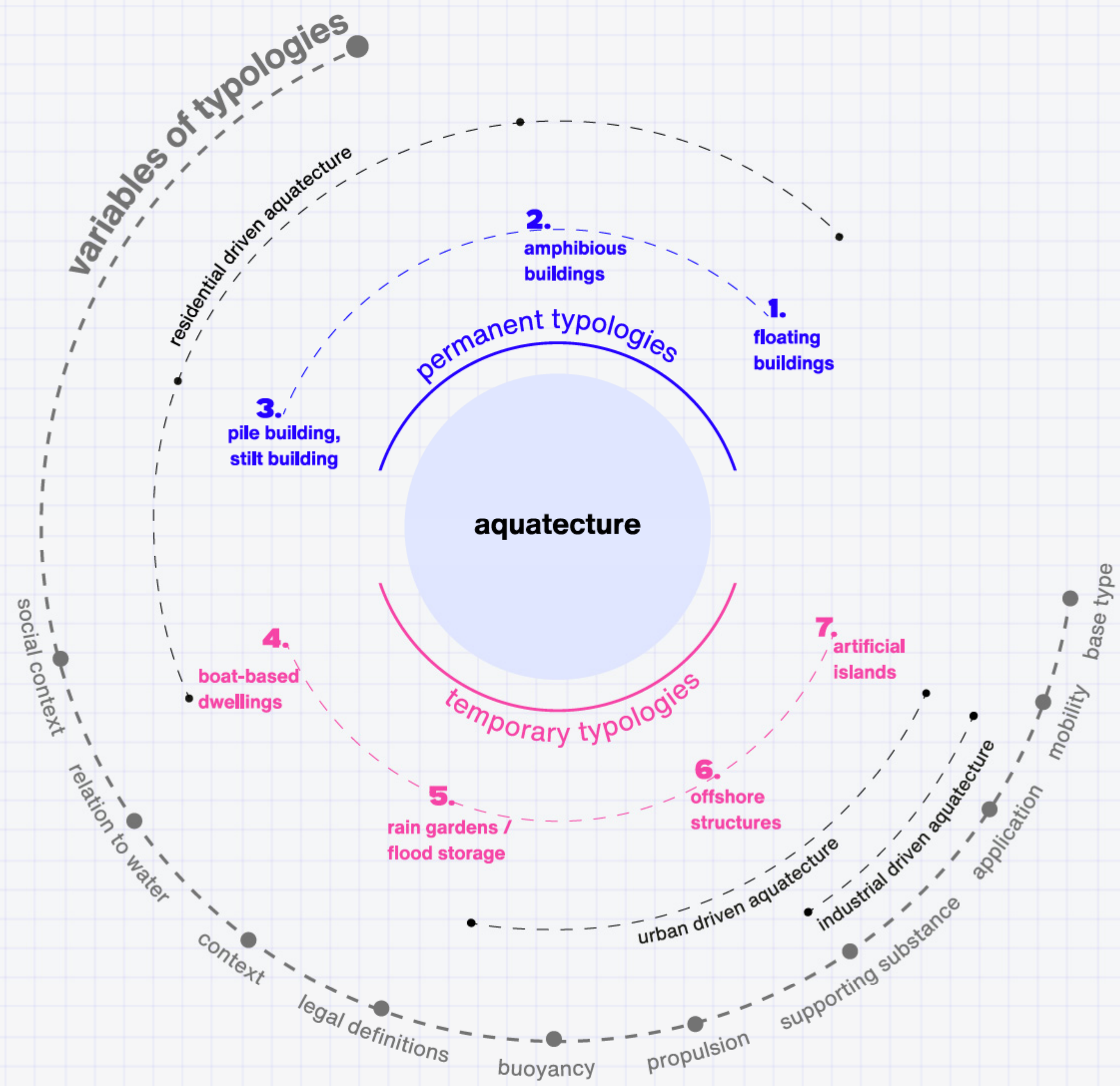


floating buildings

Floating buildings, also called floating architecture, rest entirely on the water's surface and are not physically anchored to the ground. These buildings typically float on buoyant platforms or pontoons, rising or falling with the water level. El-Shihy and Ezquiaga (2019) describe floating architecture as "buildings that are designed to float on the surface of the water and respond to its dynamics," offering flexibility in areas prone to flooding or land scarcity. They has evolved from traditional vernacular practices in Southeast Asia and the Amazon basin to high-tech, sustainable housing and infrastructure solutions in the Netherlands and beyond. Nguyen Thi Thu Trang (2020) emphasizes that floating architecture "solves spatial problems and promotes harmonious coexistence between humans and aquatic environments." This dual function, combining residential and ecological aspects, illustrates the broader goals of aquatecture.

- **Subcategories:**
Anchored floating buildings
Floating Agricultural Architecture

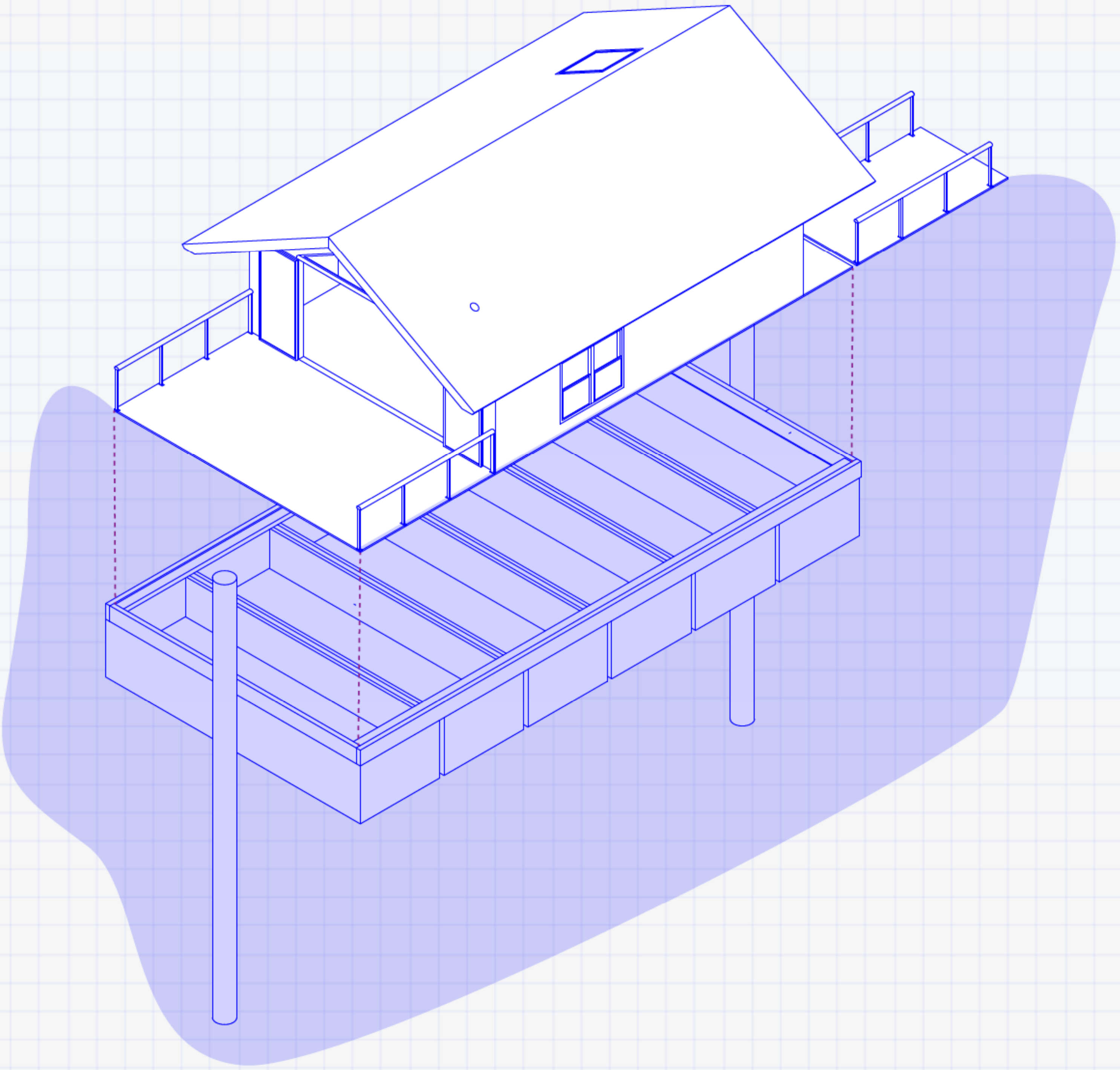
- **Technological system:**
Concrete or HDPE pontoons, anchoring systems, water-based utilities

- **Socio-cultural context:**
Urban waterfronts, tourism, climate adaptation zones

- **Materials**
Reinforced concrete, marine-grade steel, sustainable timber

- **Weaknesses:**
High initial costs, maintenance needs

- **Stenghths:**
Scalable, relocatable, adaptable to water-level changes



Floating Office Rotterdam is a three-storey building floating in Rotterdam's Rijnhaven. Photo and main image are by Marcel IJzerman

This typology of architecture differs to the ordinary methods because of its particular need of consideration for buoyancy, load distribution, anchoring systems, and wastewater management. Battisti et al. (2021) notes that "technological innovation plays a fundamental role in enabling the safety and functionality of floating structures," especially in urban contexts. These buildings are often seen as part of a future urban strategy for delta cities, offering an alternative to land reclamation or costly levee systems. It initially emerged as a response and a challenge within contemporary design, challenging the traditional dependency of architecture on solid land.

The structures are designed to inhabit water, either permanently or semi-permanently, using buoyant foundations. These buildings are not built on water as temporary shelters, but with water as long-term habitats. El-Shihy and Ezquiaga (2019) describe that floating architecture in deltaic regions, such as Abu Qir, Egypt, that blends hydraulic engineering with social resilience, enabling communities to persist despite rising tides. Nguyen Thi Thu Trang (2017) further emphasizes how floating homes in Vietnam reflect vernacular wisdom: passive strategies that will allow climate adaptation through low-tech design, flexible interiors, and strong community ties. Other authors like Nguyen Thi Thu Trang (2020) underlines the importance of anchoring systems that do not damage the riverbed and allow biodiversity to coexist with human settlement for example in the Mekong Delta, where "floating structures are designed to move and breathe with the river, without disrupting its ecological balance" (p. 56). Projects like the Makoko Floating School in Lagos or Floating Homes in Ijburg, Amsterdam, exemplify how floating buildings can provide dignity, comfort, and continuity in regions affected by floods or climate displacement. As stated in the IAPS Symposium (2011), "the reconfiguration of aquatic territories as livable and productive spaces calls for an interdisciplinary and participatory design process" (p. 35). These are some of the more high tech examples that have emerged from the traditional model of floating architecture, but there are also advancements like SEAform that is sustainability project designed in Politecnico di torino that was thought of "to address the coastal cities challenges by creating self-sufficient communities integrated with the

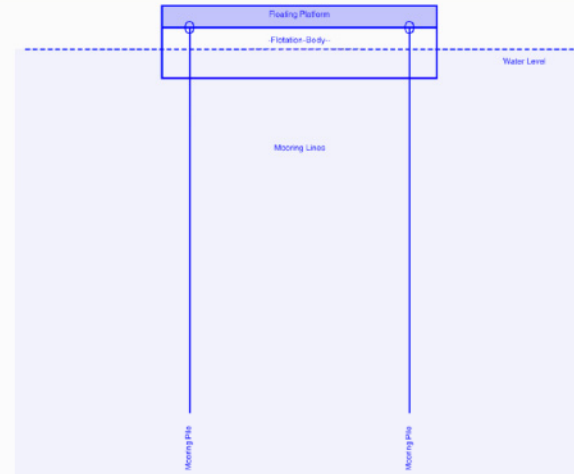


fig.1. Mooring piles stabilize floating platforms while allowing vertical movement. In projects like Schoonschip (Amsterdam), visible piles secure homes within the canal.

marine environment, using interconnected modular floating platforms. The platforms are anchored to the seabed and, if in open sea, protected from wave action by floating breakwaters" (Pincetti, 2023) We can observe that floating architecture becomes more than a construction typology, it proposes a shift in the relationship that human race has with the environment, where water becomes a new medium of housing. This typology is not simply about resisting environmental risks but rather living with them, turning it into opportunity and flexibility to climate change.

The general discussion often moves between pragmatism and utopia, which creates a difficulty to determine the authenticity of certain proposals. Nevertheless, architects such as Koen Olthuis (Waterstudio.nl) envision water-based urbanism as a necessary evolution of the city. His floating neighborhoods are not dystopian retreats but proactive responses to climate volatility, spaces that remain accessible, connected, and productive. Piątek (2019) frames floating architecture as a disruption of modernist planning. It decentralizes the grid, redefines permanence, and introduces architectural mobility. In this context, water-based buildings are prototypes of post-terrestrial urban futures.

From an engineering perspective, floating buildings must address unique challenges, including hydrodynamic forces, structural stability, anchorage, and accessibility. High-density concrete pontoons, marine-grade steel, and modular connections are standard solutions, enabling buildings to remain stable while adapting to water fluctuations. The basic principle of floating architecture is that all mass that is being placed on top need to be removed from under water, this is what gives the structure the ability to float. This is what Livia Calcagni defines in her thesis Floating Architecture for Future Waterfront Cities, as "Floating sub-structure or floating body or flotation body which are the part of the structure of the floating building that provides the buoyancy of the structure". This, paired with some tipe of mooring technique is what creates the stability of the system. The most used technique is Mooring piles. These are "Poles driven into the bottom of the waterway with their tops above the water. The floating building is tied to the poles through mooring lines to fix and stabilize its position." (Calcagni, 2024). One of the benefits of floating architecture is this flexibility of mooring and not mooring, creating opportunity of movability but always maintaining the attribute of stability.

Materiality is also critical, extending beyond structural performance to engage with ecological and cultural integrity. Malheiro et al. (2020) investigate the use of reeds in floating systems, emphasizing their insulating properties and the carbon-neutral nature of their lifecycle. Fernandes (2021) explores palafitic architecture in Portugal, showing how traditional wooden systems inherently provide climate adaptability, water resistance, and social continuity. Livia Calcagni (2022) introduces a computational approach to material selection, simulating energy performance to balance environmental and spatial quality. These studies reflect a common thread: Floating architecture must move beyond synthetic, high-carbon materials and engage with local, renewable resources, such as bamboo, timber, and recycled plastics, crafted through both digital and artisanal methods. Technological innovation must be accompanied by context-specific design since most of these floating structures risk becoming isolated and irrelevant without grounding in local climates, ecosystems, and social systems. When thinking of materiality, there is also an esencial element to keep in mind ands that is weight. As mentioned before, the size of the structure is directly dependant of the weight in the inferior structure. The heavier the top part is, the bigger the structure must be. This creates a sort of limitation in materials and height, as it need to be thought of strategically in order to maintain project financial viability. Most floating structures end up using wood which allows a bit more of a leeway in terms of weight.

Another key element that is clear in floating architecture is modularity and flexibility in program, as Koen Olthuis emphasizes phrasing them as key design principles. His projects often rely on prefabricated units that can be relocated or expanded, creating flexible, future-proof systems. We can also see this in some of the famous floating buildings like the Floating Office Rotterdam by Powerhouse Company, where it exemplifies how structures made for modularity are a perfect match for floating buildings as they not only help with the principle of stability but also with the sustainability concept that this typology natyurally follows. This building, for example, uses a gridlike wooden beam structure with punctured beams that allow the flexibility to change programs after years of being build. This mentality was a key aspect when designing the office, as it would be one of the first floating structures to be thought of as long lasting and adaptable through time. This is proof that floating architecture unlocks a diversity of programmatic possibilities. While housing remains the most common function, recent projects have expanded into education, health, culture, commerce, and research. Floating schools (e.g., in Bangladesh), mobile health clinics in the Amazon, and even floating mosques (Reinl, 2020) demonstrate how critical infrastructure can adapt to water-based environments.

Public space could and is also being redefined. Floating platforms can serve as communal dining areas, markets, recreation hubs, or venues for environmental education. These multifunctional nodes foster resilience by supporting both everyday use and emergency response. Such floating programs are not experimental in vulnerable regions; they are necessary. They respond to the lived realities of rural and peri-urban communities facing seasonal displacement and systemic neglect. Bringing back the example of the floating office of rotterdam, this structure not only added a office program to the watter, but also created a new typology of public space where people could enjoy the water in the middle of the urban center. The park added to the platform is house to all yearround public space in a part of the city that cleary lacked public areas for residents.

Despite its potential, floating architecture faces considerable limitations. First, regulatory frameworks are primarily terrestrial in nature. Building codes, land tenure systems, and municipal services are not designed to accommodate floating developments. Penning-Rowsell (2020) calls for urgent legal innovation to legitimize these habitats and integrate them into urban governance.

The Floating School in Bangladesh illustrates aquatecture as an adaptive and resilient response, providing education in flood-prone communities.

Second, scalability remains elusive. Many floating projects are limited to isolated prototypes or luxury developments, lacking systemic integration or public access. Storbjörk and Hjerpe (2020) warn of "pilot paralysis", a cycle of endless experimentation without long-term deployment or policy inclusion. Scalabiluty is also limited in terms of height, as mentioned before, the cost and likelihood of a tall structure over water is almost impossible with the technology we have today, apart from the limited space underwater for the ginormous structures that would be needed yto withhold such weights. This is something we need to keep in mind when watching the utopian floating proposals, since not only because of physics, but also in terms of cost, this architectural typology still has a lot of limitations.
Third, floating architecture risks cultural detachment. Imported models may ignore local histories, rituals, and spatial customs. For floating structures to succeed, they must be co-designed with communities, respecting vernacular logic and ecological specificity.
Finally, floating solutions must confront their environmental impacts. The carbon footprint of concrete pontoons, the ecological disturbance of anchoring systems, and the potential for pollution must be critically assessed. Without this reflexivity, floating architecture may replicate the very problems it seeks to solve.

In its many forms, floating architecture represents one of the most necessary frontiers in climate-responsive design. It challenges the traditional ground-based assumptions of architecture and offers alternative ways of living that are flexible, adaptive, and water-bound. However, it cannot be reduced to visual spectacle or technical novelty. To be truly transformative, floating architecture must be contextual, inclusive, and ecologically sound. It must weave engineering with culture, technology with tradition, and innovation with equity. As the IAPS International Symposium (2011) argued, "Cities of the future may need to embrace amphibious and floating infrastructures not only as emergency measures but as permanent features of urban life." The insight shifts the conversation from short-term adaptation to long-term transformation.

amphibious buildings

While closely related to floating buildings, amphibious buildings differ in that they rest on solid ground under normal conditions but can float during flooding. In other words, these structures have dual behavior. They usually function as conventional buildings but become buoyant when water levels rise. This is achieved by combining a fixed base with a buoyant substructure and flexible utility connections. Like mentioned before, amphibious architecture falls into the flexible avoidance through elevation strategy that provides a passive response in a flood. It functions using Archimedes' principle, meaning the buoyant force on the submerged or partially submerged structure equals the weight of the fluid it displaces, allowing it to float. According to the IAPS International Symposium (2011) findings, "amphibious architecture offers a low-impact solution for flood-prone regions, allowing inhabitants to remain in place without requiring permanent elevation or relocation." This ability to maintain everyday life while adapting temporarily to extreme events makes amphibious buildings a concrete response to climate risk.

- **Subcategories:**

Purpose-Built Amphibious Houses – such as the Baca Architects' home on the Thames, designed to float within its dock during floods.
Retrofit Systems – (e.g., Buoyant Foundation Project) where existing homes are given floating foundations. (seasonal building)

- **Technological system:**

Buoyancy blocks, vertical guidance piles, and waterproofing membranes

- **Socio-cultural context:**

Floodplain settlements, disaster-prone rural and urban areas

- **Materials**

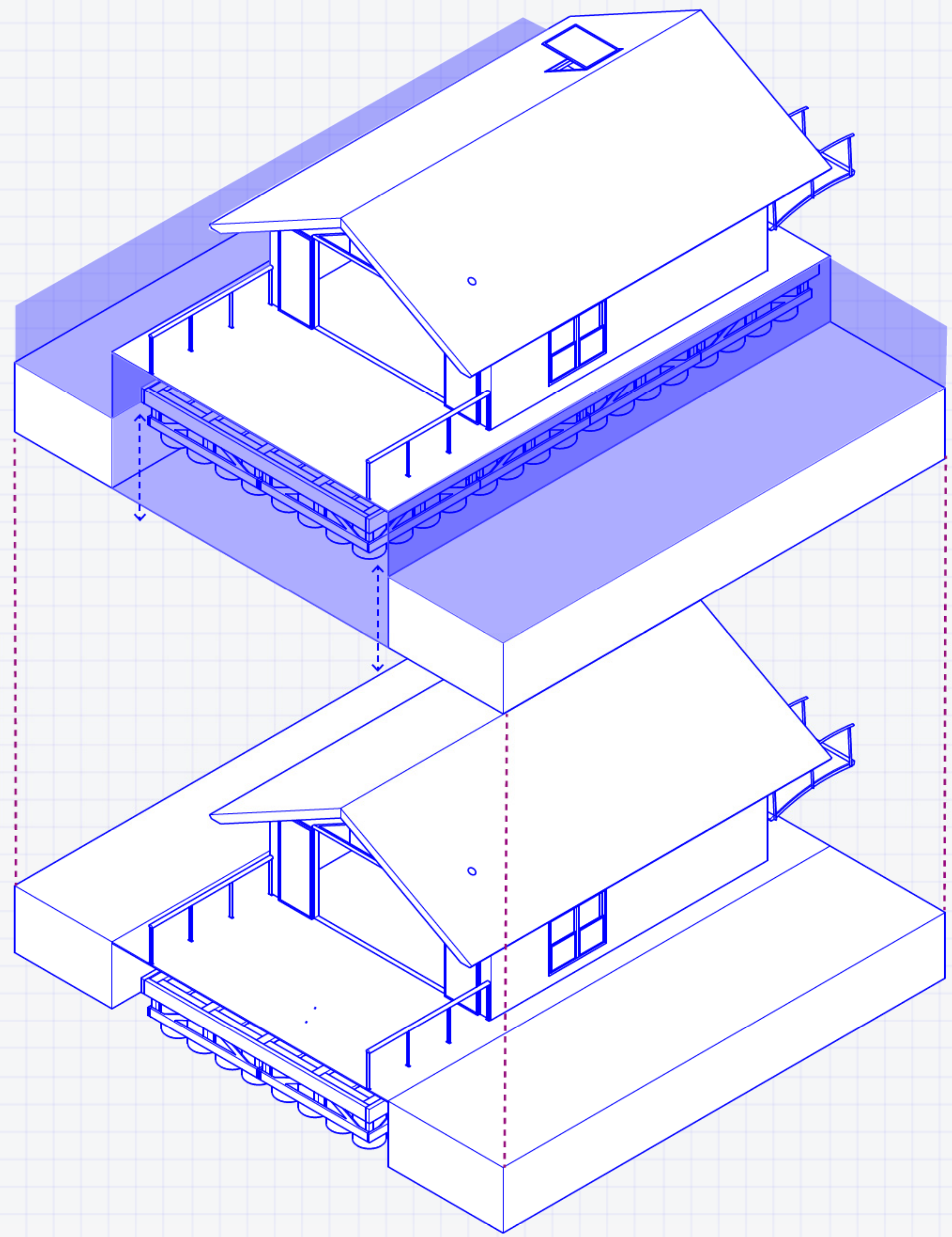
Timber frames, steel guideposts, EPS buoyant cores

- **Weaknesses:**

Requires predictable flood patterns, high engineering precision

- **Stenghths:**

No relocation needed, dual-function land/water living



Unlike floating buildings, which often require new infrastructure or urban planning models, amphibious solutions can be integrated into existing urban or rural contexts, especially in low-income or informal settlements. In her doctoral research, Livia Calcagni (2020) points out that “amphibious architecture bridges the gap between traditional building and adaptive strategies, providing a culturally sensitive and cost-effective alternative.”

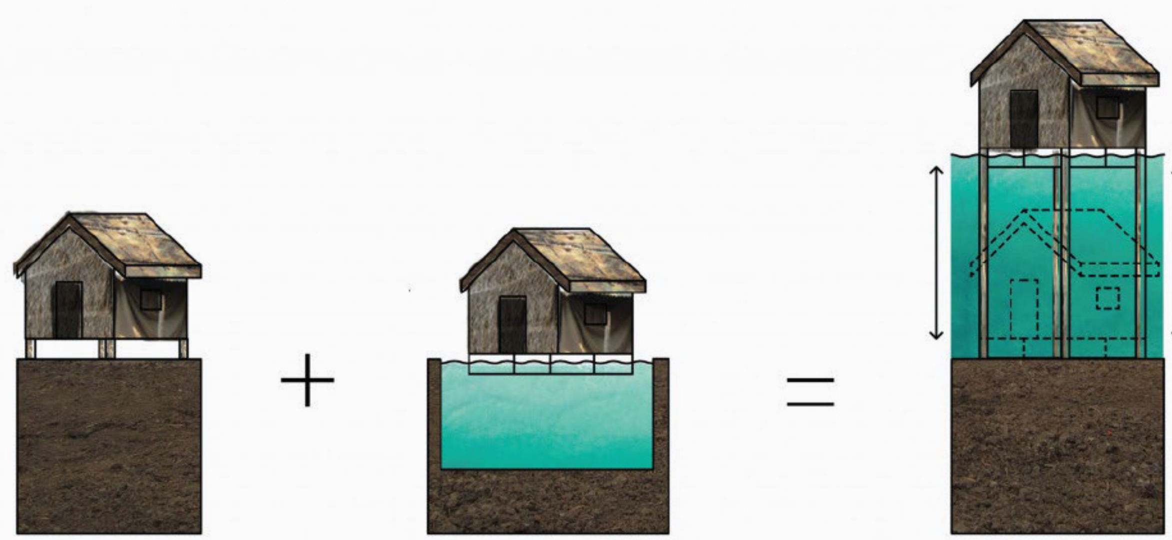
One of the key aspects of amphibious buildings is the adaptability in terms of water level variations, this is due to the need to adapt in flood-prone or tidal areas. This flexibility allows them to accommodate rising water depths and adapt to rising sea levels and land subsidence. This brings us to the concept of flooding; it is key to understand this when speaking about amphibious architecture. Floods usually arise due to multiple situations, like intense precipitation, storm surges along coasts, clogged drains, or rapid surface runoff, varying by location and conditions. From these characteristics, the main flood characteristics that influence the extent of flood damage can have to regular buildings are: the flow of velocity, duration, and contaminant content. According to an article about Amphibious Architecture: A Biomimetic Design Approach to Flood Resilience, “generally, the greater the floodwater velocity, the greater the probability of structural damage. Floodwater can also be contaminated, and the contaminants can influence the water absorption characteristics of building materials used and the drying time of the materials, as well as pose health risks and affect repair costs.” Amphibious buildings were created and designed to mitigate the damage that these elements can cause directly.

The fundation of these buildings usually consists of 4 key elements:

- The Buoyancy system/element: These elements displace water to lift the building. Examples include expanded polystyrene (EPS) blocks, watertight concrete hulls, steel Styrofoam-filled pontoons, hollow ferrocement structures, or bamboo-framed foundations filled with air-filled bottles.
- Vertical guidance posts (VGPs): These posts prevent lateral movement, ensuring the building only moves vertically up and down. They are often steel pilings or concrete foundation piles. For instance, the UK’s first amphibious house uses flexible vertical guidance posts known as ‘dolphins’ that can stretch up to 4 meters.

Built in 2007, the homes float through floods on buoyant foundations. Photo Courtesyy of Dura

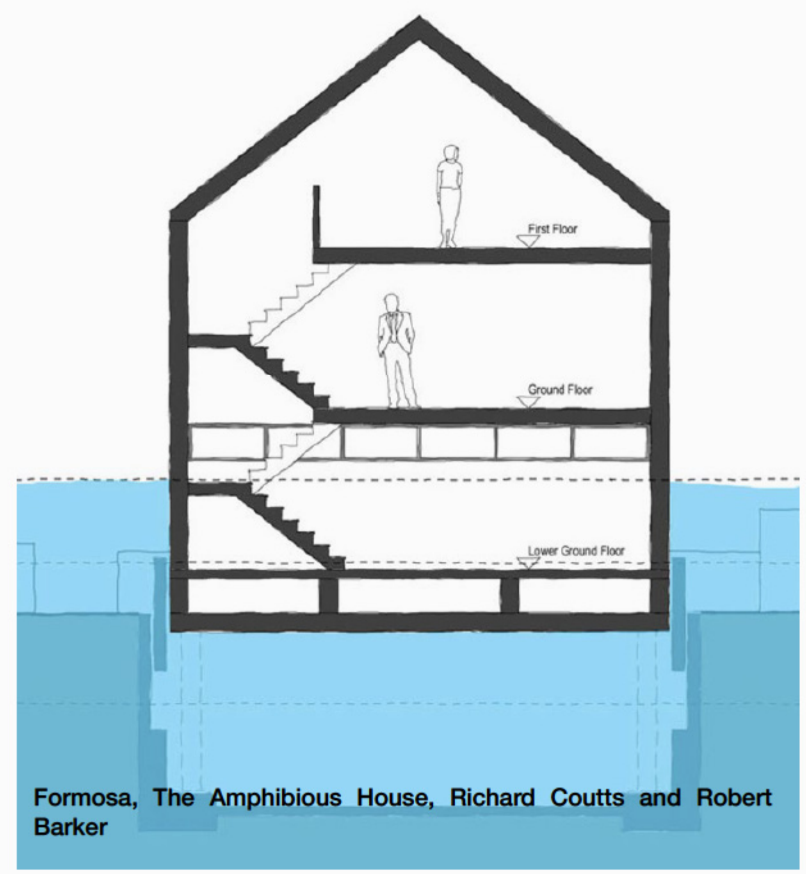
A-frame pavilion prototype as constructed at the University of Waterloo School of Architecture By Michelle Castro Bullough



Source: Buoyant foundation

- Structural sub-frame: This frame is installed beneath the floor system, connecting the superstructure to the buoyancy elements and vertical guidance posts, providing support and stability.
- Passive vs. Mechanical Systems: While originally designed to act passively without the need for external preparations during a flood, some modern amphibious buildings incorporate mechanical systems to aid buoyancy. These systems, however, require external operation, which can compromise the passive response of the original design

Amphibious architecture is essentially a subset of broader aquatecture, offers dynamic and adaptive design solutions to integrate human settlements with aquatic environments. It is a response to pressing global challenges, aiming to create sustainable, resilient, and culturally appropriate living spaces by carefully considering environmental impacts, material innovation, energy efficiency, and community participation. However, successful implementation requires overcoming significant infrastructural, social, and regulatory hurdles, especially in vulnerable, isolated communities.



Formosa, The Amphibious House, Richard Coutts and Robert Barker

pile/stilt building

Stilt buildings or pile buildings, most commonly known as palafitic architecture, are buildings constructed over water, which are most commonly found in low-income or rural aquatic areas. These buildings consist most commonly of wooden structures that are driven through the water and into the subsoil. Since they are more of a cultural and vernacular architecture, they are mostly built in community areas, which passed down the knowledge and technique for the most accurate way to be placed over water. The structures are mostly elevated and static, and often part of a more extensive urban fabric of houses of the same style, and sometimes even community and collective buildings surrounding the community. They enable communities to adapt to changing water levels in lakes, rivers, and marshes, as seen in Ganvié, Benin, and Raccourci Old River, Louisiana. In Agusan Marsh, Philippines, floating villages were developed as a “grass roots solution” to fluctuating tidewaters and frequent earthquakes, where houses on the shore were at risk of destruction.

- **Subcategories:**

1. Traditional palafitos

- **Technological system:**

Timber or concrete piles, cross-bracing, and ventilation gaps

- **Socio-cultural context:**

Fishing communities, indigenous riverine cultures

- **Materials**

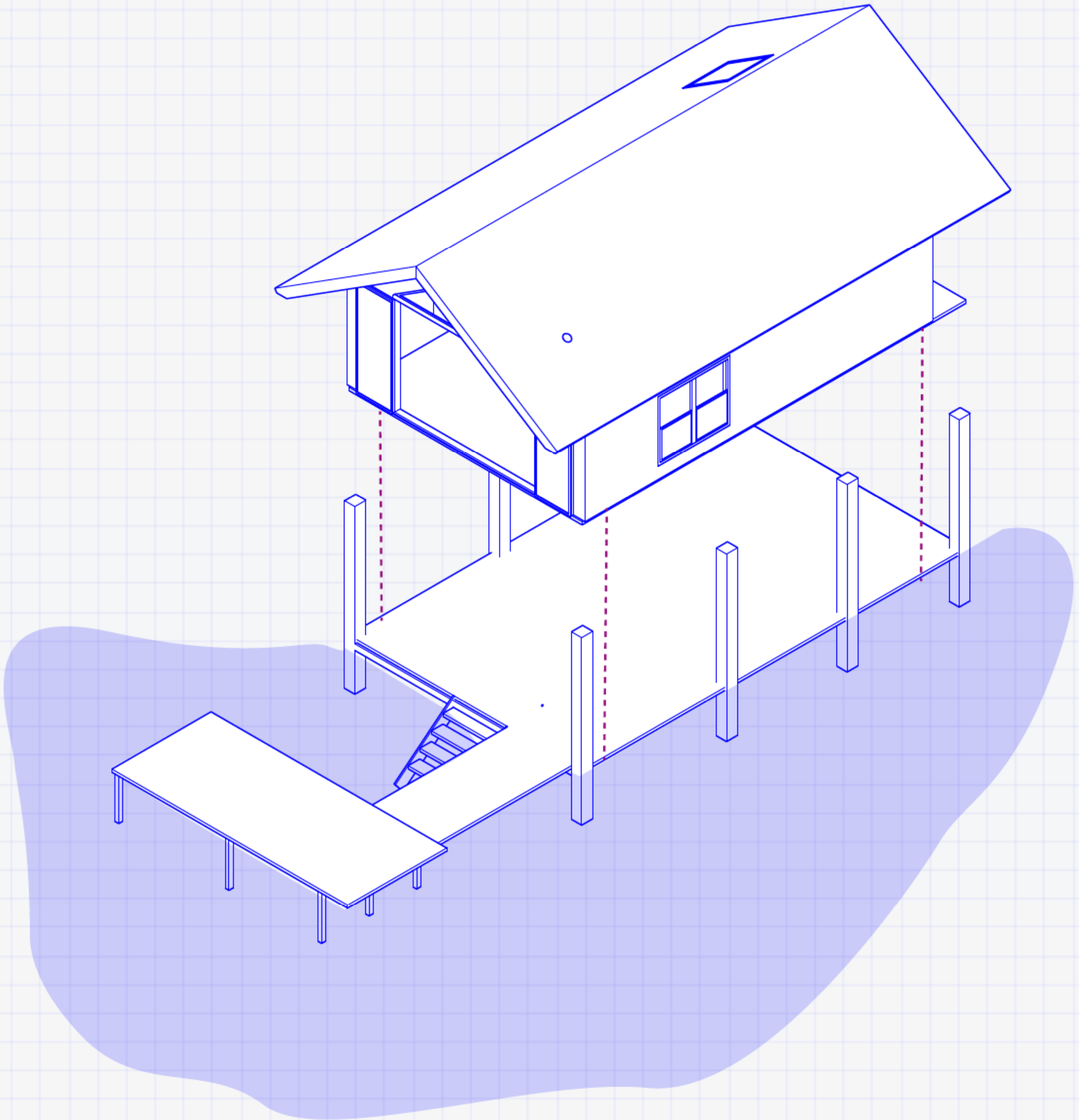
Local timber (mangrove wood (mangle)), bamboo, reinforced concrete,

- **Weaknesses:**

Fixed elevation limits adaptability to rising floods

- **Stenghths:**

Low-tech, culturally embedded, durable in stable water levels

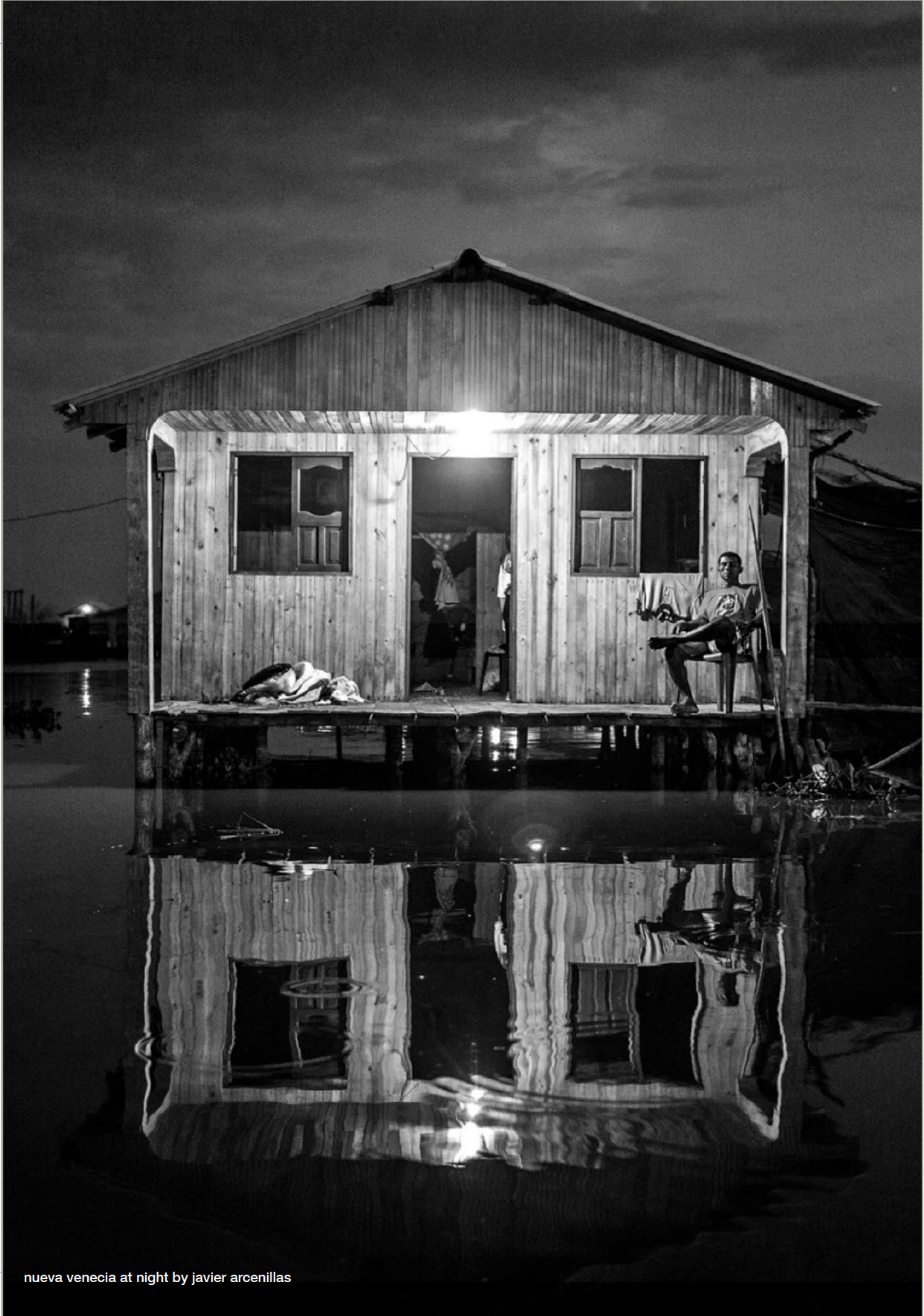


Stilt houses have proven to be the most effective way for rural areas to adapt to harsh conditions while maintaining the culture of fishing, boating and other relations to water. Historically, palafitic architecture emerged from the need to protect against predators, regulate building temperatures, and provide ancient inhabitants with easier access to water sources for fishing. They serve as a strategy to isolate structures from potential attacks by wild animals or floods during rainy seasons in high-risk zones. For these communities that have settled in the aquatic areas, they facilitate a certain use of natural resources, economic incomes and everyday tasks.

One clear example is one of our case studies, Nueva Venecia (Colombia), where a danger zone of climate change, urged a fisherman society to create this urban settlement of stilt houses, creating not only a neighborhood, but an urban fabric. Nevertheless this is not the only place where the technique has been spotted. Southeast Asian fishing villages also embody this technique and show the capacity of adaptation to wetlands and tidal areas. While inherently static, they are cost-effective and culturally significant. (Oliver, 1997). Which correlates to the fact that these structures are almos a obvious choice when it comes to water dangered zones.
The stilt houses are often conformed of a base palafitic structure, and a very lightweight and vernacular upper part, where the house rests. Roofs may be constructed from wood brought from neighboring areas, asbestos cement sheets, or more local materials like straw or palm. The lower part, often referred to as Pilots, are wooden elements that are typically driven 2.00 meters into the earth. Foundation piles are commonly made of wood, concrete, or steel. While steel piles offer high load-bearing capacity, they are susceptible to corrosion. Pre-cast concrete piles are difficult to cut and maneuver, and timber piles have limited load-bearing capacity. Increasing the angle of piles (15-30 degrees) can enhance their load-bearing capacity. The piles are then attached to the structure for decking, that can involve overlapped wooden battens, secured with stainless steel bolts and L-shaped plates, and then screwed to the pilotes. Decking itself may be sapan wood planks nailed with stainless steel nails

Some modern designs, while retaining the essence of stilt architecture, may use piles not as the primary structural support but to prevent lateral movement of floating modules,allowing the main floating structure to adapt vertically to changing water levels. This method of Exterior cladding, such as wooden boards, can be laid horizontally and overlapped for protection against wind, sand, and rain. Surfaces may be treated with substances like sardine oil, or later, burned engine oil, to enhance resistance, and pillars can be coated with asphaltic bitumen to delay degradation from soil moisture.

Unfortunately, due to the nature of the cultural context and building methods, they face significant vulnerability due to the absence of basic sanitation, a direct consequence of their isolated condition. This lack not only endangers public health but also fuels broader environmental challenges, particularly the uncontrolled disposal of waste, which can escalate into severe ecological degradation. Moreover, the timber structures that dominate palafitic architecture, while affordable and highly adaptable, demand regular upkeep of their foundations and protective coatings to withstand atmospheric wear, insect infestations, fungal growth, and the inherent risk of combustion.


nueva venecia at night by javier arcenillas

boat-based dwellings

Boat-based dwellings are mobile or semi-permanent vessels adapted for residential use. Most commonly known as houseboats, these can range from small motor yachts equipped with high-comfort interiors to repurposed working boats transformed into living spaces. Some are purpose-built for habitation, while others are retrofitted from fishing or cargo vessels. Mobility is a defining characteristic; many are self-propelled and can navigate to different mooring locations, although some are non-motorized and rely on towing or favorable currents. (Wang, K.F. 2021) Non-motorized houseboats often require access to harbor infrastructure, marinas, or designated mooring zones to connect to electricity, potable water, and sanitation facilities (McCarthy, 2005).

- **Subcategories:**

1. Houseboats
2. liveaboard barges
3. Floating shanties

- **Technological system:**

Marine hull design, onboard power/water treatment, mooring systems

- **Socio-cultural context:**

Nomadic maritime cultures, urban houseboat communities

- **Materials**

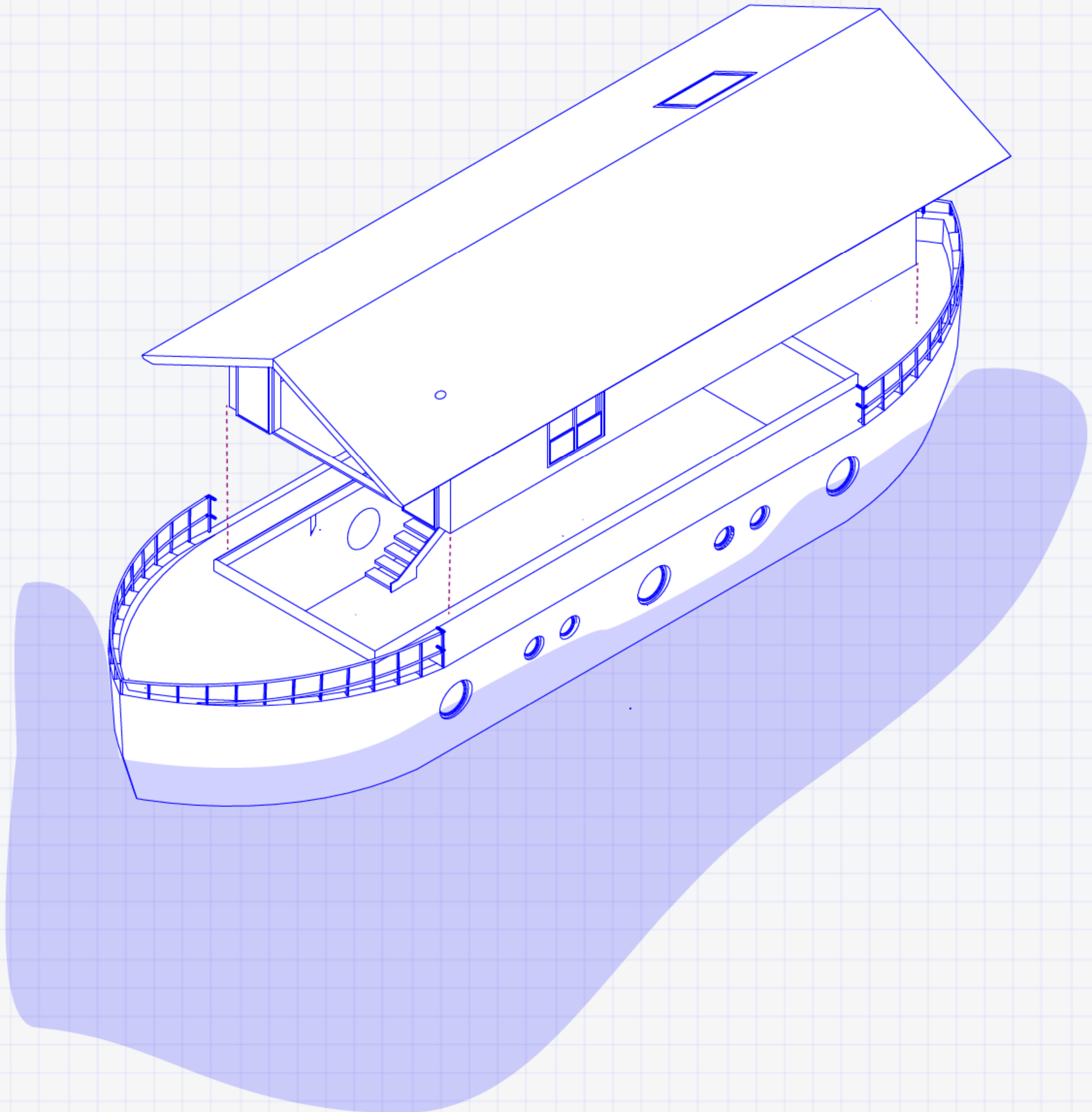
Fiberglass, marine plywood, steel

- **Weaknesses:**

Limited space, maintenance-intensive, weather-dependent

- **Stenghths:**

Relocatable, responsive to changing environments



While houseboats are frequently confused with floating houses, there is a crucial distinction. Floating houses are static structures designed to float on buoyant foundations, typically without propulsion or navigational capabilities. In contrast, houseboats originate as watercraft and are then adapted or built to serve as permanent residences. This functional and design difference impacts not only their mobility but also their legal classification, construction methods, and integration with urban or rural waterfronts.

House boats have emerged from diverse cultural, economic, and environmental needs. For example, in the Amazon Basin, seasonal flooding makes land-based housing become impractical for part of the year. Living aboard vessels allows families to adapt to fluctuating water levels without displacement. In Ganvié, Benin, the Tofinu people created an extensive waterborne settlement in the 16th century to avoid capture during the Atlantic slave trade, a defensive adaptation that also enabled sustainable fishing-based economies (Wang, 2021). Similarly, in South and Southeast Asia, boat-dwelling communities such as the Bajau Laut of the Philippines and Malaysia have maintained nomadic maritime lifestyles for centuries, using their mobility to follow fishing grounds and seasonal trade routes (Sather, 1997).

Economically, boat-based living often balances out the costs and bureaucratic constraints of land ownership. In regions where urban waterfront property is scarce or expensive (which is often most of the cases due to the high demand), houseboats can provide an affordable alternative, though they are not without hidden costs, such as mooring fees, maintenance, and fuel. Socially, these dwellings foster unique community networks, as seen in the houseboat colonies of Amsterdam, Seattle, and Kerala, where shared docking facilities and interdependent living arrangements create strong social bonds. This is why, unlike self-sufficient floating structures, many boat-based dwellings rely on shore connections for utilities such as electricity, water, and sewage. However, some modern designs are almost entirely self-sufficient. But this creates huge over costs in production and construction.
The design of boat-based dwellings is strictly related to the integration of marine engineering principles with traditional housing concept. Hull stability, corrosion resistance, weatherproofing, and efficient use of limited interior space are critical. Materials can range from traditional timber planks, favored in warmer, calmer waters, to steel or fiberglass hulls designed for durability in harsher climates.

Traditionally, they were wooden boats. Modern floating structures, even if classified as boats, might use materials like fiberglass for the hull. The floating compartment (pontoon) of more contemporary houseboats are often a waterproof platform made of fiberglass, steel, or concrete, filled with lightweight materials like foam.

There are many key limitating factors, one of the main ones being spatial constraints, which can limit programmatic diversity. While perfect for compact living, boat-based dwellings typically cannot accommodate large communal facilities without external floating platforms. Their reliance on water quality and harbor access means they are vulnerable to pollution, overcrowding in mooring areas, and legal restrictions on navigation or anchoring. Even though the ability to move and relocate easily might seem appealing, according to most water regulations, especially as specified in the NTA (Netherlands Standards for Floating Buildings), the materials and characteristics that a houseboat has, obliges an off water check of materials and integrity every 5 years. This poses an additional and costly element to the living situation. Degradation problems related to corrosion and biological colonization (e.g., mussels, marine organisms) can affect structural stability and require monitoring and maintenance. Another major challenge is their uncertain legal status, often falling between "real estate property" and "vessel". This hybrid status can lead to regulatory uncertainty and affects mortgages, insurance, and building permits. In many countries without specific floating building codes (e.g., Finland, Norway, France, Italy), obtaining building permits can be complex and time-consuming, leading structures to be classified as houseboats, boats, or barges


Dianne's Rose And Affordable Houseboat by Roy Schreyer


La Mare Apartboat M – taken from yachtall

offshore structures

In our research we came across with a very interesting variation of aquatecture. We identified offshore floating platforms as a specialized variant, often overlooked due to niche applications like energy production and exorbitant costs exceeding 50% above fixed-bottom alternatives. These structures adapt to deep waters via buoyant designs like tension leg platforms, integrating mitigation against sea-level rise through modular, self-sustaining systems including renewable energy and aquaculture. Separately, flood-proof buildings represent land-based aquatecture, resisting floods via watertight envelopes impermeable to water passage—allowing no more than 4 inches accumulation over 24 hours—or sump pumps for seepage control, ideal for non-residential uses in A zones, heritage sites, and high-value areas. Their high market value stems from intensive construction demands: advanced materials like corrosion-resistant steel and geopolymers, specialized equipment such as autonomous robots for precise placement, and highly skilled crews trained for extreme conditions including depth pressures, weather, and safety hazards.

- **Subcategories:**
Tension-Leg Platforms (TLPs)
Semi-Submersible Platforms:
Spar Platforms

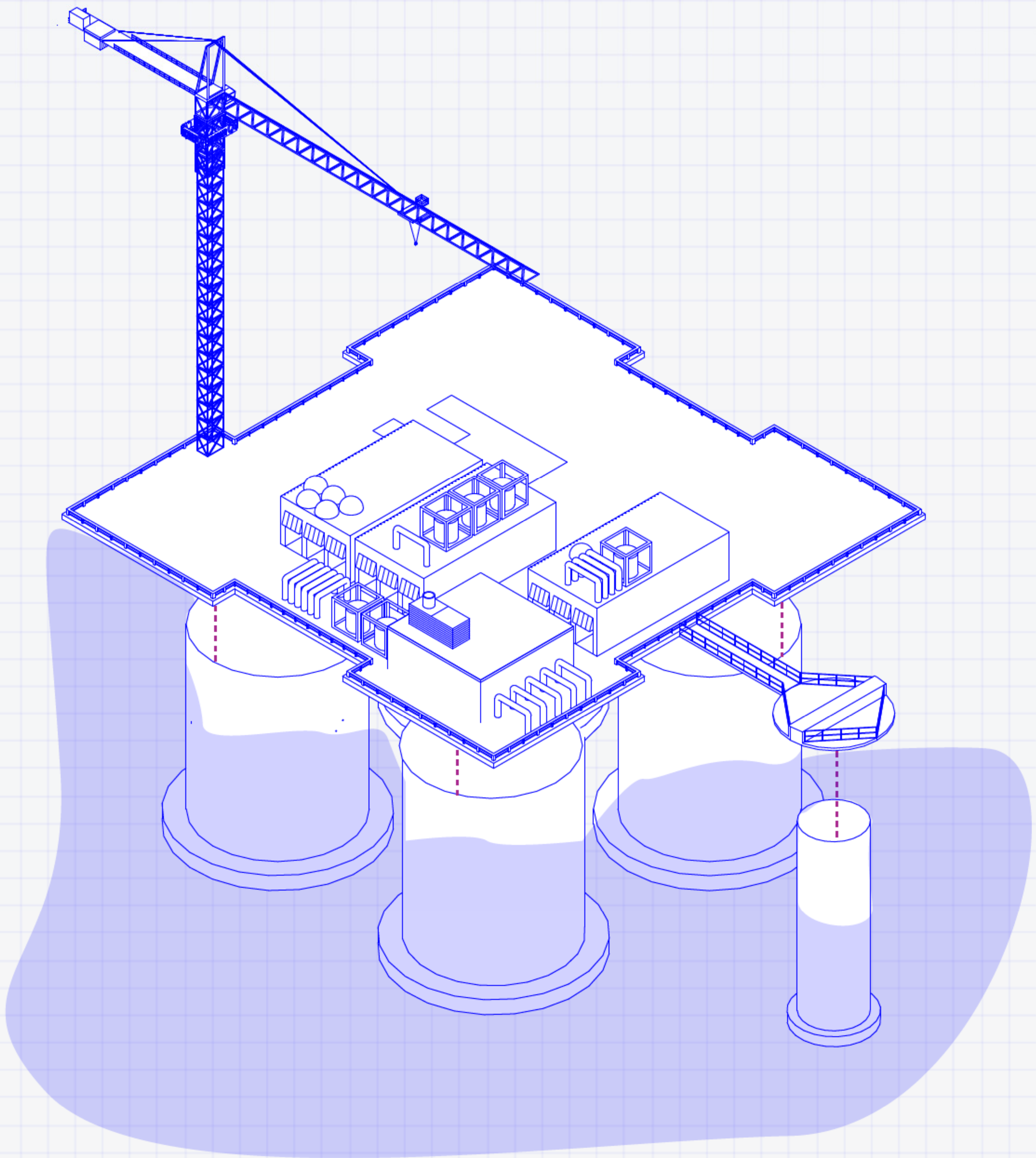
- **Technological system:**
Flood barriers, waterproof membranes, sacrificial floors

- **Socio-cultural context:**
Urban Expansion, waterfront industries, Economic Drivers

- **Materials**
Structural Waterproof Concrete, Protective Coatings, geopolymers, panels

- **Weaknesses:**
High initial costs, specialized expertise and expensive equipment, environmental impacts, Maintenance and safety inspections

- **Stenghths:**
Adaptable to deep-water environments, Scalable and modular, responsive to climate-driven coastal displacement.



These innovations highlight evolving over-water methods, from 3D reconstruction for surveys to buoyancy robots reducing labor risks, paving ways for scalable, resilient future designs.

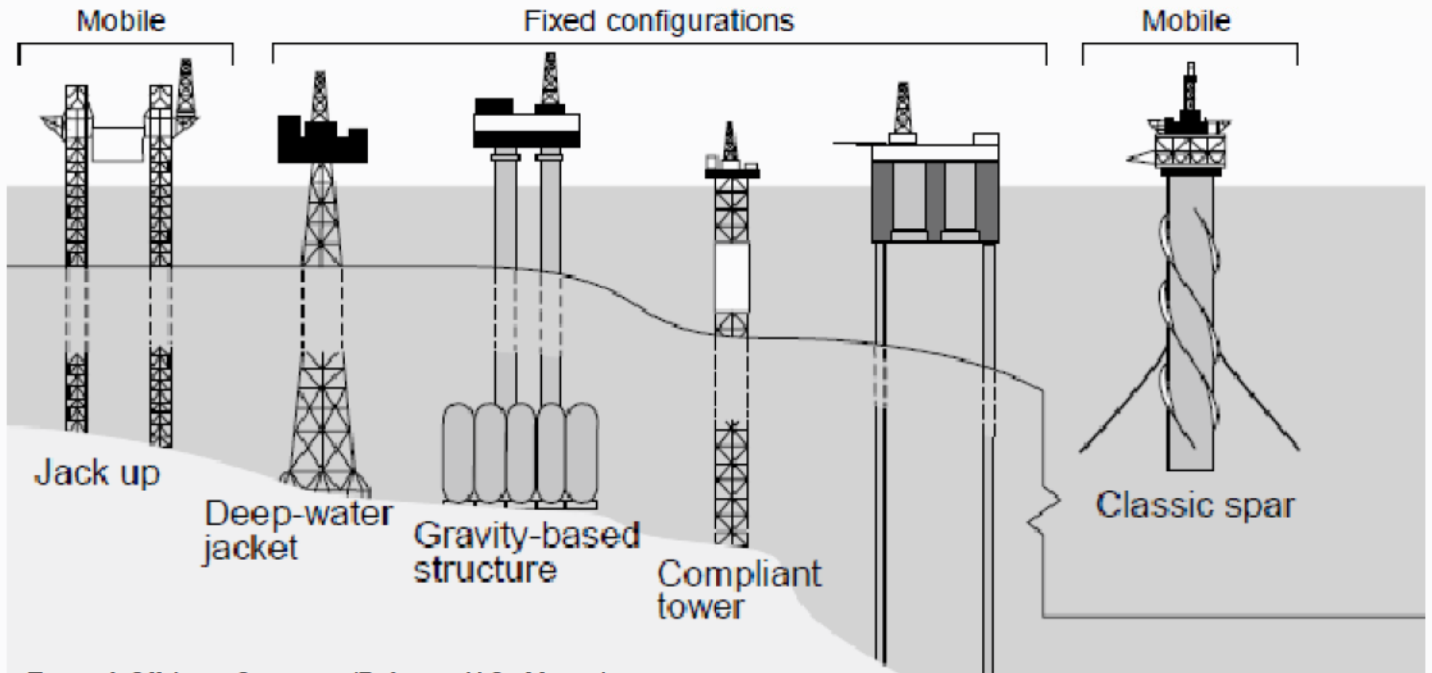
Recent developments have expanded the purpose of these platforms beyond single-use facilities into multi-use, modular systems. These Multi-Use Platforms (MUPs) integrate renewable energy production—such as wind, solar, and wave power—with aquaculture, research hubs, and even recreational facilities. Examples like the Ocean Grazer project propose hybrid systems capable of energy generation and storage, while designs by Blue21 explore floating urban extensions that could support entire offshore communities. These models envision platforms as self-sustaining nodes, embedding desalination systems, waste management cycles, and hydroponic farming into their structural frameworks. While still experimental, such modularity offers architectural possibilities for scalable, adaptive floating settlements rather than isolated technological artifacts.

In parallel, flood-proof or wet-proof buildings represent a more terrestrial counterpart within aquatecture, providing structural resilience in flood-prone environments.

Unlike floating structures, these buildings remain grounded but are designed to resist water penetration, meeting benchmarks such as allowing no more than 10 centimeters (4 inches) of water ingress within 24 hours under extreme conditions. To achieve this, they employ watertight envelopes, reinforced structural systems, and advanced drainage solutions like automated sump pumps to control seepage. Materials play a critical role: corrosion-resistant steel, geopolymers, and high-density concrete are commonly used to ensure long-term durability. These systems are frequently deployed in heritage zones, high-value districts, and critical facilities where relocation is not possible, making them ideal for safeguarding cultural assets and essential infrastructure.

Technological innovations in both typologies are reshaping construction methods. Offshore platforms increasingly rely on autonomous robotic assembly, 3D scanning for underwater surveys, and AI-driven structural monitoring to reduce labor risks and enhance precision under extreme depth pressures.

the 2014-built Olympus Mars B development in the Gulf of Mexico sits in 3,100 feet of water. By Tim Newcomb



Type of Offshore Structure (Refer to U.S. Minerals Management Service, Gulf of Mexico Region, Offshore Information, October 1999.) by Harold S.Y Ha

Similarly, dry flood-proofing techniques now integrate smart materials with real-time monitoring, enabling automated sealing and adaptive pressure control during flood events. These advances highlight a broader shift in over-water construction, where architecture merges with high-performance engineering to create systems that are not only resistant to environmental challenges but also capable of generating energy, supporting ecological functions, and integrating modular growth over time.

Together, these typologies demonstrate two complementary trajectories within aquatecture: one pushing the limits of offshore adaptability through floating, modular megastructures, and the other reinforcing land-based resilience through impermeable, high-performance systems. Their innovations—from multi-use floating platforms to robotic construction and renewable integration—reveal pathways for designing scalable, self-sustaining, and climate-resilient aquatic environments that could inform both emergency responses and long-term settlement strategies.

rain gardens / flood storage

This category represents clearly the aquatecture that repels water actively, not necessarily being surmeged. It talks directly about the coexisting of water in the traditional sense of architecture. Rain gardens and flood storage landscapes are land-based aquatecture typologies that integrate water management with urban green infrastructure. They reduce runoff, recharge aquifers, and mitigate flooding impacts. Notable examples include Rotterdam's Benthemplein Water Square. [Source: Ahern, J. (2011). From fail-safe to safe-to-fail.] This typology is key to our analysis since it pertains the innovative strategies on how to manage water in therms of urban architecture and in traditional architecture, it becomes passive strategies that have been implemented in zones of high water danger. They are integrated into building design to foster biodiversity and can be used to improve urban resilient capacity and efficiency, as well as risk management. For instance, one design scenario in the Tiber River Delta included "raingardens" as part of green and blue infrastructure to enhance the microclimate.

- **Subcategories:**

Tension-Leg Platforms (TLPs)
Semi-Submersible Platforms:
Spar Platforms

- **Technological system:**

Flood barriers, waterproof membranes, sacrificial floors

- **Socio-cultural context:**

Urban Expansion, waterfront industries, Economic Drivers

- **Materials**

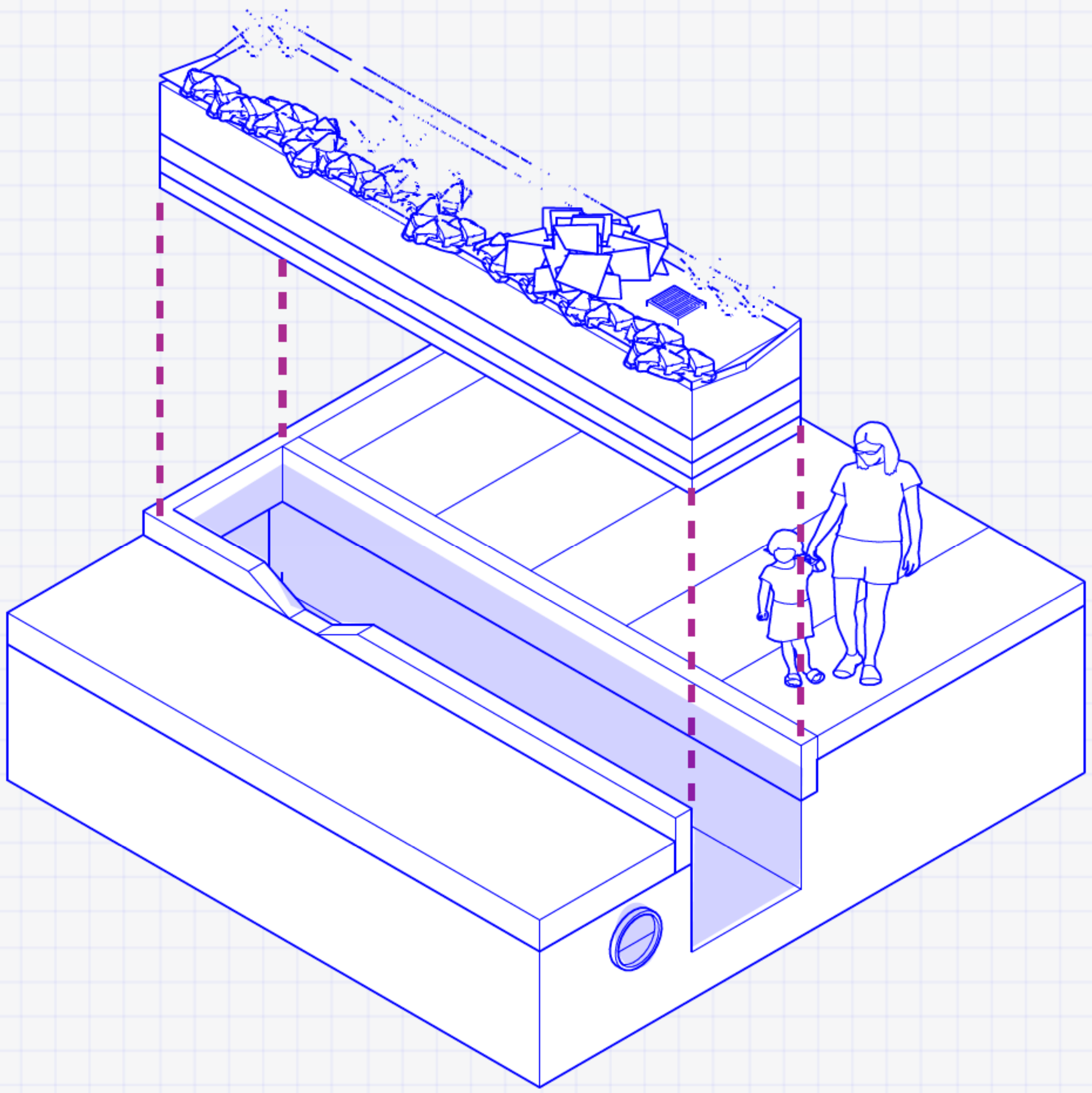
Structural Waterproof Concrete, Protective Coatings, geopolymers, panels

- **Weaknesses:**

High initial costs, specialized expertise and expensive equipment, environmental impacts, Maintenance and safety inspections

- **Stenghths:**

Adaptable to deep-water environments, Scalable and modular, responsive to climate-driven coastal displacement.



What makes rain gardens unique is the fact that they help with natural filtration. Planted with native shrubs, grasses, and perennials, rain gardens improve water quality by naturally removing pollutants such as fertilizers, oils, and sediment through soil and vegetation layers (UC Agriculture and Natural Resources, 2025). They also reduce stormwater runoff volume and speed, helping mitigate flooding and recharge groundwater. In certain urban areas, they can reduce runoff by up to 30% compared to conventional lawns. Beyond water management, rain gardens provide habitat for pollinators and help cool urban microclimates by reducing heat island effects.

Rain gardens are a core component of green infrastructure or low-impact development (LID). These strategies integrate natural systems into urban water management, keeping precipitation close to its source through infiltration, storage, and evapotranspiration. In China's sponge city model—a holistic approach to urban resilience—rain gardens are integral for capturing and retaining stormwater, restoring natural water cycles, and preventing floods while improving urban ecology.

Some of the techniques that can be seen are:

- Inflow Architecture: Stormwater is directed into the garden through architectural channels—like downspouts, sloped hardscapes, or shallow, rock-lined swales. Ensuring gentle, erosion-free entry is crucial.

- Ponding Area / Excavated Basin: A bowl-shaped depression captures and temporarily holds surface runoff. This basin is bordered by a berm that contains water until it infiltrates or drains steadily.

- Filter Media / Engineered Soil Mix: Beneath the surface planting layer lies a specialized soil/media blend—commonly around 60% sand, 20% compost, 20% topsoil—that supports both filtration and infiltration of water.

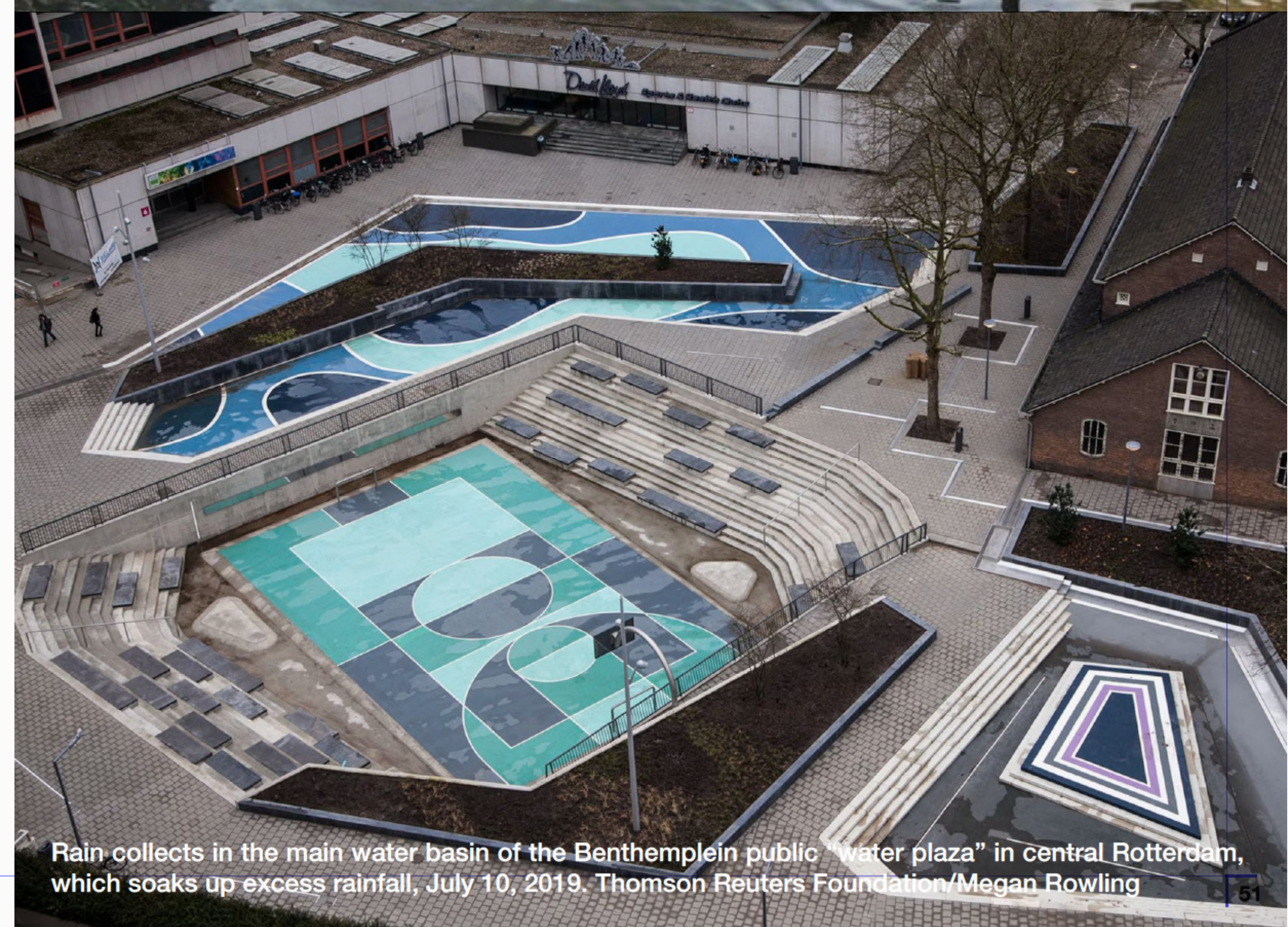
- Mulch Layer: A simple mulch layer (e.g., wood chips) covers the surface to filter pollutants, reduce erosion, retain moisture, and sustain plant health.

- Vegetation Zones: Plant species are selected to handle both wet and dry conditions. Native perennials, grasses, and shrubs with robust root systems are ideal—they increase permeability, uptake nutrients, and foster biodiversity.

- Optional Underdrains or Gravel Beds: In areas with low soil permeability, gravel beds or subsurface PVC underdrains ensure effective drainage, preventing waterlogging and backing up during saturation events.

- Overflow Mechanisms: When the garden reaches capacity during heavy rain, overflow is managed through a rock-lined notch in the berm or other low-impact outlets to prevent uncontrolled runoff or erosion.

Axo Brabant Water terrain credits: Felixx



Rain collects in the main water basin of the Benthemplein public "water plaza" in central Rotterdam, which soaks up excess rainfall, July 10, 2019. Thomson Reuters Foundation/Megan Rowling

artificial islands

Very large floating structures (VLFSs) or commonly known as Artificial [floating] islands primarily designed for floating airports and ports, for calm waters on the coast or on open sea. (...) they include other uses: bridges, breakwaters, piers and floating docks, energy storage facilities for oil and natural gas, wind and solar power plants, military purposes and emergency bases, to create industrial space, emergency bases, entertainment facilities, recreation parks, mobile off-shore structures, floating farms and even for habitation [Lamas-Pardo et al., 2015].

- **Subcategories:**
Land filling island
Floating island

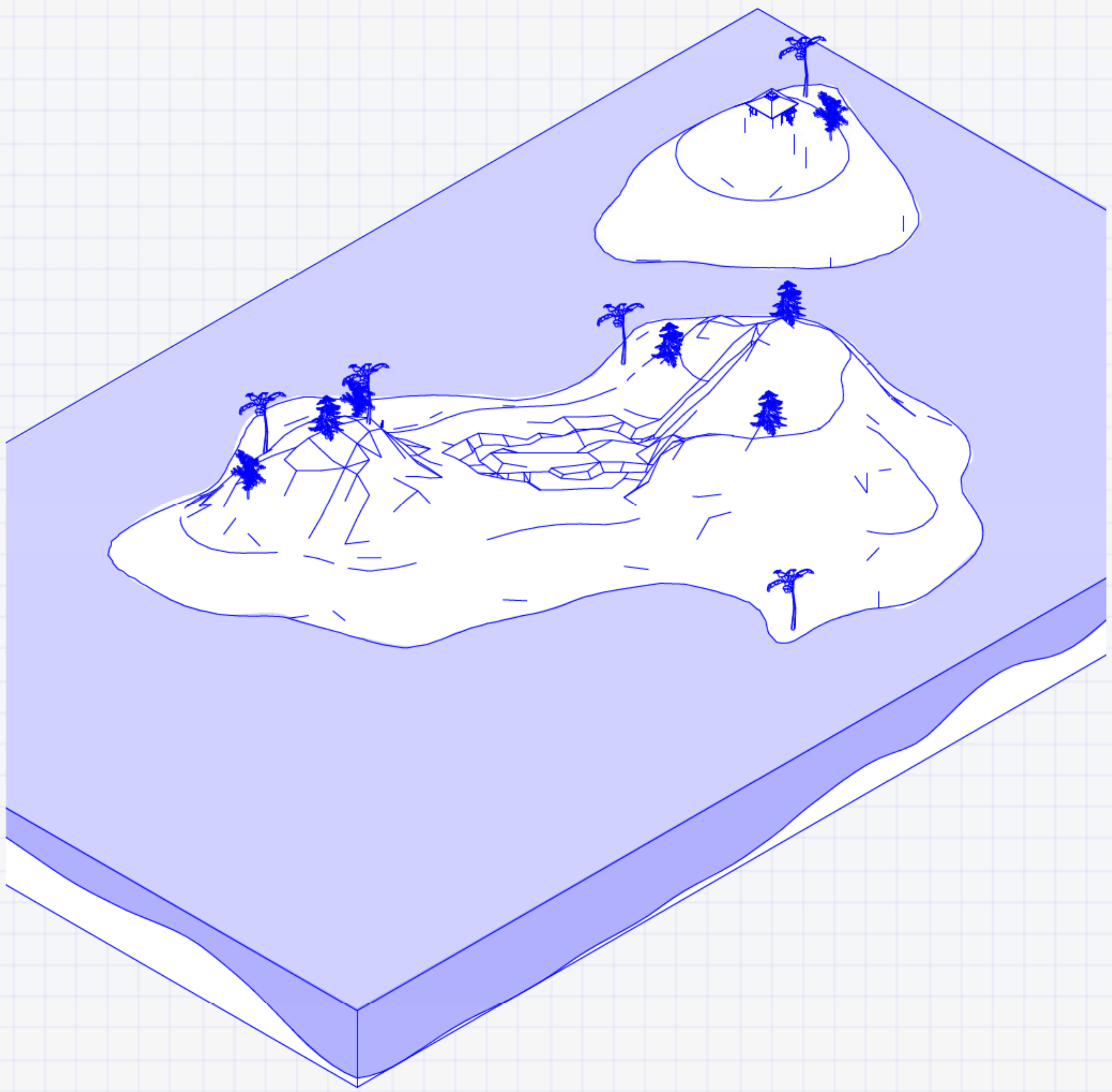
- **Technological system:**
Landfill or modular pontoons, erosion control, renewable integration

- **Socio-cultural context:**
Tourism, urban expansion, exclusive developments, emergency circumstances

- **Materials**
Sand, concrete, geotextiles

- **Weaknesses:**
Environmental impact, extremely costly

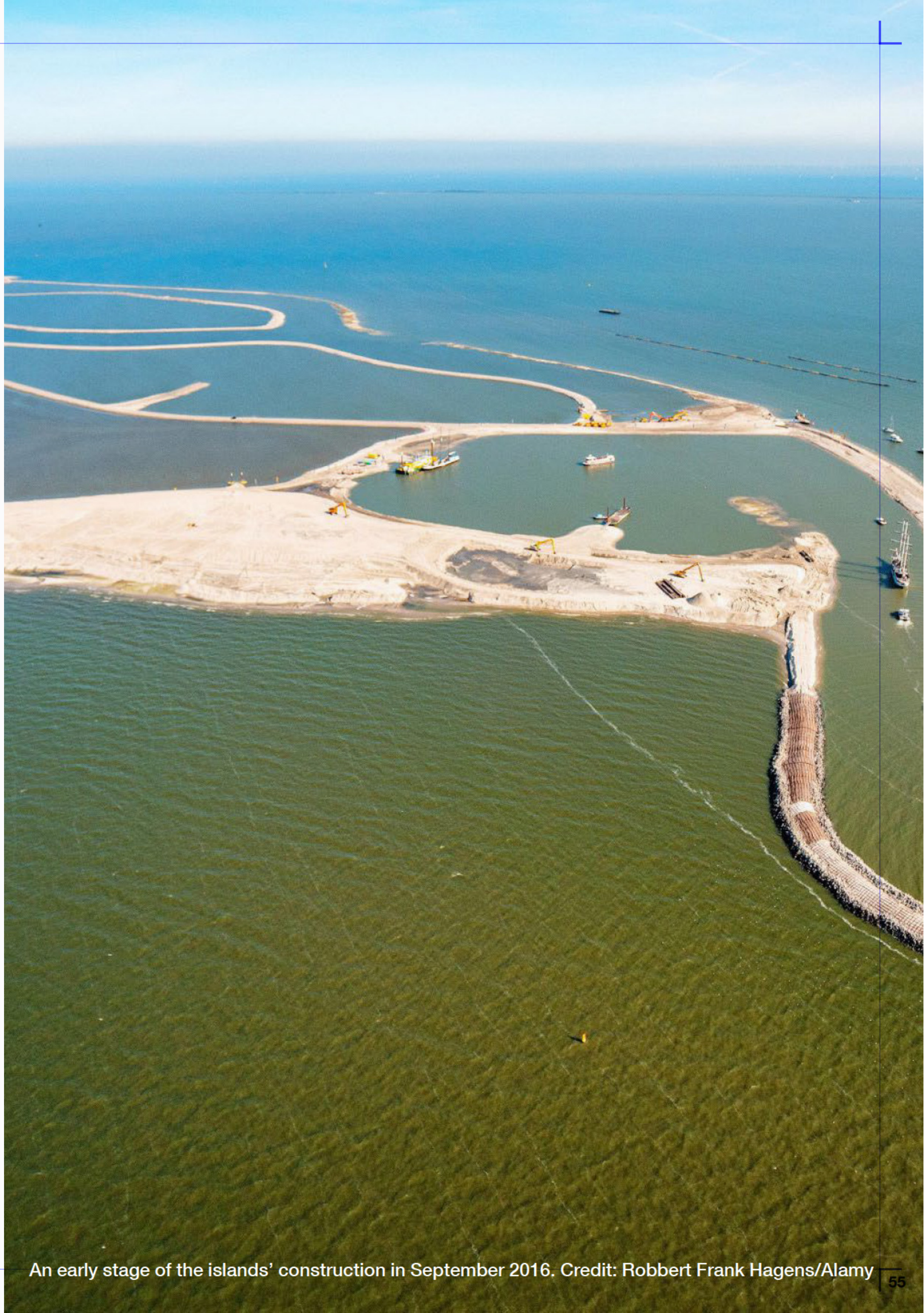
- **Stenghths:**
Customizable, large-scale development potential



In terms of the first scenario, Artificial islands represent an evolving and increasingly diverse approach to urban development and climate change adaptation, enabling human habitation and activities to extend into aquatic environments. Unlike natural islands that were formed over time by geological or biological processes, artificial islands are entirely human-made, designed to transform water surfaces into productive land. These structures are not merely extensions of existing shorelines but intentional interventions to create new, usable territory where none existed before. Their primary motivations have historically been to address land scarcity and enable urban expansion, but in recent decades they have also emerged as strategic tools in responding to pressing global challenges such as sea-level rise, flooding, and the need for climate-resilient infrastructure.

Usually they will be designed to host entire communities, from single dwellings to multi-unit complexes and complete urban districts. In contexts where safe, inhabitable land is scarce or where populations are at risk of displacement, these islands provide an alternative to forced relocation and allowing people to remain close to their cultural, economic, and social networks.

These typologies are far from a modern invention—human beings have been building them for millennia, adapting water landscapes to human needs. The most known case dates back to the seventeenth century when the Dutch first utilized the technique for land expansion. But in prehistoric Europe, crannógs (wooden or stone-built dwelling platforms) were constructed in lakes and rivers in Scotland and Ireland, demonstrating early experimentation with dwelling over water (National Geographic, 2019. We can also observe it in Micronesia, where Nan Madol is a classic example of artificial islets constructed with basalt columns in shallow seas, forming ritual and civic centers. The Aztecs also famously built chinampas—floating agricultural islands in Lake Texcoco—that expanded usable land for crops. But as mentioned previously, in more recent centuries, land reclamation in the Netherlands became a major turning point. Confronted with the challenges of living in a deltaic environment below sea level, Dutch engineers began reclaiming land through polder systems, using dikes



An early stage of the islands' construction in September 2016. Credit: Robbert Frank Hagens/Alamy and wind-powered pumps to drain water and expand inhabitable territory. These techniques evolved a lot from the 17th century onward, forming the foundation of Dutch hydraulic engineering, and a precedent for the rest of the world in terms of what could be accomplished in a big scale from land reclamation. By the 18th and 19th centuries, these methods were being replicated elsewhere for port expansion and, surprisingly a lot for military purposes.

In the 20th century, the practice gained new momentum with the rise of urban megaprojects — from Tokyo Bay's landfill islands to Hong Kong's Chek Lap Kok Airport, which expanded urban and infrastructural capacity beyond existing shorelines. These megaptjects mimicked the idea of the dutch, but also denmostrated how to make an outdated technology, work to the current fast growing citiscopes of the world. Here we could alos see the integration of other aquatectural typologies, where the masterplan was mainly populated with floating buildings. Today, the number of documented artificial island projects exceeds 150 globally, ranging from large-scale urban districts and industrial zones to specialized ecological reserves and energy platforms. They are increasingly seen not only as tools of territorial expansion but as proactive responses to climate adaptation, enabling urban areas to address land scarcity, sea-level rise, and flooding risks (Schmitt et al., 2018; Misdorp, 2011).

Modern artificial islands are built through a range of engineering strategies, each suited to specific geotechnical, hydrological, and environmental conditions. These methods have evolved from simple earth-moving operations into highly sophisticated, multi-stage processes combining civil, marine, and environmental engineering.

Plan for Tokyo Top View | Kenzo Tange

1. Land Reclamation & Fill Construction

This is the most established method. It :is often created by dredging sediment, sand, or rock and depositing it in the target zone. Over time, more complex techniques, based on the original, have emerged, such as "rainbowing" (spraying sediment through pipelines), "pump ashore methods", or use of barges to fill the water. (Islands Building Company) The soil compaction, drainage, and foundation prep are essential to enssure a safe and stable base.
In order to hold the material used to fill the water spaces, sheet piles (steel or composite walls), retaining walls, or caisson foundations are often used to create and complement stability.
Before adding structures, the seabed or reclaimed land often requires pre-treatment: consolidation, dewatering, vertical drains, or surcharge loading to accelerate settlement and create stable substrate. (HSB Marine)

2. For Challenging Conditions:

In regions with softer coral sand or difficult underwater substrate, advanced excavation and stabilization techniques are employed. Autonomous dredging vessels, robotic assembly systems, and AI-assisted bathymetric mapping improve precision and safety. Additionally Materials innovations like the geopolymers, marine-grade composites, and recycled aggregates, help reduce environmental impact while enhancing durability. Recent Chinese projects in the South China Sea have even demonstrated techniques for stabilizing coral sand, expanding the geographical range of artificial island construction (Asia Times, 2024).

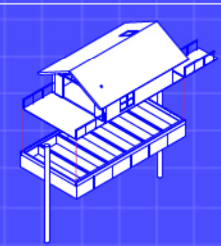
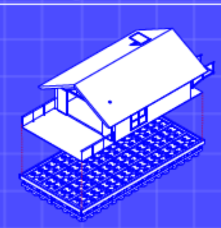
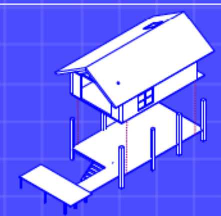
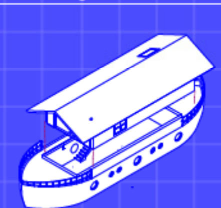
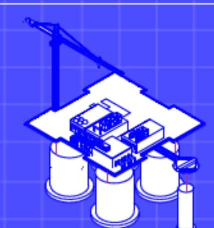
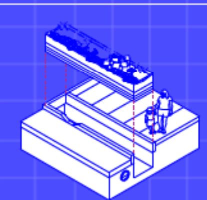
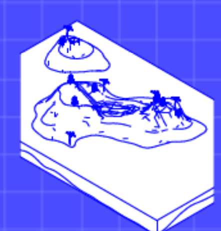
A more recent evolution of the typology involves floating platforms that function as artificial islands but are not fixed to the seabed. These buoyant structures rise and fall with water levels, offering passive resilience to flooding and tidal fluctuations (Olthuis & Keuning, 2010). While sharing technological similarities with floating architecture, they differ in scale and purpose, often serving as multifunctional hubs for airports, bridges, breakwaters, or energy production facilities. The Mega-Float project in Japan and the proposed Blue21 floating city concepts in the Netherlands exemplify this approach, highlighting its potential for rapid deployment in emergency situations and its adaptability to changing climatic conditions.

catalog of typologies

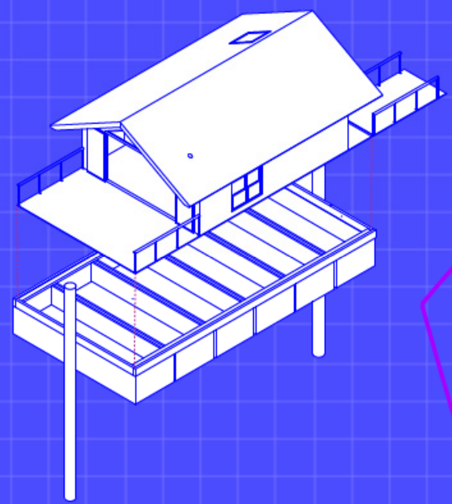
The categorization of floating and aquatic structures remains underexplored in architectural scholarship. Recent studies, however, propose more comprehensive frameworks for understanding and analyzing these designs. Research by Łukasz Piątek (2016) argues that traditional approaches to classifying aquatecture are outdated, offering instead a system with distinct advantages:

- Openness and inclusivity, allowing for detailed expansion to include diverse buildings, vessels, or water-based engineering structures;
- Interdisciplinarity, fostering collaboration and technology exchange across fields;
- Activating potential, encouraging architects to explore innovative design possibilities;
- Cohesion and clarity, providing a structured yet adaptable framework (Piątek, 2016).

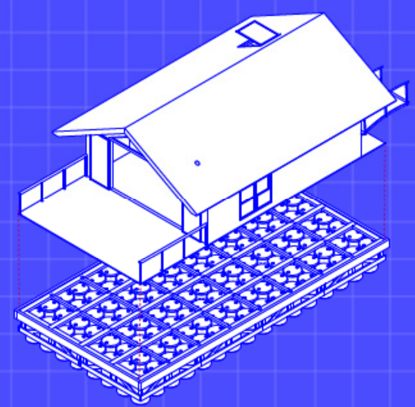
While Piątek's categories offer a strong foundation, this research identifies alternative classifications that better capture the interplay between **technological innovation** and social context. These new categories prioritize adaptability for vulnerable urban settings, such as flood-prone regions, and draw on technologies suited to modular, cost-effective designs. A new analytical lens has also been proposed, in order to focus on social inclusion to address gaps in Piątek's framework, particularly the lack of emphasis on community needs in underserved areas.

type	relation to water	application	context	legal definitions	buoyancy	propulsion	supporting substance	mobility	base type	social context
 floating architecture	floating	water	water	real-estate; mobility - watercraft	bouyant	unpowered	water	portable	pontoon / float / raft; hull	residencial
 amphibious buildings	floating	water banks; flood-prone land	water; land	real-estate	bouyant	unpowered	water; land	kinetic	pontoon / float / raft	residencial; emergency architecture
 pile building, stilt building	elevation	flood-prone land; water	water	real-estate	non-bouyant	unpowered	water; land	static	pilles/stilts / columns	residencial; emergency architecture
 boat-based dwellings	cruising	water	water	mobility - watercraft	bouyant	self-powered	water	transient	hull	residencial
 offshore structures	floating	water	water	real-estate	bouyant; non-bouyant	self-powered	water	static; portable	pontoon / float / raft; pilles/stilts /columns	industrial
 rain gardens / flood storage	floating; delimiting	water banks; flood-prone land	water; land	real-estate	non-bouyant	unpowered	water; land	static	pontoon / float / raft; pilles/stilts /columns	urban
 artificial islands	floating; delimiting	water banks; flood-prone land	water; land	real-estate	non-bouyant	unpowered	water; land	static	pilles/stilts /columns	urban; residencial

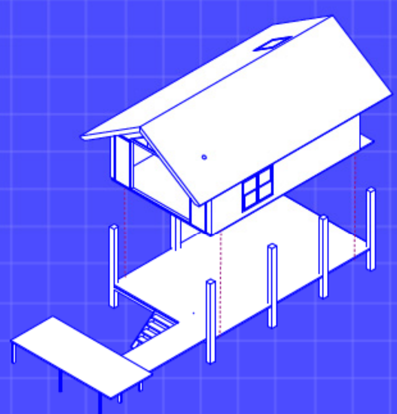
catalog of typologies



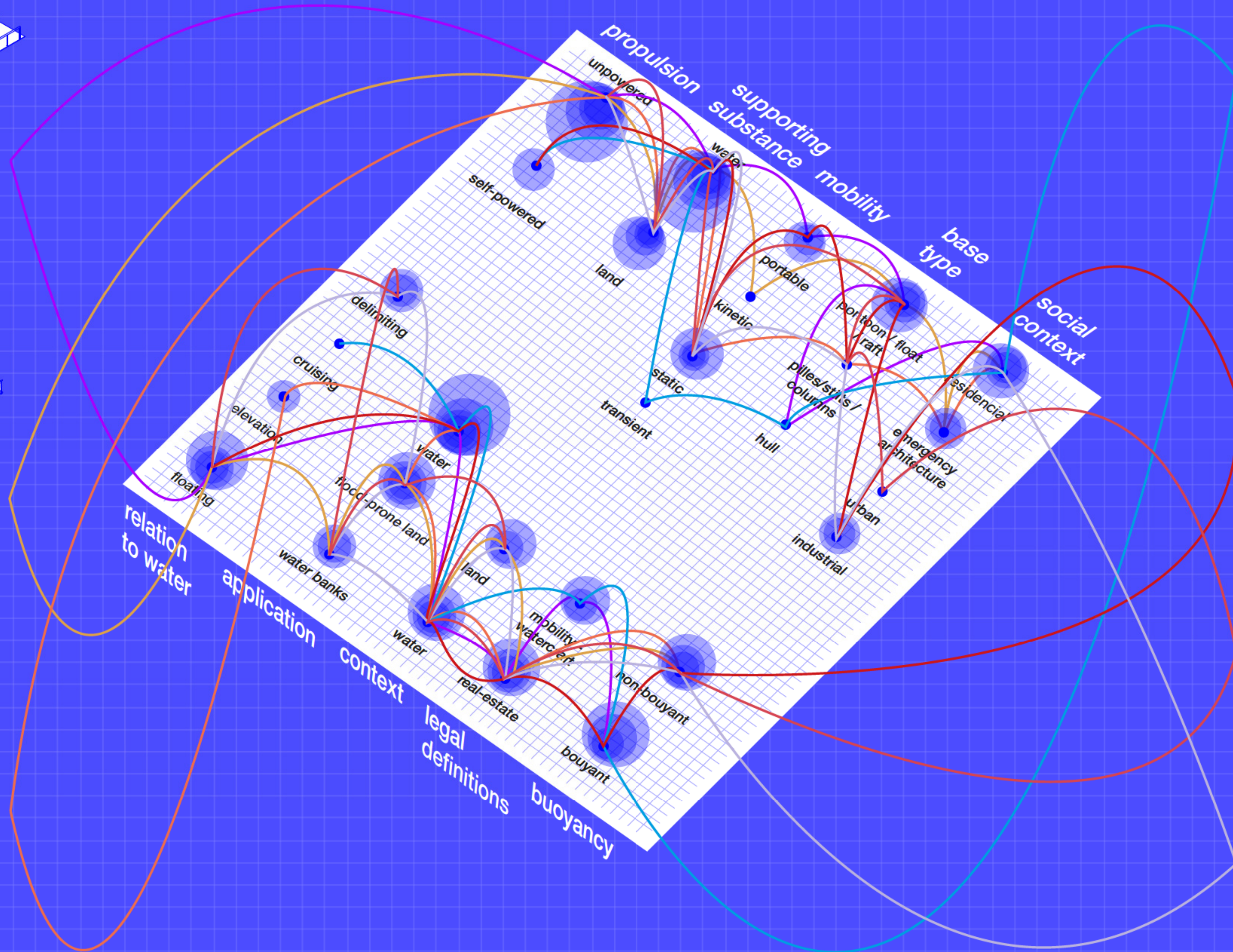
floating architecture

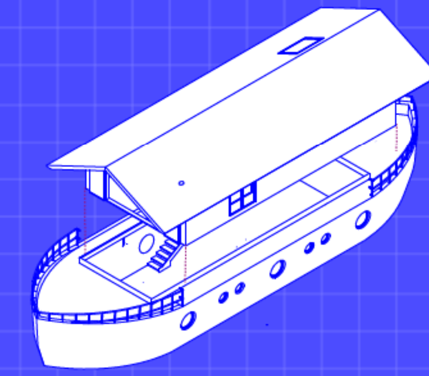


amphibious buildings

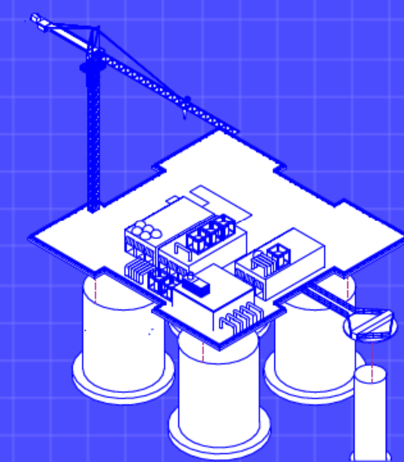


pile building, stilt building

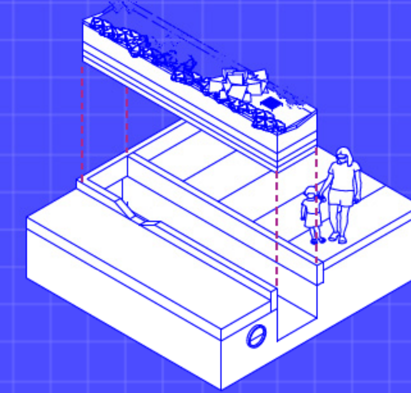




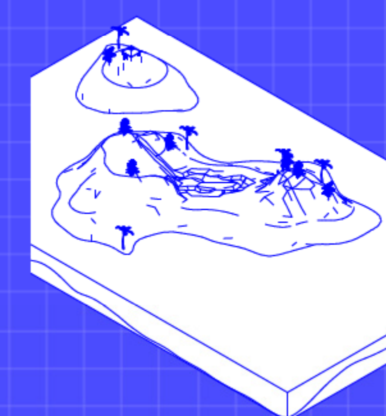
boat-based dwellings



offshore structures



rain gardens / flood storage



artificial islands

from categories to case studies

The selection of floating buildings, amphibious buildings, pile/stilt buildings, and boat-based dwellings as the primary typologies in this research stems directly from the project's conceptual foundation: the democratization of aquatecture. These four typologies embody the architectural capacity to coexist with water while maintaining a human scale, affordability, and adaptability, qualities essential for communities facing the socio-environmental impacts of climate change.

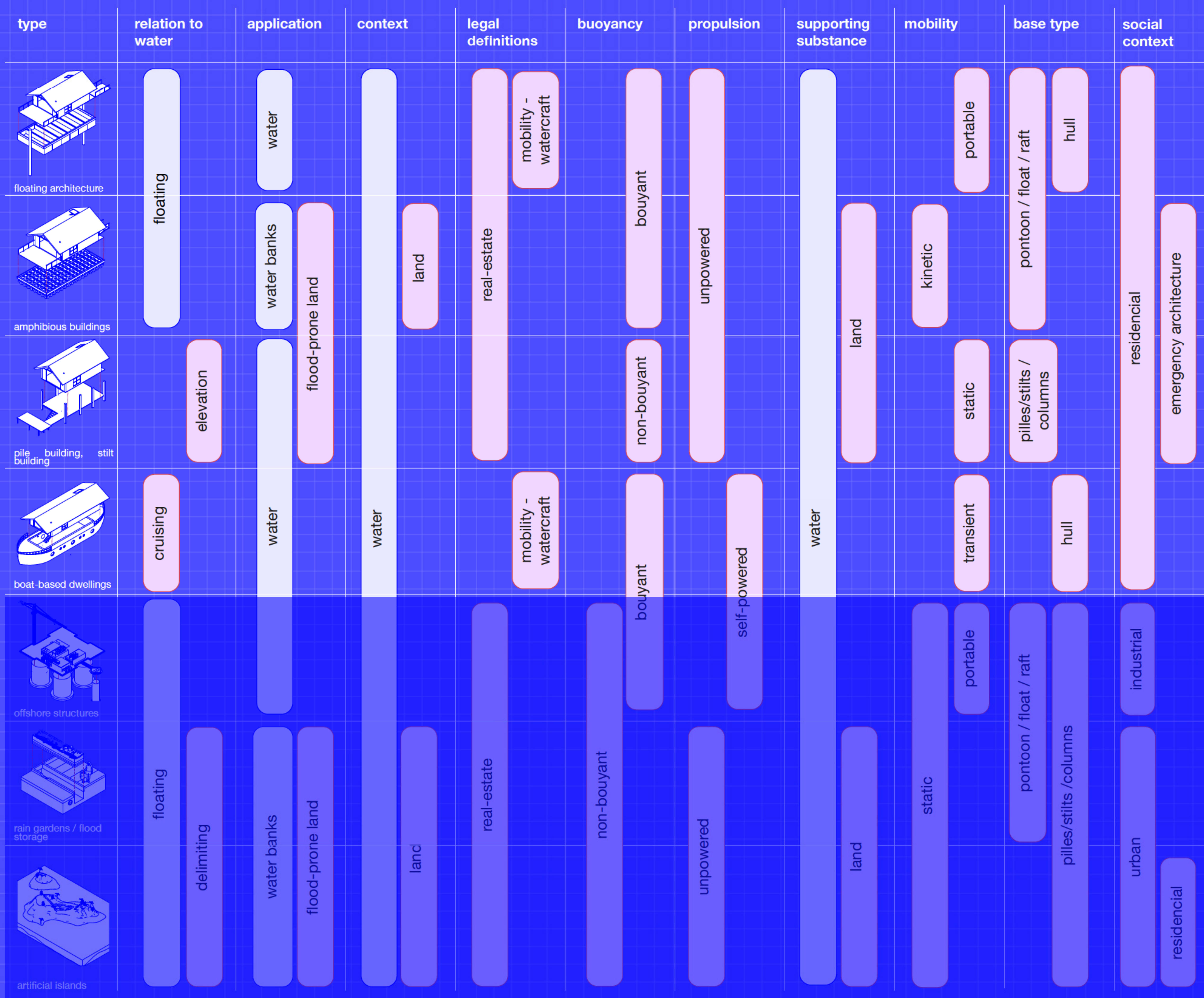
Unlike large-scale infrastructural or speculative typologies such as offshore structures, rain gardens, or artificial islands, the four selected typologies operate within a domestic and community scale. They are spatially intimate, socially embedded, and technically attainable. These systems can be reproduced with local knowledge, vernacular materials, and community participation, attributes that align with the thesis aim to propose a middle ground between high-tech and emergency housing.

Floating buildings demonstrate modular scalability and passive adaptability to water fluctuations.

Amphibious buildings introduce flexibility through hybrid anchoring systems that respond to floods without permanent detachment from the land.

Pile or stilt buildings represent a long-standing vernacular logic, offering economic and structural simplicity.

Boat-based dwellings embody mobility and transience, enabling life to adapt fluidly to seasonal or environmental shifts.



2.1 case study analysis:

evaluation phase

As outlined in the methodology, once aquatecture, floating architecture, and their main categories were examined in depth, the research progressed to the analysis of real-world case studies to understand how these concepts are applied in practice. To identify case studies, we utilize academic platforms such as Google Scholar, Litmaps, ResearchGate, and Scopus, with priority given to projects that have been cited in the literature, demonstrate relevance within academic debates, or represent significant examples of adaptation to aquatic environments. This approach ensured that the selected cases were both geographically diverse and academically validated, allowing the study to capture a broad spectrum of contexts, typologies, and scales of intervention.

A total of 34 case studies were chosen, a number considered optimal to enable the application of multiple variables while maintaining the possibility of meaningful comparison and categorization. The literature review was conducted in accordance with academic guidelines to ensure rigor and minimize subjective bias, drawing on peer-reviewed journal articles, books, technical reports, and architectural case documentation.

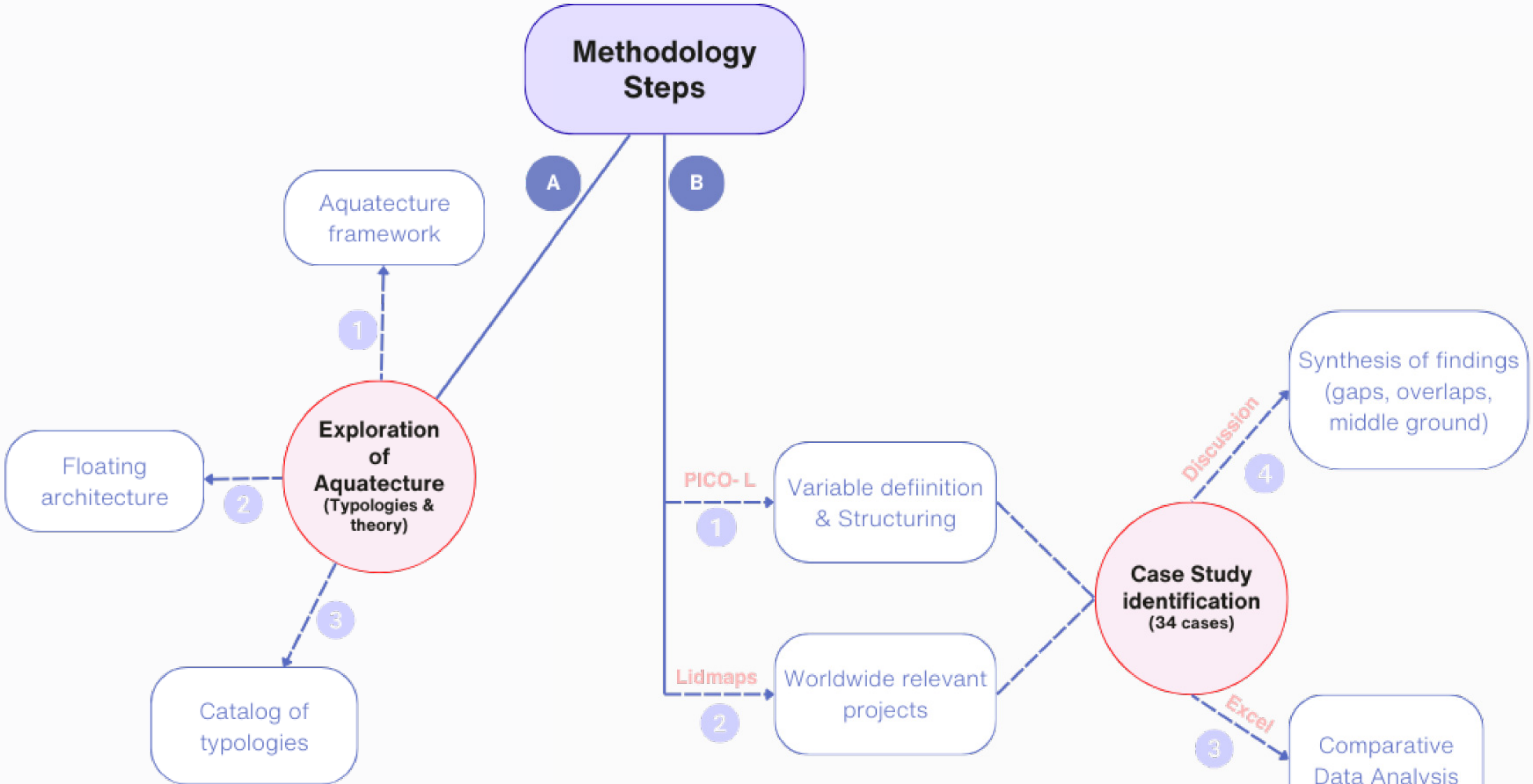
methodology steps

Our objectives were to:

- Map the current discourse and contemporary developments in floating architecture and aquatecture.
- Identify technological, social, and environmental parameters within different floating typologies.
- Evaluate the affordability, adaptability, and scalability of various solutions.

Detect knowledge gaps and emerging areas of innovation that could inform the design phase.
Within this framework, case study research is particularly valuable for investigating floating architecture embedded in its real-life context. The comparative analysis is both descriptive and exploratory, as it documents existing practices while also generating hypotheses to find the missing gap. In this sense, the study not only compiles a broad database of projects but also identifies the missing point that has not been explored deeply at the intersection of technology, affordability, and socio-cultural adaptation.

The comparative indicator matrix used for this research had two main objectives: first, to identify best practices among the case studies according to their performance in relation to environmental, social, and technological requirements; and second, to determine the technology, location, and materiality that we are going to apply to our design toolbox. To achieve this, the information sources consulted went beyond conventional academic literature, incorporating grey literature, unpublished reports, technical drawings, and digital platforms. This methodological pluralism was crucial for capturing the complexity and diversity of floating architecture worldwide, ensuring that the analysis reflects both its experimental high-tech expressions and its vernacular, community-driven forms.



variable identification: PICO-L method adaptation

To bridge literature findings with design parameters, the PICO-L method is adapted in this step to suit the context of architectural research. This framework enables the systematic and focused extraction of relevant variables to inform design and innovation in floating architecture.
In the context of this thesis, the PICO(L) framework was the best methodology option because it brings clarity and structure to finding variables. This precision enabled the identification of meaningful patterns and relationships across different types of floating settlements, moving beyond theoretical exploration. It provides a solid foundation for the design phase, ensuring that architectural proposals are innovative and grounded in empirical evidence and practical realities.

Applying this framework made the literature review significantly more targeted and efficient. This approach's additional strength lies in its capacity for comparative analysis and knowledge synthesis. It facilitates the identification of context-sensitive and scalable design strategies, while also revealing gaps in existing literature that this thesis aims to address.

P - Population

At-risk urban or semi-rural communities exposed to recurrent flooding, rising sea levels, or climate-driven water stress.

I - Intervention

Implement floating architecture solutions such as palafitic structures, amphibious housing, modular pontoons, or high-tech floating buildings.

C - Comparison

Analysis of high-tech versus vernacular approaches regarding affordability, resilience, cultural integration, and technological complexity.

O - Outcomes

Long-term habitability, social cohesion, affordability, scalability, and environmental resilience.

L - Location

Contexts include diverse geographies, from the Global South (e.g., Colombia, Bangladesh) to developed cities experimenting with floating infrastructure (e.g., Rotterdam, Amsterdam, Copenhagen).

variable selection criteria for literature review analysis

The variables used to structure the analysis were selected based on the goals of our thesis, ensuring that the literature review remains logical and focused on the research questions. Since this research explores the intersection between floating architecture, affordability, technological innovation, and socio-cultural adaptation, the following variables were chosen to reflect the need to evaluate each case from multiple yet interconnected dimensions.

The variables were designed to directly address the core research questions driving this investigation, specifically affordability, adaptability to community needs, and the role of floating architecture in urban resilience strategies.

- Contextual and Spatial Relevance:

Categories such as geographic location, urban versus rural context, and climatic zone were included to facilitate comparison across different regions and to understand how location influences architectural decisions and outcomes.

- Technological and Structural Analysis:

Variables like construction system, materials used, and technological complexity help assess the role of innovation. They also help identify whether a project leans more toward high-tech or vernacular solutions and how these affect cost and feasibility.

- Affordability and Funding:

Since one of the key concerns of this thesis is affordability, specific variables, such as the target social group and an estimated affordability score, were included to understand economic viability from both user and implementation perspectives.

- Design Performance and Impact:

Other variables, such as social integration and community participation, were introduced to measure a project's responsiveness to its social context, which is critical for identifying long-term viability and inclusivity.

- Sustainability and Adaptability:

Considering the focus on resilience and adaptability to climate change, variables that assess climatic adaptation strategies and environmental impact were also included.

- Typological Categorization of Floating Architecture:

Finally, each case was classified according to its typology of floating architecture, whether high-tech floating modules, hybrid amphibious systems, or vernacular stilt-based settlements. This enables us to identify which typologies are most prevalent globally, which are emerging as experimental alternatives, and, most importantly, why certain typologies predominate in specific contexts. Including this variable highlights the contrasting prevalence of technologically advanced projects in high-income contexts versus vernacular, low-cost solutions in vulnerable regions. It also helps expose whether a potential "middle ground" between these extremes is currently underexplored.

definition of objetives for the selection of case sudies

The methodological framework of this thesis relies on the construction of a corpus of 34 case studies of floating and amphibious architecture. The objective of assembling this body of projects was to create a broad, balanced, and representative basis for analysis, capable of capturing the diversity of approaches that define floating architecture today. The selection process was guided by a series of objectives, preliminary restrictions, and a systematic search strategy that ensured academic rigor and contextual relevance.

To begin with, the main objective behind the selection was to secure a global distribution of cases. Floating architecture is highly context-dependent, shaped by specific climatic, cultural, and regulatory environments. By including projects from Europe, Latin America, North America, Southeast Asia, and Africa, the research aimed to mitigate geographic bias and reveal how environmental conditions and cultural traditions influence architectural outcomes.

In addition to geographic breadth, typological variety was a central criterion. The corpus includes both vernacular palafitic settlements, such as Nueva Venecia in Colombia, Palheiro in Portugal, and La Balsanera in Ecuador, as well as high-tech prototypes or experimental districts, including the Floating Office Rotterdam, Schoonschip in Amsterdam, and Urban Riggers in Copenhagen. This contrast between vernacular and high-tech examples was essential to explore the possibility of a middle-ground typology that reconciles affordability and cultural rootedness with technological innovation.

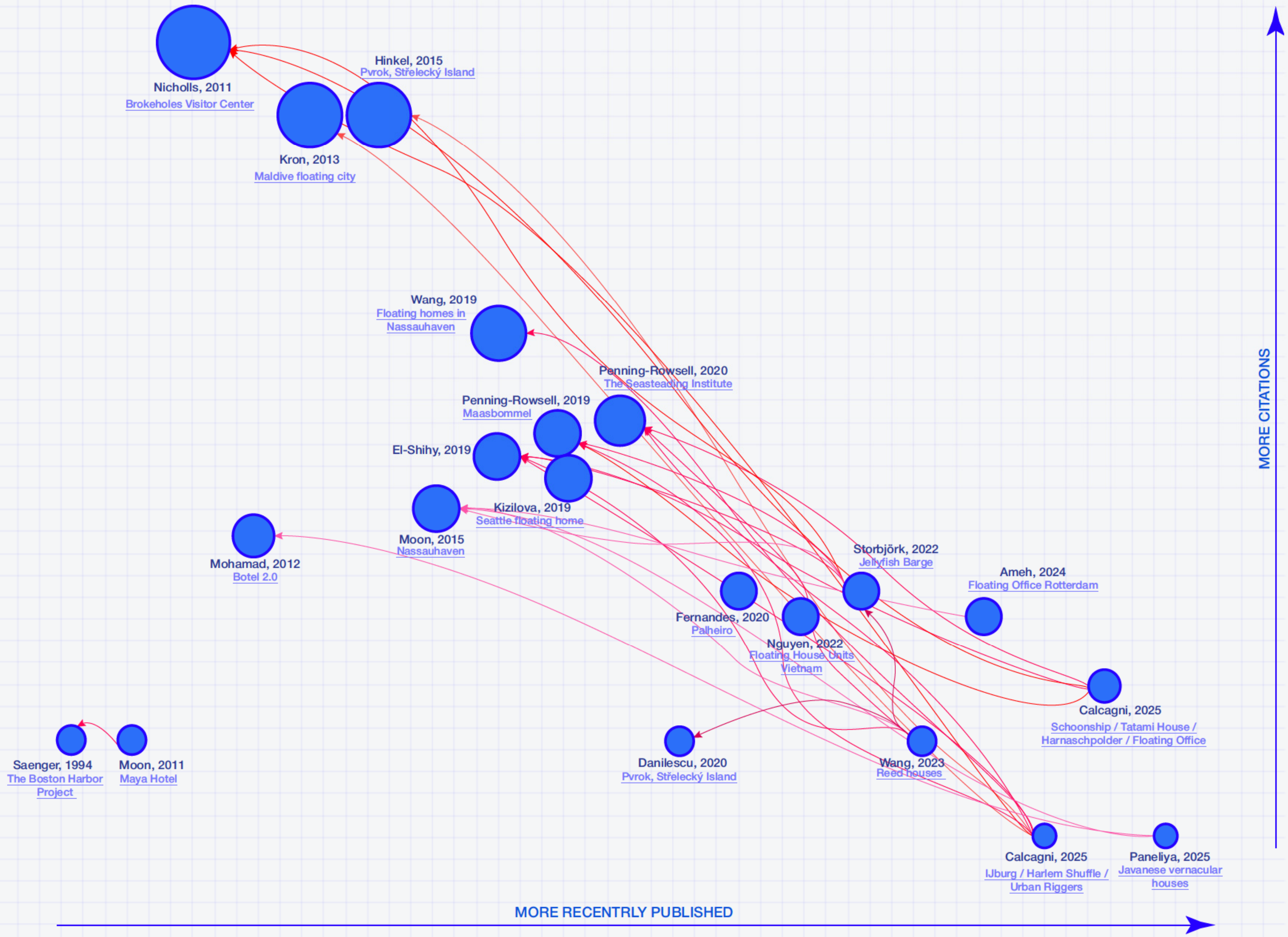
Another important layer of selection was the diversity of scale and use. The cases range from single-family floating houses to entire neighborhoods and large-scale cultural or infrastructural projects. Their programs are equally diverse, spanning residential, commercial, touristic, and exhibition functions. This distribution allows us to understand not only how floating technologies are adapted to different architectural scales, but also how materiality and foundation systems respond to different uses and programmatic demands. At a functional level, 16 projects are primarily residential, four are tourist-related, two serve as exhibition spaces, and one is commercial. When grouped more broadly, 16 can be classified as residential and 18 as non-residential, highlighting a nearly even balance that strengthens comparative analysis.

The cases were also selected with documented relevance in mind. Each project had to be supported by sufficient academic, technical, or institutional documentation to allow for a systematic evaluation across the variables defined for this thesis. Many of the projects chosen are frequently cited in the literature or are directly linked to urban and environmental policy discussions, confirming their significance for both theory and practice. To reinforce this relevance, preliminary restrictions were introduced to narrow the scope: only built projects still in existence were included; the timeframe was limited to the last 15 years to ensure contemporary relevance; the location was restricted to inland or sheltered waters, excluding speculative offshore proposals; and cases without sufficient data availability were screened out.

Jellyfish Barge, Italy. Photo source: Matteo de Mayda

Within this framework, the geographical distribution of the final sample also reveals an interesting imbalance: 20 of the projects are located in Europe, 4 in Latin America, 4 in Asia, and only 1 in Africa. While this reflects the greater concentration of documented floating architecture in Europe, it also underscores the importance of bringing Latin American and Asian cases into the discussion to diversify perspectives.
The selection process itself followed a systematic search strategy. Databases such as Google Scholar, Scopus, and ResearchGate were consulted, complemented by institutional reports and documentation from architectural offices. To refine the search and validate the academic recognition of specific projects, the tool Litmaps was employed. Litmaps enabled the visualization of citation networks, revealing which projects were most frequently referenced in academic literature and which emerging examples were starting to gain attention. In this way, Litmaps served as both a validation tool for relevance and a means of identifying underexplored yet promising cases.
The search employed a set of targeted keywords, in both English and Spanish, to ensure inclusivity across different linguistic and academic contexts. These included: “floating architecture” / “arquitectura flotante”; “aquatecture”; “floating housing” / “vivienda flotante”; “amphibious housing” / “vivienda anfibia”; “palafitic settlements” / “arquitectura palafítica”; “climate adaptation floating structures”; “modular floating structures”; “sustainable stilt housing”; and “vernacular aquatic communities”. These terms were further cross-referenced with geographic identifiers, such as the Netherlands, Colombia, or Vietnam, to ensure representation across continents.

In summary, the construction of the corpus was not a random aggregation of cases but a carefully curated process. By combining global distribution, typological variety, diversity of scale and use, and documented relevance, while applying preliminary restrictions to ensure comparability, the resulting 34 case studies provide a representative panorama of floating architecture today. This foundation enables the research to move forward with a systematic evaluation of variables such as technology, materiality, affordability, community participation, and typological categorization, laying the groundwork for cross-case conclusions and identifying gaps where a middle-ground typology might emerge.



catalog of indicators and their relevance

To guide the literature review and subsequent comparative analysis, a set of variables was defined to ensure a systematic and multidimensional evaluation of floating architecture. These variables were not chosen arbitrarily but were instead derived from the central questions driving this thesis: How does floating architecture respond to climate change? To what extent can it be affordable and socially inclusive? Moreover, how can different technological and cultural approaches inform the design of a middle-ground typology?

The variables were organized into five analytical clusters: Contextual and Environmental Factors, Technological and Structural Logic, Economic Accessibility and Viability, Social and Cultural Dimensions, and Sustainability and Long-Term Resilience. This clustering enables a comprehensive evaluation of each case, ensuring that projects are assessed not only in terms of their technical and aesthetic qualities, but also in terms of their affordability, community relevance, and capacity for long-term resilience.

For example, contextual factors such as climate zone and urban versus rural location are crucial for understanding how geography and environment influence architectural responses. Meanwhile, construction systems, materials, and degree of technological integration reveal the logic behind each project's feasibility and innovation, highlighting whether it leans toward high-tech experimentation or vernacular adaptation.

contextual and environmental factors

climate zone	Temperate Europe dominates; vulnerable tropical zones underrepresented, limiting lessons where adaptation is most needed.
urban vs rural context	Urban cases dominate; rural contexts remain marginal despite acute vulnerability.
year	Two waves: early 2000s European experiments and post-2015 resurgence tied to climate
floating architecture category	Floating (anchored/modular) dominates; palafitic and amphibious systems remain marginal.

technological and structural logic

type (high-tech / vernacular)	High-tech documented, vernacular underrepresented; panorama polarized.
construction system	Concrete/steel dominate; vernacular wood/bamboo marginalized; lifecycle data absent.
materials	Spectrum of materials; hybridity common but underreported; integration of bio-based/recycled needed.
tech integration (low/med /high)	Medium-tech linked to affordability; high-tech inflates costs; low-tech ignored in formal discourse.

Equally important are the variables linked to affordability and economic viability, which include direct measures such as affordability scores and maintenance costs, as well as socio-economic fit by identifying the income level of target communities. This economic dimension is complemented by social and cultural variables, such as the project's main objective, its level of community participation, and its role within everyday livelihoods.

Finally, sustainability-oriented variables, such as environmental strategies, capacity for urban integration, and scalability, help determine whether a project is not only a one-off experiment but also a replicable, resilient model that could inform future urban and rural development.

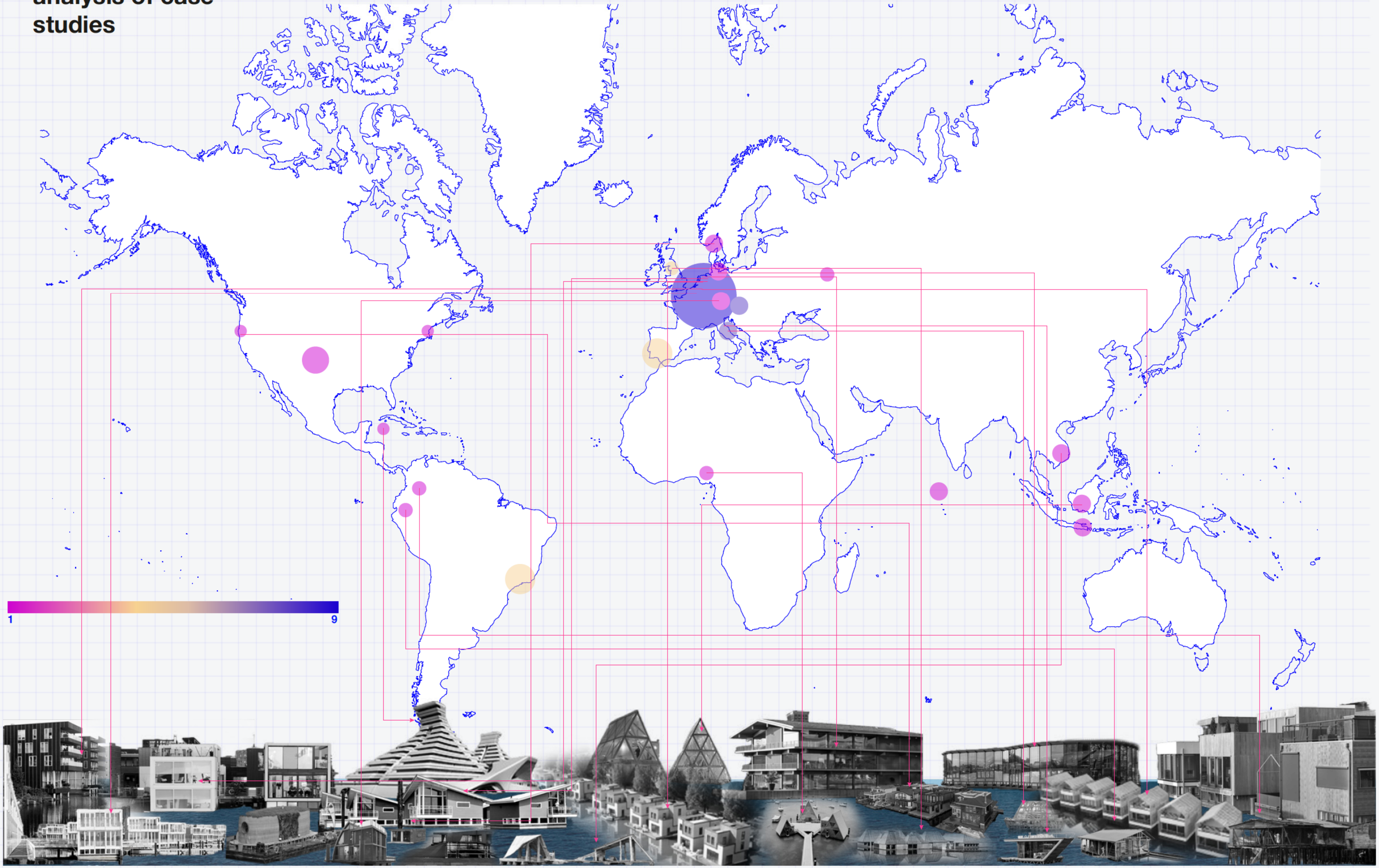
By structuring the analysis through this variable framework, the research avoids overly subjective interpretation and instead generates a comparative dataset. This makes it possible to identify patterns across high-tech and vernacular cases, to highlight the absence of an accessible "middle ground," and to establish the parameters for developing a modular, community-oriented floating architecture model.

economic accessibility and viability	
affordable / not affordable	Affordability shaped by governance, not just technology; participatory projects more affordable.
maintenance cost	Maintenance data sparse; lifecycle costs of both high-tech and vernacular poorly captured.
community fit income	Most cases target middle/high-income; low-income vulnerable groups overlooked.
affordability score	Affordability is multidimensional; governance and maintenance as decisive as construction costs.

social and cultural dimensions	
community participation	Participation underreported but correlated with affordability; top-down projects exclusive.
main objective / use	Residential/mixed-use dominate; tourism/exhibition risk trivializing adaptation; vernacular = survival.
community fit income	Most cases target middle/high-income; low-income vulnerable groups overlooked.

sustainability and long-term resilience	
sustainability features	Sustainability framed as add-on; vernacular embodies circularity but unrecognized.
urban integration	Europe integrates projects into urban systems; vernacular remains peripheral and excluded.
scalability	Scalability theoretical; high-tech replicates slowly, vernacular scales organically but lacks legitimacy.

analysis of case studies



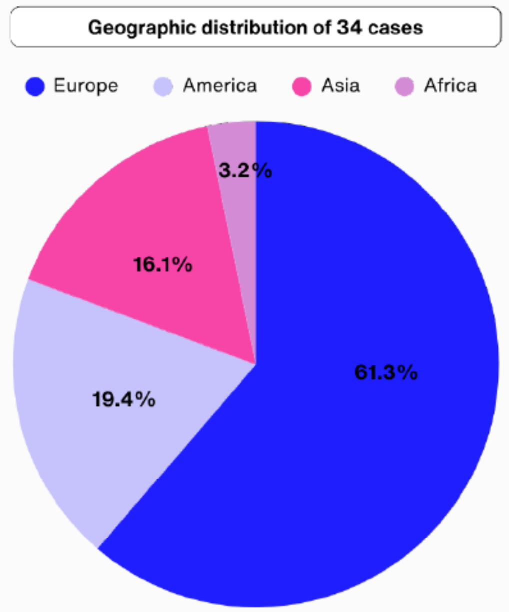
representative panorama of floating architecture

The comparative analysis of 34 case studies provides a representative yet uneven snapshot of the current state of floating architecture. The dataset, while skewed towards European projects, reveals meaningful trends across typology, geography, temporality, materiality, technology, affordability, and community participation. Together, these dimensions outline both the strengths of the typology and the critical gaps that hinder its broader applicability.

typological and geographic Patterns

Based on 34 analyzable entries, the typological and geographic panorama of floating architecture reveals strong imbalances. Floating buildings, mainly anchored and modular forms, dominate with 24/34 cases (≈70%), while palafitic/stilt structures appear in only 4/34 (≈11%), amphibious systems in 2/34 (≈6%), and other or unclear types in 6/34 (≈13%). This typological skew is mirrored geographically: Europe accounts for 19 out of 34 cases (≈55%), followed by America with 6 out of 34 (≈17%), Asia with 5 out of 34 (≈15%), Africa with 1 out of 34 (≈3%), and unknown locations with 3 out of 34 (≈8%). A cross-tabulation sharpens the contrast: two-thirds of all floating cases (16/24; approximately 67%) occur in Europe, whereas no palafitic examples are documented in Europe; instead, they appear only in Asia and Latin America.

These distributions are not neutral but reflect a bias in documentation and institutional practices. Projects embedded in European regulatory frameworks, formal procurement, and engineered delivery systems are more likely to be designed, permitted, published, and cited, thereby entering academic discourse. By contrast, vernacular aquatic settlements, abundant in Southeast Asia and Latin America, remain underrepresented because they often fall outside formal regulation, lack institutional commissioning, and are seldom framed as discrete "projects."



The result is a "global" panorama that foregrounds technologically advanced European models while obscuring long-standing vernacular traditions that continue to house millions in waterborne environments.

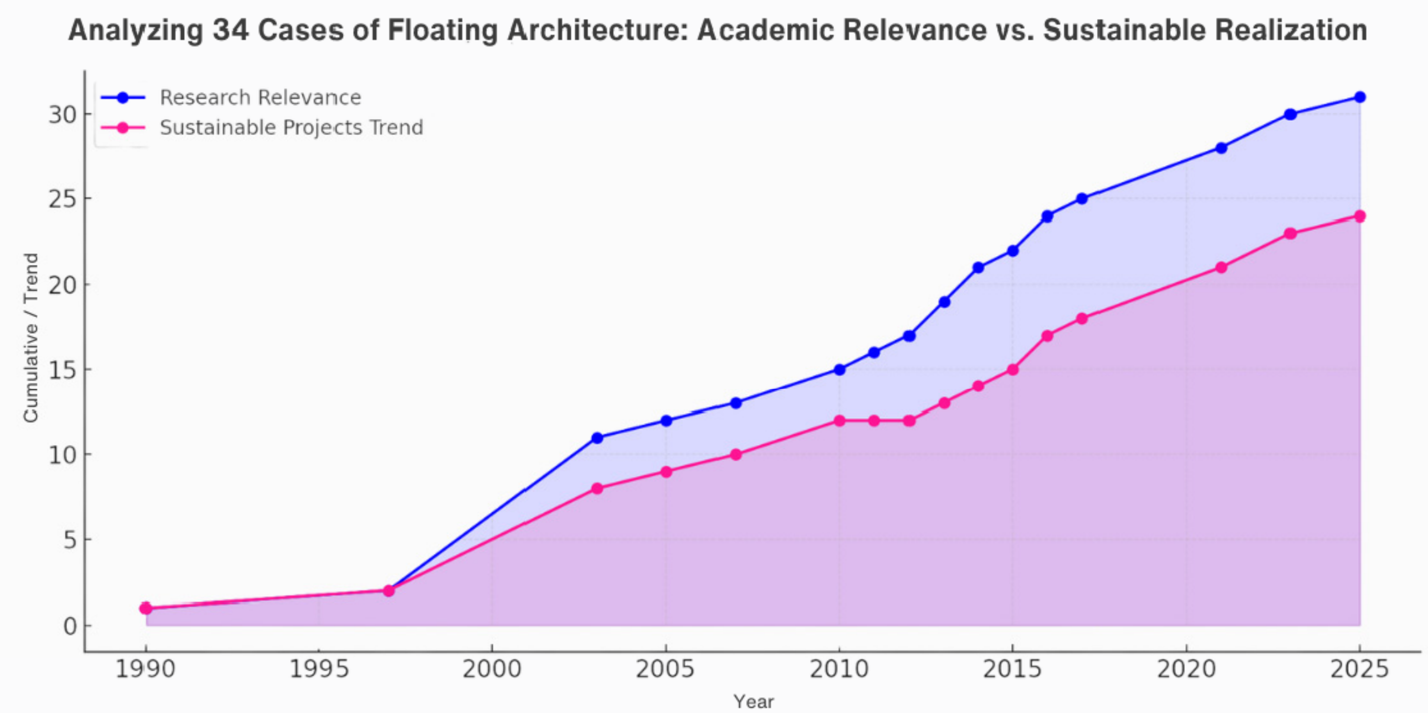
Moreover, distinguishing between built projects with verifiable sites and conceptual or reference entries reinforces the observed pattern: Europe's dominance in floating typologies becomes even more pronounced. At the same time, palafitic and amphibious solutions appear as marginal in the documented corpus. Taken together, these measures ensure that the dataset does not overstate coverage but instead reflects the actual state of documented practice: a panorama where the institutional face of floating architecture, engineered, codified, and European, prevails, while vernacular, informal, and Global South realities remain systematically undersampled despite their undeniable relevance.

temporal dimension

The temporal profile of the corpus indicates two distinct waves rather than a linear growth curve. Among the 31 dated cases, the early 2000s form a first peak centered on 2003 (9 cases; ≈approximately 29% of the dated sample), primarily tied to European pilot projects and district-scale experiments. A second wave from 2021 onward (6 cases; ≈approximately 19%) signals renewed momentum aligned with climate adaptation agendas, urban resilience programming, and growing private investment. In decade terms, the distribution reads: 1990s: 2, 2000s: 11, 2010s: 12, 2020s: 6, meaning ≈that approximately 94% of the documented activity concentrates in the last two decades. Notably, the recent wave is visible but not the densest in this dataset; the 2003 cohort remains the most concentrated single-year cluster, suggesting cyclical patterns of experimentation, consolidation, and reinvigoration rather than steady escalation.

This reading was consolidated by reporting unknown dates transparently and distinguishing built, site-verifiable projects from conceptual/reference entries, which strengthens the two-wave pattern: early European demonstrators dominate the first cycle; the post-2021 resurgence remains Europe-led but broadens thematically (energy autonomy, modularization, off-grid services) and institutionally (more public-private constellations).

Overall, the temporal analysis suggests that floating architecture has matured in phases: an early 2000s period of technical proof of concept and regulatory navigation, followed by a contemporary phase of market adoption and policy-aligned implementation. This cyclical dynamic, rather than simple growth, better explains the current landscape and frames the next step of the thesis: relating the timing of projects to technology levels, affordability profiles, and governance arrangements, to understand which conditions actually trigger transitions from experimental prototypes to scalable, socially embedded interventions.



Cumulative trends of academic relevance (blue) and sustainable built projects (pink) in floating architecture. The graph shows two waves: an early peak around 2003 and a renewed acceleration after 2015–2021, where sustainable projects begin to close the gap with academic discourse, signaling a shift from experimentation to implementation.

affordability vs. technology

Beyond the construction of projects, a critical question is how they are designed and for whom. The relationship between technological sophistication and affordability is crucial in determining whether floating architecture can extend beyond elite enclaves to achieve broader societal relevance. The dataset of 34 cases complicates conventional assumptions.

On the technology side, Medium-tech projects dominate (19/33), followed by High-tech (13/33), while low-tech projects are almost absent (1/33). Affordability, however, is reported unevenly: affordable (7), not affordable (5), Variable (2), and Unknown (19; ≈approximately 58%). This lack of transparency is itself a structural finding; documentation tends to highlight technical performance but neglects cost reporting, obscuring affordability as a design and policy issue.

Within the subset where affordability is specified, patterns emerge. Medium-tech cases are affordable in ≈approximately 71% of instances (5/7), whereas High-tech cases are not affordable in ≈approximately 67% of instances (4/6). Low-tech, with only one reported case, cannot be generalized. These figures suggest that Medium-tech represents the most adaptable "bandwidth" for reconciling performance and cost. At the same time, High-tech is not intrinsically unaffordable but tends to cluster in high-income markets, where design ambition, regulatory compliance, and premium finishes elevate both capital and operational costs.

When cross-referenced with Community Fit income, the picture becomes sharper. Medium-tech projects span both high- and low-income target groups, while High-tech projects concentrate around high- and middle-income users, rarely reaching low-income constituencies. This suggests that market positioning and governance frameworks, rather than the technological level alone, drive cost trajectories. Moreover, community participation appears as a moderating factor.

Among cases reporting participation, Affordable outcomes outweigh non-affordable ones (7 vs. 3), while projects without participation show the opposite balance. Although based on small numbers, this correlation suggests that co-production and local embedding are linked to greater cost containment and accessibility.

Taken together, the data reframes affordability not as a technological inevitability but as an interaction problem: the product of technology, governance, regulation, market ambition, and social participation. The dominance of Medium-tech in affordable outcomes points toward the space of the "missing middle", design strategies that combine modular floating systems, renewable technologies, and contextually appropriate materials without the cost inflation of high-end finishes or exclusive markets. Conversely, the underrepresentation of Low-tech vernacular solutions in formal documentation reveals a different kind of bias: practices that may indeed be affordable and resilient are undersampled and under-reported, leaving the academic record skewed toward European, engineered examples.

In this light, affordability in floating architecture must be understood through a holistic lens: not only upfront construction costs but also lifecycle performance, maintenance, community engagement, and cultural value. The challenge for future practice lies in developing hybrid models that are medium-tech, participatory, and cost-conscious, bridging the current polarity between high-tech exclusivity and invisible vernacular informality, and enabling floating architecture to serve diverse populations more equitably.

MAKOKO FLOATING SCHOOL

material strategies

If affordability complicates simplistic assumptions about technology, materiality introduces an equally decisive dimension of hybridity. The 34 cases analyzed reveal not a binary opposition but a spectrum of strategies negotiated between performance, affordability, regulation, and identity. When categorized, the distribution is uneven, with concrete-based systems dominating (≈approximately 12 cases), primarily in European floating projects, where regulatory compliance, buoyancy reliability, and durability are prioritized. Steel/metal structures appear in ≈4 cases, often combined with concrete pontoons for added stability. Wood/bamboo systems account for ≈approximately 5 cases, concentrated in palafitic and vernacular settlements in Asia and Latin America, highlighting cultural continuity and local resource availability, but are constrained by maintenance demands and a lack of recognition in formal frameworks. Reused/recycled solutions (≈approximately 3 cases, including containers, barrels, and modular blocks) and plastics/composites (≈approximately 2 cases, including fiberglass and 3D-printed concrete) remain marginal, primarily appearing in experimental or transitional prototypes.

At the foundation level, buoyancy is most commonly achieved through reinforced concrete pontoons, hollow concrete boxes filled with polystyrene, or steel hulls treated with epoxy, ensuring durability under marine conditions and meeting regulatory expectations.

Vernacular flotation methods, by contrast, employ recycled barrels, plastic drums, or bamboo rafts, resourceful solutions in contexts without industrial supply chains. However, these remain underrepresented in academic and institutional discourse, despite their affordability and embedded resilience. Anchoring systems, across both high-tech and vernacular projects, consistently rely on steel mooring piles, chains, or poles, confirming an almost universal dependency on industrial components for lateral stability.

At the superstructure level, hybridity becomes even more evident. High-tech projects utilize engineered timber (e.g., glulam, cedar) and steel frames, striking a balance between lightness and longevity.

Some experimental cases incorporate composite plastics, retrofitted shipping containers, or 3D-printed concrete, reflecting the search for circular design and efficiency. Vernacular palafitic settlements, by contrast, are built with materials such as bamboo, palm thatch, and local woods, which embody centuries of accumulated environmental knowledge but struggle with durability and acceptance in formal planning regimes.

Three critical insights emerge from this comparative analysis:

1

hybridity is the rule, not the exception. few projects are purely "vernacular" or "high-tech." most combine industrial foundations with lighter, sometimes vernacular, superstructures.

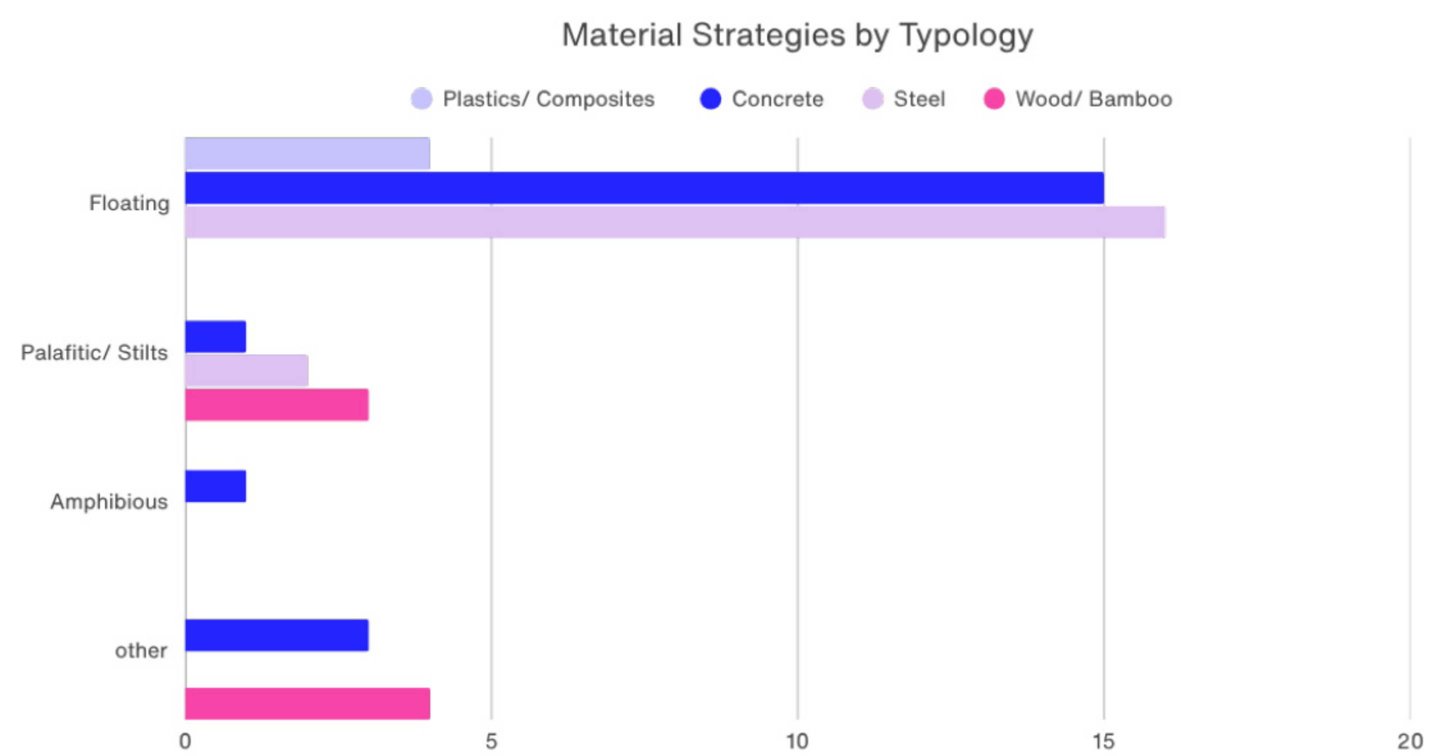
2

performance versus identity trade-off. concrete and steel offer durability and regulatory approval, but they also increase costs and embodied carbon. in contrast, wood and bamboo preserve cultural identity, yet they face stigmatization and faster degradation.

3

lifecycle costs remain invisible. reporting focuses almost exclusively on construction materials. differences in **maintenance cycles and long-term affordability**, which likely diverge sharply between concrete and steel/steel and bamboo/thatch, are rarely documented, masking the true economic sustainability of material choices.

Taken together, the evidence positions materiality as a negotiation arena where technical performance, cost, and cultural symbolism converge. The European cases institutionalize concrete- and steel-heavy strategies, while Global South vernaculars demonstrate resourcefulness through reuse and bio-based approaches, although these remain underdocumented and underrecognized. For future practice, the key challenge lies in developing hybrid material models that combine industrial durability with vernacular adaptability, thereby populating the "missing middle": durable, affordable, and culturally embedded solutions that extend the relevance of floating architecture to vulnerable communities worldwide.



community participation and governance

Technical and material innovation alone do not determine the viability of floating architecture; governance arrangements and community participation shape who benefits, at what cost, and for how long. In the coded sample (34), participation is explicitly reported in 20 cases, absent in 2 cases, and unreported in 11 cases. This nevenness is more than a methodological inconvenience: it reflects a broader structural tendency in the field to prioritize technical description over social and institutional dimensions. However, where affordability is known, the relationship is clear. Participatory projects are more frequently reported as affordable (7 cases) than not affordable (3), while projects without participation trend in the opposite direction. Although modest in scale, this signal reinforces that affordability is not a technical inevitability but an interaction between technology, governance, and market positioning.

Participation as a driver of equity
Projects that incorporate community input tend to strike a balance between medium-level technology and affordability, reinforcing the concept of a "missing middle": design solutions that combine sufficient technical sophistication with social integration. Conversely, high-tech, top-down developments are disproportionately clustered in high-income markets, elevating costs through regulatory compliance, premium finishes, and exclusive positioning. The data thus suggests that participation is not a cosmetic add-on but a material condition for equitable aquatecture.

Governance mechanics behind the scenes
Scattered notes across cases, such as references to "registered as a boat", "certified as a houseboat", or "construction took 10 years due to bureaucracy", hint at the decisive role of governance mechanisms, even if these are rarely documented systematically. The analysis points to several variables that remain under-reported but are critical to long-term viability:

- Legal status and code pathway (maritime registration vs. building classification).
- Tenure and rights (ownership, leasehold, cooperative arrangements, or mooring rights).
- Delivery model (developer-led, public-private partnerships, municipal, or cooperative).
- Finance structure (market-driven vs. blended with subsidies, grants, or green funds).
- Service integration (utilities, emergency access, off- vs on-grid connections).
- Operation and maintenance plans (whether ad hoc or supported by sinking funds).
- Insurance and liability frameworks (flood, storm, mooring failure).
- Community participation in governance (from consultation to co-production).

These dimensions remain largely invisible in the dataset, limiting the ability to assess how projects function once they are built. Their absence also explains why affordability appears to track technological sophistication: in practice, regulatory compliance, financing, tenure arrangements, and insurance obligations drive cost as much as materials or systems.

Socio-spatial divides
Scattered notes across cases, such as The dataset reproduces a broader dichotomy in the geography of floating architecture. In Europe, high-tech, formally regulated projects dominate, targeting middle- and high-income users and benefiting from robust institutional support. In Southeast Asia and Latin America, by contrast, long-standing vernacular waterborne settlements persist, resilient and adaptive yet underrepresented in academic and policy discourse. These are seldom documented as discrete "projects," despite their significance for millions of residents. The result is a fragmented global panorama where formal, engineered aquatecture is celebrated. At the same time, vernacular resilience remains invisible, thereby reducing opportunities for cross-learning between technologically advanced systems and those that are socially embedded.

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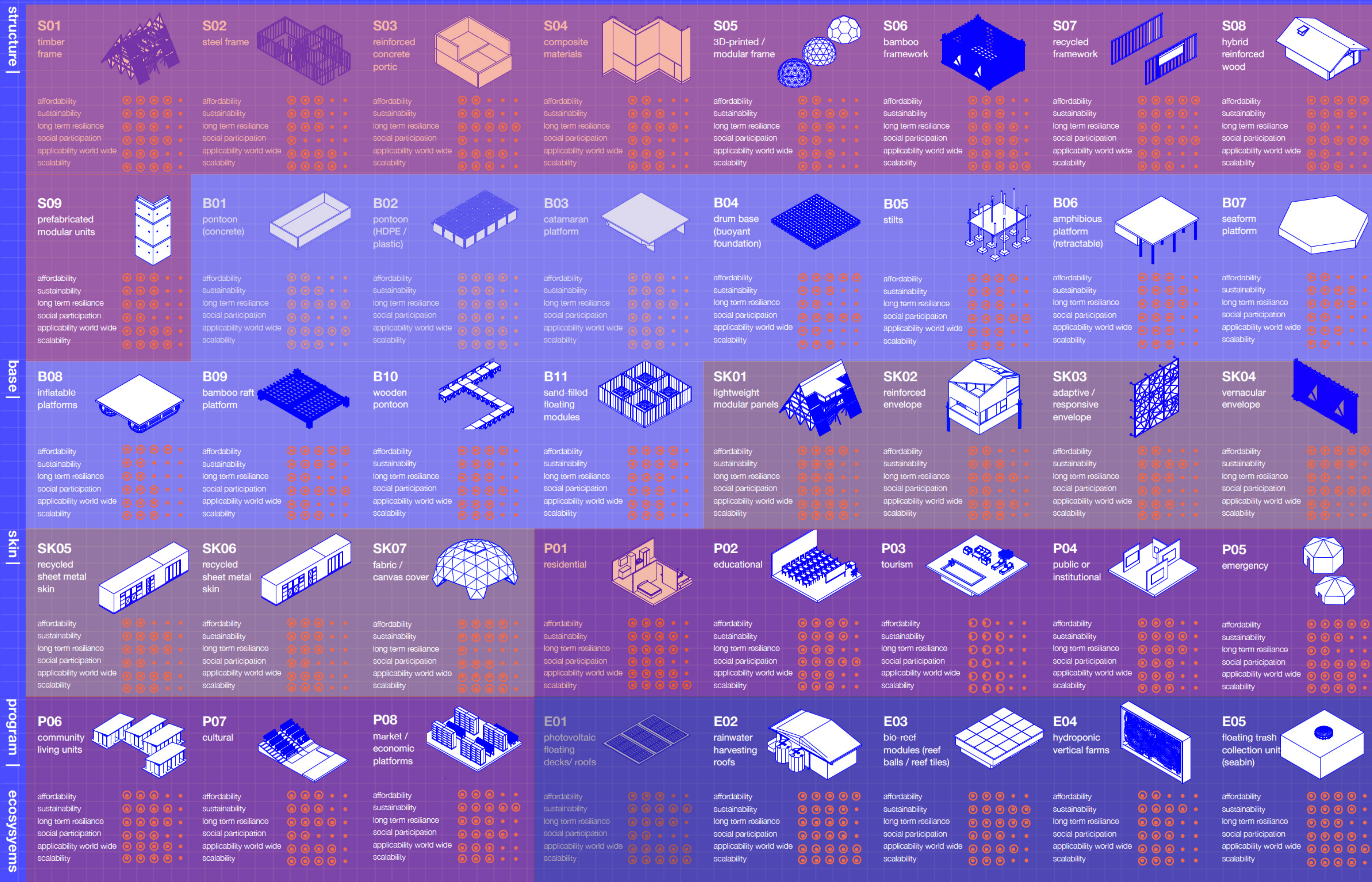
Toward an institutional "missing middle"
Taken together, the evidence positions participatory, medium-tech projects, supported by secure legal status, cooperative or blended finance, service integration, and clear maintenance plans, as the most credible route out of the current polarization between enclave urbanism and precarious informality. Governance is not a secondary layer but a constitutive design element: without it, floating architecture risks remaining either an exclusive spectacle or an invisible survival strategy. Only by embedding social participation within supportive institutional frameworks can floating architecture transition into an equitable and scalable adaptation, a mode of practice where technical sophistication and social justice converge.

typology matrix



toward the missing middle

The analysis across temporal, typological, material, technological, and governance dimensions exposes a central gap in floating architecture today. Current practices tend to polarize between two extremes: advanced, market-driven European projects for affluent groups, and vernacular, informal settlements in the Global South that remain undervalued despite their resilience. What is absent mainly is a “missing middle”: hybrid models that combine technological durability and compliance with affordability, contextual sensitivity, and participatory processes.

This absence is more than descriptive; it is programmatic. Without hybrid solutions, floating architecture risks reinforcing exclusivity on one side and invisibility on the other. The real opportunity lies in typologies that combine technical performance with social equity: designs that are both cost-efficient and durable, regulated and culturally grounded. Such approaches could transform floating architecture from either spectacle or survival mechanism into a viable adaptation strategy for populations facing flooding, displacement, and housing insecurity.

Recognizing this missing middle, floating architecture is framed as an ethical and political project, not just a technical field. Governance, affordability, and cultural integration are just as important as engineering systems. This perspective guided the selection of two contrasting case studies: Rotterdam, representing high-tech, regulated aquatecture; and Nueva Venecia, embodying informal, culturally rooted settlement. Studying these cases side by side reveals their respective strengths and limitations, while highlighting the unoccupied space in between, the terrain where the future of floating architecture must be imagined.

City of Tigre, Argentina, a city coexixting with water and with potential acuatinc development. - by Lucia Capretti

two worlds of water: from global analysis to Rotterdam and Nueva Venecia

1.

| case studes |

the dataset selection included diverse typologies of aquatecture from across Latin America, Europe, Africa, and Asia.

selection criteria

- **geographical diversity (tropical vs temperate zones)**
- **degree of urban integration (rural / urban / peri-urban)**
- **environmental risk exposure (flood-prone / deltaic / tidal)**
- **socioeconomic accessibility (high-tech vs low-income)**
- **relationship to water (floating / amphibious / pile-based / house boats)**

patterns of polarization

economic

Wealthier, technologically advanced nations (Netherlands, UAE, Singapore) developed high-tech floating projects with heavy infrastructure investment, while low-income, water-dependent communities (Colombia, Nigeria, Cambodia) relied on vernacular, self-built models with minimal resources.

technological

Advanced buoyancy systems, automation, and hybrid materials characterized one extreme, while the other depended on manual construction, wood-based materials, and adaptive reuse.

spatial

High-tech models prioritized individual ownership and modular privacy, whereas vernacular ones emphasized communal layouts, shared docks, and collective infrastructure.

palafitic construction in water

ancestral relationship with water

nueva venecia — **tradition based palafitic building**

high-tech contemporary bulding — **rotterdam**

floating construction in water

concious climatic responce

common ground = proof of water coexisting with architecture as a transversal worldwide lenguage

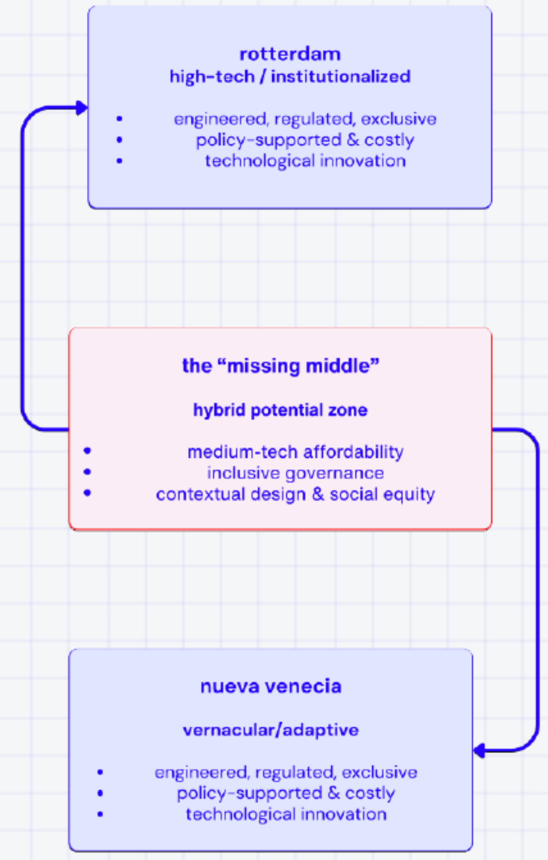
2.2 case studies: rotterdam and nueva venecia

To explore the contrasting paths within the world of floating architecture, this section presents a comparative analysis of two case studies: Rotterdam, in the Netherlands, and Nueva Venecia, in Colombia. These cities represent two divergent approaches to living on water, one shaped by technological innovation, planned interventions, and urban development, the other by vernacular practices, community resilience, and adaptation to environmental vulnerability. We chose these two case studies to deepen on, since they represent the polar opposites of cities that have succesfully developed acuatecture, making it part of its urban tissue. These examples also heighten the clear gap between both typologies, since they are not only on drastic ends culturally, but also in the economic spectrum. Contrasting the polar opposites of a high tech, economical exclusivity aquatecture in rotterdam and culturally driven, palafitic urban development in Nueva Venecia.

Through the study of these two contexts, we aim to understand how geography, climate, and urbanization influence architectural choices and spatial organization. We are interested in uncovering not just the physical characteristics of the floating structures but also how these are shaped by and respond to local needs, economic constraints, and social dynamics. We examine how each city approaches the challenges of building on water, whether through engineered, high-tech solutions, as in Rotterdam, or through informal, community-based practices, like those in Nueva Venecia.

Moreover, our analysis aims to evaluate the viability, affordability, and long-term implications of each model. We investigate the relationship between the built environment and the communities it serves, examining the balance between innovation and tradition and how each settlement responds to climatic risks and sustainability concerns. By applying the same analytical framework used in our literature review, we aim to extract comparable insights that reveal both the tensions and opportunities present in floating architecture today.

Ultimately, this comparative study will help us reflect on whether it is possible to envision a middle ground, a hybrid model that bridges technological advancement with social and environmental inclusivity.

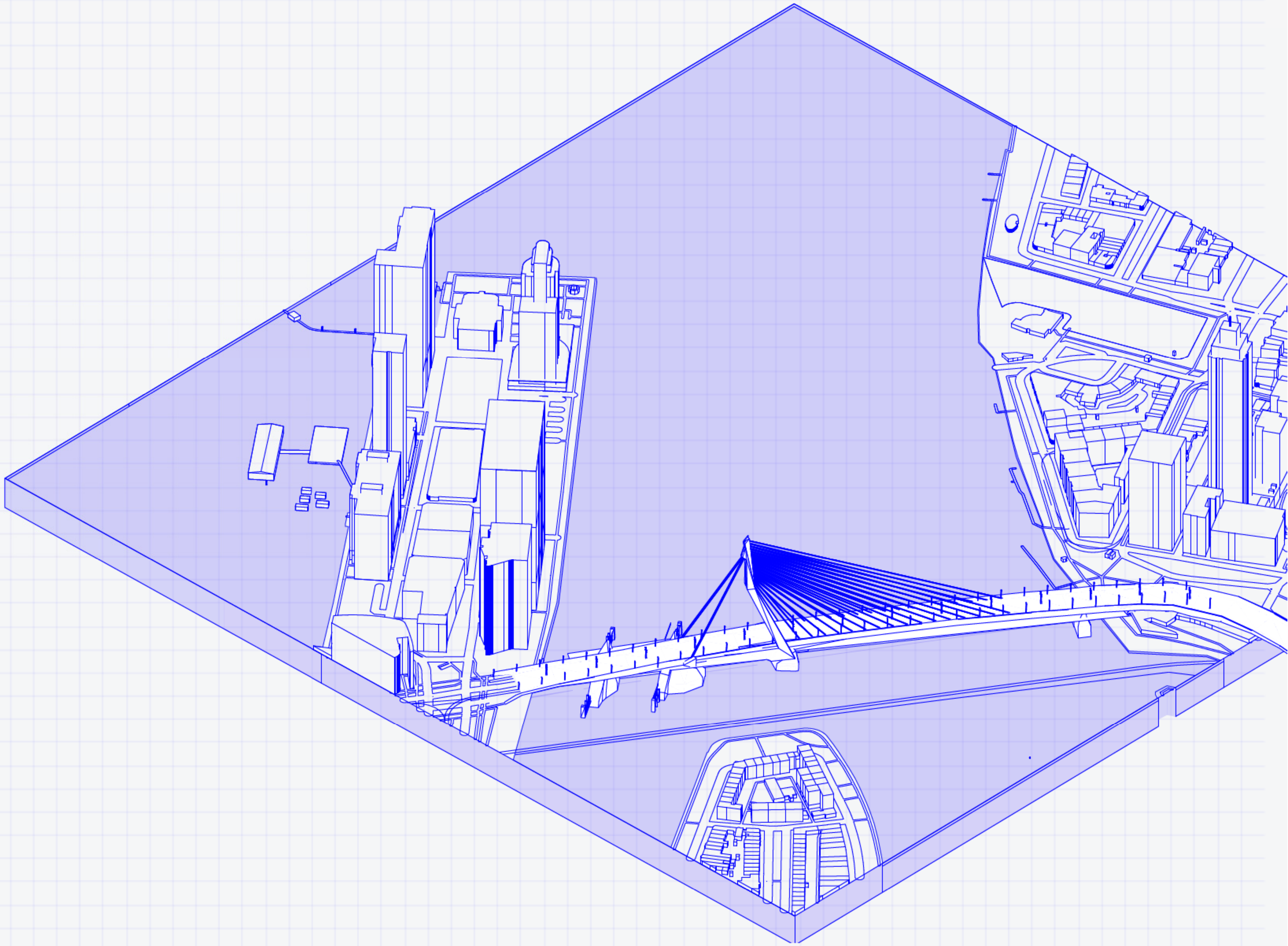


Rotterdam and Nueva Venecia represent opposite ends of global practice. Their comparison reveals the unoccupied zone where innovation, equity, and resilience could converge.

rotterdam, netherlands

Rotterdam stands out as a key case study within the spectrum of high-tech aquatecture. The city's deep-rooted relationship with water, embedded in Dutch culture and centuries of adaptation to life below sea level, has fostered a unique mindset where water is seen not only as a challenge but as an opportunity. Unlike many European cities shaped by preservation, Rotterdam was rebuilt almost entirely after World War II, giving it both architectural freedom and a forward-looking, experimental identity.

This combination of historical resilience, socio-economic strength, and progressive urban planning has turned Rotterdam into a living laboratory for floating architecture. Projects like the Floating Pavilion and the Floating Office Rotterdam symbolize how technology, sustainability, and design merge into practical urban solutions. For these reasons, Rotterdam represents a crucial reference point for understanding contemporary high-tech floating architecture, making it an ideal counterpart to vernacular, community-driven case studies.










01. geographic and environmental context

The geographical context of Rotterdam is very interesting, as it is for the rest of the netherlands. Defined by its location as a major delta city (an urban center located within a river delta or a major river basin system) in the Netherlands, Rotterdam is characterized by low elevation, high vulnerability to water, and a history intrinsically linked to managing its major river and port systems. It is situated in the Rhine–Meuse Delta, which is recognized as the lowest delta in Europe. The city owes its existence and expansion primarily to the river Meuse. Its historical core developed along the Rotte river, where a dam was built in the 13th century. The Netherlands in general has approximately 20% of the country comprised of water, and Rotterdam is not the exception, as it is characterized as one of the lowest-lying cities in Europe. The inner-dike area of the city, protected by extensive flood defenses, is mostly well below sea level, reaching its lowest point at 6.67 meters below NAP (National Amsterdam Level). This pervasive influence of water has led to the necessity of constant protection and adaptation against potential flooding, causing a series of innovative solutions to surge throught the years. the Dutch have long mastered hydraulic engineering, but Rotterdam's current transition toward floating development represents a conceptual shift: from resisting water to living with it (Zand, 2023; Penning-Rowsell, 2019).

Historically, delta areas were attractive for large settlements due to multiple natural advantages. Cities like rotterdam, traditionally can provide reliable water resources and fertile land for agriculture, allowing for a food surplus that supported a population available to produce other goods and services. They also provide good connections by water transport, which facilitates the easy movement of goods worldwide, making them economic hubs. This is clearly shown in rotterdam, as it has mayor ports arpundt the city that function year long for activities related to tourism and industry. Nevertheless, rotterdam also faces the fear of disapearance because of its geographical condition, revealing a constant fear of flooding, overflowing or even sinking.

01. geographic and environmental context

multiscalarity

national scale

At the national scale, Rotterdam is positioned within the dense infrastructural and hydrological network of the Netherlands, a country historically shaped by its constant interaction with water. The map highlights the intricate system of rivers, canals, and dikes that define the Dutch landscape and connect Rotterdam to other major cities.

regional scale

At the regional scale, the focus shifts to South Holland, one of the Netherlands most densely populated and economically dynamic provinces. The map reveals Rotterdam's strategic position within this deltaic region, emphasizing its close connection to The Hague, Delft, and Dordrecht, as well as the shared environmental challenges of water management and land reclamation that characterize the province.

zonal scale

At the zonal scale, the view narrows to the urban core and waterfronts of Rotterdam. The map illustrates the city's intricate relationship with its harbors, canals, and reclaimed lands, showing how its built environment continuously negotiates with water through adaptive planning and infrastructure.

02. memory, territory, and the makings - historical relationship with water

The history of Rotterdam is fundamentally intertwined with the management and utilization of water, which is described as both an “enemy” and a “source of life” for the city. Its development could be traced to a small settlement in the low-lying Rhine–Meuse Delta. Around 1200, the first permanent settlements occurred at the location where a 400-meter dam was constructed in the Rotte river near the end of the 13th century. This dam provided the necessary initial protection and defined the city’s location. By 1360, Rotterdam had become a major sea port after a canal was built connecting it to the waterways of the Schie, facilitating the flow of goods between England and Germany. In the 17th century, the outer dike areas were vibrant residential and working environments, despite occasional flooding. The Boompjes waterfront functioned as both a quay and a boulevard, becoming the “rich façade” of the city overlooking the Meuse.

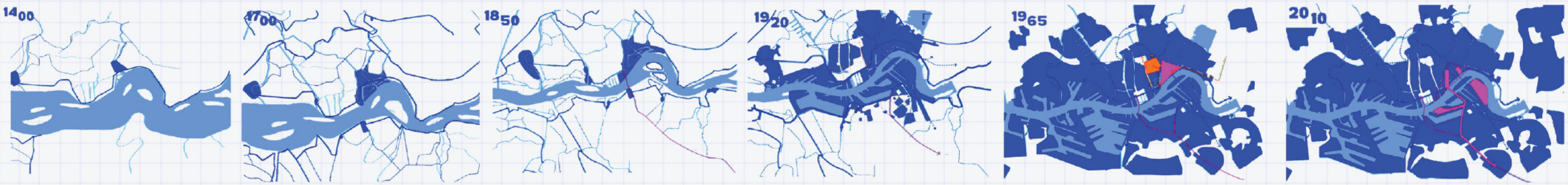
By 1850, the south side of the Meuse was largely rural land. In 1863, the Municipality began developing Feijenoord and constructing harbors capable of hosting larger ships. Due to increasing volume, major basins like the Rijnhaven and Maashaven were added by 1908. The Rijnhaven (built 1887–1895) was critical, being the first large transit port where transshipment from ship to ship was possible, solidifying Rotterdam as a world port. (Kokhuis, 2013)

The 19th and 20th centuries were marked by massive industrial expansion, resulting infrastructure that segmented the city, and major challenges in defense and hygiene. By 1850, the south side of the Meuse was largely rural land. In 1863, the Municipality began developing

The central part of the city immediately after the bombing. Photo: Wikimedia Commons

Feijenoord and constructing harbors capable of hosting larger ships. Due to increasing volume, major basins like the Rijnhaven and Maashaven were added by 1908. The Rijnhaven (built 1887–1895) was critical, being the first large transit port where transshipment from ship to ship was possible, solidifying Rotterdam as a world port. Historically, Dutch cities had used water systems intensively for transportation until the 19th century.
During 1953, there was a mayor flood that came drom the north sea. This devastating disaster forced the city to significantly rethink its flood management. Following the event, the primary levees needed to be even higher, contributing to the city moving the flood defense to the former Boompjes. These necessary height regulations and infrastructure projects created profound scars in the city pattern, dividing it into an “agglomeration of isles”. As harbor activities continued to move westward towards the sea (following the growth of ships and global containerization), the relationship between the city center and the river became strained. Most industrial activity moved out of sight to the west. The functional connection to the river, which used to provide labor for many residents, weakened, turning the industrial sites along the river into a barrier.

A slow process of reclamation and re-engagement began. The opening of the Erasmus Bridge in 1996 was a critical moment, creating a crucial physical and psychological link between the north and the Kop van Zuid in the south. The city began efforts to revitalize old port areas (like Wijnhaven and Leuvehaven), turning them into lively urban neighborhoods. The urban planning history of Rotterdam is marked by these continuous, but often challenging, attempts to connect the city with the river and the harbor. In more recent years, small concloerates of buildings like the zone Wilhelminaplein, have been keen areas of floating architecture due to its direcvt proximity to the harbor. It shows how before the canals were key relation to water and the tren now, often shows the priority of populating the borders of water that surrounds rotterdam



1200 | **1400** | **1700** | **1900** | **1940** | **1970** | **2000** | **2019** | **FUTURE**

1200
First permanent settlements along the Rotte.

1270
A dam is built across the Rotte (origin of the name "Rotterdam")

1360
Canal built connecting Rotterdam to the Schie, linking trade routes between England and Germany.

late 1300
Rotterdam grows into a seaport, shaped by dikes and water systems.

1466
Rotterdam granted city rights.

1500
Herring fishing and shipbuilding dominate the economy.

1600
Outerdike areas become vibrant residential/working quarters, despite periodic floods. Boompjes waterfront becomes the "rich façade" of the city, functioning both as quay and boulevard.

1700
Polder reclamation enlarges habitable/industrial land.

1825
First major industrial activities along the Maas.

1850
South side of the Maas still largely rural.

1863
Municipality begins development of Feijenoord and construction of harbors for larger ships.

1863–72
Nieuwe Waterweg gives direct sea access → significant growth in shipping.

1887–95
Construction of the Rijnhaven, first large transit port allowing direct ship-to-ship transfers.

1908
Rijnhaven and Maashaven harbors completed.

19th–early 20th c.
Canals intensively used for transportation, but many were later filled in due to hygiene/pollution problems.

1940
German bombing destroys city center; 80,000 homeless.

1946
Witteveen's Basisplan modernist reconstruction reshapes the city with modular, prefabricated methods.

1953
North Sea Flood → higher levees, relocation of flood defenses to the Boompjes area.
These measures divided Rotterdam into an "agglomeration of isles", separating city districts.

1960
Port expansion westwards; the city's contact with the river weakens.

1970
Urban renewal, focus on housing and human scale.

1980
Old harbors (Wijnhaven, Leuvehaven) revitalized as cultural/neighborhood spaces.

1996
Erasmus Bridge opens, reconnecting north & south physically and symbolically.

Port continues shifting west; central waterfront becomes cultural/urban renewal zone.

2005
First municipal Green Strategy: concentric rings, climate resilience.

2010
Rotterdam Climate Initiative (50% CO_2 reduction goal).

2011
BlueCity founded (circular economy hub).

2013–16
Water Squares (Benthemplein) designed as public spaces that also store stormwater.

City begins to see water not just as enemy, but as partner in urban living.

2019
Floating Farm (Merwe-Vierhavens), world's first floating dairy farm.

2021
ity 7 Projects launched: tidal parks, 100,000 m² green, 700 trees.

2023–25
Rijnhaven redevelopment: large-scale floating housing, mixed-use waterfront, floating parks.

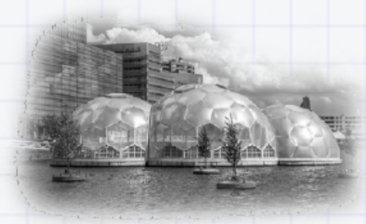
Today, Rotterdam is a global pioneer in floating urbanism, integrating adaptive design, climate resilience, and urban-water reconnection.












Birth of a Water Town

City of Trade and Herring

Industrial Port Rising

Gateway to Europe

City of Rubble and Reconstruction

From Modernism to Renewal

Floating Experiments

Floating Futures

03. local water adaptation strategies (urban dynamics)

The increasing severity of climate change, as evidenced by rising sea levels, heavier rainfall, and prolonged droughts, has significantly threatened the city's safety and livability. Simultaneously, the demand for urban expansion and housing affordability has intensified, particularly as available land within Rotterdam becomes increasingly scarce. These overlapping challenges have led to a new paradigm of spatial planning, one that views water not as a constraint but as an opportunity (Frantzeskaki & Tillie, 2014). This vision materialized in part through Rotterdam's proactive policy strategies, notably the "Rotterdam Climate Proof" initiative, which has guided the city's urban planning since 2010. This plan explicitly positions floating buildings among its five core strategies to address urban flooding and reduce carbon emissions. Nationally, the Delta Program further reinforces this direction by encouraging cities like Rotterdam to build resilient systems for flood protection and freshwater supply, with a horizon extending to 2100 (Mees et al., 2013). These planning tools, paired with increasing institutional collaboration between water managers and urban planners, have legitimized and even institutionalized floating construction as part of the city's official spatial vision.

Another critical enabler of floating architecture in Rotterdam is the transformation of underused harbor zones into experimental urban territories. Areas like Rijnhaven and Nassauhaven, once bustling with industrial shipping activities, have been reimagined as spaces for innovative housing, ecological restoration, and public engagement. The Floating Pavilion in Rijnhaven, one of the earliest showcases, set a precedent as a climate-resilient exhibition space. At the same time, projects like the Floating Office Rotterdam (FOR) and Nassauhaven's floating neighborhood continue to demonstrate the feasibility of long-term aquatic urbanism.

Inner-dike neighborhoods lie up to 6.67 meters below sea level, making traditional flood mitigation measures increasingly insufficient as climate projections forecast heavier rainfall, rising sea levels, and hotter summers (Frantzeskaki & Tillie, 2013). In response, the city's adaptation strategy embraces a philosophy of "living with water." Instead of exclusively relying on flood barriers, Rotterdam implements flexible, adaptive interventions, including floating architecture, that both mitigate risk and create spatial value. These projects not only reflect the Dutch ethos, but also serve as platforms for testing technological innovation, urban regeneration, and sustainable design principles in authentic contexts.

The cultural and economic drivers behind these developments are equally significant. The Dutch public's growing appetite for waterfront living, driven by higher income levels and lifestyle preferences, has made floating housing a desirable alternative to conventional models. However, as observed by Zand (2023), most floating developments in Rotterdam have so far catered to middle- or upper-income groups, raising critical questions around accessibility, affordability, and inclusion.

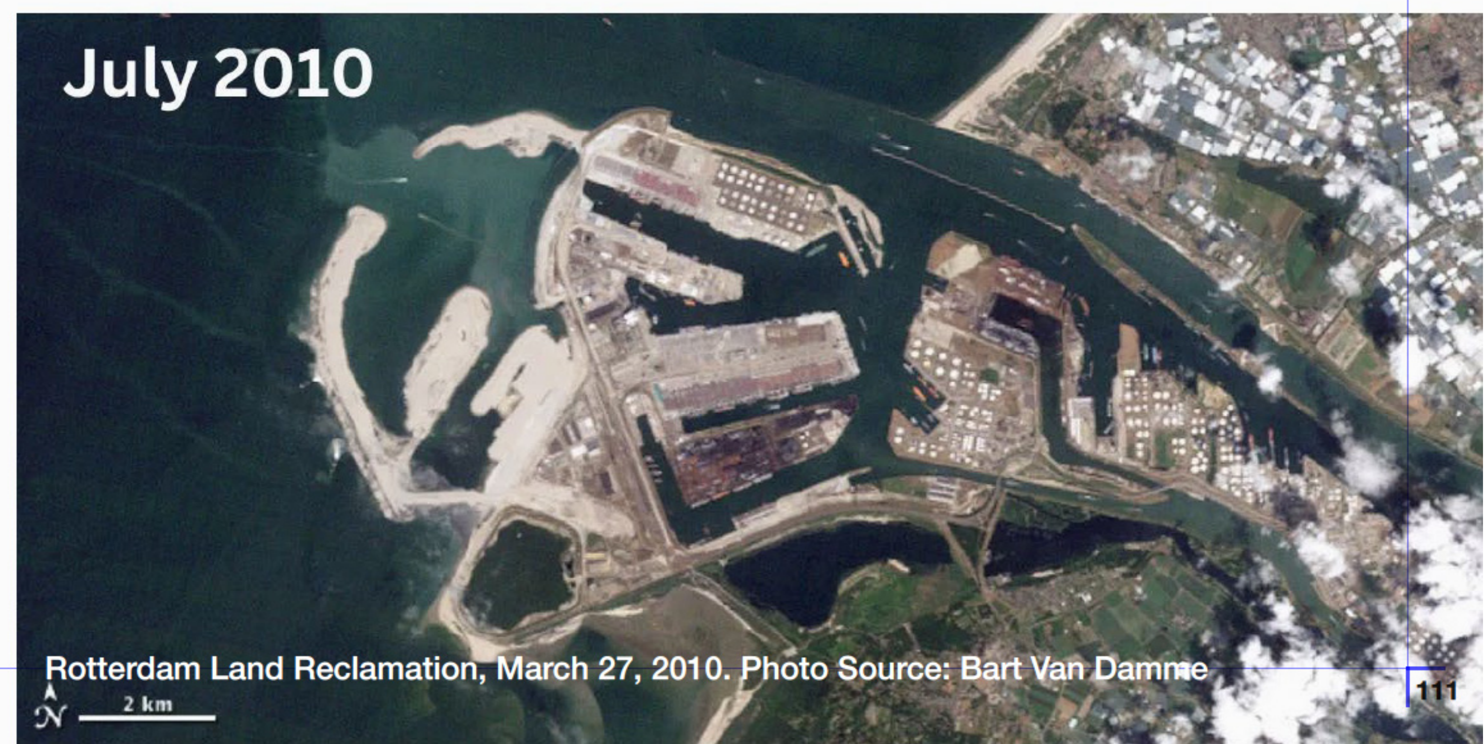
the world's first floating farm in rotterdam (see previous coverage here and here) as an agricultural building based on nautical principles. - image by ruben dario kleimeer

As shown in the case of Nassauhaven and comparable developments in IJburg and Schoonschip (Amsterdam), early adopters tend to be higher-income, well-educated individuals. The cost of floating structures, due to the specialized engineering and infrastructure required, often exceeds that of land-based buildings (Zand, 2023; Kokhuis, 2020). While the technological solutions exist, their social reach remains limited.

From a governance standpoint, Rotterdam's implementation relies heavily on public-private partnerships and a decentralized innovation ecosystem. Facilities like AquaDock serve as living labs for floating prototypes, and the Delta Program supports long-term climate resilience planning through multilevel collaboration. However, participatory design in floating housing remains limited. While water squares like Benthemplein engaged citizens in early design phases, most floating residential projects have been developer-led, with limited inclusion of broader public perspectives, especially from socio-economically vulnerable groups (Mees et al., 2013; Damen, 2022). This economic exclusivity has led to critical debates around spatial justice and social inclusion. Researchers and planners have raised concerns that floating neighborhoods could result in the privatization of water surfaces, the creation of low-density luxury enclaves, or even socio-spatial segregation. Moreover, replicating terrestrial design logic in floating projects risks disconnecting these developments from their unique hydrological context and diminishing their adaptive potential (Adnan, 2023; Penning-Rowsell, 2019).

Nonetheless, Rotterdam has made efforts to address these concerns through participatory urban planning. The municipality actively engages citizens and stakeholders in climate adaptation strategies, including the Delta Program and specific redevelopment projects. The case of Maashaven demonstrates this: although large-scale floating neighborhoods were ultimately rejected, the process involved public consultation and an investigation into how amphibious public space could function inclusively. Similarly, other city initiatives, such as the Benthemplein water square and the Van Meekeren redevelopment, reflect a growing institutional awareness of the importance of community engagement and co-design.

Rotterdam's contribution to floating urbanism is invaluable. It offers a high-tech, scalable model for climate-responsive design, showing how architecture can interact with hydrological systems without land reclamation; the technological sophistication, material research, and spatial experimentation position Rotterdam at the forefront of urban aquatecture. Institutions like AquaDock, which acts as a development hub for floating urbanization technologies, further support Rotterdam's ambition to become a global leader in water-based innovation. By hosting pilot projects, encouraging cross-sector collaboration, and promoting experimental architecture, the city has positioned itself not only as a case study in climate resilience but also as a living laboratory for new models of urban life on water (Errigo, 2021; De Graaf, 2009).



Rotterdam Land Reclamation, March 27, 2010. Photo Source: Bart Van Damme

04. typological, spatial and technological systems

Rotterdam uses mainly floating building typologies. People from the area, like many others, had been using the floating house typology for many years, but it resembled more of a houseboat than a true floating typology. But, while there's no single "first" floating building, Rotterdam's pioneering work on sustainable, tidal-resistant floating structures began significantly with the Floating Pavilion in 2010 and was followed by the development of the Nassauhaven floating neighborhood starting in 2020, which introduced the first street of sustainable water homes built to withstand tidal changes. Among the most emblematic examples are the Floating Office Rotterdam (FOR), the Floating Pavilion, the Floating Farm and the Recycled Park. These projects collectively form a timeline of how Rotterdam has reimagined its waterfront areas and transformed former industrial harbors into sites of ecological and architectural experimentation.

For the purpose of the research we would like to go back to the FOR, which is perhaps the most symbolic project to date. Designed as the headquarters for the Global Center on Adaptation, FOR embodies the city's ambition to be a leader in climate-resilient urban development. Constructed with a monumental wooden frame resting on prefabricated concrete hulls, the building illustrates a strong commitment to circularity. Its modular and dismountable structure allows it to be relocated, reflecting a shift from permanence to adaptive flexibility in architectural design. Technologically, it incorporates an off-grid energy system that uses the surrounding water for heating and cooling through a thermal energy loop embedded in the foundation. Built in only 18 months, the FOR exemplifies sustainability and innovation, being both energy-positive and CO_2-neutral. Its circular design philosophy, employing wooden modules that can be relocated or disassembled, demonstrates how floating architecture can evolve from concept to viable infrastructure (Red Company, 2022).

It embodies "Buoyant technology" and is a crucial example of an architectural adaptation, designed to mitigate and manage flooding. The building is intended to float, rather than flood, if water levels rise due to climate change. Additionally, the spatial organization of FOR is driven by the need for modularity, connection to the water, and functional flow. These two concepts are directly related to the stability of

The floating foundation travelled to Rotterdam by river from Zaandam, where it was made. Credit: Marcel IJzerman

the building, which, according to the FOR main designer Albert Takashi, was the main element to solve when speaking of a floating element. The modularity, gives it equal balance on each side of the building, allowing not only to have a generalized grid (which feeds into the sustainability aspect), but also a simplified design that provided a lightweight option. This is the reason the buoyancy works, as the stability of the structure above is key for its "floatability".

Similarly, the floating homes in Nassauhaven represent an important shift toward integrating floating living within the existing urban fabric. These homes are anchored to the harbor bed with mooring and stabilizer systems, allowing for vertical movement of up to two meters in response to tidal fluctuations. Although they provide important lessons in adaptability and climate responsiveness, affordability remains a significant issue. Like other floating initiatives in the Netherlands, these dwellings were not developed for low-income populations but as part of a larger urban renewal strategy aimed at middle-income groups (Penning-Rowsell, 2019; Zand, 2023). The Floating Pavilion on the other hand, situated in Rijnhaven, serves as an exhibition and research facility, and was one of the first floating structures to promote climate-responsive design in the city. It utilizes a self-sufficient sanitation system, passive solar heating, and photovoltaic panels to demonstrate how floating structures can also serve as sustainable ecosystems.

In the case of the Recycled Park the stategy was more sustainability centered, it uses floating platforms made from plastic waste collected in the Nieuwe Maas river. While modest in architectural scale, the project adds ecological and educational value by supporting river biodiversity and serving as a prototype for future eco-infrastructures (WHIM architects, 2021). In contrast, the Floating Farm, a self-sustaining agricultural platform in the port area, challenges conventional notions of urban food production and land use. These varied programs illustrate that floating architecture is not limited to housing but can support multiple urban functions, from offices and exhibitions to farming and recreation.

floating building typology

The scheme shown below is a depiction of the systems of the most common floating technology used in Rotterdam

structural bones

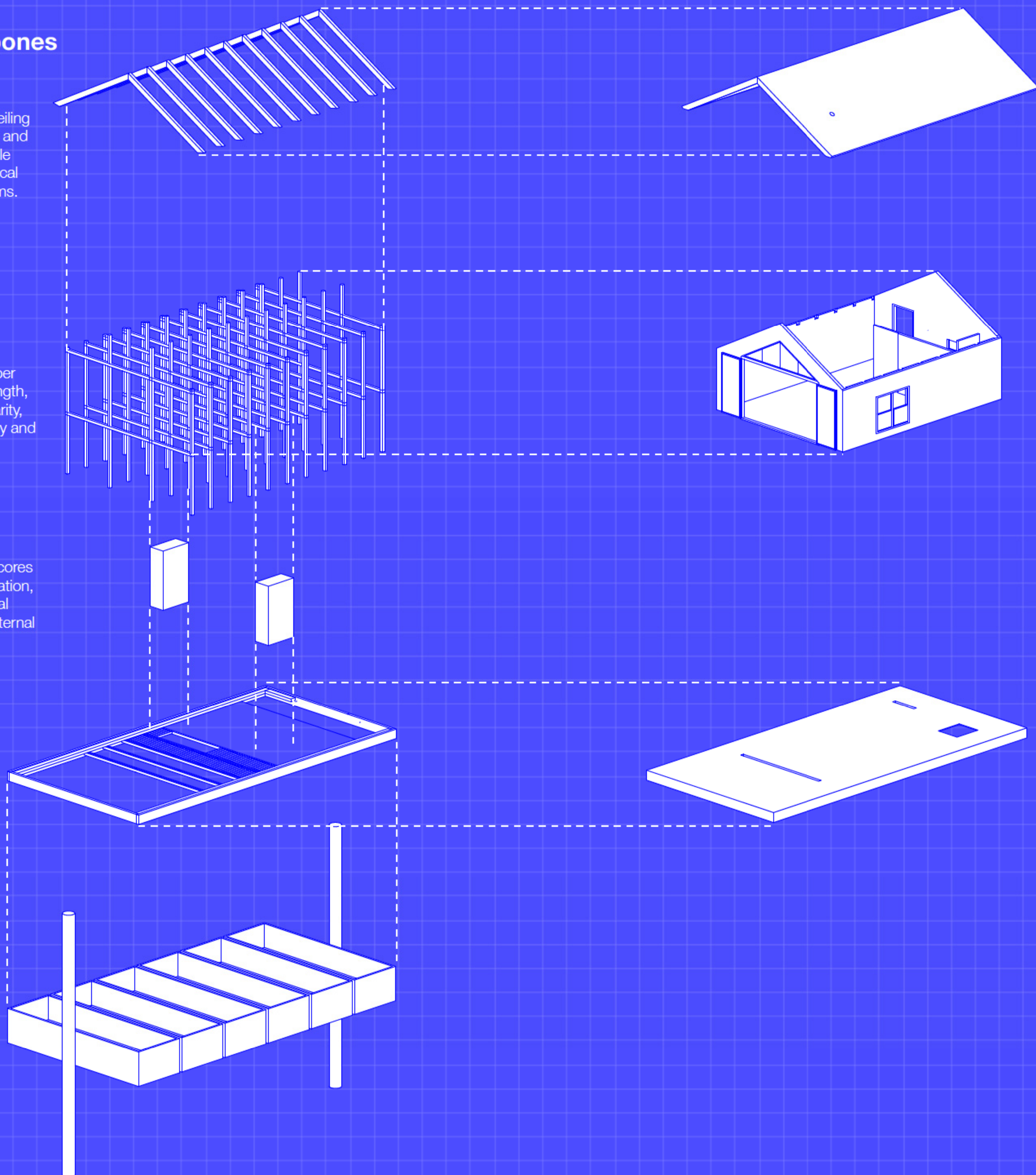
ceiling:
lightweight timber ceiling integrates insulation and acoustic control while concealing mechanical and electrical systems.

structure:
modular glulam timber frame provides strength, flexibility, and circularity, allowing disassembly and relocation.

cores:
Centralized service cores house vertical circulation, utilities, and technical shafts, optimizing internal spatial organization.

bands:
Steel connection bands secure the timber modules, ensuring rigidity and distributing loads evenly.

base:
prefabricated concrete pontoons form the buoyant base, distributing weight and enabling stable flotation.



exterior facing bones

ceiling:
Temperature regulated material finish.

skin:
glazed, metal and timber façade maximizes daylight and views while maintaining thermal performance and energy efficiency.

base:
The primary platform integrates structural support, circulation surfaces, and access points to the water. Equal in all directions

transversal systems

services

water:
closed-loop thermal system uses surrounding water for heating and cooling via embedded heat exchangers.

sanitary:
Self-contained sanitation connects to onshore systems through flexible service lines designed for tidal movement.

electricity:
Photovoltaic panels supply renewable power, supported by smart distribution systems to optimize energy use.

systems

affordability:
Prefabrication and modular design reduce construction time and lifecycle costs despite high initial investment.

construction:
Built in just 18 months, the structure demonstrates rapid deployment through off-site fabrication and on-site assembly. Precise building method, starting from the middle, equally expanding to the sides.

bouyoncy:
The displacement of water by hollow concrete pontoons ensures stability and allows the building to rise and fall with tides.

05. socio-cultural context - dynamics of water-based life

Rotterdam is a densely populated and highly diverse port city whose identity is inseparable from its relationship with water. With a population of approximately 611,000 inhabitants representing 173 nationalities, it is one of Europe's most multicultural urban environments. Its geographic condition — located in a delta formed by the Rhine and Meuse rivers and closely connected to the North Sea — has shaped both its historical development and its urban future. The city's growth has always depended on water: it is home to one of the world's largest ports, and its urban fabric, economic activities, and strategic planning are deeply influenced by hydrological dynamics. Water is not only a physical feature of Rotterdam but also a central driver of its spatial evolution. As the city continues to expand and densify, its dependence on water infrastructure and water-based planning becomes increasingly intrinsic to how it addresses contemporary challenges such as climate adaptation, land scarcity, and economic transformation.

Despite its strategic significance, Rotterdam also faces pronounced socio-economic disparities, particularly in its southern districts. Several neighborhoods have been designated as "priority areas" due to persistent challenges such as poverty, unemployment, inadequate housing, and educational underachievement. Central South Rotterdam is often described as socially segregated, with high unemployment, low income and education levels, high youth dropout rates, and ongoing integration difficulties. Many of these neighborhoods have a large proportion of non-native residents who often face practical and financial barriers to mobility. As a result, they tend to engage more in localized leisure activities — such as walking, shopping, or meeting in neighborhood cafés — rather than accessing recreational landscapes beyond the city.

Floating public space in Rotterdam : PHOTO: MARCEL IJZERMAN

Among younger residents, participation is higher in local cultural and social events, including markets, music, festivals, and community performances.

Rotterdam's relationship with water intersects with these socio-economic dynamics in several ways. The city's waterways are not only logistical and infrastructural assets but also public spaces and ecological corridors that shape daily life. However, access to water-related amenities and waterfront developments often reflects broader socio-economic inequalities. Many water-oriented projects, such as floating housing or waterfront renewal schemes, are concentrated in redeveloped areas and target middle- or higher-income groups, leaving marginalized communities with limited participation in or benefit from these spatial transformations. This highlights an ongoing challenge for Rotterdam: how to ensure that water, as both a physical and social resource, contributes to inclusive urban development.

This tension is particularly visible in the field of floating architecture. As discussed in the literature, most floating projects in Rotterdam and beyond remain within the high-tech or luxury segments (Battisti et al., 2025; Calcagni, 2025). Their technical sophistication — including water-based thermal systems, modular construction, solar integration, and advanced anchoring technologies — leads to higher initial costs and limits accessibility for lower-income populations. A Delft University study (2008) found that most floating homes target "well-educated, higher-income buyers aged 25–50," with prices between 8–16% higher than comparable land-based dwellings. In Maasbommel, amphibious houses began at €310,000, approximately 44% above the national average (Zand, 2022). These figures reflect a recurring pattern in aquatecture: while technological innovation enhances environmental performance and resilience, it does not necessarily overcome economic barriers to large-scale, inclusive adoption (Barker & Coutts, 2019; Thi & Trang, 2022).

06. what is coming in the future?

The city's ambition to build up to 6,000 floating homes over the next decades is supported by concrete spatial strategies. (Graaf, 2012) In Rijnhaven, the municipality envisions a vibrant urban waterfront that combines floating housing, parks, leisure infrastructure, and cultural activities. Meanwhile, in Maashaven, floating gardens, natural islands, and helophyte filters are part of a plan to create a "blue-green oasis" that benefits both people and biodiversity. Such projects align with Rotterdam's goal of becoming climate-proof by 2025, as established in its Climate Initiative (RCI), and reflect a shift from defensive to adaptive urban water strategies (Frantzeskaki & Tillie, 2014; Mees et al., 2013).

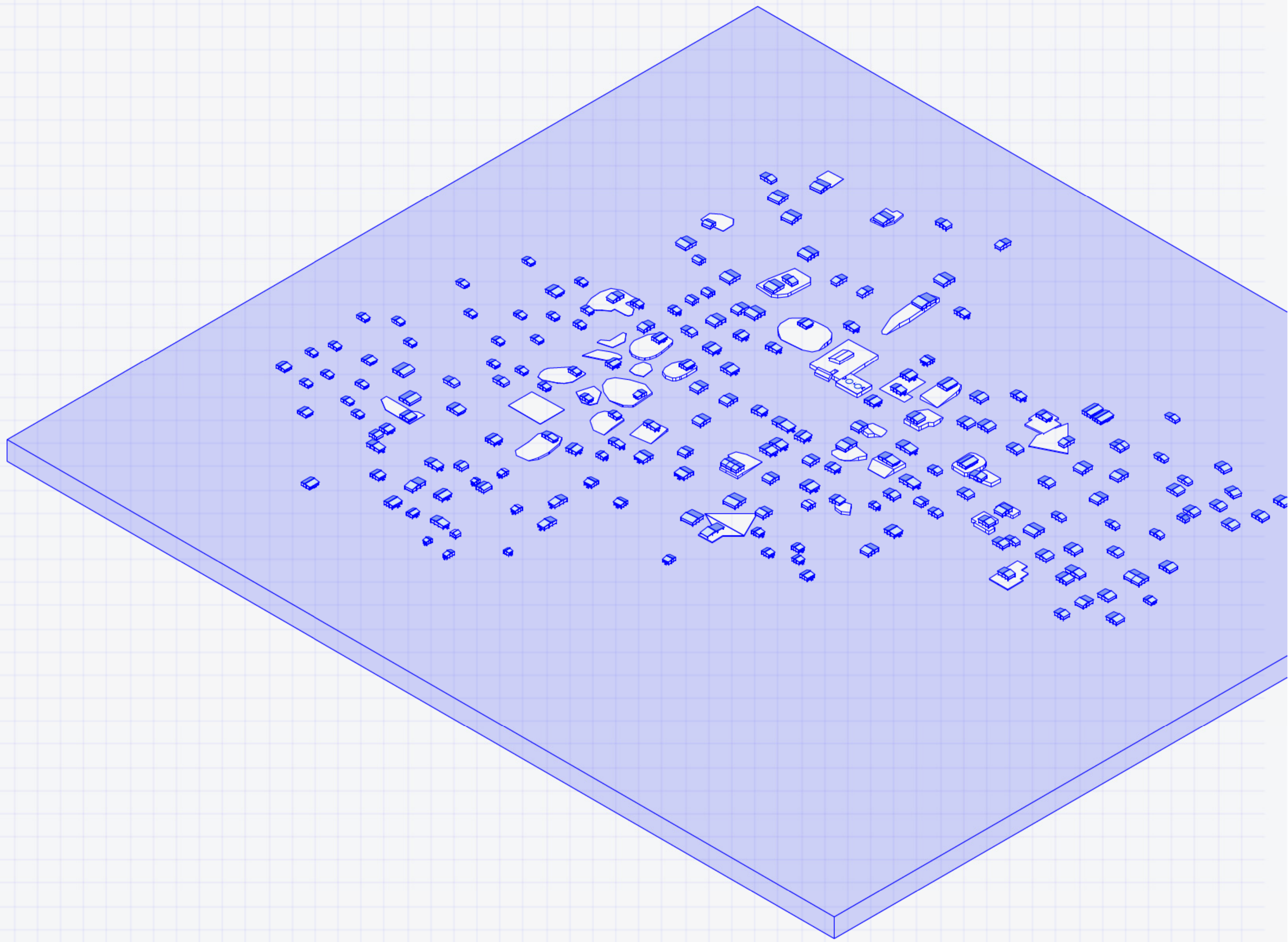
The city is focusing its floating urbanization efforts on the Stadshavens area, a vast area (1600 ha) of old port sites located outside the dikes that are losing their industrial function and are open for redevelopment. Plans include creating a new, 18-hectare park with floating elements. The Rijnhaven Masterplan outlines the regeneration of the area to include a new park with its own beach. Concepts developed for the Rijnhavenpark include diverse functions such as green space, a hotel, a restaurant, flexible office space, a theatre, and a stage. These functions are intended to create a comprehensive floating city model that incorporates public space and infrastructure, not just isolated buildings.

To realize the vision of floating districts and cities, Rotterdam relies on institutions and research efforts dedicated to testing and scaling up floating technologies.

Rotterdam will see the construction of Europe's largest floating housing development Photo Source: Slimstudio

nueva venecia, colombia

While Rotterdam exemplifies a technologically advanced, policy-driven response to climate change through floating architecture, the case of Nueva Venecia, a palafitic village in Colombia, presents a radically different reality. Rather than emerging from innovation-driven urban planning, Nueva Venecia is the result of necessity, collective resilience, and deep-rooted cultural practices tied to water. This creates a completely different dynamic that underlays the systemic differences between both practices.



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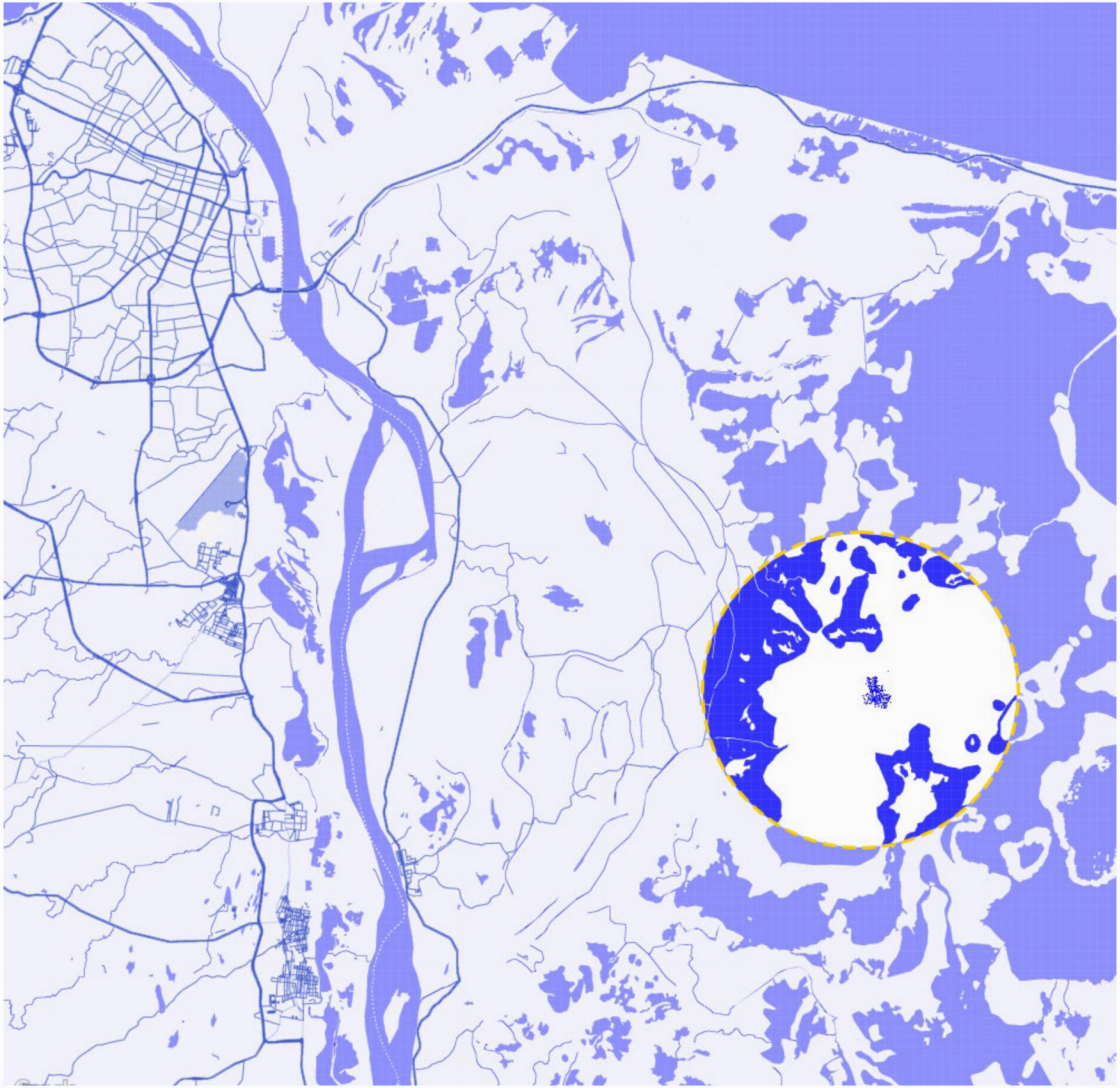
01. geographic and environmental context

Nueva Venecia is a stilt village located at the center of the Ciénaga Grande de Santa Marta (CGSM), an extensive estuarine lagoon system on Colombia's Caribbean coast that forms part of the larger deltaic plain of the Magdalena River. This wetland complex, covering more than 450,000 hectares, is the country's largest and most ecologically productive coastal wetland, characterized by a mosaic of lagoons, mangrove forests, marshes, and channels. Nueva Venecia is one of three palafitic settlements scattered across this vast aquatic expanse, situated approximately 30 kilometers inland from the Caribbean shoreline and embedded within a labyrinthine network of water bodies.

The waters surrounding Nueva Venecia arise from the confluence of three hydrological systems: the freshwater inflows from the Magdalena River, which enter the lagoon through distributary channels; the seasonal runoff from the Sierra Nevada de Santa Marta, whose steep slopes funnel rainfall and sediment into the wetland; and the tidal and saline currents from the Caribbean Sea, which enter the system through natural inlets and man-made channels. This interaction of freshwater, saltwater, and sediment has produced a brackish, nutrient-rich environment that sustains extensive biodiversity and drives high levels of primary productivity.

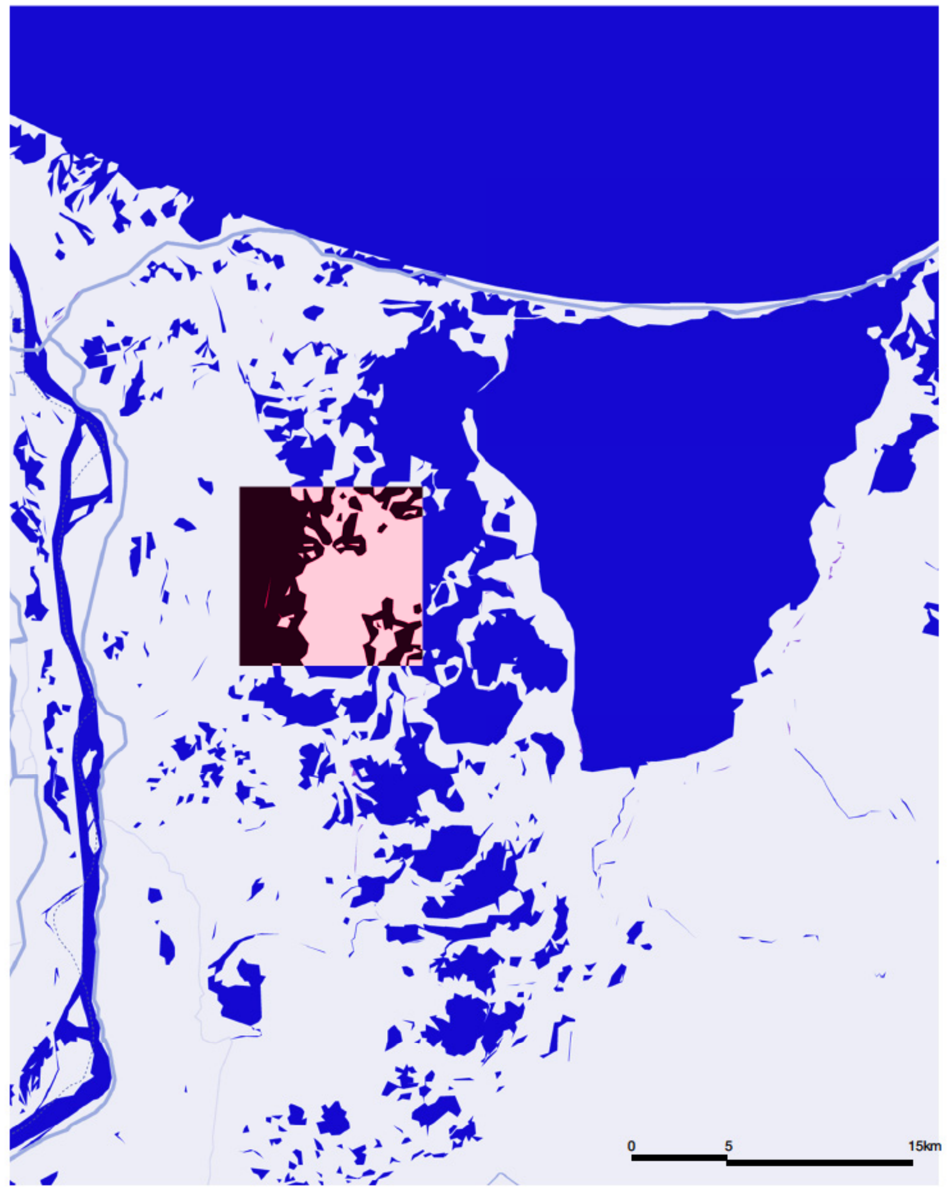
The lagoon's depth averages between 0.5 and 2.5 meters, fluctuating seasonally in response to rainfall patterns and river discharge, while its salinity gradients shift according to the balance of riverine and marine inputs. Surrounding Nueva Venecia are dense mangrove stands, primarily Rhizophora mangle, Avicennia germinans, and Laguncularia racemosa, which stabilize shorelines, regulate salinity, and provide critical habitats for fish and bird species. The settlement itself is organized within this aquatic matrix, built atop submerged mudflats and shallow zones where water levels vary throughout the year. Its position within the wetland's hydrodynamic system means that access, circulation, and resource availability are closely tied to seasonal fluctuations and the broader watershed processes that define the Ciénaga Grande.



01. geographic and environmental context
multiscalarity

national scale

At the national scale, the map situates the Ciénaga Grande de Santa Marta within Colombia's northern Caribbean region. This vast deltaic and lagoonal system lies between the Magdalena River and the Sierra Nevada de Santa Marta, forming one of the country's most significant ecological and hydrological networks.



regional scale

At the regional scale, the focus highlights the intricate relationship between the Ciénaga Grande, the Magdalena River delta, and the surrounding municipalities of the Department of Magdalena. This view reveals the strong interdependence between freshwater, brackish, and marine environments, shaping a complex socio-ecological system that sustains local fishing communities.

zonal scale

At the zonal scale, the map centers on Nueva Venecia, one of the stilt villages located within the Ciénaga Grande. The settlement exemplifies a vernacular adaptation to the aquatic environment, where housing, mobility, and livelihood are deeply intertwined with the dynamics of water.

02. memory, territory, and the makings - historical relationship with water

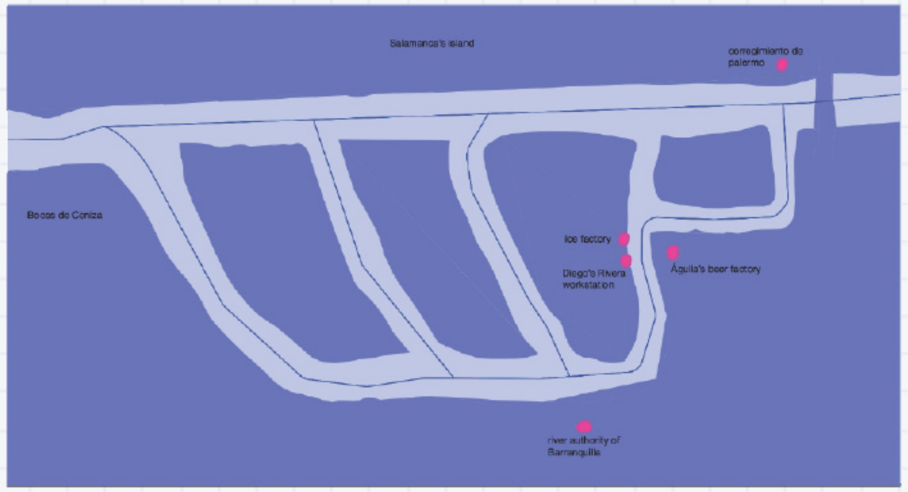
Unlike Rotterdam, where floating architecture emerges as a strategic response to climate adaptation and urban innovation, Nueva Venecia represents a traditional, community-built adaptation, less engineered, yet deeply rooted in local knowledge and environmental relation.

The broader region of the Ciénaga has a long history of human occupation. It can be traced back to show pre-Columbian settlements in the area, with the oldest known records on the Island of Salamanca dating back to 362 A.D. (Los Jagüeyes) and sites near the current palafitos dating to the beginning of the 12th century A.D. (Cecilio). But Nueva Venecia itself originated from a process of more or less, recent colonization. It can be dated back to the displacement of fishermen groups from Trojas de Gálvez (another palafitic town near the cienaga) who were escaping low water levels and mosquito plagues. It can also be traced back to the desire to find better fishing locations and the political uncertainty during the Spanish Reconquest period (1817). Over time, these small settlements or camps gradually evolved into permanent palafitic communities. For the early settlers, the abundance of fish, mollusks, and other aquatic resources provided not only sustenance but also the basis for a water-centered way of life that started to define the community's identity and economic activity. Initially known as El Morro, the village took the name "Nueva Venecia" from a resident who likened its aquatic layout to that of Venice. Although less romanticized, this comparison highlights the spatial logic of a town built entirely on water, where streets are navigated by canoe and public life unfolds on the terraces of stilt houses. (Sarmiento, 2017)

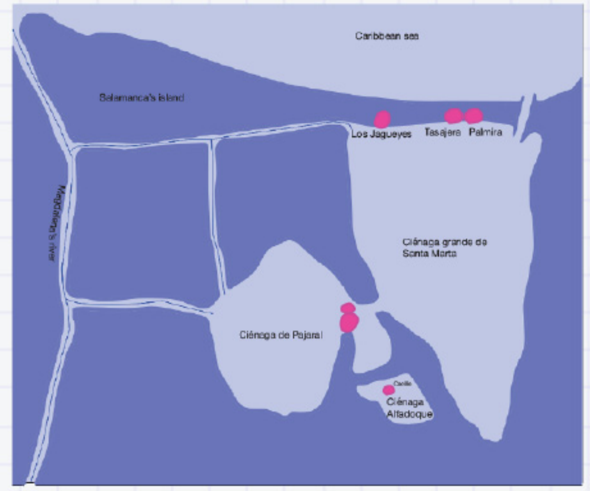
However, this sort of poetic harmony has been repeatedly disrupted, like many other peripheral towns in Colombia, which suffered in the time of the Violence (A decades-long civil conflict fueled by drug trafficking, inequality, and a weak state presence, that caused armed groups to compete for territorial control, causing ongoing displacement, and diverse abuses against civilians). On November 22, 2000, Nueva Venecia became the site of a massacre by the paramilitary AUC, who accused residents of guerrilla collaboration. Between 38 and 60 villagers were killed in the central square, triggering massive displacement to cities like Barranquilla and Sitionuevo. Faced with a significant lowering of population, the town suffered through many crises during that period. With 90% of the population leaving, and constantly being forced to abandon the territory for many years, Nueva Venecia was almost erradicated completely. It was only 20 years after that many families returned, not because conditions had improved, but because urban life on land could not replace the cultural cohesion and sensory familiarity of their aquatic environment. Their return marked what some locals now refer to as "Nueva Venecia 3.0": a regeneration born out of trauma, memory, and resilience. Much like Rotterdam itself, nueva venecia is rebuilt after urban and social devastation, strengthening the initial and cultural relationship that the community had with water.

Environmental degradation has also played a devastating role in this community through the years. Infrastructure projects, such as the Barranquilla-Ciénaga highway and the Magdalena River road, altered water flows, leading to hypersalinization and the collapse of local fish population. The salinization caused mass mortality of mangroves and a significant reduction in fish and oyster populations, devastating the local economy. Before the highway, 25,000 tons of fish were collected annually in Sitionuevo; afterward, this dropped to 4,000 tons. Combined with pollution from nearby agro-industrial plantations, the ecological integrity of the CGSM has been severely compromised. These changes have undermined both the subsistence economy and the region's physical habitability.

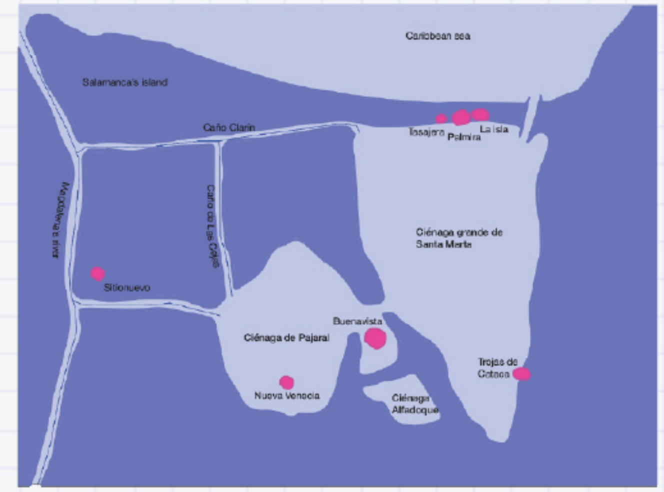
Entrance sign of Nueva Venecia's floating village, depicting its stilt-house layout and symbolizing the community's enduring connection with water. Photo Source: Diario las Américas



Barranquilla canals and other sites



first human settlements found



lagoon complex of the Ciénaga Grande de Santa Marta

1499 — 1820 — 1847 — 1930 — 1970 — 1990 — 2000 — 2012 — 2018 — 2025 — FUTURE

Before 1500
Indigenous peoples (Chimilas, Tayronas, Concheros) **adapted their lives to water** → canals, flood-resistant farming, and houses on elevated platforms.

16th–18th centuries
The CGSM became a strategic route along the **Magdalena River** and a refuge for indigenous groups.

1820
Battle of the Ciénaga, a decisive moment in Colombia's independence.

1847
Emergence of **El Morro (Nueva Venecia)**, founded by fishermen displaced from Trojas de Gálvez.

Consolidation of stilt houses (palafitos)
Vernacular, community-built wooden structures on piles with palm or zinc roofs.
Artisanal fishing became the main economic and cultural activity.

1930s–60s
River canalization for banana and palm plantations → **disruption of freshwater flows.**

1955–76
Construction of the Barranquilla–Ciénaga highway blocked wetland-water exchanges → **massive fish mortality and mangrove loss.**

1960s–70s
Mangrove logging, dikes, and landfills further **degraded the ecosystem.**
Fish production collapsed from 25,000 tons/year to only 4,000 tons/year.

1970s–1990s
Territorial disputes between guerrilla groups (FARC, ELN) and paramilitaries.

Nov 22, 2000
Nueva Venecia massacre → 37–38 people killed by paramilitaries, leading to mass displacement.

1998
CGSM designated as a **Ramsar Wetland** of International Importance (400,000 ha protected)

2000s–2010s
Mangrove restoration and socio-productive projects (Corpamag, SINAP), though many remained unexecuted.

Isolated improvements
School, health center, community hall (donated by Japan), floating soccer field (donated by Radamel Falcao)

1961–2018
Urban footprint decreased by 20%

Loss of 141 peripheral houses, leaving about 335–380 stilt dwellings.

Urban fabric remains spontaneous and unplanned: wooden walkways, patios, and water-based streets.

The community still relies on artisanal fishing, now threatened by pollution and river diversions for agricultural purposes.

Severe deficiencies
No potable water, sewage, or waste management. Most waste ends up in the lagoon. Still considered an "illegal settlement" under Sitionuevo's land-use plan.

Challenges ahead
Regenerative economy (sustainable fishing, recycling, eco-design).
Education and culture (community spaces, eco-tourism).
Climate and environmental resilience (mangrove restoration, adaptation strategies).

Ramsar
Convention on Wetlands

Pre-Hispanic and Colonial Period

19th Century – Founding of the Stilt Village

20th Century – Transformation and Environmental Decline

Armed Conflict

Environmental Recognition

Present and Future

Urban Transformations

03. local water adaptation strategies (urban dynamics)

Despite the adversities, the residents of Nueva Venecia have cultivated autonomous strategies of survival and reconstruction. In the absence of formal urban planning or state-led development, they have organized community-driven projects to reclaim public space, rebuild infrastructure, and sustain cultural life. The town remains formally undocumented in most urban policy instruments, yet it continues to exist, persisting as a floating testament to the power of vernacular resilience.

Spatially, Nueva Venecia is an extraordinary example of a fluvial urban system, one that challenges dominant models of territorial order. Rather than fixed streets and sidewalks, it offers a network of water paths navigated exclusively by canoe. While this liquid topography may appear informal or improvised, it is shaped by a logic that responds to both environmental dynamics and community rhythms. The village follows a centrifugal growth pattern, radiating outward from a central axis composed of landfill-based public infrastructure, including the church, school, a modest plaza, a police post, and a now-abandoned health center. This core concentrates most commercial and social activity and is connected to peripheral homes via wooden bridges or directly by boat.

Daily life in the village is entirely shaped by water: mobility, subsistence, and sociability are inseparable from the surrounding aquatic landscape. The canoe, for instance, is not simply a mode of transport but a key spatial and social device, used for commuting, fishing, trade, water collection, waste disposal, and even funeral rites. Referred to as "the only dry space outside the four walls of the home," the canoe mediates all forms of interaction, both within the community and with the surrounding ecosystem.

This total fluvial condition has fostered a lifestyle defined as amphibious culture, in which the water is not a boundary but a medium of continuity. Nearly 90% of the population engages in artisanal fishing as their primary economic activity, relying on the biodiversity of the Ciénaga Grande de Santa Marta, which is primarily composed of fish, mollusks, and crustaceans that thrive in mangrove ecosystems. Fishing is not only an economic practice but a key dimension of social identity, passed down intergenerationally through embodied knowledge and collective memory. Informal commerce and canoe-based services supplement household incomes; however, environmental degradation, notably pollution and declining fish stocks, has severely threatened this traditional way of life.

Community solidarity remains a central organizing principle. Collective efforts to build or maintain shared infrastructure, such as bridges or wooden walkways, reflect not only pragmatic cooperation but also a cultural ethic of mutual aid and support. These acts of collective maintenance, however, are uneven. In some cases, the absence of connecting paths between homes has contributed to social fragmentation, reinforcing physical and symbolic distances within the community.

Children commuting to school by canoe in Nueva Venecia, reflecting the community's daily life and deep integration with its aquatic environment. Photo Source: Juan Diego Pinzon Photography

Another interesting element of the urban fabric is that even though Nueva Venecia is completely surrounded by water, it still faces a critical lack of potable water. The village lacks a centralized water supply network, and residents primarily rely on shipments from the Aracataca River or the Aguas Negras Canal, which are delivered by large boats colloquially known as bongoductos. This water is often untreated or only minimally clarified using aluminum sulfate, leaving the population highly vulnerable to waterborne diseases. Electricity is the only consolidated public service currently available. Installed in 1994, the electrical system remains precarious, having been manually assembled by residents through an 18-kilometer cable submerged from Sitio Nuevo. This artisanal setup, while innovative, poses serious safety risks, particularly during periods of high water.

The education infrastructure is similarly fragile. Only two schools exist in the area, one in Nueva Venecia and another in Buenavista, both of which are overcrowded and lack adequate teaching resources. Infrastructural deficiencies in Nueva Venecia are multiple and interdependent. The absence of a potable water network, basic sanitation systems, and formal waste management has led to severe contamination of the lagoon. Greywater and sewage are discharged directly into the water, and solid waste accumulates in and around homes, obstructing navigation and threatening biodiversity. The limited housing infrastructure, built primarily from wood and exposed to high humidity and salinity, deteriorates rapidly under harsh environmental conditions.

Without terrestrial ground, conventional urban typologies and public spaces, such as parks or squares, are absent. Instead, water functions as a shared yet undefined public domain. Bridges and walkways connecting houses are few and often constructed individually, leading to spatial and social fragmentation. Collective facilities for health, education, recreation, and culture are minimal, deteriorated, or only intermittently functional. Economically, the community is highly dependent on artisanal fishing, which constitutes approximately 95% of household income. The combined effects of environmental degradation and economic dependence result in precarious living conditions for the majority of inhabitants.

From the fishing typology, emerges the primary means of transportation, which is the canoe. The canoe holds high material and symbolic value, being essential for mobility, fishing, fetching water, transportation, and even funerary services. All urban connections depend directly on the ownership of this highly unconventional form of transportation. This and swimming are the collective common in the community. The canoes are so connected to the urban tissue, that they also act as public spaces, as they are often used to stop by the neighboring houses and talk, as if it was the iteration of the doorstep.

Nueva Venecia has intrinsically converted traditional urban dynamics to an sort of aquatic neighborhoodn which essentially represents a case of bottom-up aquatic urbanism. It highlights the possibilities and limitations of vernacular adaptation in fragile ecosystems. Its comparison with engineered solutions in developed contexts invites reflection on equity, participation, and the role of traditional knowledge in shaping a complete urban tissue.

Children playing in the shallow waters of Nueva Venecia, illustrating the community's intimate coexistence with its aquatic surroundings and everyday life on water. Photo Source: Juan Diego Pinzon Photography.

04. typological, spatial and technological systems

Homes in Nueva Venecia are built entirely on stilts driven into the lagoon bed, creating a scattered constellation of stilted volumes surrounded by water. These constructions rely on traditional materials, primarily mangrove wood, palm, and bamboo, as well as local building knowledge. Over time, wooden walls have replaced palm cladding, and asbestos or Eternit sheets have begun to substitute traditional thatched roofs. However, despite these minor evolutions, the structural essence remains vernacular and artisanal, often built directly by the inhabitants themselves. Inhabitants also take aesthetic pride in their homes, painting them in vivid colors that act as both navigational markers and expressions of identity.

These domestic architecture and construction practices reflect a deep historical connection to water. Housing is typically self-built using vernacular methods, which means that building knowledge is transmitted orally, through observation, imitation, and trial and error. Most of the houses have either been passed down through generations or have been added by the community itself using this sophisticated vernacular response to living in an amphibious environment. Houses are elevated on wooden piles, primarily made from locally sourced mangrove, that are driven several meters into the lagoon bed to ensure structural stability. These piles support wooden platforms that serve as the base of the dwelling, upon which walls of timber boards and roofs of palm thatch or asbestos sheets are assembled. Communities employ curing techniques, such as soaking mangrove wood in water before sun-drying, to improve material durability in the region's humid and saline conditions. While traditional palm roofing offers thermal comfort, recent shifts toward industrial materials, such as zinc or asbestos, have addressed concerns of longevity and fire resistance, albeit at the expense of compromised environmental performance. The houses are typically organized with multifunctional layouts and rear landfills, known as rellenos, where residents accumulate sand and debris to create rudimentary backyards for gardening, small-scale livestock, and shaded outdoor space. Such adaptations reveal a hybridization between aquatic and terrestrial living, grounded in experiential knowledge rather than formal engineering. Aesthetic practices, such as the use of vivid exterior colors, also serve functional purposes, acting as visual landmarks for navigation and expressions of individual and collective identity.

Stilt houses in Nueva Venecia adapted to the aquatic terrain, where residents extend their structures toward the rear patios to create small gardens, crops, and spaces for daily subsistence. Photo Source: Colombia Belleza Pura

This palafitic practice, however, exists in an increasingly precarious state. The gradual disappearance of traditional canoe-building (something that was once a cornerstone of these water-based communities) in favor of industrial fiberglass alternatives illustrates the fragility of this artisanal heritage. Such shifts raise broader concerns that the same erosion could extend to vernacular construction techniques and ancestral building knowledge, threatening the continuity of a cultural lineage intimately tied to water. In response, new initiatives have begun to emerge, seeking not only to document and safeguard these practices but to actively integrate them into educational and training programs, ensuring their transmission to future generations and reinforcing their relevance in contemporary contexts.

One particularly compelling element of this typology is the emergence of hybrid spatial practices within the palafitic settlement. Despite the village being entirely embedded in water, there has been a recent surge in the creation of small, improvised landfills directly behind houses, forming rudimentary backyards where trees are planted, crops cultivated, and chickens roam freely. These micro-terrains function as amphibious extensions of the built environment, enabling families to access shade, grow basic food, and reclaim fragments of stable, dry land. More than utilitarian adaptations, these interventions reveal the community's resilience and ingenuity, demonstrating their capacity to reconfigure their surroundings in response to both ecological and social pressures. At the same time, they reintroduce land-like qualities, such as soil, vegetation, and terrestrial domestic life, into the aquatic context, symbolically and physically connecting the settlement to the landscapes of the nearby mainland. In essence the public space is "virtual" or inmaterial, occurring largely in the shared space of the terraces which function as private docks and areas for sociability.

stilt house typology

The scheme shown below is a depiction of the systems of all the palafitic buildings in Nueva Venecia

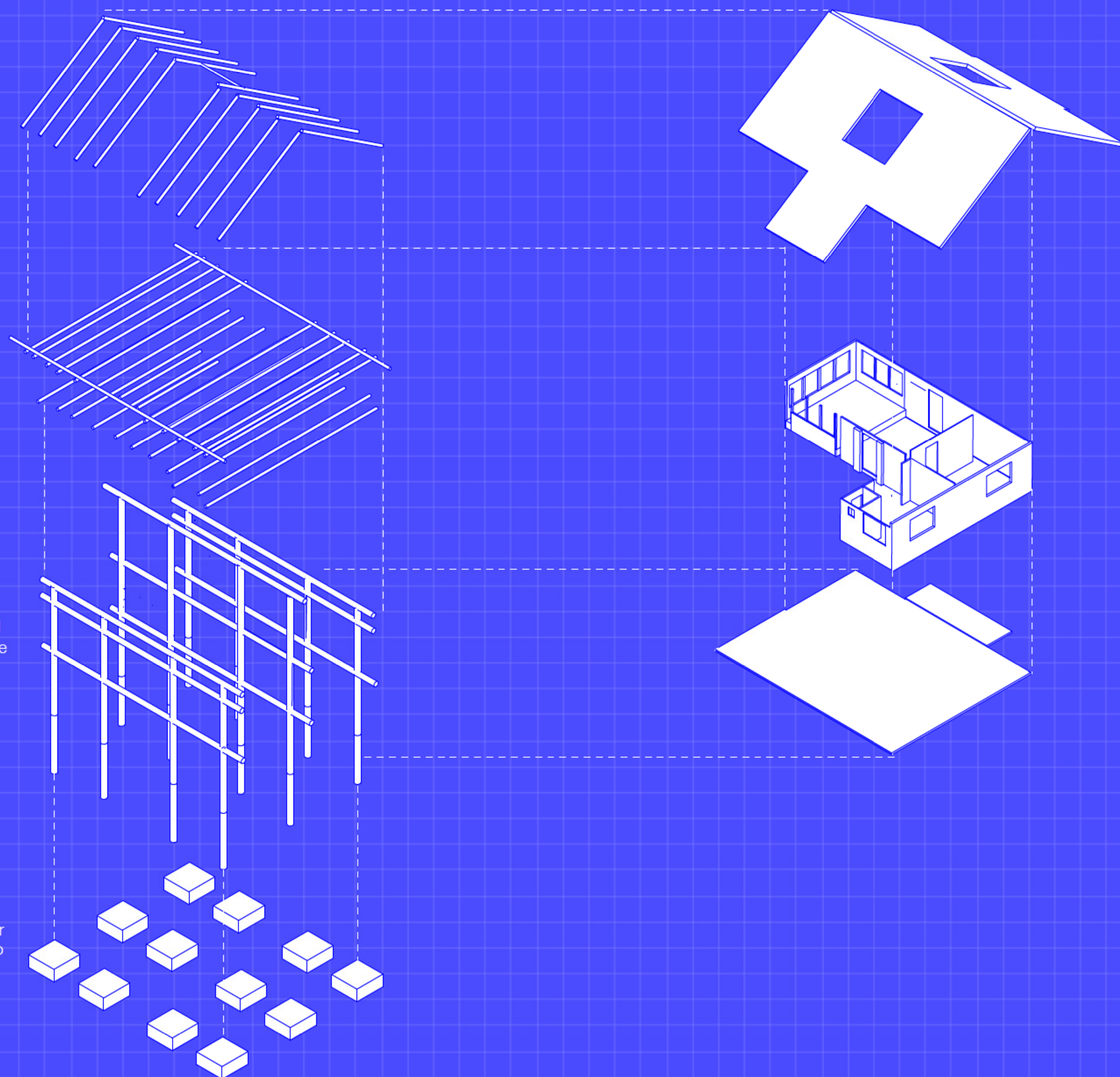
structural bones

ceiling:
Simple timber structure tied with rope or bolts

substructure:
Cross-bracing and horizontal beams tie vertical piles together, stabilizing the frame against water movement and wind.

stucture:
Timber piles driven into the lagoon bed elevate the structure above water levels, anchoring it in place.

base:
Concrete blocks dug in the subwater ground, attached to the timber piles



exterior facing bones

ceiling:
Temperature regulated material finish.

skin:
Timber planks, palm leaves, or recycled boards form breathable façades that allow cross-ventilation and rapid repair.

social core:
Central living spaces serve multifunctional purposes without enclosed cores, reflecting flexible, open-plan layouts.

base:
Raised wooden floors create a dry living surface above fluctuating water levels and seasonal flooding.

transversal systems

services

water:
Direct reliance on lagoon water for basic uses, sometimes complemented by rainwater collection for domestic consumption.

sanitary:
Basic latrine systems often discharge directly into the water, reflecting infrastructural limitations and environmental challenges.

electricity:
Limited or absent grid connection; where present, basic wiring powers lighting and small appliances.

systems

affordability:
Locally sourced materials and self-construction make palafitos cost-effective and accessible to low-income populations.

construction:
Built collectively by residents using traditional knowledge, with techniques passed down through generations.

bouyoncy:
Structures are static rather than buoyant, relying on pile elevation to remain above changing water levels.

05. socio-cultural context - dynamics of water-based life

Life in Nueva Venecia is more than adaptation; it is a cultural synthesis. Scholars such as Orlando Fals Borda have described this way of living as an "amphibious culture," a term now often replaced by "aquatic culture" to reflect the centrality of water not just as a challenge, but as an ontological framework. Inhabitants do not simply coexist with water; they are of it. Navigation replaces walking, and the rhythmic fluctuations of the water dictate spatial behavior, construction techniques, and even rituals. The economic structure of Nueva Venecia is highly centralized and dependent on the aquatic ecosystem. Fishing, specifically is the major source of income and sustenance for families, with some sources stating that up to 95% of the economy depends on it. The process of artisanal fishing and commercialization provides economic activity for most families.

The community uses a central locality for commercial activities. Some residents run small commercial operations (stores, cantinas) from their homes, making the houses themselves part of the public space. Inside of this familiar economic ecosystem, the barter or trueque, is used to exchange fish production for basic necessities. Water once again integrated even in the money exchange.

Unfortunately, limited recreational opportunities are available, mainly consisting of billiards, cockfights (gallera), and soccer, utilizing the few organized spaces. Nevertheless one of the biggest piece of land, placed in the middle of the collection of houses is a big soccer field, signifying the connection to the general culture of the country. They found a way to create religious and educational spaces, that fit to the particular typology of the town, giving these communal spaces a more permanent and land like character than the rest of the houses.

Daily life in Nueva Venecia's central square, where the church and surrounding canals function as social and cultural meeting points, reflecting the town's integration of land and water-based activities. Photo Source: Colombia Belleza Pura.

The community faces severe educational challenges, highlighted by a 57.5% rate of illiteracy according to 2009 data. There is a dependence between the place of birth and the level of education achieved; those born on land tend to have a higher level of education than those born in Nueva Venecia. This is caused by the significant disconnection to the rest of the state. The difficult accessibility creates a segregation of not only education, but general services and basic necessities. This state ineffectiveness is a significant contributor to the precarious socio-economic situation. The lack of policies and infrastructure hinders consistent progressive development. In the vacuum left by public authorities, multilateral private intervention sometimes replaces public power. This is why, even today, there is almost no law in places like Nueva Venecia.

Since 2009, tourism has emerged as a secondary activity for the people of nueva venecia. Stemmed from the need to connect to society and expand the insider economy, the cienega and the palafitic towns like nueva venecia, have become an interesting new form of "sustainable tourism". Recent efforts to paint the stilt houses in vibrant colors have attracted tourists and journalists, temporarily reactivating the connection to the towns interesting dynamics. But this economic improvement has also come with the ciénaga's contamination, causing an increase in trash and pollution of waters and ecosystems.

06. what is coming in the future?

Through the years, several architectural and urban proposals have emerged, some from local actors, others from external institutions, to reimagine the settlement through the lens of advancement and contemporary design. These include floating housing modules that can adapt to rising water levels, as well as floating platforms that can serve as community gathering spaces, breakwaters, and sites for tourism or recreation. Proposals also include floating gardens to enhance food sovereignty and canoe-based systems for managing mobile blackwater. A project called Centro Integral Nueva Venecia, developed by architecture students, envisions a floating civic center for cultural, educational, and public services.

Recent proposals envision rainwater harvesting systems for vertical and horizontal collection, on-site wastewater treatment through dry toilets or anaerobic processes, and renewable energy sources such as solar, wind, or biomass. Such strategies not only mitigate environmental impacts but also reduce dependence on unreliable public utilities. In terms of materials and design, architectural proposals prioritize bioclimatic principles and the use of local resources, including recycled plastics and agricultural waste (e.g., banana fibers). These considerations aim to enhance thermal comfort, improve energy efficiency, and extend the lifespan of structures in a highly humid and saline environment.

The community centered initiatives also propose the creation of multifunctional public spaces for education, culture, sports, and collective activities. By integrating architectural interventions with ecotourism and community-led design, the region could diversify its economy and strengthen social cohesion. Participatory planning is essential in this context; co-design processes ensure that new infrastructure respects local traditions and draws on community expertise, reinforcing both cultural identity and adaptive capacity.

Unfortunately, the Governmental and NGO interventions have been sporadic and often misaligned with local realities. The Department for Social Prosperity (DPS) and Fondo de Adaptación have implemented programs, including job training and the construction of stilt-type school facilities. However, these initiatives are generally small in scale and face difficulties related to funding, continuity, and cultural integration.

These emerging ideas remain are mostly unbuilt, but they reveal a latent desire to blend vernacular logic with technological possibility. Even in the absence of formal planning, the community continuously adapts and extends its architectural vocabulary. The canoe, still the most indispensable element of daily life, from transporting goods to conducting funeral processions, remains the clearest symbol of this culture: not just a means of movement, but a vessel of resilience, of place-making, and survival. This has proven to be a dynamic and resilient way of transportation that could continue to adapt to the future proposals. The community's intention of advancement is clear, as they sticde to find solutions of how to maintain the general dynamics, but still have a connection to the outer world.

Children in Nueva Venecia enjoying the water as an extension of public space, showing how daily life naturally adapts to and harmonizes with the aquatic environment.Photo Source: seguimiento.co

conclusion: the need for a middle ground

The comparative study of Rotterdam and Nueva Venecia illustrates a dichotomy in the development of floating architecture worldwide: on one end, highly engineered, technologically advanced, and resource-intensive floating housing; on the other, community-built, low-tech stilt settlements born out of necessity, vulnerability, and adaptation. This divide raises an urgent question: can a meaningful middle ground be achieved, one that combines the sophistication and resilience of high-tech models with the affordability, adaptability, and cultural embeddedness of vernacular floating settlements?

As climate change intensifies and the risks of flooding, sea-level rise, and hydrological instability expand globally, the demand for amphibious and floating housing models is no longer confined to high-income cities experimenting with innovation. The need now extends to vulnerable, under-resourced, and historically marginalized communities who face environmental threats without access to infrastructure, state support, or adequate housing.

This community is not planned in the formal sense, yet it embodies a form of vernacular aquatecture, built over generations through local knowledge of tides, materials, and environmental cycles. Unlike the prefabricated, high-performance floating structures in Rotterdam, the stilted houses of Nueva Venecia are constructed with low-cost, often reused materials, which are maintained and adapted over time through communal effort and intimate environmental awareness. Analyzing Nueva Venecia allows us to shift from a techno-centric view of floating architecture to one grounded in social adaptability, ecological interdependence, and everyday ingenuity. It helps expose the gap between floating architecture as a high-end innovation and floating settlements as expressions of survival and identity.

By comparing both contexts, we aim to uncover whether a meaningful “middle ground” can emerge that integrates the strengths of both paradigms, technological sophistication with affordability, standardization with local adaptability, and resilience with cultural rootedness.

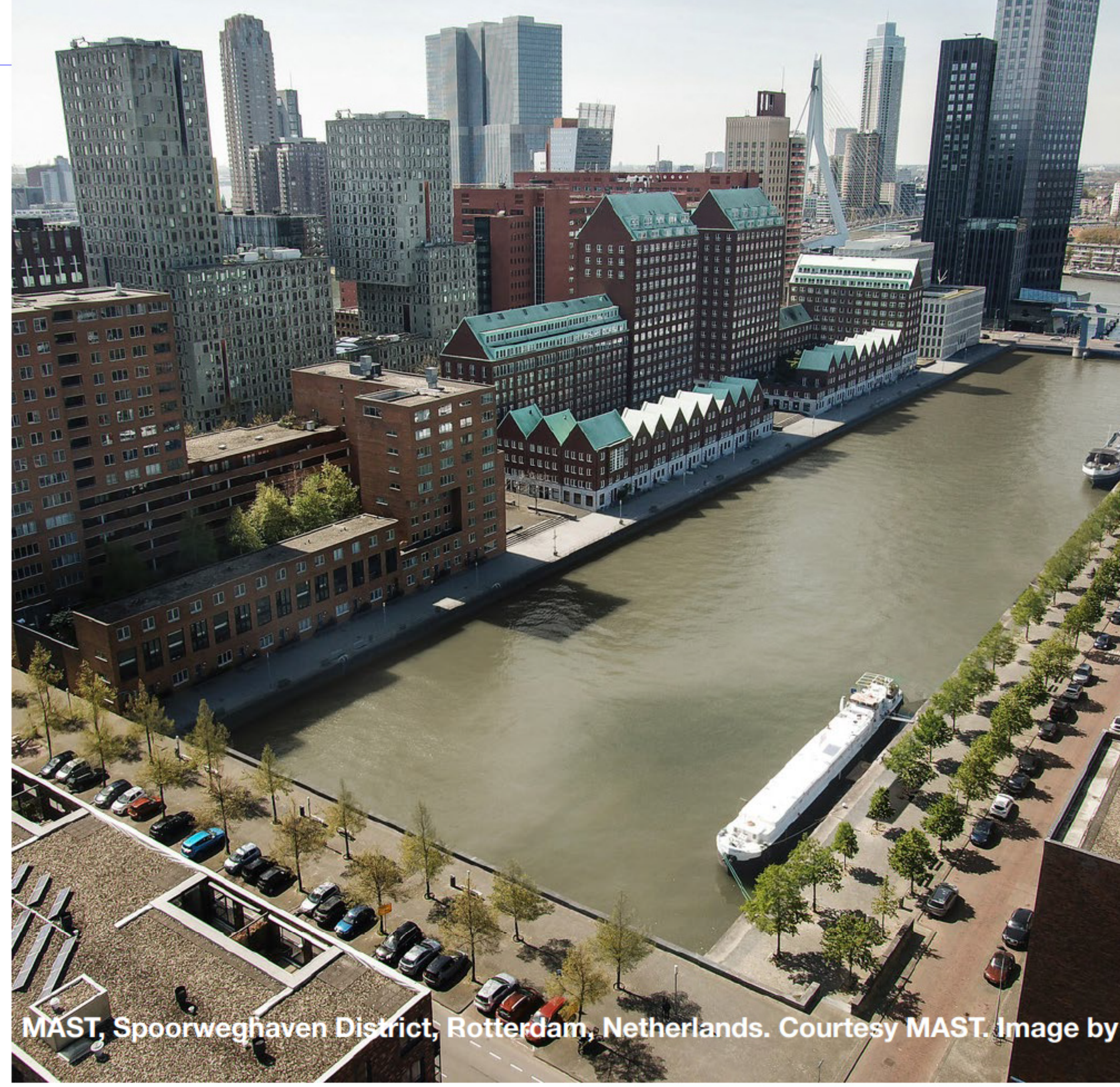
3.0 a starting point for our middle ground

The comparative study of Rotterdam and Nueva Venecia exposes not only two contrasting architectural realities but two ways of understanding the human condition in relation to water. Rotterdam, with its technological precision, institutional strength, and strategic vision, transforms water into a field of innovation and control. It represents the triumph of engineering over uncertainty, the capacity to calculate, predict, and design for resilience. Nueva Venecia, by contrast, embodies an architecture of coexistence: an intuitive, collective intelligence that evolves through necessity rather than design, and that accepts water not as an obstacle but as the natural extension of life itself.

However, between these two extremes, the controlled and the spontaneous, the engineered and the improvised, there lies a profound absence. This gap is not merely one of aesthetics or resources, but of ideology. It is a void in architectural thinking where innovation and inclusion, progress and belonging, have rarely met. High-tech floating cities, as seen in Rotterdam, respond effectively to climate adaptation but often reproduce economic exclusion and spatial inequality. Meanwhile, vernacular palafitic settlements, like those of Nueva Venecia, embody centuries of adaptive wisdom but remain vulnerable to the same climatic and infrastructural forces that threaten their survival. Neither model alone can answer the global challenges of the Anthropocene: rising seas, environmental displacement, and the growing demand for affordable, adaptable habitats.

The “middle ground” thus emerges as an urgent proposition, a conceptual and practical bridge between these worlds. It is not a compromise between opposites, but a convergence of their strengths: the precision of technology with the empathy of vernacular culture; the resilience of innovation with the humility of tradition. The middle ground seeks to redefine floating architecture as a democratic condition, one that does not belong exclusively to the privileged economies of the Global North nor remain confined to the survival tactics of the Global South. Instead, it envisions aquatecture as a continuum of adaptation, an evolving language of living with water that is accessible, contextual, and sustainable.

In this sense, Rotterdam and Nueva Venecia are not antagonists but interlocutors. Each holds what the other lacks. Rotterdam teaches us how to institutionalize adaptation and embed water within planning, governance, and design as a medium of urban life.


MAST, Spoorweghaven District, Rotterdam, Netherlands. Courtesy MAST. Image by


Nueva Venecia life style. Image by awake.travel

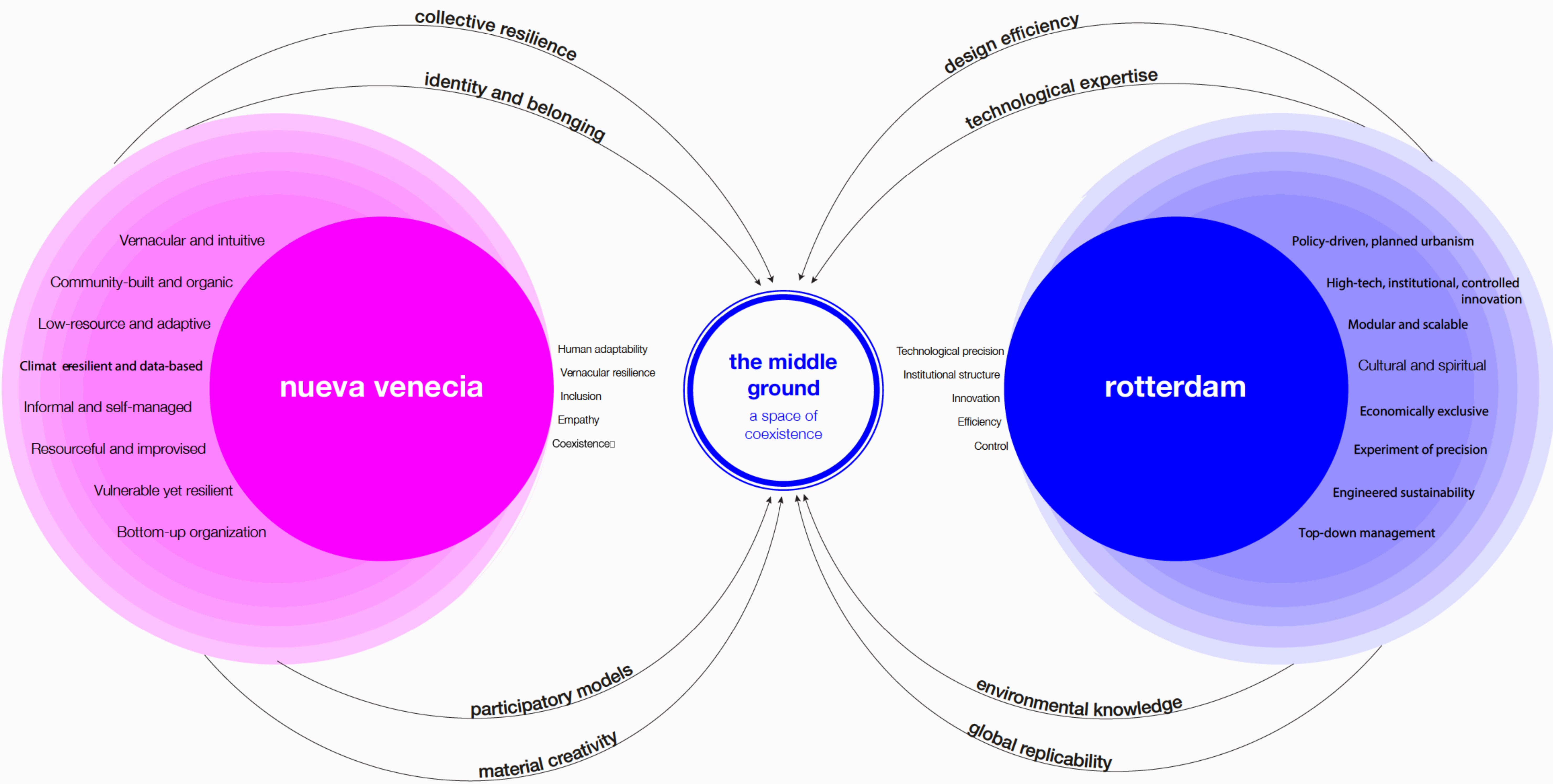
Nueva Venecia, on the other hand, reveals how culture, community, and collective knowledge can build a resilient urbanism from within, without the need for large infrastructures or external capital. Rotterdam operates through systemic logic; Nueva Venecia, through emotional intelligence. One builds through strategy, the other through memory. Together, they outline the coordinates of a possible equilibrium: the point where technology becomes human and tradition becomes forward-looking.

However, this gap also reveals a theoretical imbalance within architecture itself. The discipline has long celebrated either end of the spectrum: the spectacle of innovation and the poetry of the vernacular. What remains underexplored is the dialogue between them, the hybrid condition where the technological meets the cultural, and the architectural form that becomes a medium of negotiation between environmental and social systems. The middle ground, therefore, is not only a design agenda but a theoretical necessity: a framework to rethink the ethics and accessibility of architectural production in an age defined by climate uncertainty.

To construct this theoretical bridge, we must look beyond architecture as an object and see it as an interface between the human and the non-human, land and water, capital and culture. In this expanded view, the middle ground becomes a tool for spatial justice, echoing the ideas of thinkers like David Harvey and Saskia Sassen, who remind us that access to space and resources is a collective right, not a privilege. It also resonates with resilience theorists such as Walker and Holling, who define adaptability as the key measure of sustainability, and with architectural voices such as Kenneth Frampton and Amos Rapoport, who call for a synthesis between global modernity and local intelligence.

The middle ground, then, is not merely a proposal for new buildings, but for a new way of thinking about architecture, one that reconciles precision with empathy, efficiency with culture, and innovation with identity. It proposes that floating architecture can evolve from an isolated experiment to a global paradigm, from an exclusive prototype to an accessible system. In doing so, it reframes the act of building on water not as resistance to climate change, but as an act of coexistence: an architecture that learns from both Rotterdam and Nueva Venecia to imagine futures where we not only survive on water, but belong to it.

the middle ground – a fluid equilibrium



quantifiable methodology: defining percentage parameters

In this research, percentage parameters represent proportional indicators that express the extent to which each factor, such as technological, social, material, or environmental, influences the design model.

They translate qualitative insights into measurable proportions that define the balance between vernacular and high-tech floating approaches.

In terms of materials, the balance between 60% local renewable materials and 40% imported materials reflects the degree of vernacular adaptability. This proportion encourages the use of regional, low-impact resources while ensuring technical reliability and performance within the construction process. The technological parameter, defined by 70% prefabrication and 30% on-site construction, represents the relationship between speed and local engagement.

This balance allows scalability and efficiency without neglecting the involvement of local labor and craftsmanship. From an environmental perspective, the 80% self-sufficiency to 20% dependence ratio reflects the project's environmental resilience, underscoring its capacity to operate independently of external energy or resource grids while reinforcing sustainability and autonomy. Economically, the distribution of 50% structure, 30% systems, and 20% finishing outlines an affordability breakdown that directs resources toward structural efficiency, ensuring that investments prioritize stability and performance over superficial finishes.

Finally, the social dimension, with 40% professional involvement and 60% participatory contribution, indicates the project's social integration. This parameter highlights community inclusion throughout the design and maintenance phases, promoting collective ownership and long-term sustainability of the built environment.

These values act as design weights, showing how the model positions itself between two poles:

high-tech floating typologies

technologically complex, industrially produced, and resource-intensive.

vernacular floating typologies

locally sourced, socially embedded, and materially adaptive.

extracting parameters from case studies

The extraction process builds on the comparative coding of the 34 analyzed cases and the two primary references: Rotterdam (as a high-tech benchmark) and Nueva Venecia (as a vernacular reference).

It follows four analytical stages:

1. Define Key Variables

The project parameters are also organized across five dimensions: technological, social, material, environmental, and economic; each defined by specific variables and their corresponding implications for design.

2. Comparative Case Study data extraction

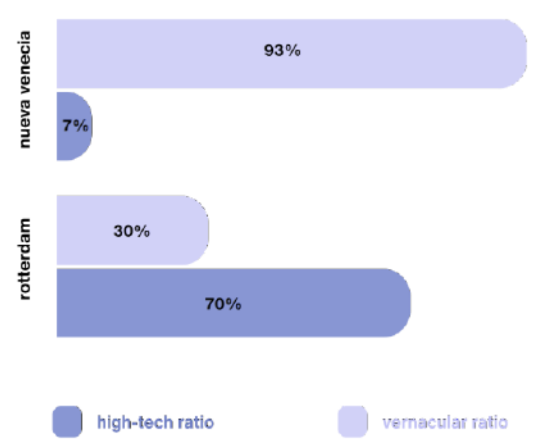
The comparative analysis between Nueva Venecia (Colombia) and Rotterdam (The Netherlands) reveals contrasting priorities in labor structure, material sourcing, technological integration, and governance, illustrating the divergence between vernacular and high-tech floating architecture models.

In terms of local labor, Nueva Venecia relies on community-based construction, with approximately 85% local participation, while Rotterdam depends largely on industrialized systems, involving only 20% local labor. This contrast highlights how Rotterdam's production is rooted in technology and efficiency, whereas Nueva Venecia's model is grounded in social cohesion and collective knowledge.

Regarding renewable materials, Nueva Venecia relies 100% on natural, locally available resources, whereas Rotterdam relies on 40% natural, locally available resources and 60% on traditional and industrially produced materials. This demonstrates the opposition between high vernacular materiality and hybrid construction practices that merge sustainability with industrial precision.

The incorporation of technological systems further underscores this difference: Nueva Venecia operates entirely without technological infrastructure (0%), while Rotterdam's projects achieve 90% technological integration, highlighting a clear distinction in energy autonomy and system complexity.
Similarly, energy self-generation is absent in Nueva Venecia (0%), yet it represents 80% of Rotterdam's operational model. This reflects the Dutch approach's strong emphasis on high-tech sustainability, innovation, and energy efficiency as central design drivers.
Finally, in terms of community governance, Nueva Venecia demonstrates 90% participation, indicating strong local organization and shared decision-making, while Rotterdam shows only 15%. This contrast reinforces the idea that social participation constitutes the vernacular strength of Nueva Venecia, while Rotterdam's governance model prioritizes institutional and technical management.

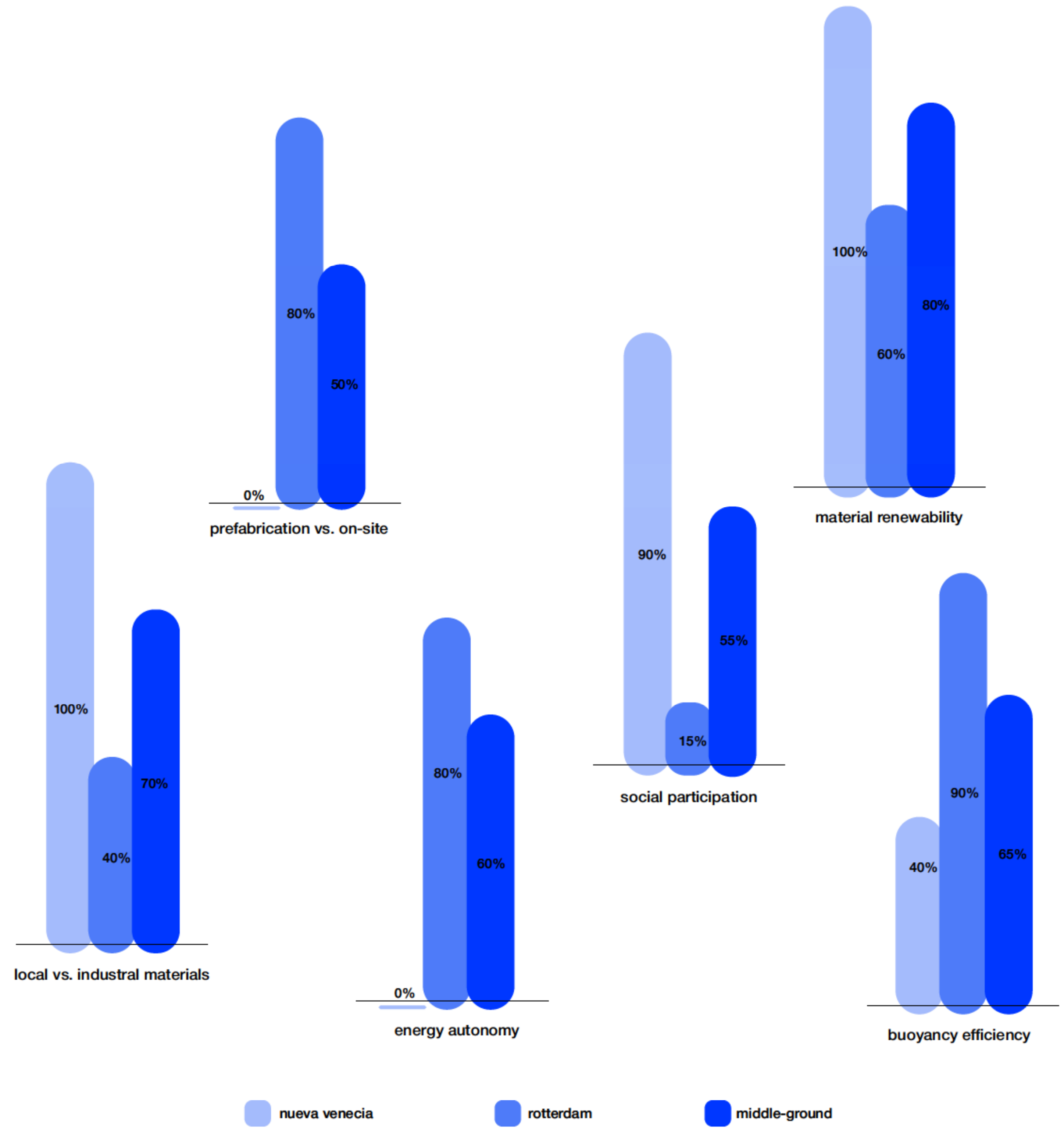
3. Normalize and Compare



From Vernacular Roots to High-Tech Systems:
Defining the Spectrum of Floating Architecture

These ratios define the two extremes

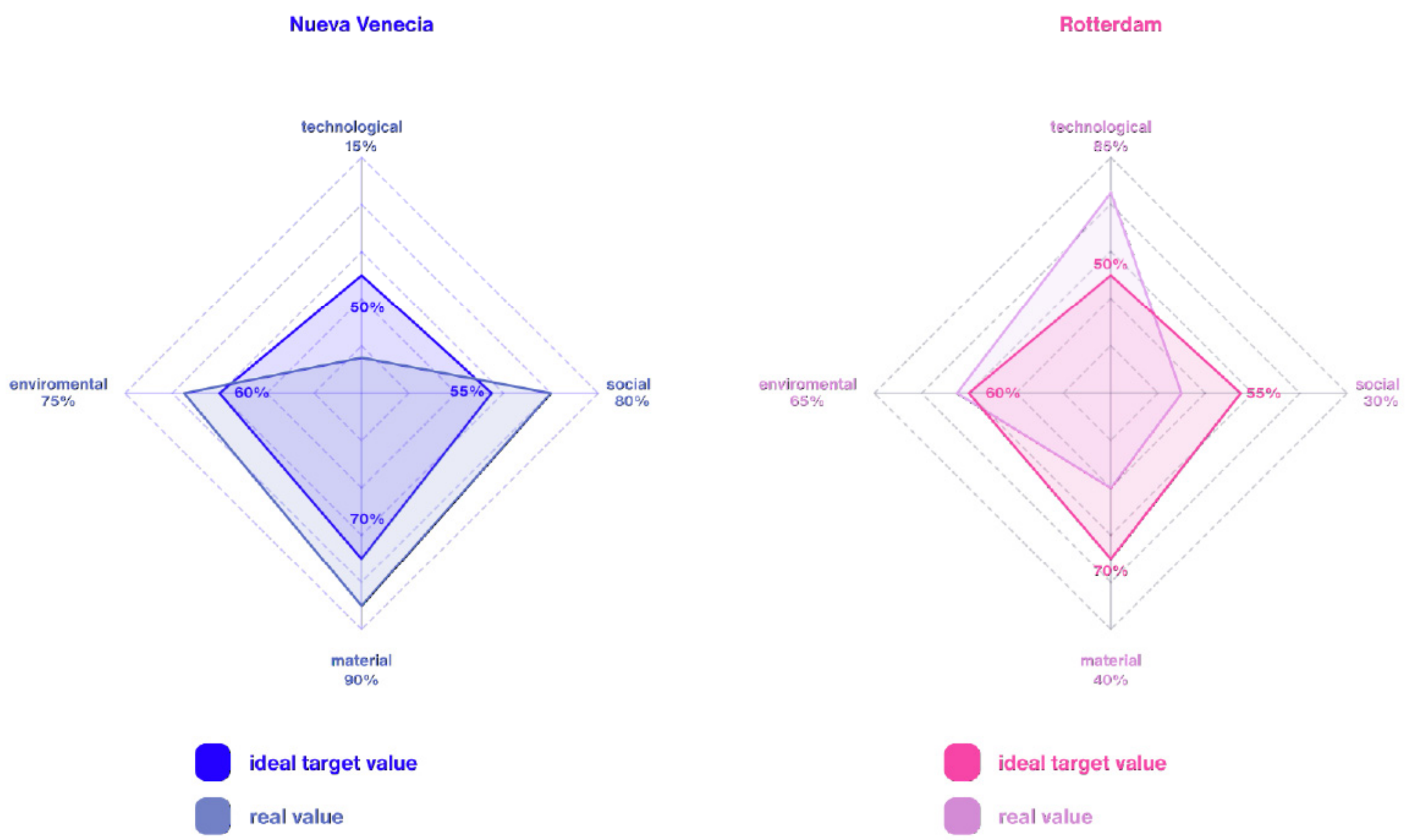
4.0 Find the Middle ground parameters
By averaging compatible variables between the two ends of the spectrum, a target percentage range was defined for the Toolbox.



defining the operational parameters for a middle-ground framework
a balanced model that performs across both vernacular adn technological contexts

final parameters to the toolbox

The resulting data forms a parameter matrix that becomes the operational core of the Floating Toolbox.



comparative performance of vernacular and high-tech parameters

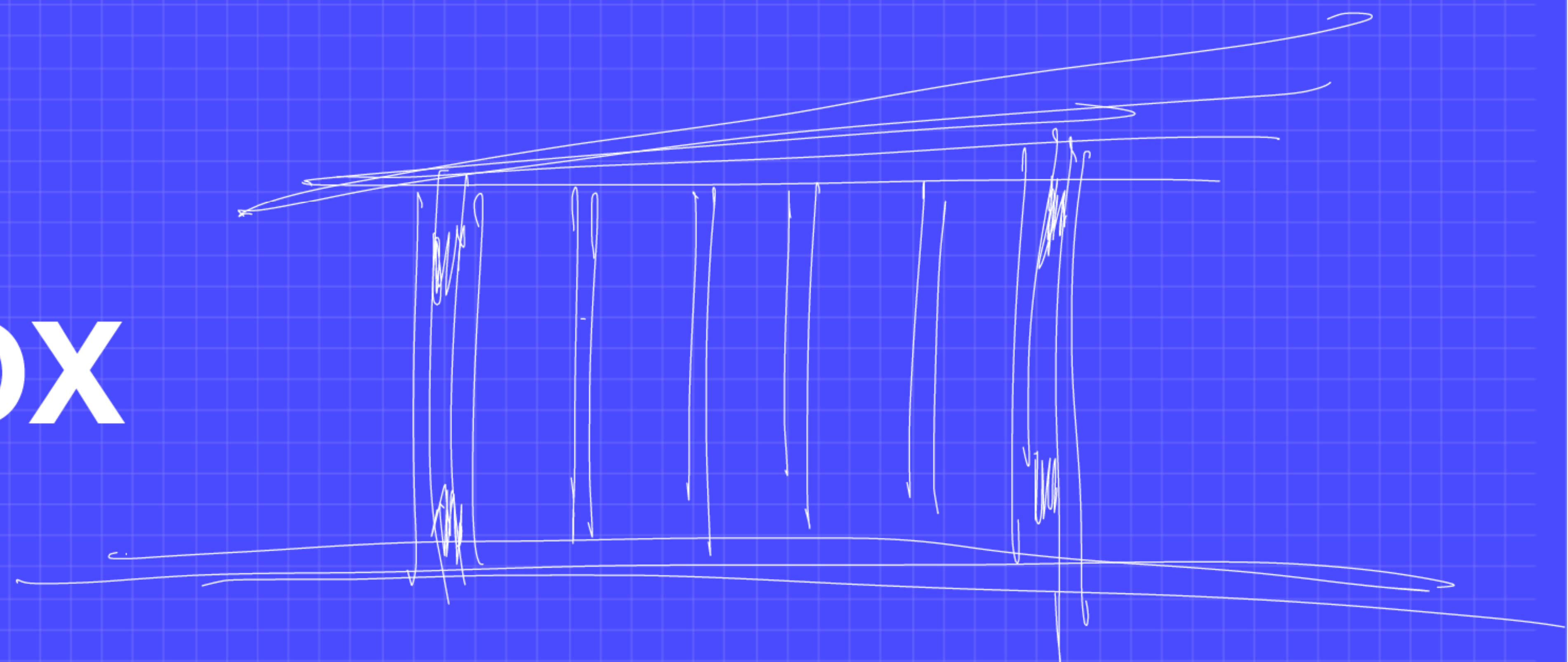
These diagrams compare the real performance of Nueva Venecia and Rotterdam against the ideal target values defined by the Floating Toolbox.

Nueva Venecia exceeds the target in material, environmental, and social dimensions, revealing strong vernacular resilience but minimal technological integration. In contrast, Rotterdam prioritizes technology and efficiency, surpassing the target in technical and environmental aspects while showing lower social and material engagement.

Together, they represent the two extremes of the floating architectural spectrum: the vernacular resilience of Nueva Venecia and the technological autonomy of Rotterdam. Defining the boundaries within which the Floating Toolbox seeks its middle ground.

The sum of these weighted factors defines the Quantifiable Identity of the Toolbox, a model that stands halfway between vernacular wisdom and technological innovation, measurable, adaptable, and globally replicable.

THE TOOLBOX



01. concept:
the middle ground

1.

| the middle ground |

palafitic construction in water

ancestral relationship with water

tradition based palafitic building

high-tech contemporary bulding

floating construction in water

concious climatic responce

water as a common and transversal worldwide lenguage

how can we make water inhabiting a universal concept as a it is a worldwide language?

a replicable architectural paradigm where floating or amphibious structures operate as collective infrastructures rather than isolated objects. It positions water not as a limit but as a democratic ground, open to human habitation, ecological regeneration, and cultural continuity. The project envisions architecture as a framework for coexistence, integrating vernacular intelligence with contemporary modularity to create accessible, evolving, and resilient aquatic settlements.

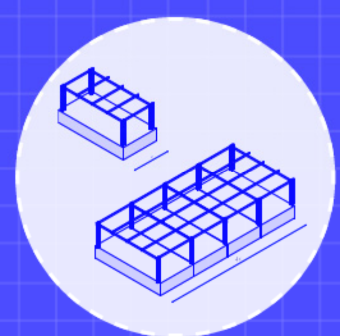
conceptual pillars

democratizing architecture and access to space

affordability

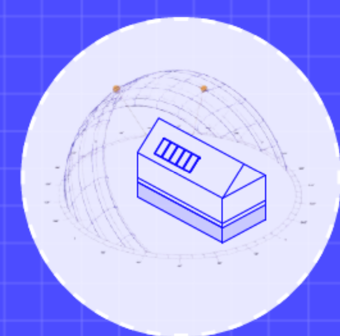
aquatecture as a global and replicable paradigm

applicability world wide



scalability

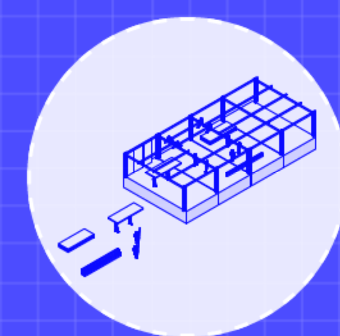
resilience, adaptation, and the post-anthropocentric city



sustainability

long term resiliance

between vernacular intelligence and technological innovation



social participation

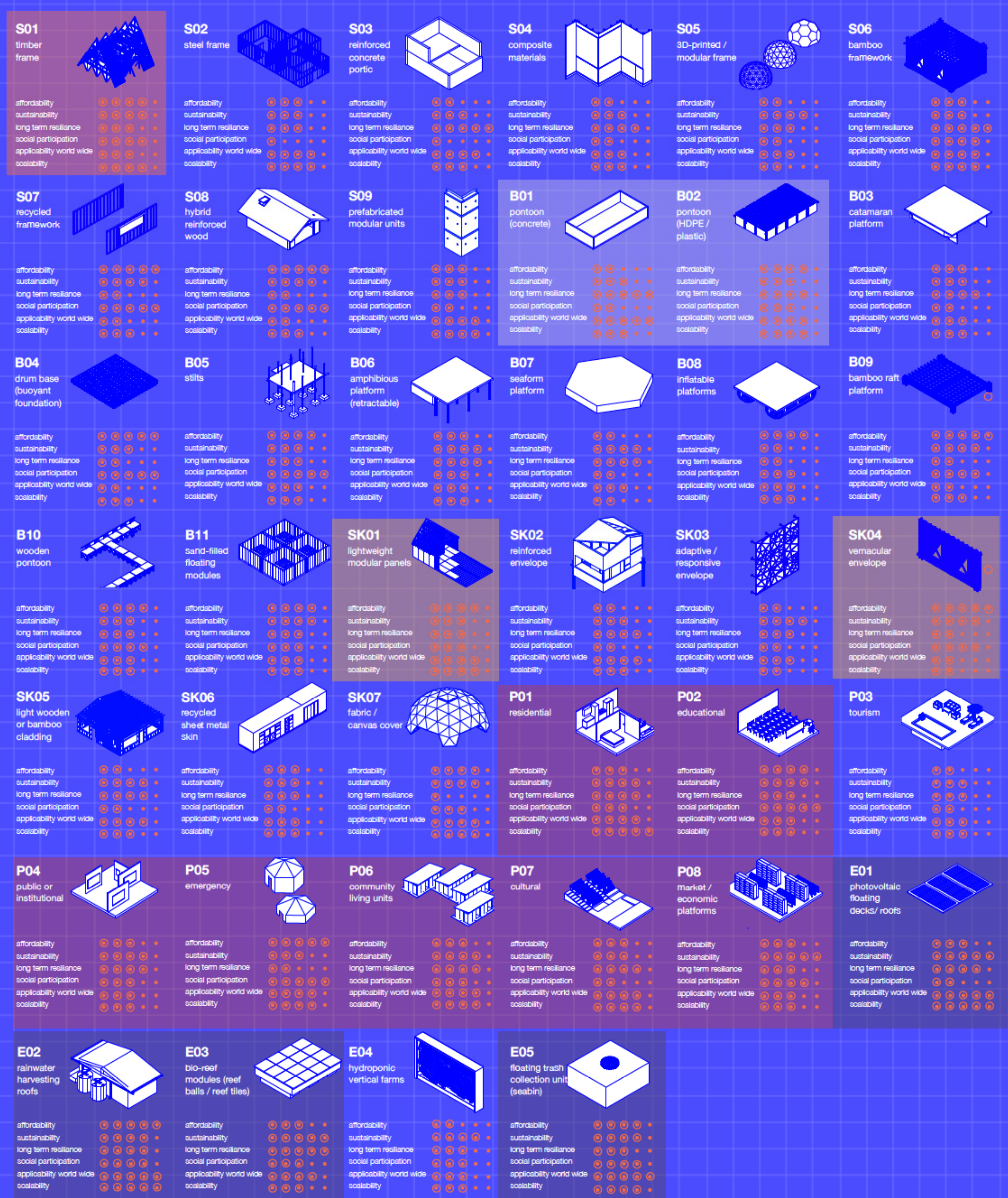
2.

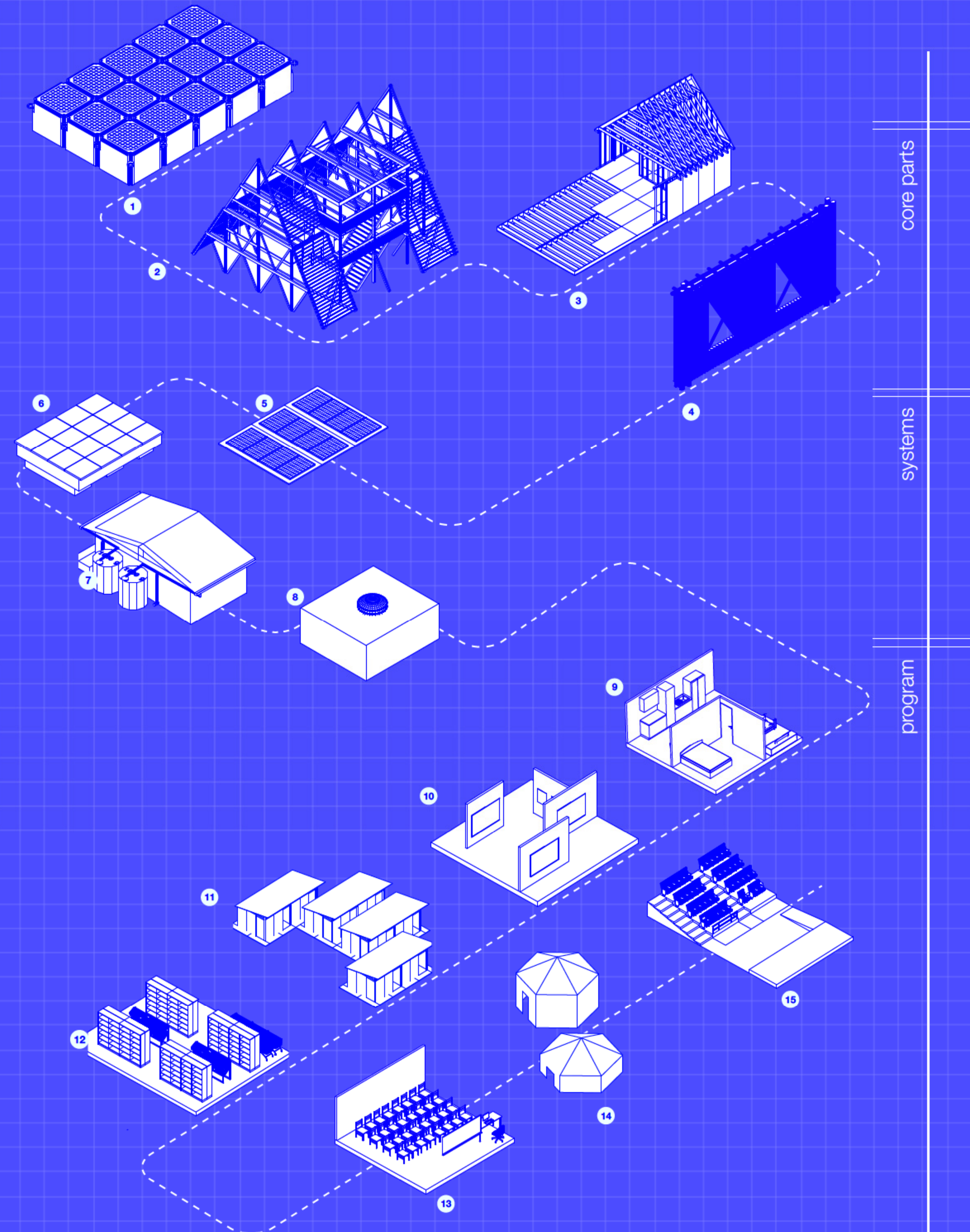
| base selections |

02. base selections:

defining the selected parts based on the matrix

After analyzing and comparing all elements, we made a series of grades that transversally analyzed the viability of each method based on the core values of our project: affordability, sustainability, long term reciliance applicability world wide and scalability. based on this, the decition of which element to choose was based on the one that served the most the proposal.





03. kit of parts:
the middle ground

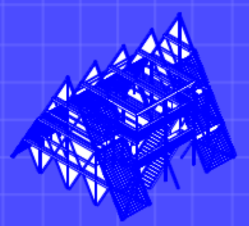
prioritizing and defining the main values of the design.

2.

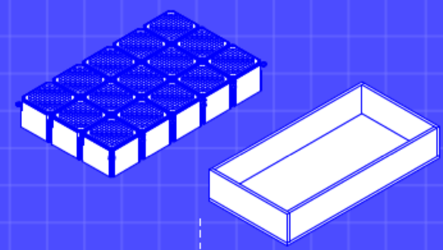
| base selections |

selections based on the most applicable parameters extracted from the concept. Based on the selection we now needed to determine what level of rigidity this items entailed in our proposal

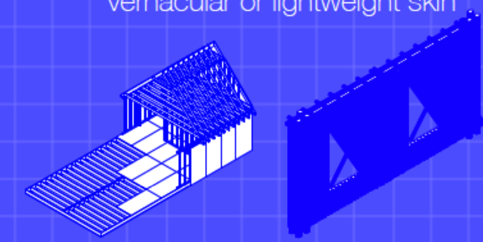
structure:
modular timber frame



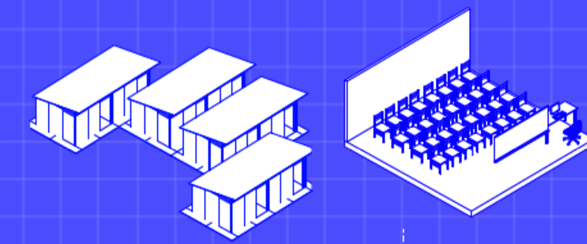
bases:
pontoon typology



skin:
vernacular or lightweight skin



program:
adjustable program depending on need



we identified the same recurring pattern — a stable structural core, a set of context-dependent adjustments, and a series of incremental additions that allow communities to evolve their built environment over time. Translating this shared adaptive logic into Core Items, Variable Parameters, and Add-Ons allowed us to encode the essence of aquatecture as a democratic, replicable system grounded in both innovation and vernacular intelligence.

3.

| defining your kit |

a. the core:
rigid variables that must be met.

structure

The structure (buoyant base + lightweight frame) is the foundation of water-based architecture. Without a clear structural logic, the platform cannot be safe, scalable, or replicable.

Importance:
Determines buoyancy, load capacity, safety.

Provides universal engineering logic applicable in multiple climates.

Allows prefabrication, community building, and low-cost materials.

assembly process

The way the module is assembled determines whether it is democratizable. Rotterdam has highly modular prefabricated systems and Nueva Venecia has community-built incremental systems.

Importance:
Defines whether communities can build it themselves.

Influences transportability, emergency deployment, and cost.

Determines how easily a neighborhood grows over time.

proportion

Keeping the specific proportion is esencial for bouyoncy and also allows modularity and the capability of expansion in the future

Importance:
Prevents structures from becoming inefficient or top-heavy (crucial on water!).

Allows modules to aggregate coherently.

modularity

Modularity is the key to democratization and replicability. A middle-ground system MUST be modular to remain affordable and adaptable.

Importance:
Ensures buildings can grow incrementally (like palafíticos).

Allows prefabrication (like Rotterdam).

Simplifies maintenance, relocation, and adaptation to climate risk.

program

Program shapes how communities inhabit water.

Importance:
Determines whether a floating neighborhood becomes livable, social, and sustainable.

Ensures essential functions: housing, gathering, working, food production.

Aligns with local cultural patterns.

b. the dependants / variables:
stiff variables that can be adjusted based on circumstalcial elements

low budget or **medium high budget**

	low budget	medium high budget
base	plastic pontoon	concrete pontoon
height	1 floor	2 floors
plan/ connection	unified	connected
anchoring	multiplied	single

tropical or still temperature or **seasons or changing weather**

	tropical or still temperature	seasons or changing weather
skin	simple build	climatic layering
roof	simple build	climatic layering

c. the add-ons:
variables that can be added to improve or mantain architectural language

ecosystems
- coral cultivations
- and / or
- photovoltaic

water systems
- water purification
- and / or
- rain collection/ harvesting

sevices
- inclined water connection to city system
- and / or
- HVAC water cooling from waters

facade add - ons
- commerce
- and / or
- living quarters
- and / or
- office
- and / or
- service entrance
- and / or
- gardens
- and / or
- emergency shelter

03. kit of parts:
the middle ground

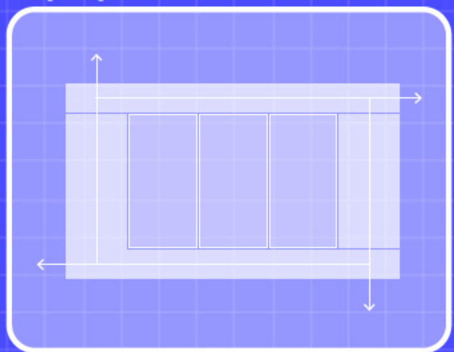
3.

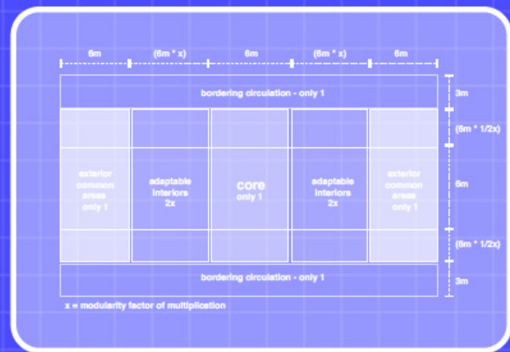
a.

| defining your kit |

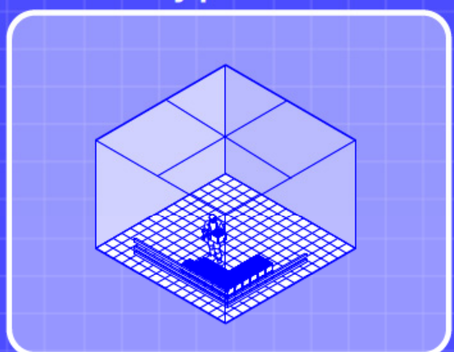
the core:
rigid variables that must be met.

proportion

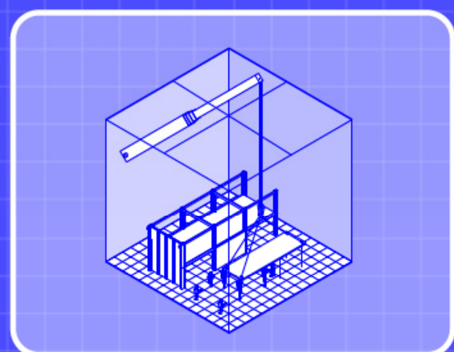




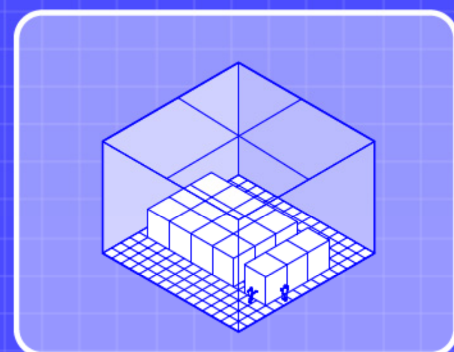
assembly process



choose bases

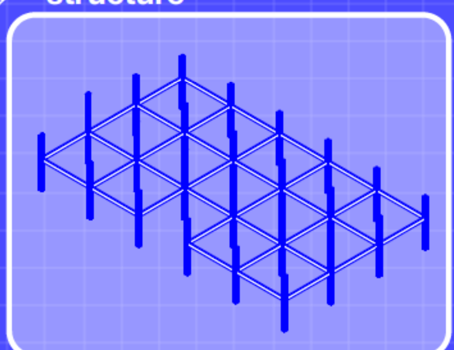


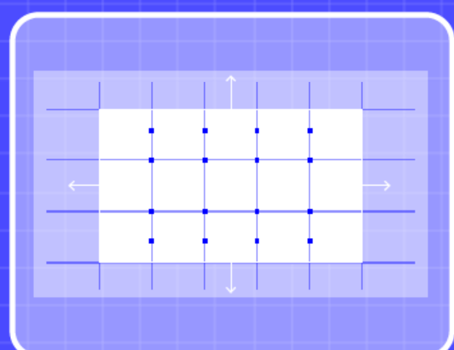
pre made frame and panel system



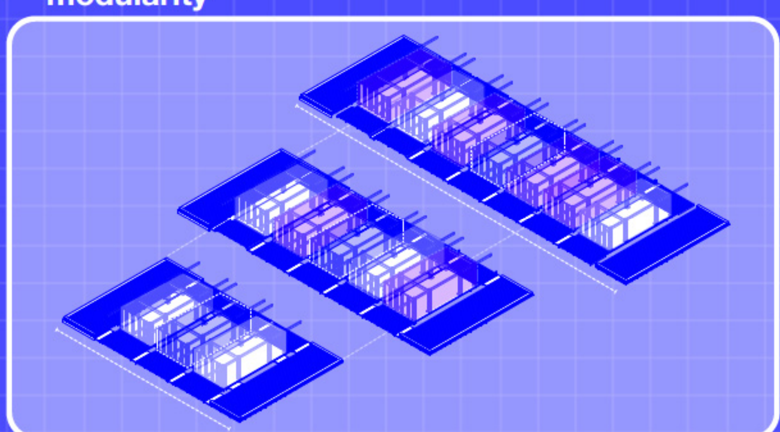
aggregated module system

structure

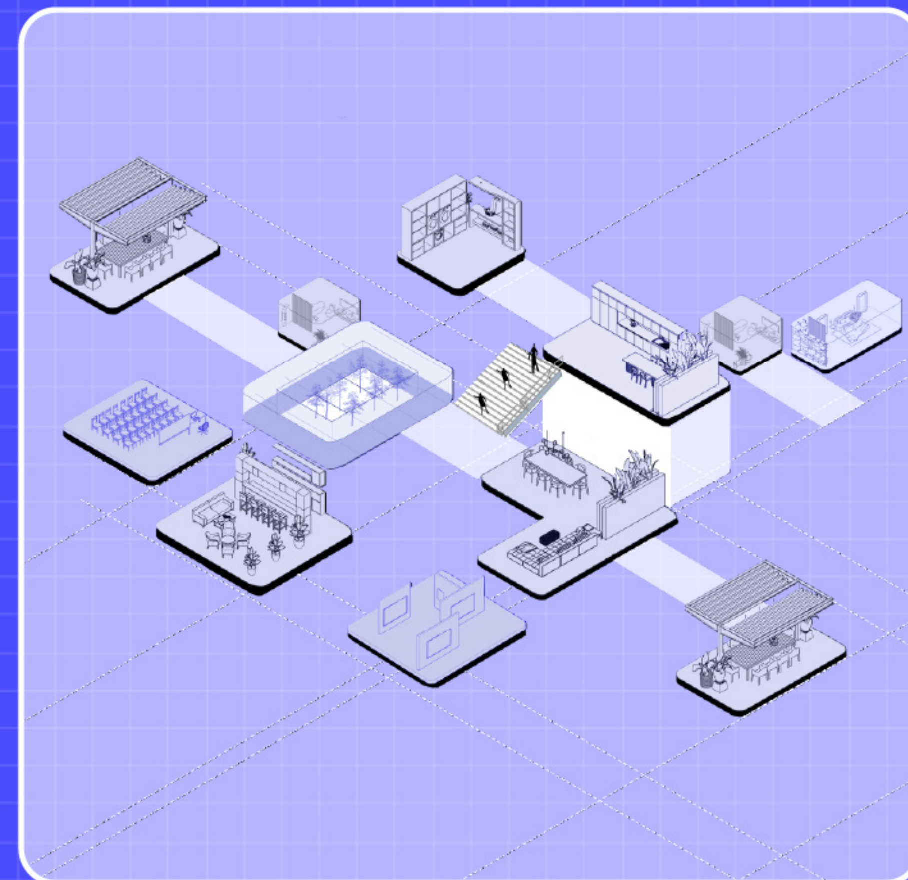




modularity



program



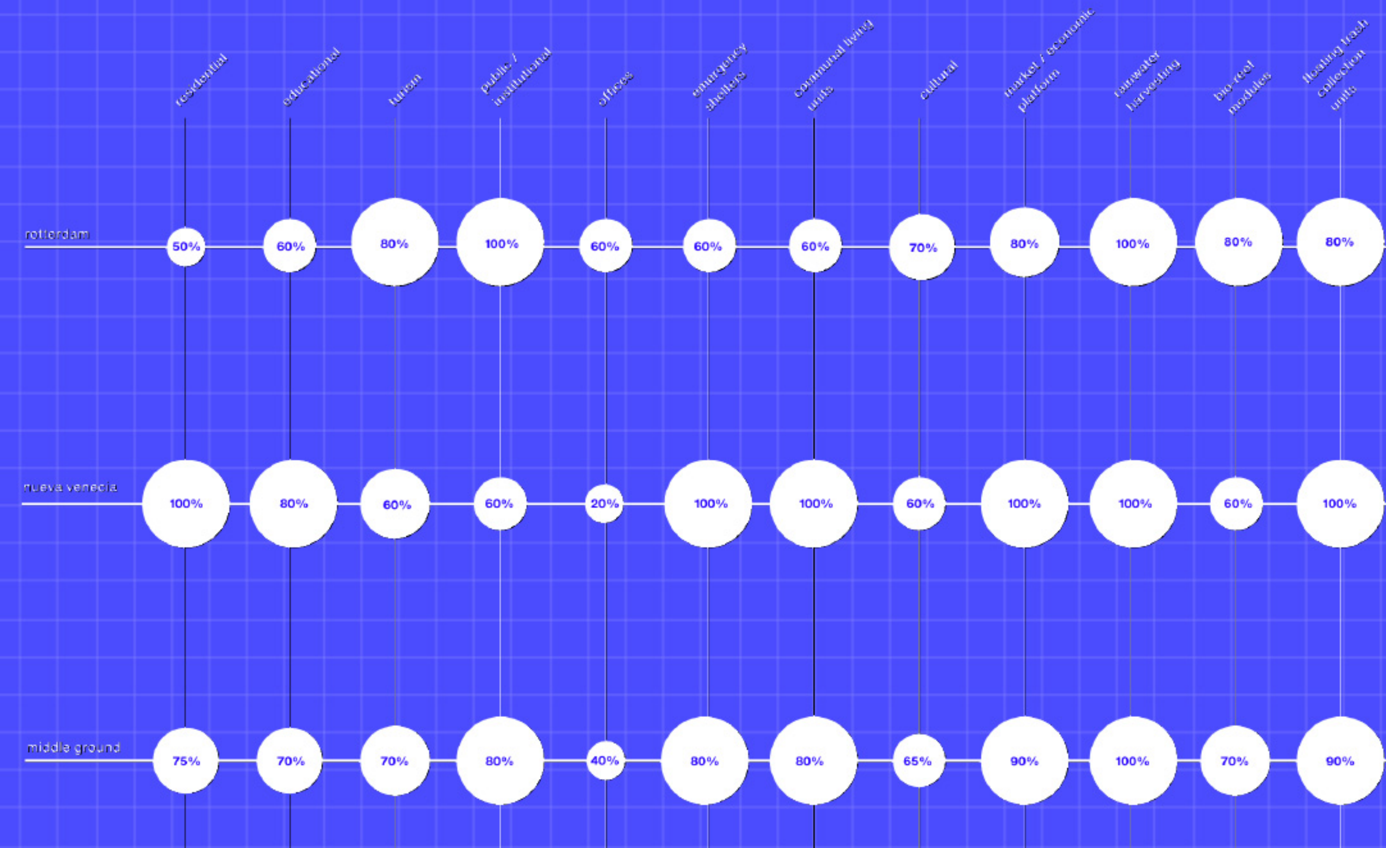
emergency adaptability
≥ 30%

ecosystem responces
≥ 10%

public space
≥ 15%

circulation
≥ 20%

green or vegetation
≥ 10%



03. kit of parts:
the middle ground

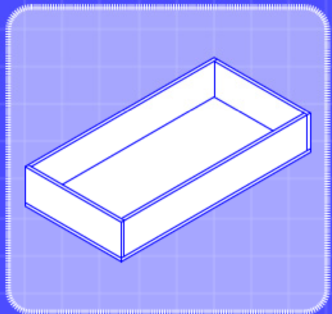
3.

budget ← | defining your kit | → climate

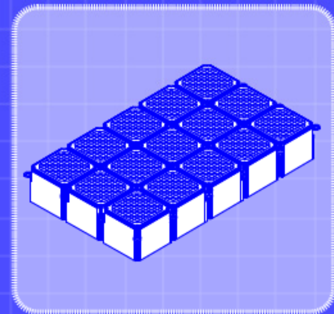
budget: medium high budget / low budget

climate: tropical or still temperature / seasons or changing weather

base

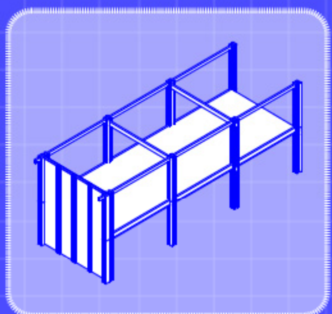


concrete pontoon
prefabricated monolithic pontoon offering higher structural resistance and fast installation due to its single-piece construction.

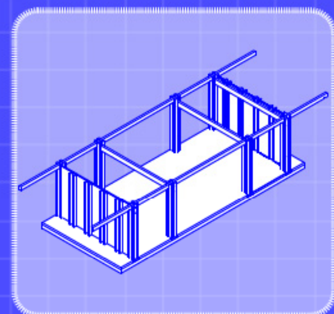


plastic pontoon
low-cost modular pontoon made of 50×50×40 cm units assembled piece by piece, allowing easy transport and incremental installation.

height

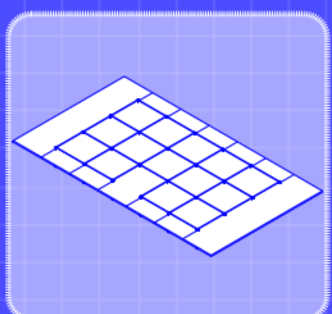


2 floors
two-storey structure engineered to support vertical growth, allowing up to two full levels stacked safely.

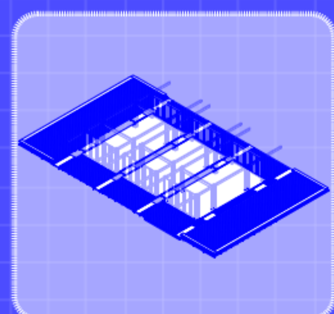


1 floor
single-storey structure designed for one level, with capacity to grow horizontally

plan/ con-nection

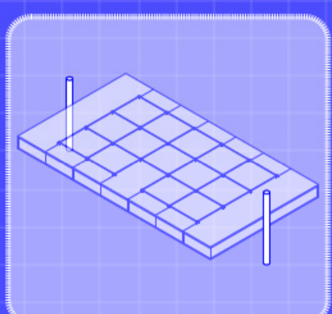


unified
pontoons are joined into a single continuous platform, creating one unified floor plate above

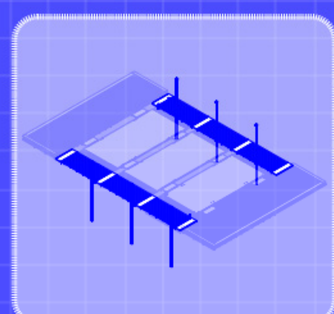


connected
independent modules linked through articu-lated bridge elements that allow flexible movement between units

anchoring

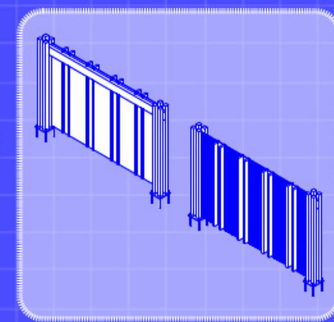


single
one anchoring system per side, suitable for unified platforms and higher structural stability.

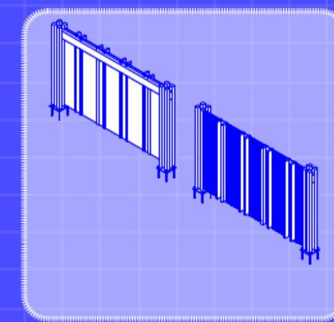


multiplied
each module carries its own pair of anchors, multiplying anchoring points across the entire system.

skin

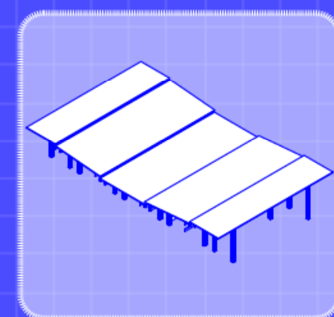


simple build
single-layer envelope suitable for tropical or stable climates where thermal variation and weather impact are minimal.

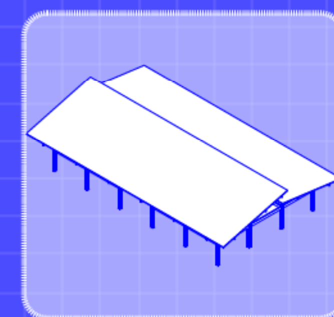


climatic layering
multi-layered skin designed to respond to seasonal shifts and climate extremes, improving insulation and environmental control.

roof

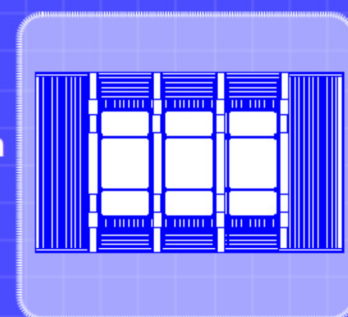


small incline
lightly sloped roof adequate for mild climates with low rainfall.

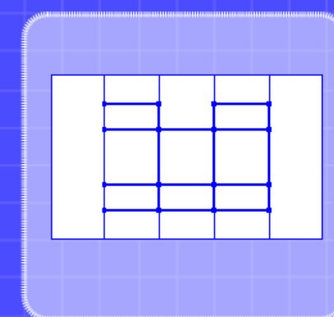


calculated incline
precisely angled roof dimensioned for heavy rain, snow, and extreme seasonal conditions, ensuring efficient runoff and durability

min

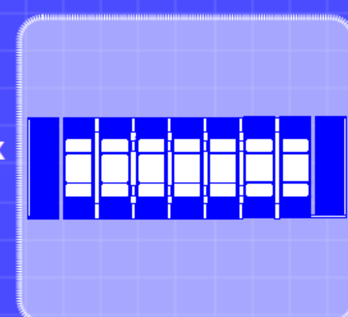


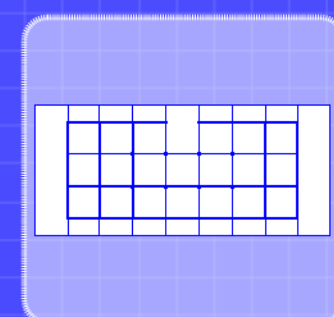
expandable module by module, from a minimum of one unit up to a maximum of nine connected modules.



minimum of five modules, scalable up to nine, adapting to available site dimensions and climatic requirements.

max



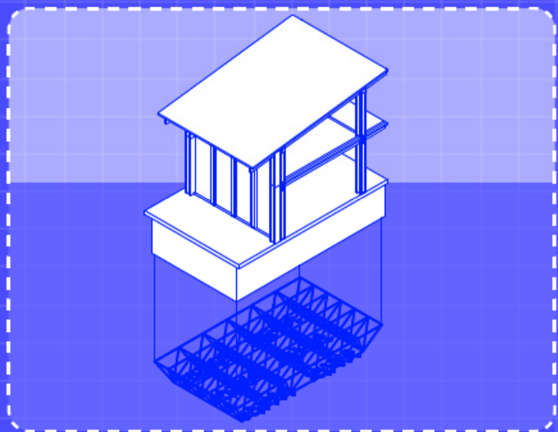


03. kit of parts:
the middle ground

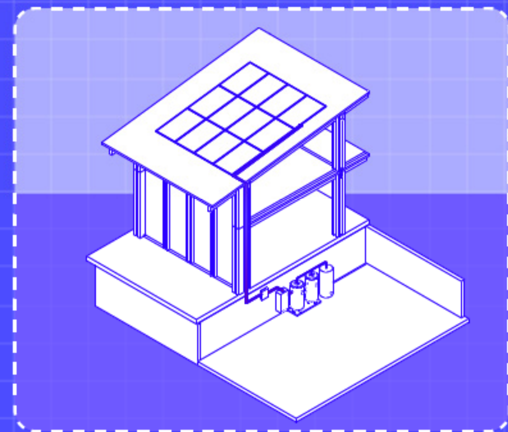
3.

| defining your kit |

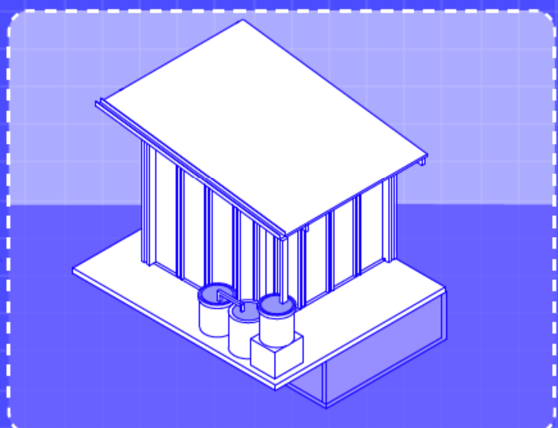
ecosystems


coral cultivations

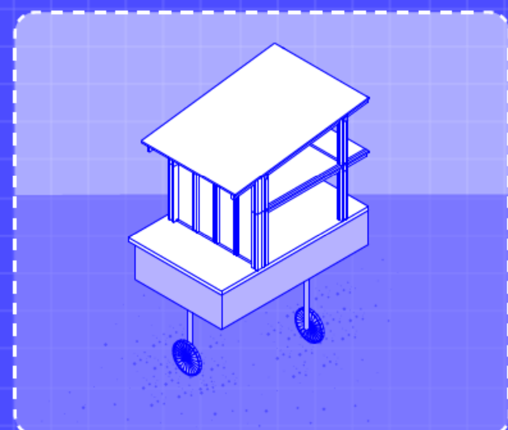
or


photovoltaic

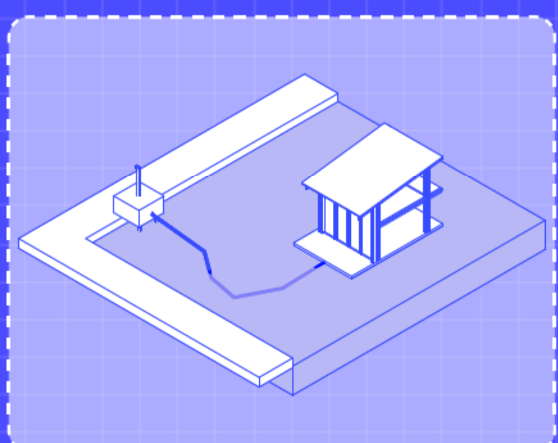
water systems


rain collection/ harvesting

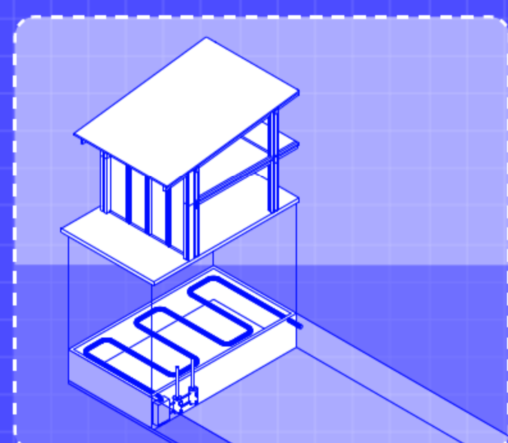
or


water purification

sevices

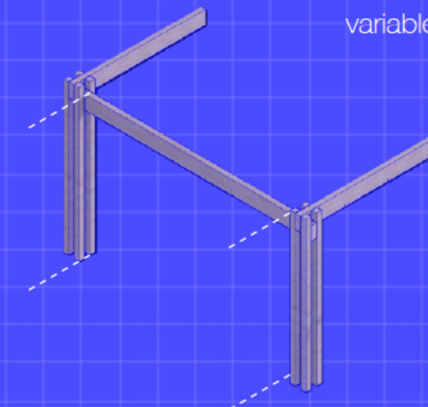

inclined water connection to city system

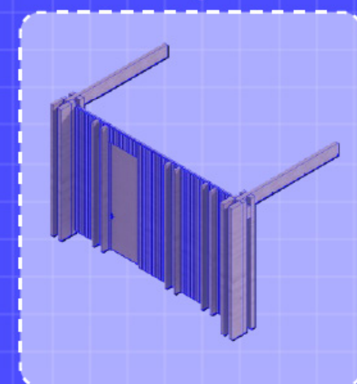
or

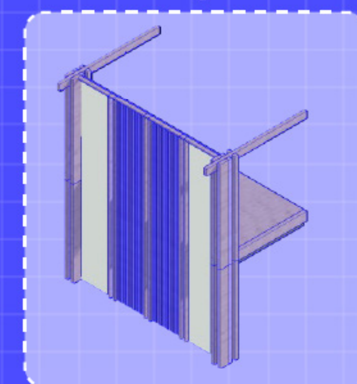

HVAC water cooling from waters

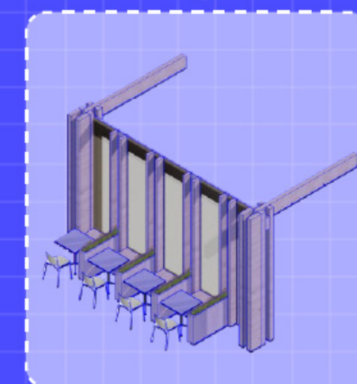
c.

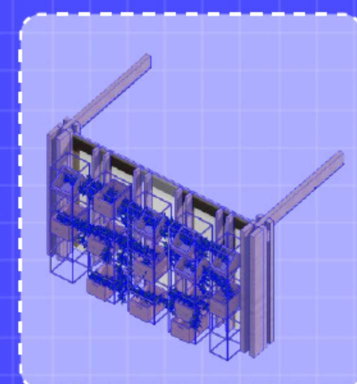
the add-ons:
variables that can be added to improve or mantain architectural language

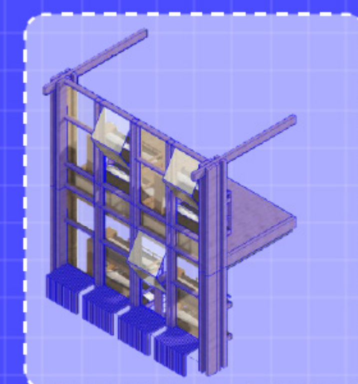

facade add - ons

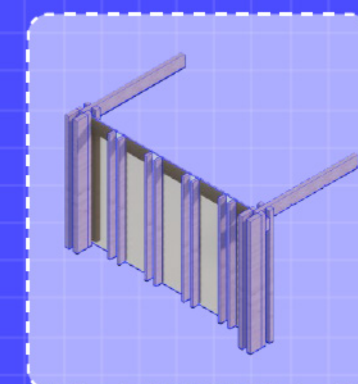

service entrance


office

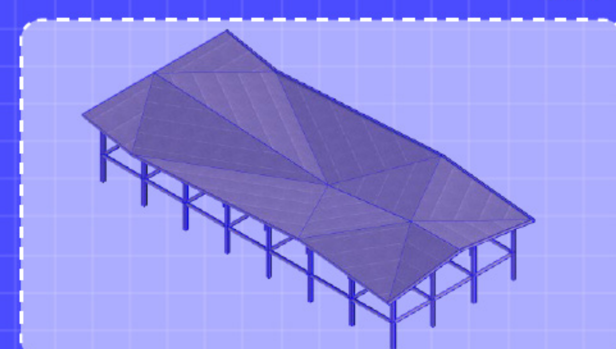

commerce

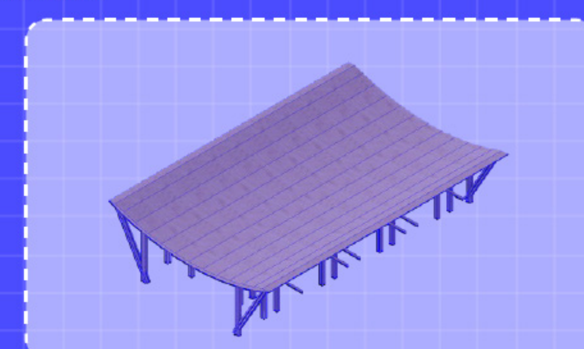

gardens


emergency shelter


living quarters

roof iteration


faceted climatic roof


curved passive roof

4.

| assemble your kit |

4.

| assemble your kit |

1. evaluate:
(Understanding the community's lived conditions)

The process begins with the community or local stakeholders evaluating their daily realities, not abstract technical data. This includes:

- How they use space (communal vs. private)
- What materials are available or affordable locally
- How the water behaves daily, seasonally, and during crises
- Cultural expectations for housing shape, hierarchy, and proximity
- Skills present in the community (carpentry, fishing, assembling, etc.)
- Their economic thresholds and long-term maintenance capacity

This step mirrors how Nueva Venecia evolved naturally and how Rotterdam formalized its high-tech responses.
Both started with a deep reading of daily life, and this thesis transforms that reading into a structured method.

outcome:
A clear understanding of what the community actually needs, protects, values, and can maintain.

2. identify needs:
(Translating lived reality into architectural priorities)

Once the evaluation is complete, the community identifies which challenges are most urgent and which opportunities matter most.
For example:

- A tropical community might prioritize ventilation and shaded public space.
- A temperate community might prioritize insulation and heat loops.
- An at-risk fishing village might prioritize storage and amphibious mobility.
- A European harbor might prioritize modular growth and energy systems.

This step reflects the idea that aquatecture is a universal language shaped by local accents.
Rotterdam and Nueva Venecia express different priorities, yet both articulate the same human need: learning to live with water.

outcome:
A list of local priorities that determines which parts of the toolbox should be chosen.

3. assemble:
(Choosing the right components for the right place)

With their priorities clarified, the community uses the toolbox as a decision-making guide, selecting:

- Which core items apply universally (structure, assembly, proportion, modularity, program).
- Which variable components need adjustment (base type, height, plan, anchoring, skin, roof).
- Which add-ons they can include now or in the future (facades, systems, public extensions).

This step is the democratizing heart of the project:
The toolbox is not a design you impose, but a framework that communities can adapt according to culture, climate, and resources.

Rotterdam selects differently than Nueva Venecia, but both select from the same system, proving that aquatecture can be globally replicable.

outcome:
A site-specific model architecture that is affordable, culturally grounded, technically sound, and socially cohesive, that mantains the principles of the toolbox

1. evaluate

rotterdam

- **Deep harbor water**
- **Climate is cold, seasonal, requires insulation and airtight envelopes**
- **Water used as infrastructure: heating/cooling loops, energy systems**
- **Strong regulatory framework**
- **Higher budgets, capacity for technical maintenance**
- **Public space integrated into waterfront redevelopment strategies**

nueva venecia

- **Shallow brackish water, fluctuating seasonally**
- **Houses are built incrementally by families and neighbors**
- **Community life is highly collective (open porches, canoe movement, multi-family clusters)**
- **High exposure to humidity, sun, insects; low insulation needs**
- **Most movement is by canoe; no formal infrastructure**
- **Limited financial resources; maintenance must be simple and cheap**

2. identify needs

rotterdam

- **High buoyancy and stability for multi-story programs**
- **Insulation and controlled internal climate**
- **Strong anchoring systems for tide fluctuations**
- **Integration with municipal utilities (sewer, electricity, district heating)**
- **Durable materials for long-term lifespan**
- **Mixed-use public programs (offices, cultural platforms, farming)**

nueva venecia

- **Shade and ventilation as primary climatic needs**
- **Simple, reparable structures (no heavy machinery)**
- **Spaces for gathering**
- **Elevated or floating systems that withstand seasonal floods**
- **Lightweight materials to reduce cost and ease construction**
- **Communal platforms for trade and social life**
- **Canoe-based circulation, low-speed movement**

3. assemble

rotterdam

Core Items.
Variables chosen:
- Base: Concrete pontoons
- Height: Two stories
- Plan: unified plan
- Anchoring: single pile attachment
- Skin: High-performance envelope with insulation
- Roof: faceted climatic roof

Add-ons:
- coral cultivations
- rain collection/ harvesting
- inclined water connection to city system
- HVAC water cooling from waters

nueva venecia

Core Items:
Variables chosen:
- Base: Plastic pontoons
- Height: Single story
- Plan: Connected
- Anchoring: multiple Timber piles
- Skin: simple build with ventilation openings
- Roof: Ventilated, simple, metal or palm roofing

Add-ons:
- water purification
- rain collection/ harvesting
- inclined water connection to city system

4.

| assemble your kit |

4. performance analysis:
a. cost breakdown

Evaluates how much the Floating Toolbox costs to build by breaking down all components, pontoon, structure, envelope, installations, and add-ons, using real construction benchmarks from each context (Netherlands and Colombia). It reveals how the same architectural system adapts economically to different regions.

b. performance

Measures how effectively the Toolbox behaves in technological, social, material, and environmental terms. Each dimension is expressed as a percentage and compared against the ideal middle-ground target to understand how each design responds to its specific context.

c. bouyancy

Determines how much total weight each floating module can safely support. Using Archimedes' principle, the analysis calculates the volume of water displaced by the pontoon to verify structural stability, safety margins, and the feasibility of the architectural load for each site.

a. cost breakdown

rotterdam

Construction costs for the Rotterdam module were estimated through a detailed breakdown of the pontoon, structure, envelope, installations, and finishes. A value of €2,000/m² was used for the superstructure, representing the midpoint of the Dutch construction cost range documented by EstimationQS (€1,700–€2,500/m²). This ensures the estimate reflects realistic national market conditions.

Cost Breakdown
Using €2,000/m² as defined above:

nueva venecia

The cost assessment for the Nueva Venecia module relies on Colombian construction benchmarks. Instead of using national averages, the analysis applies the official unit-price list for public works in the Department of Magdalena (Resolution 092 of 2022, modifying Resolution 053 of 2020), which provides standardized material and labour costs, meaning the values represent direct construction costs. Converting the regional price band of 2,300,000–4,000,000 COP/m² yields a mid-range equivalent of 716 €/m².

cost breakdown
Using €2,000/m² as defined above:

cost breakdown
Using €716/m² as defined above:

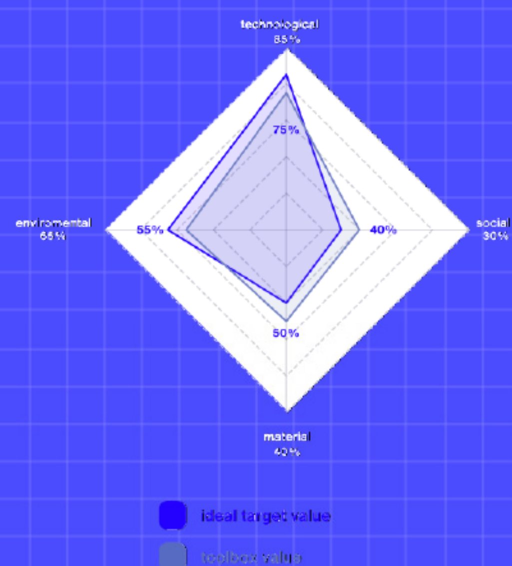
b. performance

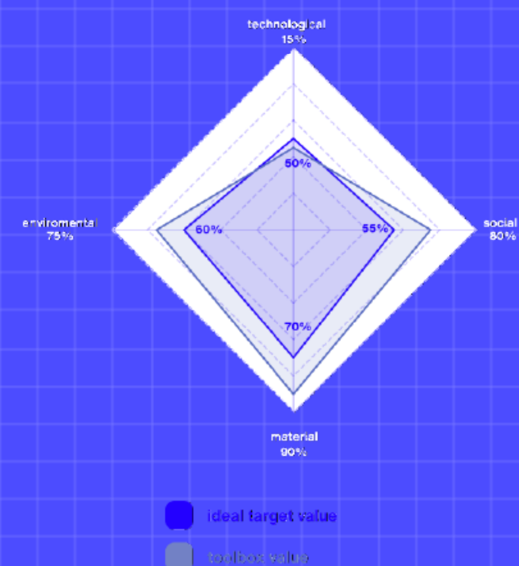
rotterdam

Performance values for Rotterdam were determined by assessing technological, material, environmental, and social factors on a 0–100% scale and comparing them to the ideal middle-ground target. The module scores high in technological and environmental aspects—thanks to water-source HVAC, climatic layering, and strong utility connections—while material renewability is lower due to the concrete pontoon.

nueva venecia

The module scores high in social and material performance due to strong community participation and the use of renewable, locally sourced materials. Environmental performance is moderate, reflecting the degraded lagoon conditions and limited treatment capacity, while technological performance remains intentionally low-tech to match local feasibility and maintenance capabilities.





c. bouyancy

rotterdam

The maximum load capacity is obtained by multiplying the displaced water volume by 1,000 kg/m³. This indicates how much weight the module can safely carry, including the pontoon, structure, envelope, installations, occupants, and live loads. The displaced volume was computed by multiplying the pontoon's plan area by its immersion depth, representing the portion of the system below the waterline.

nueva venecia

The buoyancy calculation for Nueva Venecia reflects the lighter load of a single-storey timber structure. The 6 × 18 m pontoon, submerged by 1 m, displaces 108 m³ of water, giving a load capacity of 108 tonnes (≈1,000 kg/m³). The building load, about 510 kg/m², uses only half of this capacity, ensuring a wide safety margin and stable flotation. The Nueva Venecia Toolbox proves economically accessible, materially renewable, socially embedded, and structurally feasible, while maintaining adaptability and contextual resilience.

distributed load capacity per square metre

$$w_{m^2} = \frac{W_{max}}{A}$$

w_{m^2}: load capacity per square metre of pontoon surface (kg/m²)

percentage of capacity used (based on estimated building weight)

$$\%\,Capacity\,Used = \left(\frac{W_{building}}{W_{max}}\right) \times 100$$

$$\%\,Safety\,Margin = 100 - \%\,Capacity\,Used$$

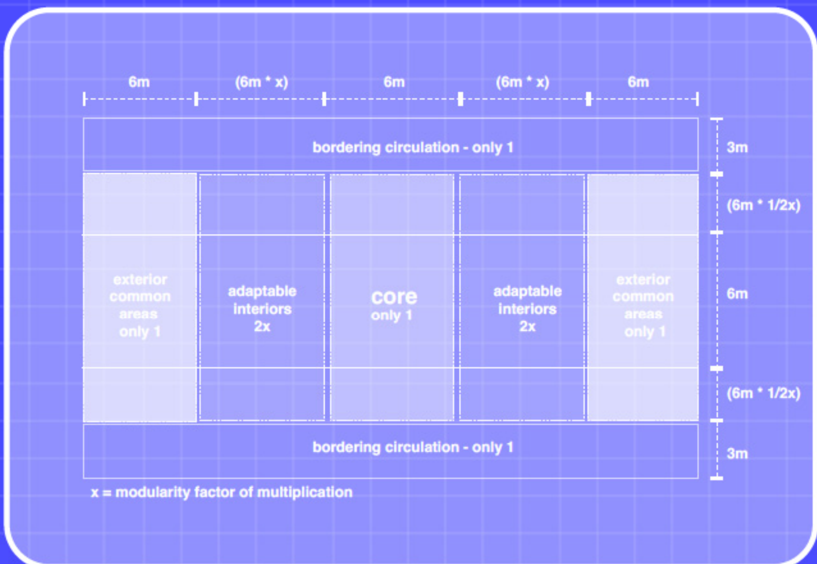
$W_{building}$: load capacity per square metre of pontoon surface (kg/m²)

05. assembly of parts rotterdam:

tool box assembly - iterations of design

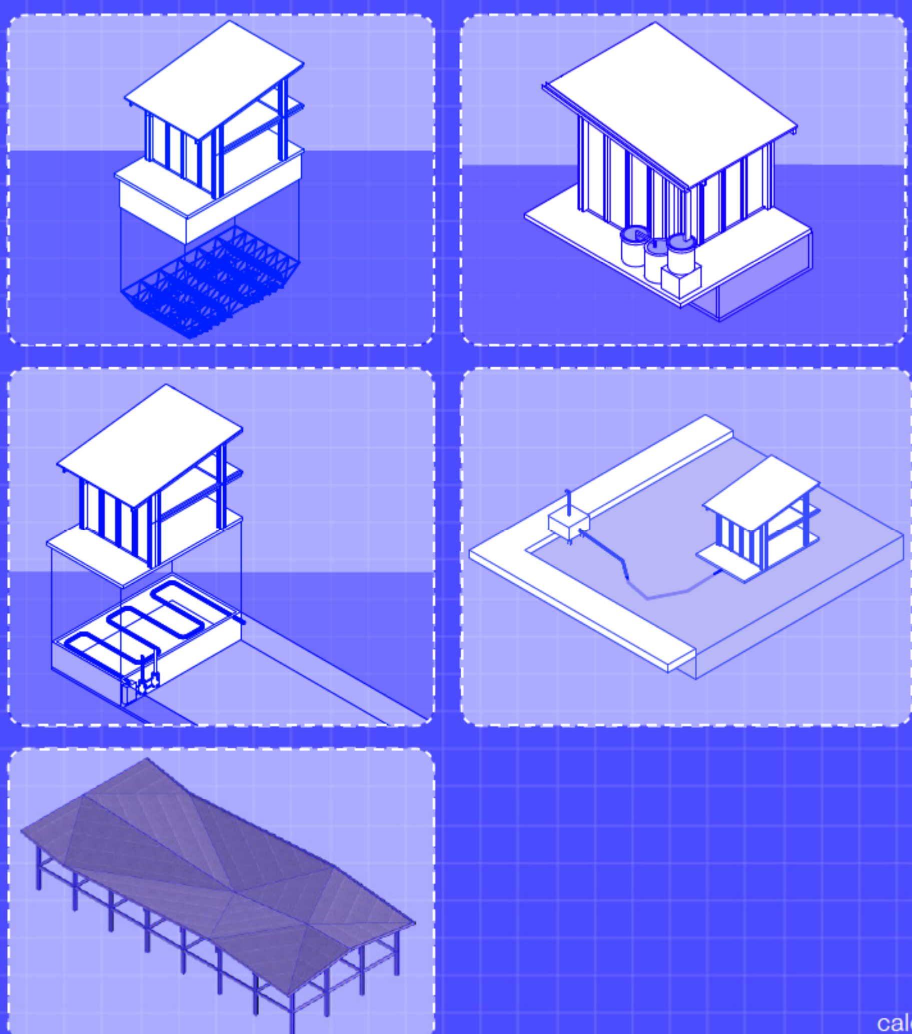
The Rotterdam core module is built on a unified concrete pontoon, carrying a two-storey structural frame, climatic-layered skin, and a calculated-incline roof optimized for heavy rainfall and seasonal variation. This assembly operates within a fixed proportion logic, enabling the integration of functional add-ons such as *coral cultivation units*, *rainwater harvesting systems*, *HVAC water cooling* from the waterbody, the *inclined water connection* to the municipal network, and the *faceted climatic roof* for advanced climatic response.

proportion



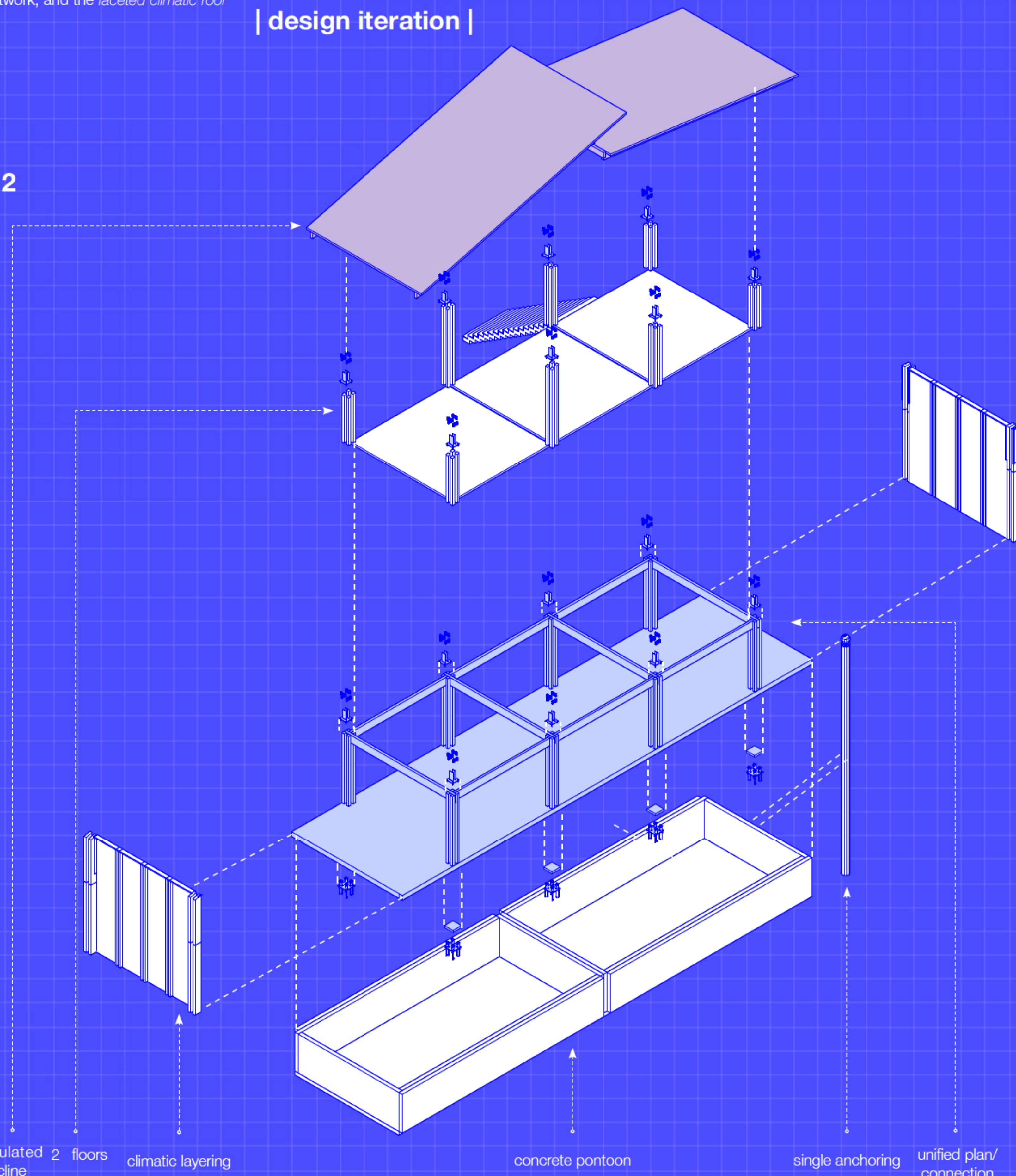
x = 2

add ons



5.

| design iteration |



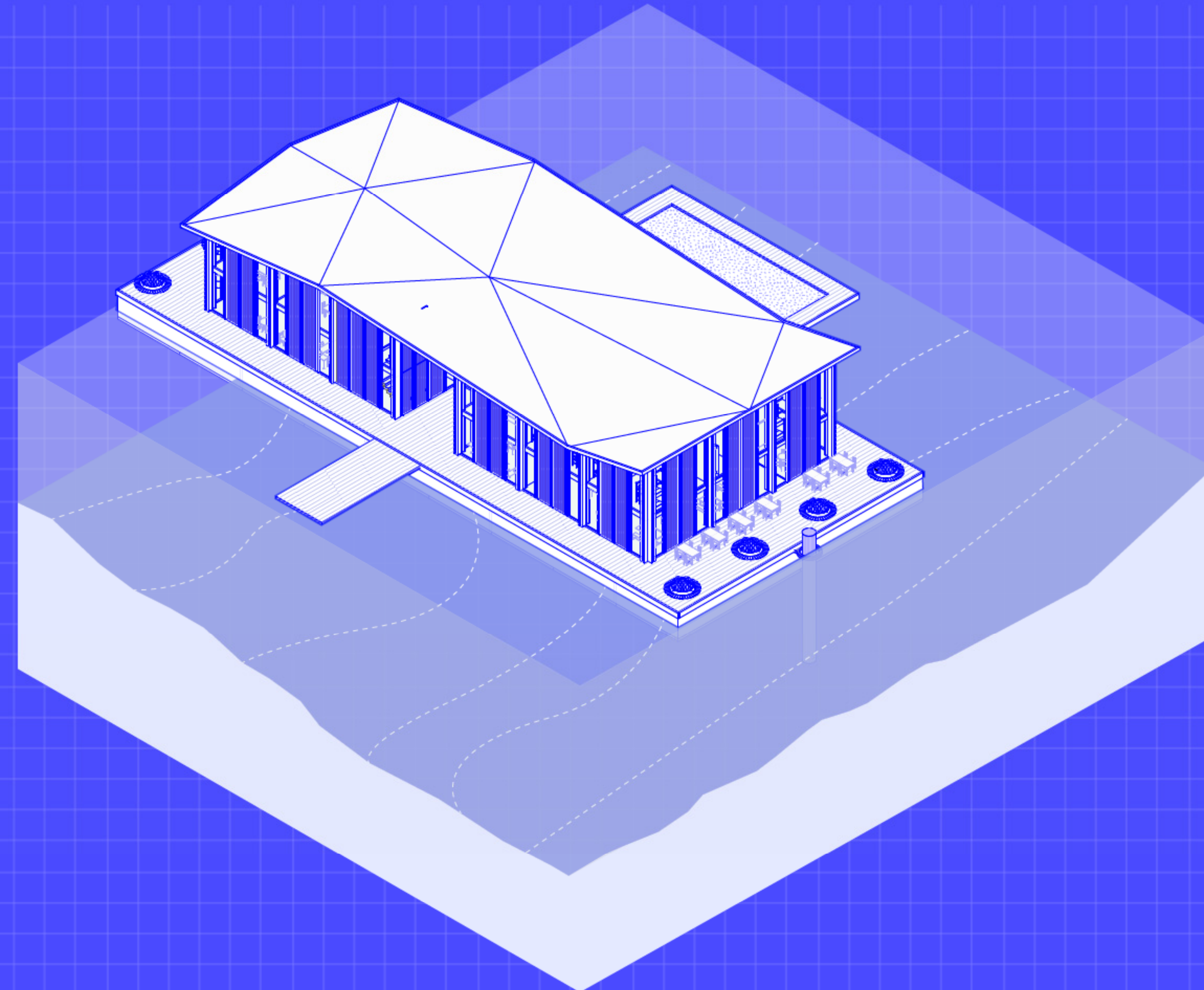
performance evaluation:

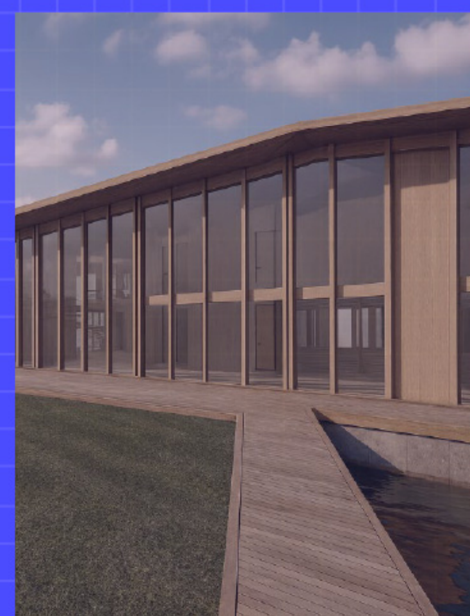
ceiling	cost	600 € / m²
structure	cost	1200€ / m²
facade add ons	cost	100€ / m²
structure	cost	450€ / m²
	total cost	2225€ / m²

05. assembly of parts rotterdam:

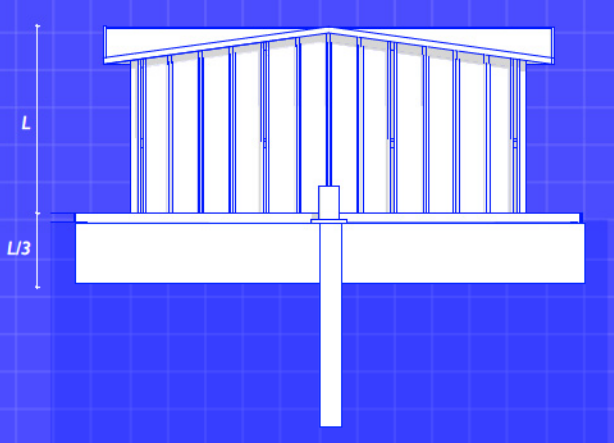
tool box assembly - iterations of design

The identified locations: Koningshaven, Persoonshaven, Rijnhaven North, Nassauhaven, Parkhaven, Spoorweghaven, Leuvehaven, Wijnhaven, and Maashaven. These locations represent optimal conditions for installing the Toolbox. These sites were selected based on hydrodynamic stability, channel width, accessibility, and compatibility with existing urban and port operations, ensuring feasible integration and minimal disruption to navigation and surrounding infrastructure.





buoyancy



The Rotterdam pontoon can support ≈288 tonnes before sinking deeper than the designed immersion depth of 2 m.

This is significantly higher than the estimated weight of:
- a two-story timber superstructure
- occupants during cultural events
- emergency-shelter loads

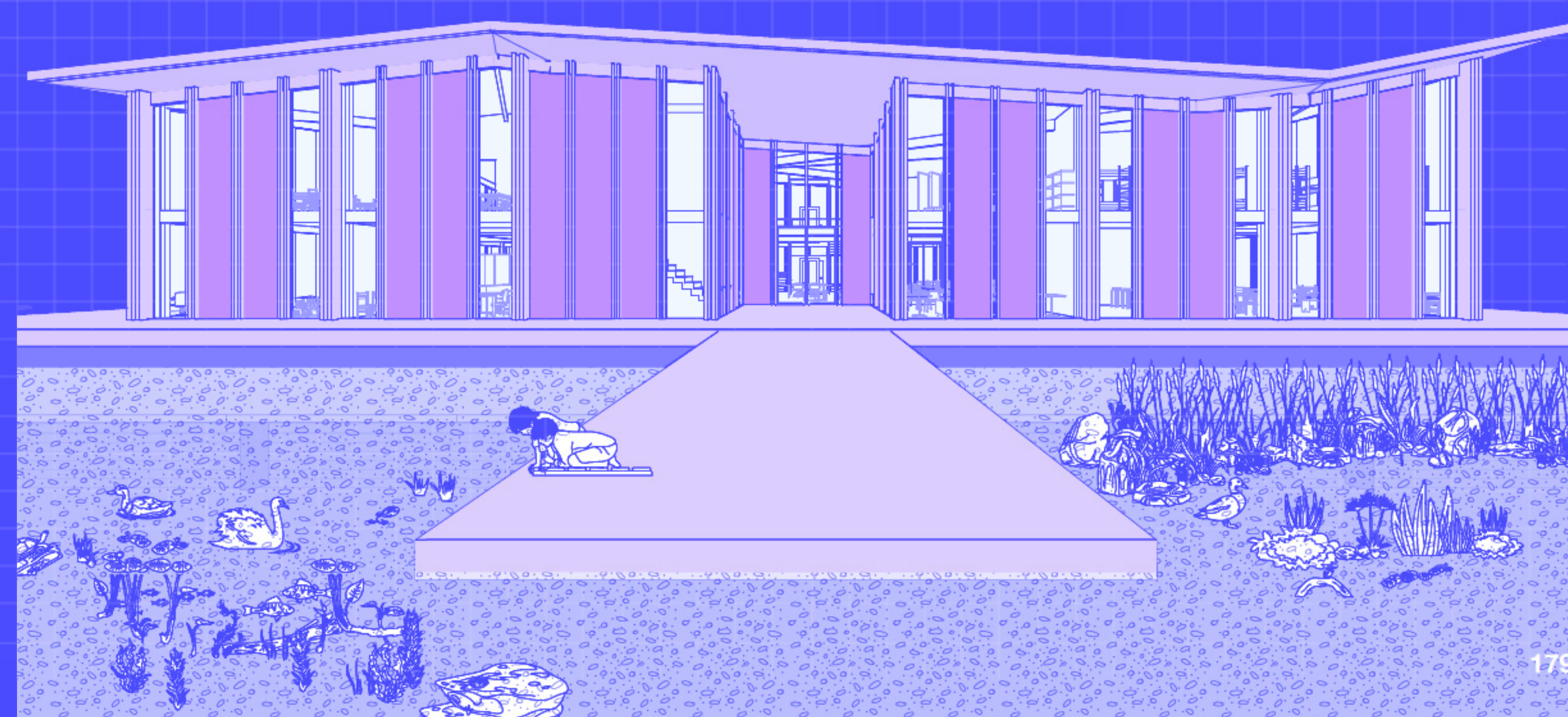
The resulting buoyancy safety margin is approx. 40%, confirming that the Rotterdam module is safe and stable in a harbour environment.

- displaced volume: 288 m³

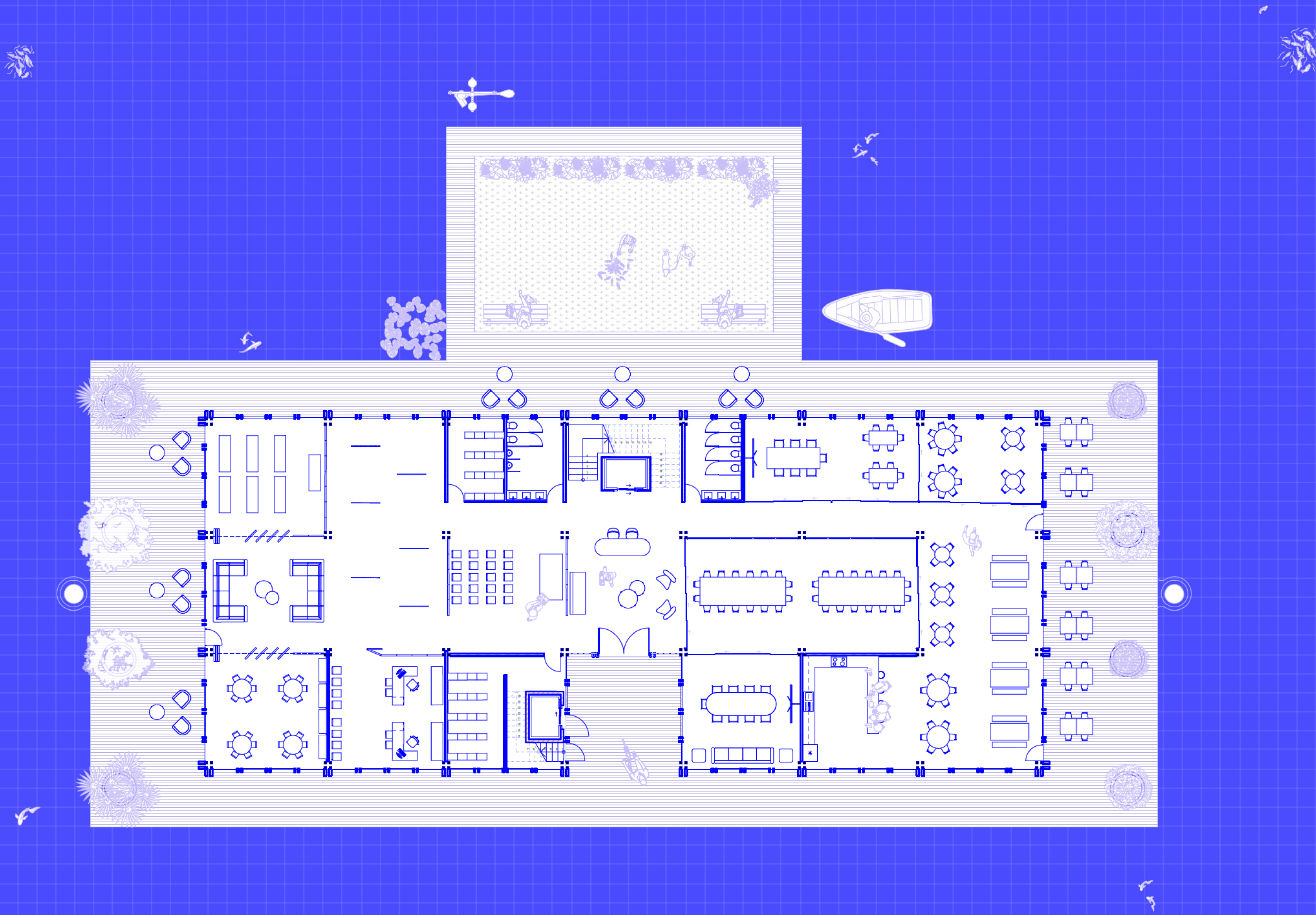
- max load capacity: 288,000 kg

- building load: ≈1,220 kg/m²

-safety margin: ≈40%



SCALE: 1:200

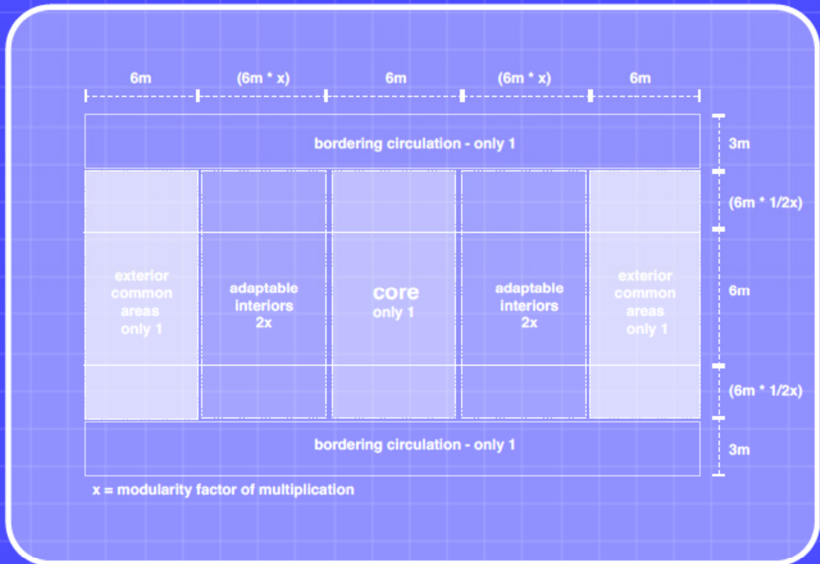


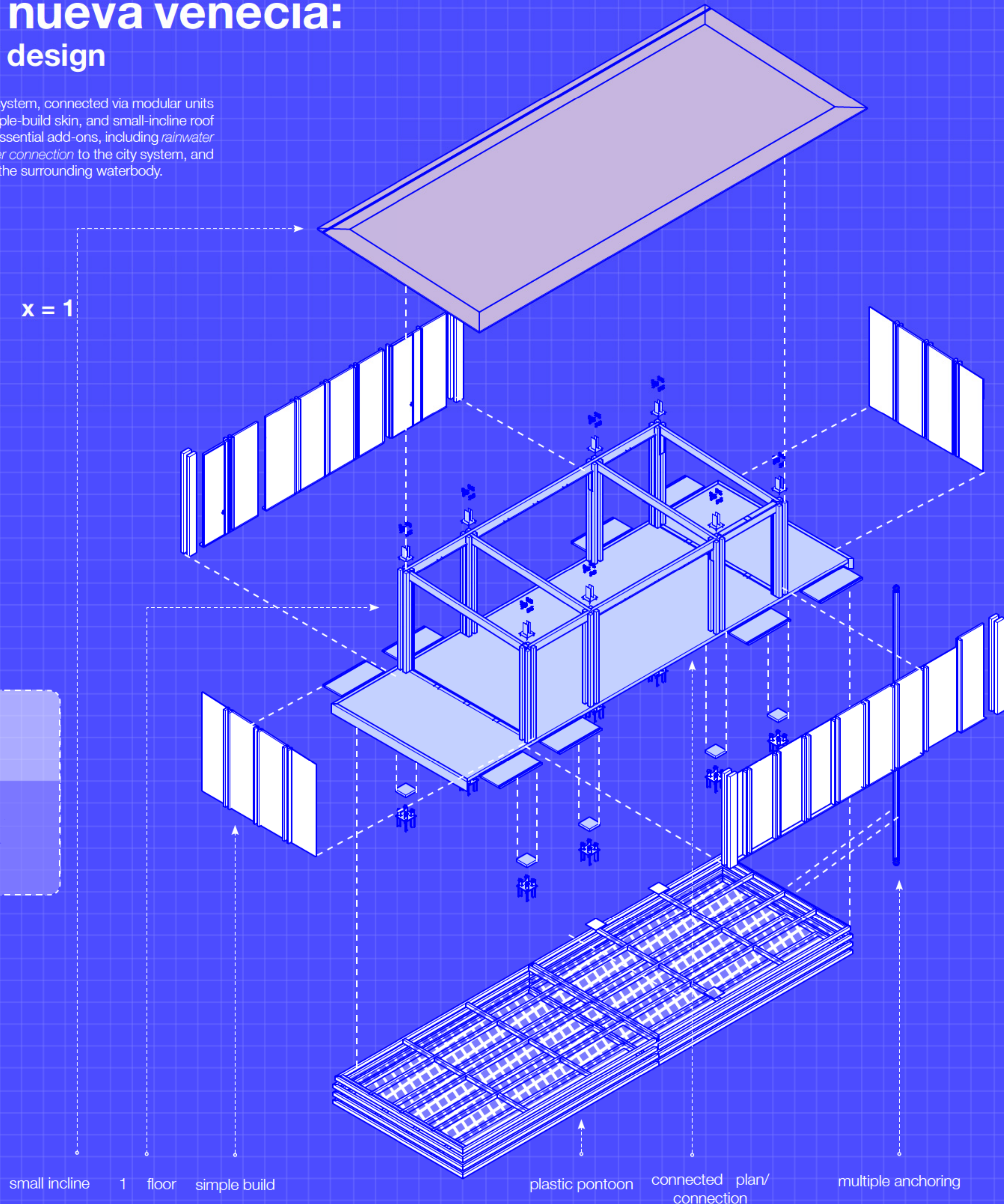
05. assembly of parts nueva venecia:

tool box assembly - iterations of design

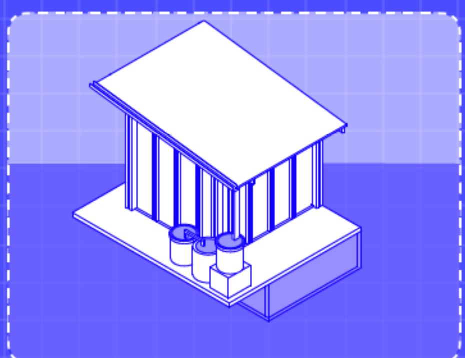
The Nueva Venecia core module is assembled on a lightweight plastic pontoon system, connected via modular units and stabilized by multiple anchoring points. A single-storey structural frame, simple-build skin, and small-incline roof respond to the tropical, low-variation climate. This core allows the integration of essential add-ons, including *rainwater harvesting*, *HVAC water cooling* from the surrounding water body, an *inclined water connection* to the city system, and a *compact water purification system* designed to treat and improve the quality of the surrounding waterbody.

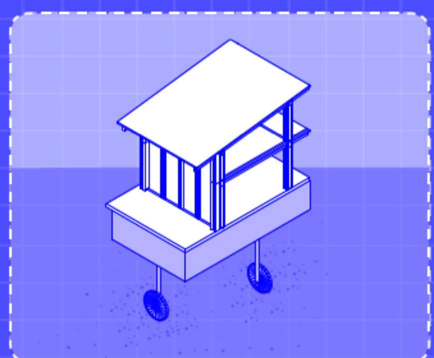
proportion

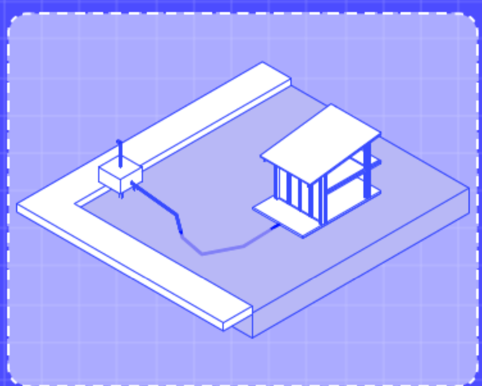




add ons







performance evaluation:

ceiling
cost
107€ / m²

structure
cost
214€ / m²

facade add ons
cost
178€ / m²

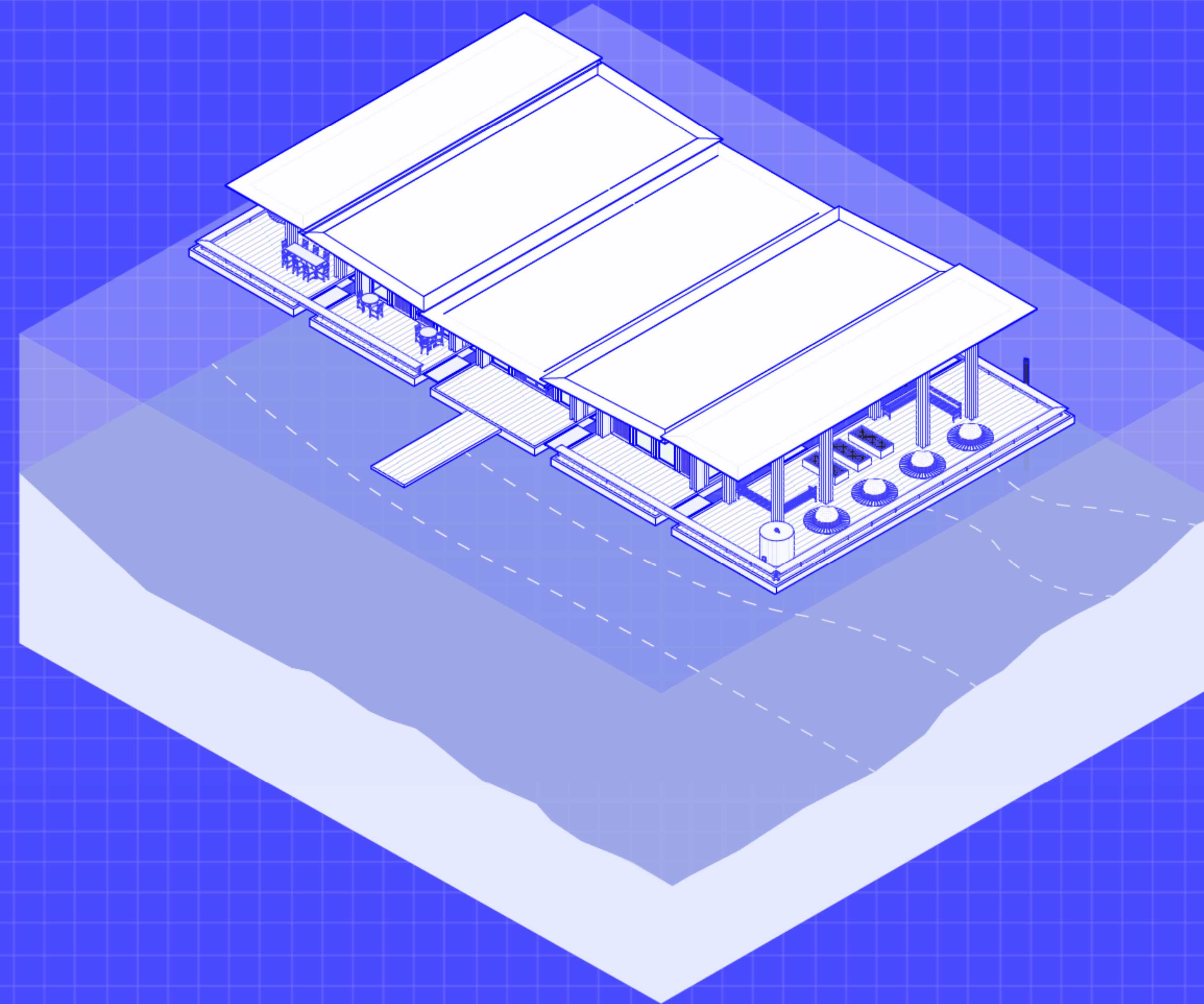
structure
cost
100€ /m²

total cost
816€ / m²

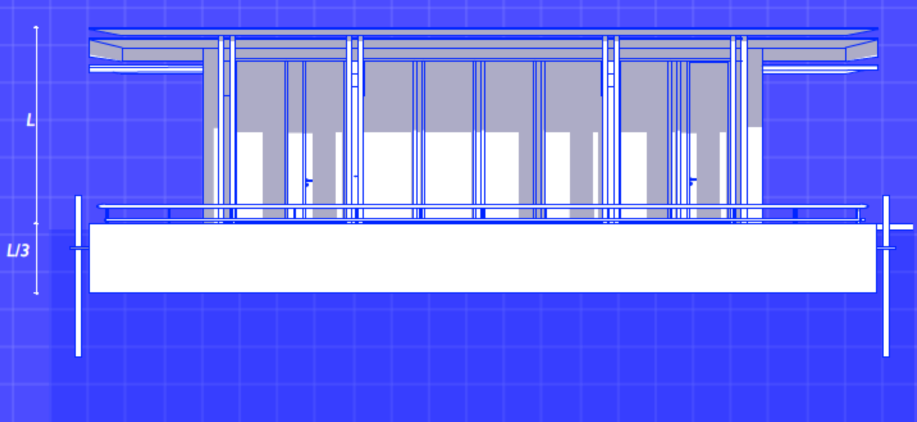
05. assembly of parts nueva venecia:

tool box assembly - iterations of design

Given the absence of formal loading zones or designated infrastructure corridors in Nueva Venecia, the identification of viable installation points for the Toolbox relied exclusively on spatial and functional analysis of the settlement's aquatic network. Potential sites were determined by locating stable water voids, low-traffic channels, and inter-house gaps with sufficient clearance for the module's footprint. These areas present minimal interference with local mobility patterns, fishing routes, and docking behavior, while offering optimal conditions for structural stability and operational integration within the existing stilt-house fabric.



buoyancy



The Nueva Venecia pontoon system can safely support ≈108 tonnes at 1 m immersion, which is twice the estimated structural and live load of:

-a single-storey timber community building
-community gathering
-emergency use
-storage and circulation

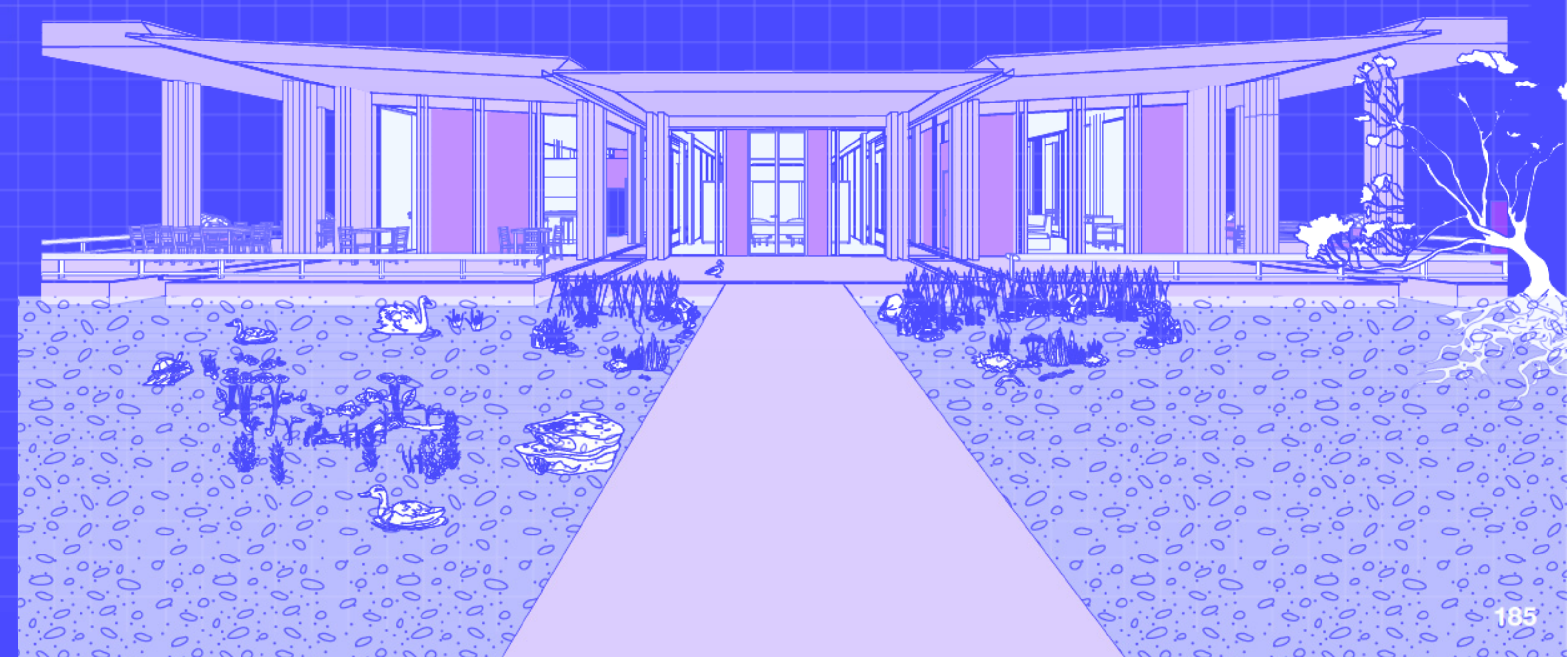
This results in a buoyancy safety margin of approx. 50%, well within safe operational limits.

Displaced volume: 108 m³

Max load capacity: 108,000 kg

Building load: ≈510 kg/m²

Safety margin: ≈50%



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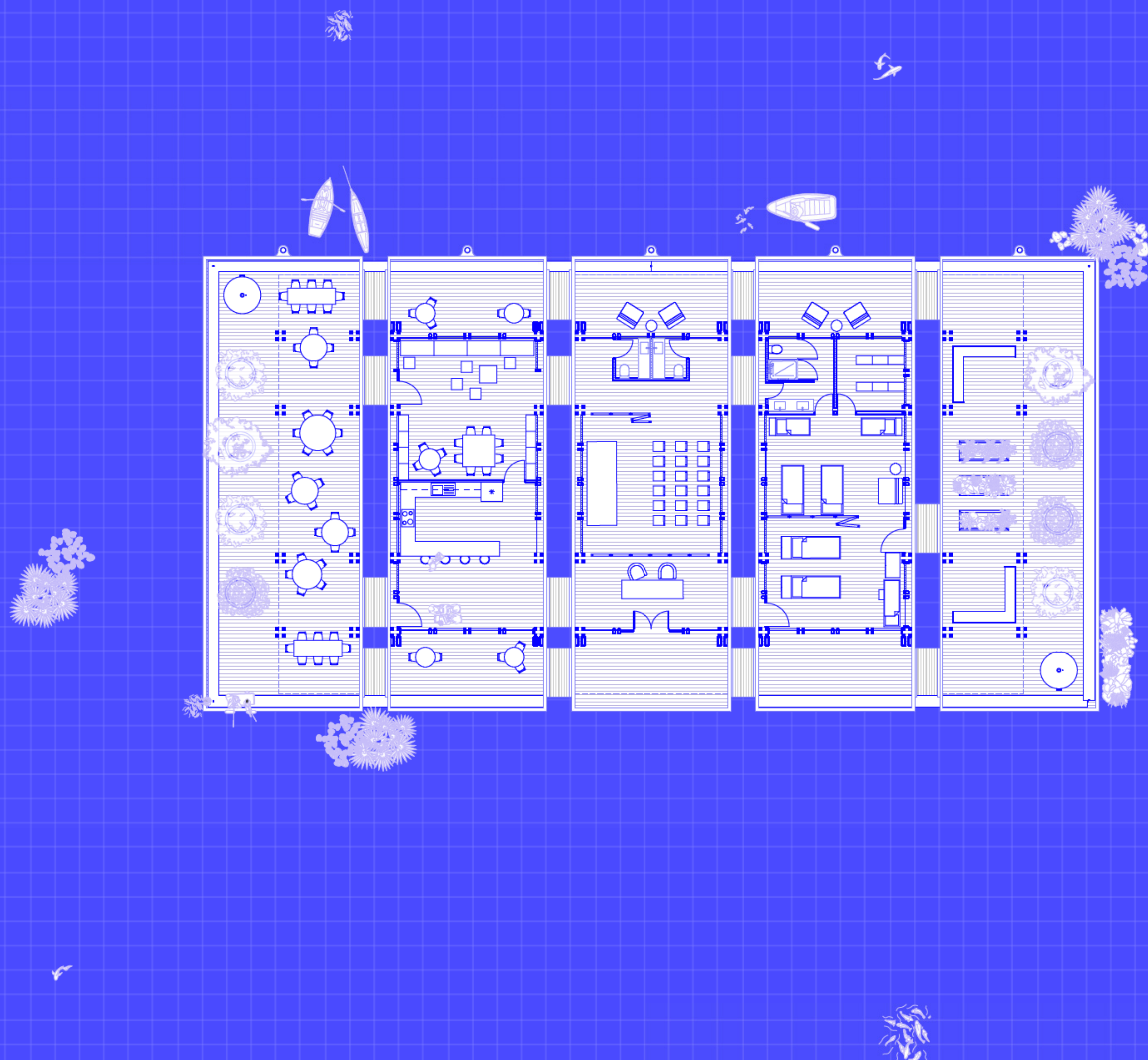

conclusion: closing the gap

The comparative evaluation of the two Toolbox implementations, Rotterdam and Nueva Venecia, reveals the capacity that **adaptive a single architectural logic** has to respond meaningfully to radically different environmental, economic, and social conditions. Although both projects share the same **structural grammar and spatial core**, their performance profiles, costs, and buoyancy behaviours diverge in ways that reflect the realities of their respective contexts.

In Rotterdam, the Toolbox manifests as a more robust, high performance floating unit anchored within a **regulated harbour environment**. Its cost aligns with standard Dutch construction benchmarks (on the lower side), its technological layer integrates advanced climatic and water-based systems, and its concrete pontoon delivers high stiffness and ample reserve buoyancy. The resulting architecture occupies the upper end of the middle-ground spectrum: **not a high-tech icon, but a resilient, durable, and institutionally compatible civic structure.**

On the other hand, in Nueva Venecia, the toolbox reorganises itself into a less complex model, **socially integrated form**, grounded in local materials, local labour, and community-managed systems. Its costs reflect rural Colombian construction rates, its **material palette maximises renewability,** and its buoyancy, provided by modular HDPE floats, matches the needs of a single-storey community building with generous safety margins. Here, the architecture becomes a platform for cultural continuity, autonomy, and environmental repair rather than optimisation or technological efficiency.

We approached Rotterdam from above, through **controlled robustness, technical infrastructure, and system integration.** At the same time, Nueva Venecia approaches it from below, through social agency, low material cost, and contextual adaptability. The middle-ground emerges, therefore, not as a rigid technical standard but as a common language between extremes, where the toolbox adjusts its components, costs, and performance strategies to match the constraints and opportunities of place.

Ultimately, the dual case study demonstrates that floating architecture does not need to choose between high-tech northern prototypes and low-tech vernacular systems. Instead, it can operate **as a scalable, context-responsive framework that absorbs complexity without abandoning accessibility.** The toolbox becomes not a single solution but a family of solutions and iterations, each calibrated to its socio-ecological surroundings, that always maintains its core values. This comparative reading confirms the central hypothesis of the thesis: that a meaningful middle-ground in floating architecture is not achieved through uniformity, but through adaptive equivalence, different means achieving comparable resilience, dignity, and environmental performance across geographically and economically diverse territories.

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