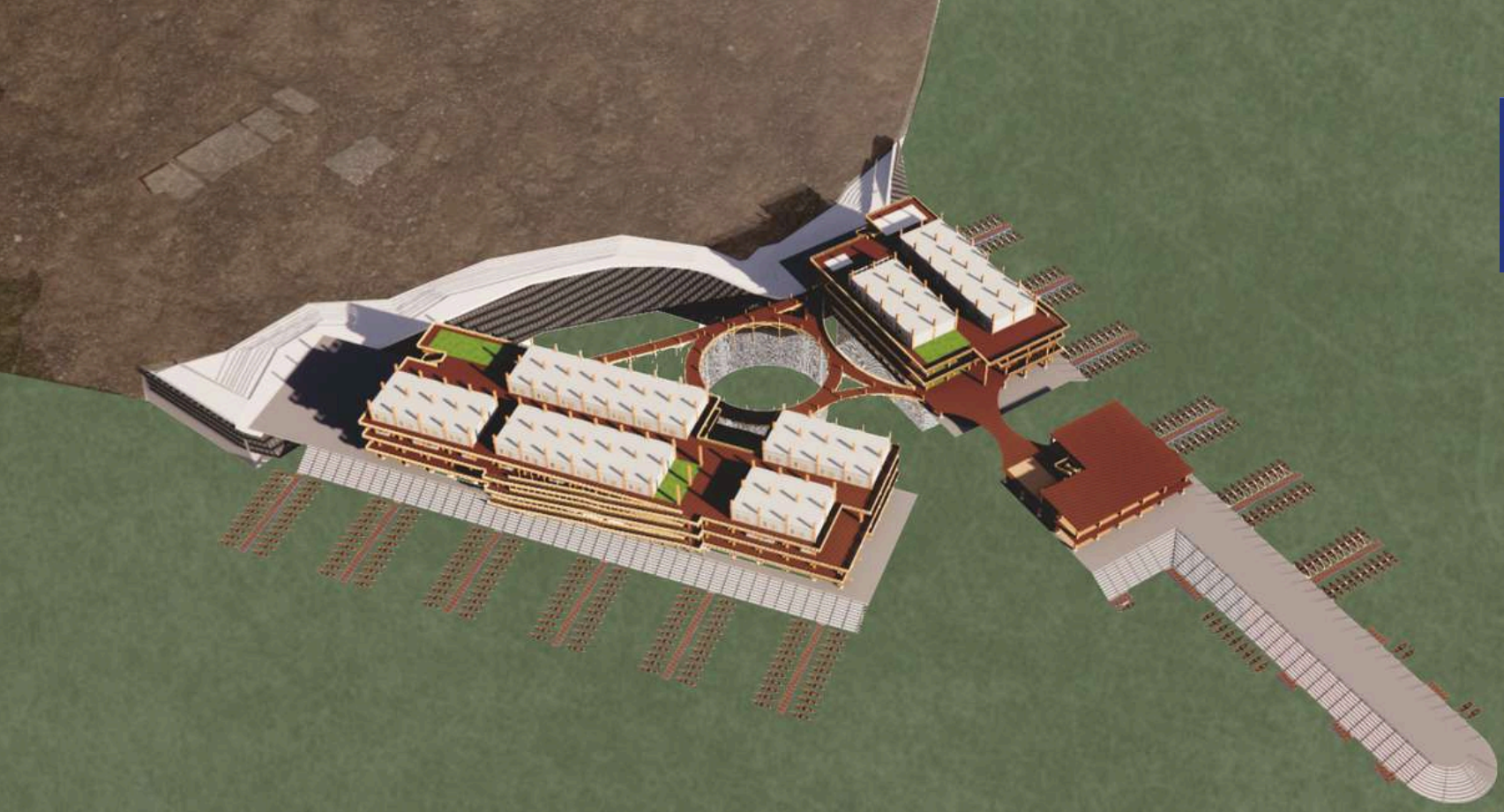


Pemodelan Arsitektur & Perkotaan

Design for Reviving Post-Submergence Settlements

SEMONET

Final Architectural Design Studio

—

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International Undergraduate Program in Architecture

Ditelan Abrasi, Permukiman Dusun Semonet Pekalongan Resmi Hilang dari Peta

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Validation Page

Final Architectural Design Studio entitled:

Design for Reviving Post-Submergence Settlements in Dusun Semonet, Pekalongan

Desain untuk Menghidupkan Kembali Permukiman Pasca Tenggelam di Dusun Semonet, Pekalongan

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Acknowledge by
Head of Undergraduate Program in Architecture

UNIVERSITAS ISLAM INDONESIA
FAKULTAS TEKNIK SIPIL DAN PERENCANAAN
YOGYAKARTA

Ir. Hanif Budiman, MT., Ph.D

Supervisor Lecturer's Note Sheet

Final Architectural Design Studio Entitled

Design for Reviving Post-Submergence Settlements in Dusun Semonet, Pekalongan

Desain untuk Menghidupkan Kembali Permukiman Pasca Tenggelam di Dusun Semonet, Pekalongan

Nama Lengkap Mahasiswa : Raisa Maranta Saika
Students Full Name

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Supervisor

Ir. Wiryono Raharjo, M.Arch., Ph.D

Preface

All praise and gratitude are due to Allah SWT, the Most Gracious and Most Merciful, for His blessings, guidance, and strength throughout the process of completing this Final Project entitled Design for Reviving Post-Submergence Settlements in Dusun Semonet, Pekalongan. This report is prepared as one of the requirements to complete the Undergraduate (S1) Degree in the Architecture Study Program, Faculty of Civil Engineering and Planning, Universitas Islam Indonesia.

On this occasion, the writer would like to express sincere gratitude to:

1 Allah SWT, for His endless grace and ease, which enabled the writer to persevere and complete this Final Project.

2 To the writer herself, Raisa Maranta Saika, for the hard work and all the exhaustion endured, yet still choosing to keep going until the end

3 The writer's beloved parents and sibling Muhammad Ariq Atma Saika, for their unconditional support, love, and continuous prayers.

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5 Close friends including Kirana, Caca, Zaza, Rhafie, Darrel, and Kak Kemal, as well as many other architecture colleagues whose names cannot all be mentioned here, for sharing the ups and downs throughout the academic journey.

6 Mr. Surya Negara, for being a supportive partner during this process and helping the writer stay sane through stressful moments.

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With the prayers, assistance, encouragement, and guidance that have been given, the writer hopes this Final Architectural Design Studio report may offer meaningful benefits for all readers and contribute positively to the field of architecture.

Yogyakarta, August 2025
Raisa Maranta Saika

Statement of Authenticity

By signing this form, I

Student Name : Raisa Maranta Saika
Student Number : 21512183
Study Program : Architecture
Faculty : Faculty of Civil Engineering and Planning
University : Universitas Islam Indonesia

State that all parts of the thesis work or Final Project entitled

Design for Reviving Post-Submergence Settlements in Dusun Semonet, Pekalongan

This work is entirely my own, except for the materials cited in the references, and it was completed without assistance from any other party, either in whole or in part. The final product has been submitted to the Department of Architecture, Islamic University of Indonesia, for educational and publication purposes. However, the intellectual property rights remain fully with the author.





Raisa Maranta Saika

Abstract

Dusun Semonet is facing the threat of permanent submergence due to severe land subsidence and rising sea levels. These worsening conditions have made the area uninhabitable, causing the community to leave their homes. Once a lively place where people lived closely with the coast and relied on fishing, Dusun Semonet now stands as a clear example of how climate change affects vulnerable coastal areas.

This study presents a design proposal to help bring life back to the area using a resilient approach. The concept includes stilt houses built above the water and floating walkways to maintain connectivity. It also provides facilities that support traditional livelihoods, such as fishing and aquaculture, directly on the water.

This proposal offers a real response to climate threats by turning challenges into new possibilities. Instead of resisting nature, the design adapts to it. The water becomes a platform for living, working, and social interaction. In doing so, the design not only addresses the effects of climate change but also helps restore the resilience, sustainability, and identity of the coastal community.

Keywords: *Permanent Submergence, Land Subsidence, Resilient Architecture, Stilt Housing, Coastal Livelihoods*

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Design for Reviving Post-Submergence Settlements

SEMONET

Introduction

01

Background Issue

Pekalongan, located on the northern coast of Central Java, is a region with a rich cultural identity and economic activity, especially known for its traditional batik industry and coastal communities. However, the area is now facing a serious environmental crisis. Rising sea levels, ongoing land subsidence, and coastal erosion are threatening large parts of the region with permanent flooding. Among the most heavily impacted areas is Dusun Semonet, a small coastal village that has now been completely submerged.

The submergence of Dusun Semonet is the result of multiple environmental issues happening at the same time. Coastal erosion has slowly eaten away at the shoreline, driven by strong tidal currents, extreme weather conditions, and the reduction of natural coastal buffers. Mangrove forests, which used to protect the coast from waves and floods, have been cut down to make space for aquaculture ponds or urban expansion. Without these natural defenses, the coastline has become more vulnerable to damage from the sea.

In addition to coastal erosion, the area is also experiencing rapid land subsidence—the sinking of the ground over time. In some subdistricts of Pekalongan, such as Siwalan, Wonokerto, and Tirto, the ground is sinking at rates of 25 to 40 centimeters per year. This phenomenon is mostly caused by excessive groundwater extraction, where both households and industries pump large amounts of water from underground aquifers. As the water is removed, the soil becomes compacted and the ground level gradually lowers.

This condition is further worsened by climate change, which is causing global sea levels to rise. As seawater pushes further inland, the low-lying coastal areas of Pekalongan become even more prone to regular tidal flooding, locally known as banjir rob. Moreover, Java Island lies in a tectonically active region, meaning that underground movements and earthquakes also contribute to the instability of the land.

Dusun Semonet has now become a symbol of this ongoing crisis. Once a functioning coastal village with families depending on fishing and aquaculture for their livelihoods, the entire settlement is now underwater. Houses, roads, and other infrastructure are no longer usable, and the former residents have had to relocate or live with ongoing uncertainty.

This project seeks to explore design solutions for reviving post-submergence settlements like Dusun Semonet through a Resilient Architecture Approach. The aim is not only to redesign housing and community spaces that are adaptive to water-related risks, but also to support the socio-economic recovery of former residents. Strategies may include raised structures, adaptive infrastructure, and the development of aquaculture-based systems that are more compatible with a flood-prone environment. In doing so, the project hopes to offer a model of sustainable coastal living in the face of environmental change.



Tidal Flood in Pekalongan Regency

Natural disasters like floods happen regularly every year in Indonesia. One type of flood is tidal flooding (banjir rob), which affects coastal areas where the land is lower than the sea level. Simply put, tidal flooding is water inundation caused by rising sea levels or tidal waves in areas that sit below sea level (Lindungi Hutan, 2022).

Pekalongan is located on the northern coast of Java, with land elevations ranging from 0 to 6 meters above sea level. The area is predominantly flat, with slopes of only 0–5%, making it highly susceptible to tidal flooding. The frequency and extent of flooding continue to increase each year.

Despite ongoing tidal flooding over the years, and mitigation efforts such as a 3-meter-high embankment, Pekalongan remains at risk. Land subsidence and rising sea levels have caused the embankment itself to gradually sink (El-Fath et al., 2022).

Research conducted by El-Fath et al. (2022) analyzed the spatial extent of tidal flood inundation in 2020 and projected the inundation for 2030.

Kecamatan	Elevasi Muka Tanah (m)	Warna	Kontur (m)
Siwalan	0 - 4,47	Hijau – Merah	0,5 – 5,5
Wonokerto	0 - 2,12	Hijau – Kuning	0,5 – 1,5
Tirto	0 - 5,13	Hijau – Merah	0,5 – 5,5
Wiradesa	0,03 - 5,96	Kuning – Merah	1,5 – 5,5

Table. Ground Surface Topography by District
Source: El-Fath et al. (2022)

The coastal areas of Pekalongan Regency are characterized by relatively low land surface elevation, making them highly vulnerable to tidal flooding and sea level rise. Specifically, Siwalan District has a ground elevation ranging from approximately 0 to 4.47 meters above sea level, Wonokerto District ranges from 0 to 2.12 meters, Tirto District spans 0 to 5.13 meters, and Wiradesa District ranges between 0.03 to 5.96 meters.

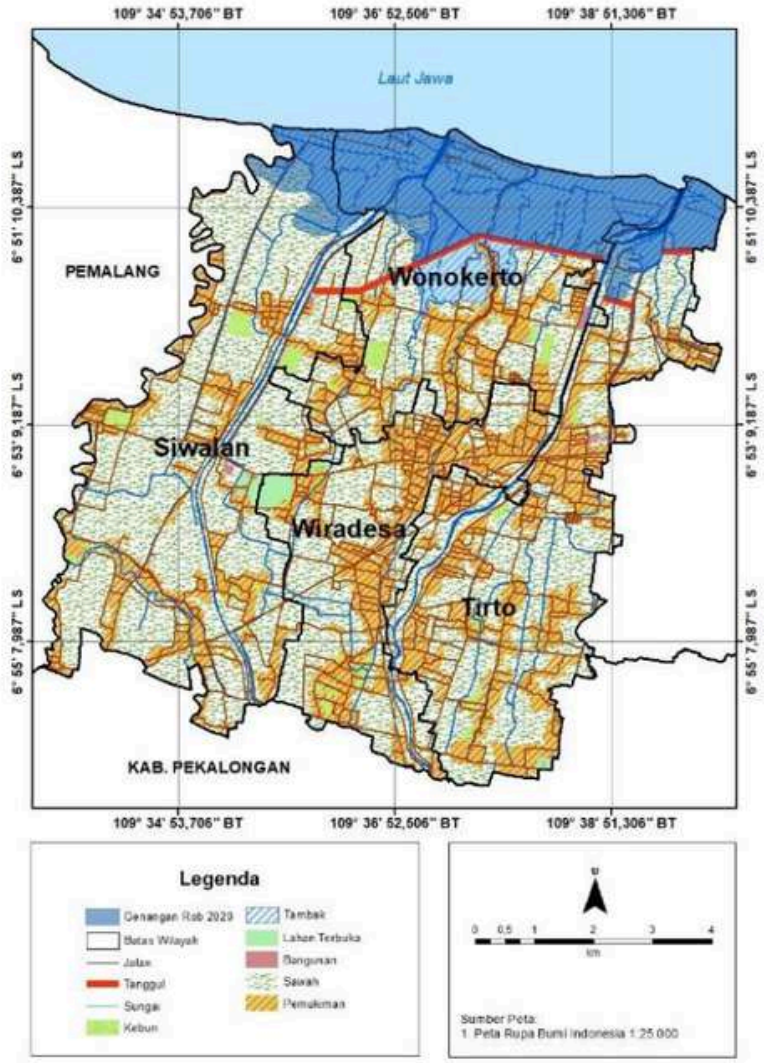


Figure 1. Tidal Flood Inundation of Pekalongan Regency in 2020
Source: El-Fath et al. (2022)

Wonokerto is an area with the lowest average ground elevation in Pekalongan Regency.

01 Land Subsidence

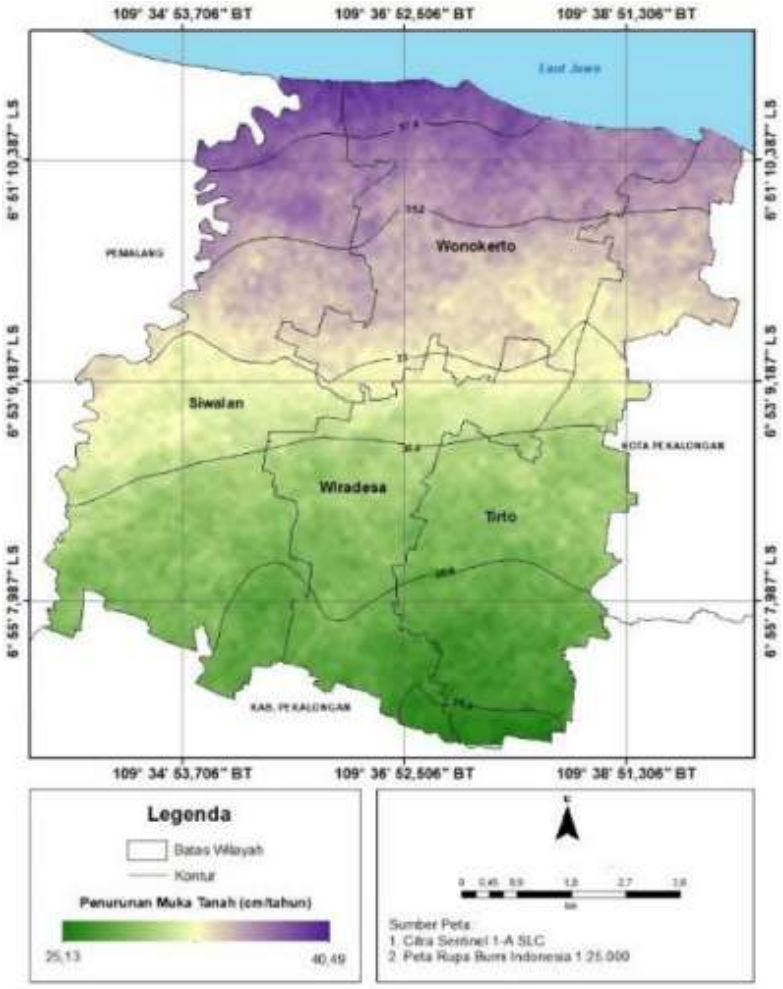


Figure 2. Land Subsidence of Pekalongan Regency
Source: El-Fath et al. (2022)

Land subsidence in Pekalongan Regency presents a significant and ongoing environmental challenge, particularly in districts situated along the northern coastline. The phenomenon is not only persistent but also increasingly severe, with annual subsidence rates showing alarming figures. Among the most affected areas is Siwalan District, where the ground surface declines by approximately 26.63 to 39.96 centimeters per year. Similarly, Wonokerto District experiences even higher rates, ranging from 32.24 to 40.49 centimeters per year, indicating a critical condition for settlements and infrastructure in the area.

Further inland, although the rates are slightly lower, Tirto District still records substantial land subsidence between 25.13 and 37.86 centimeters annually, while Wiradesa District faces a rate of 25.21 to 34.33 centimeters per year. These figures suggest that the issue is not localized but affects a broad swath of the regency, with a trend of worsening conditions closer to the coastline.

Kecamatan	Penurunan Muka Tanah	Warna	Kontur
Siwalan	26,63 – 39,96 cm/tahun	Hijau – Ungu	28,6 – 37,4 cm/tahun
Wonokerto	31,43 – 40,49 cm/tahun	Kuning – Ungu	33 – 37,4 cm/tahun
Tirto	25,13 – 37,86 cm/tahun	Hijau – Ungu	26,4 – 35,2 cm/tahun
Wiradesa	25,21 – 34,33 cm/tahun	Hijau – Kuning	26,4 – 33 cm/tahun

Table 1. Land Subsidence Mark per Year
Source: El-Fath et al. (2022)

The primary cause of this alarming land subsidence is rooted in the geological composition of the region. Much of Pekalongan's coastal plain is made up of young alluvial soils, particularly soft clay deposits, which are inherently prone to compaction and vertical displacement. As these soils are saturated and poorly consolidated, they compress easily under the weight of buildings or due to the extraction of groundwater—one of the most significant human-induced contributors to subsidence. According to Iskandar et al. (2020) and Khoirunisa et al. (2015), these unconsolidated soils play a major role in the region's vulnerability to sinking.

In terms of spatial distribution, the northwestern parts of the regency exhibit the most severe subsidence. This pattern correlates strongly with the type and distribution of alluvial soil deposits in the area. As described by Dariah et al. (2004), the soils here vary from dark gray alluvium, to grayish-brown alluvium, and hydromorphic alluvium, each with differing physical characteristics that influence their compaction rates. The darker, finer-grained clays typically found near the coastline are particularly susceptible to settling, thereby contributing to the accelerated sinking of land in those zones.

Land Subsidence

35.96 cm

Per-year

Wonokerto is the area with the highest land subsidence in Pekalongan Regency

02 Rising Sea Levels

The sea level elevation has shown a tendency to increase annually from 1993 to 2019, as shown in the table.

Tahun	Elevasi Muka Laut (m)	Tahun	Elevasi Muka Laut (m)	Tahun	Elevasi Muka Laut (m)
1993	0,968	2002	0,98	2011	1,049
1994	0,928	2003	0,985	2012	1,047
1995	0,987	2004	0,993	2013	1,073
1996	1,018	2005	1,004	2014	1,034
1997	0,932	2006	0,982	2015	1,003
1998	1,019	2007	0,993	2016	1,092
1999	1,026	2008	1,053	2017	1,073
2000	1,038	2009	1,044	2018	1,041
2001	1,021	2010	1,084	2019	1,112

Table 2. Sea Level Elevation Values
Source: El-Fath et al. (2022)

This phenomenon is supported by Kartika and Helmi (2019), who explained that sea level rise continues to increase annually as a direct consequence of global warming. The melting of polar ice caps and the thermal expansion of seawater due to rising global temperatures have significantly contributed to this trend.

A study conducted by El-Fath documented the sea level elevation in Pekalongan Regency from 1993 to 2019. On average, the sea level rose by approximately 1.174 meter over this 26-year period, indicating a consistent annual increase. These data reinforce the evidence of a sustained upward trend in sea levels, both regionally and globally. A graph illustrating the sea level rise in Pekalongan's coastal waters from 1993 to 2019 further highlights this alarming progression, providing clear visual evidence of the escalating threat.

Understanding this pattern is essential for developing and implementing effective coastal adaptation and mitigation strategies in the coming decades, especially for low-lying areas like Pekalongan that are increasingly vulnerable to tidal flooding and long-term submergence.

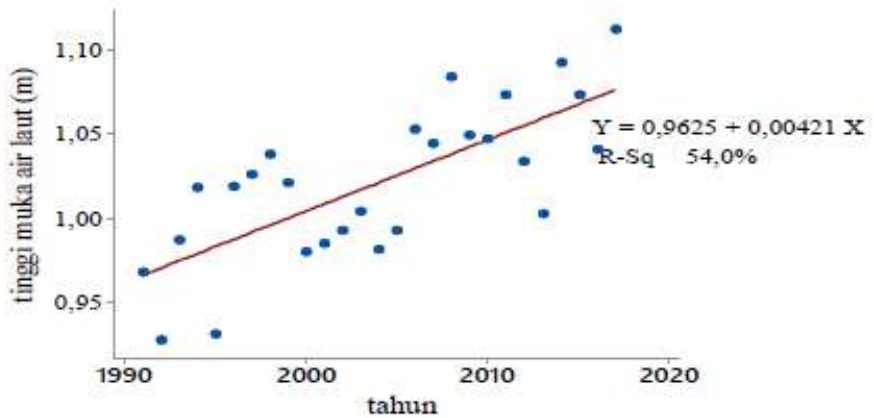


Figure 3 . Graph of Sea Level Rise Rate in Pekalongan Regency
Source: El-Fath et al. (2022)

Sea Levels Elevation

1.174 m

from 1993-2019

Sea Level Rises 3.3-4 mm peryear

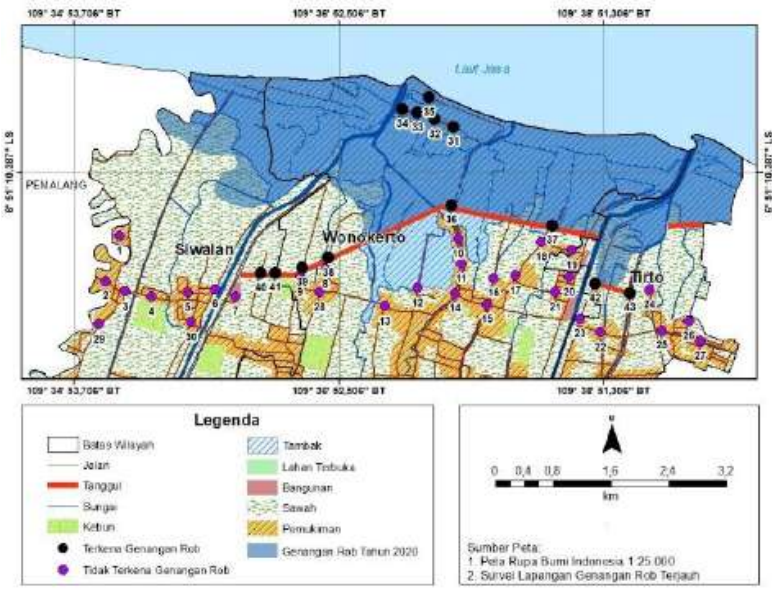
Tidal Flood Inundation in 2020

In 2020, the total tidal flood inundation area in Pekalongan Regency reached 1,081.93 hectares, with varying impacts across districts. Siwalan District experienced 169.62 hectares of inundation, Tirto District recorded 151.38 hectares, and Wonokerto District faced the most extensive flooding at 760.93 hectares, while Wiradesa District remained unaffected. Although the flooding was widespread in several areas, the floodwaters in Siwalan, Wonokerto, and Tirto had not yet overtopped the embankments. With a total length of 6,147.01 meters, these embankments remained above the 2020 flood levels, indicating that the coastal defense infrastructure was still functioning effectively in containing the tide.

Kecamatan	Luas Genangan (ha)	Luas Daerah (ha)	Panjang Tanggul Tenggelam (m)	Persentase Genangan Terhadap Luas Daerah (%)	
				Kecamatan	Kab. Pekalongan
Siwalan	169,62	2836,16	0	5,98	0,19
Wonokerto	760,93	2000,1	0	38,04	0,85
Tirto	151,38	2124,81	0	7,12	0,17
Wiradesa	0	1364,86	-	0	0
TOTAL	1081,93	8325,93	0	Persentase Total	1,21 %

Table 4. Extent of Tidal Flooding in 2020
Source: El-Fath et al. (2022)

Based on field surveys, a total of 13 survey points were identified as still submerged due to tidal flooding. Of these, 8 points were categorized as the furthest extent of tidal inundation, highlighting the outward reach of floodwaters despite existing embankments.



Titik	Kecamatan	Jarak dari Genangan Rob	Jarak dari Garis Pantai	Titik	Kecamatan	Jarak dari Genangan Rob	Jarak dari Garis Pantai
36	Wonokerto	0 m	1291,22 m	40	Siwalan	1047,41 m	2740,41 m
37	Wonokerto	0 m	1268,38 m	41	Siwalan	1307,2 m	2744,45 m
38	Wonokerto	884,15 m	2557,59 m	42	Tirto	0 m	2182,14 m
39	Wonokerto	1253,27 m	2655,73 m	43	Tirto	1068,16 m	2089,87 m

Table 5. Distance to the Furthest Tidal Inundation
Source: El-Fath et al. (2022)

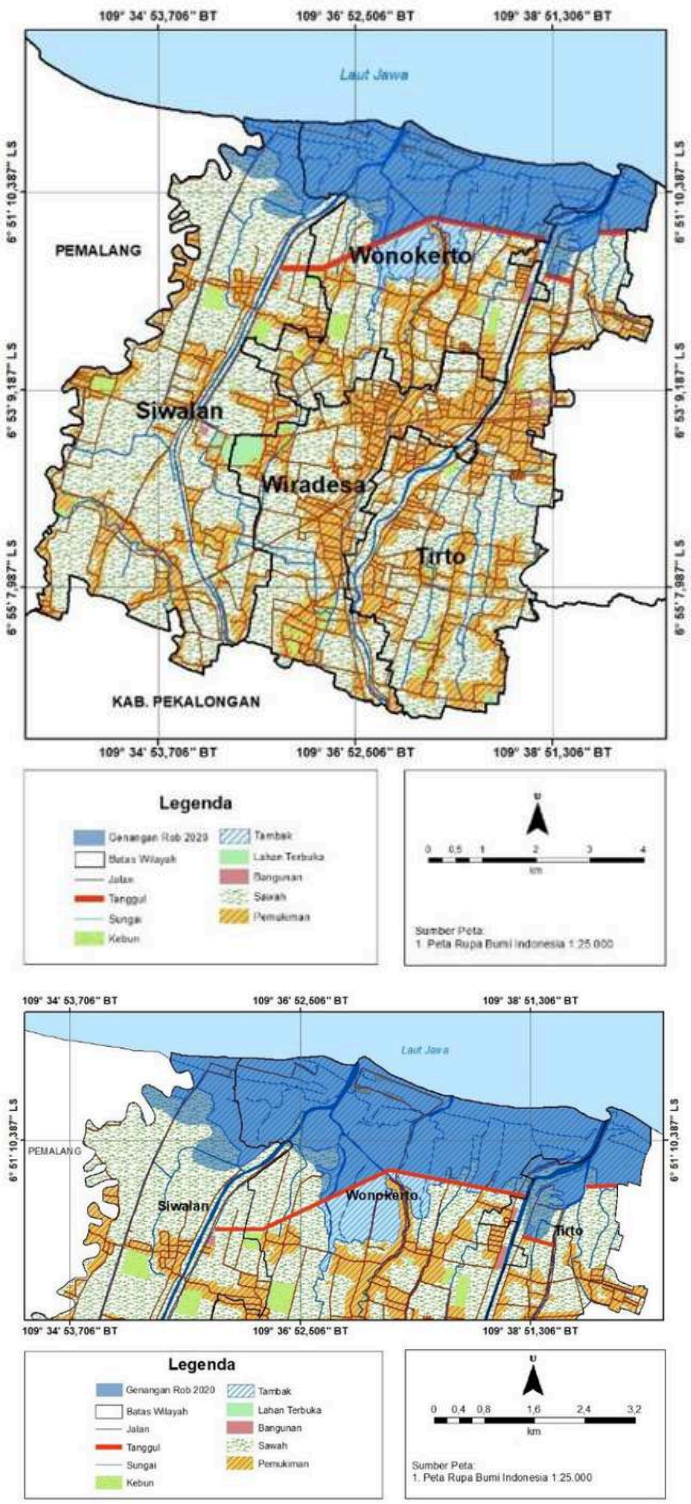


Figure 4. Map of 2020 Tidal Flood Inundation and Affected Coastal Embankments
Source: El-Fath et al. (2022)

Predicted Tidal Flood Inundation for 2021–2030

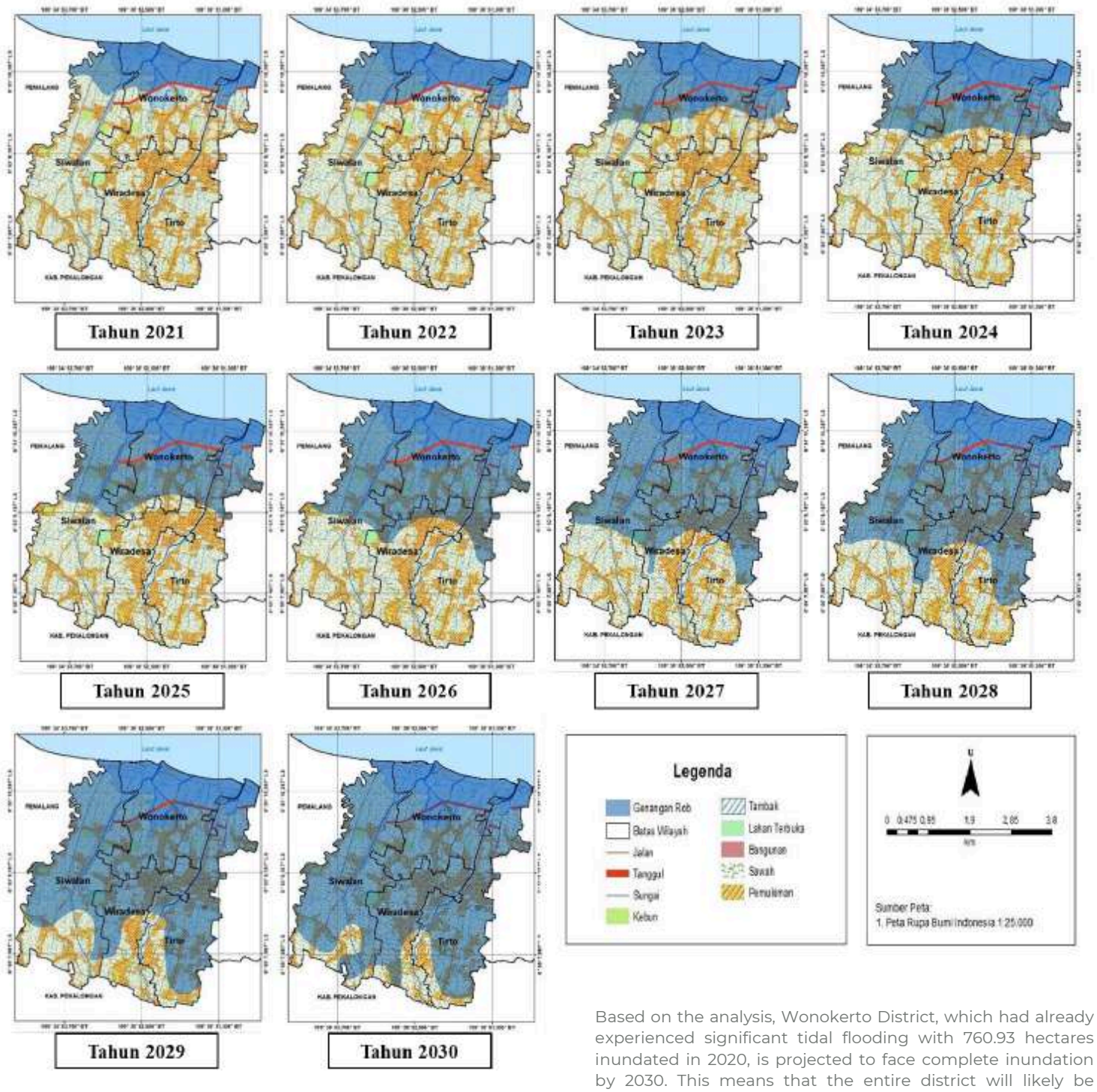
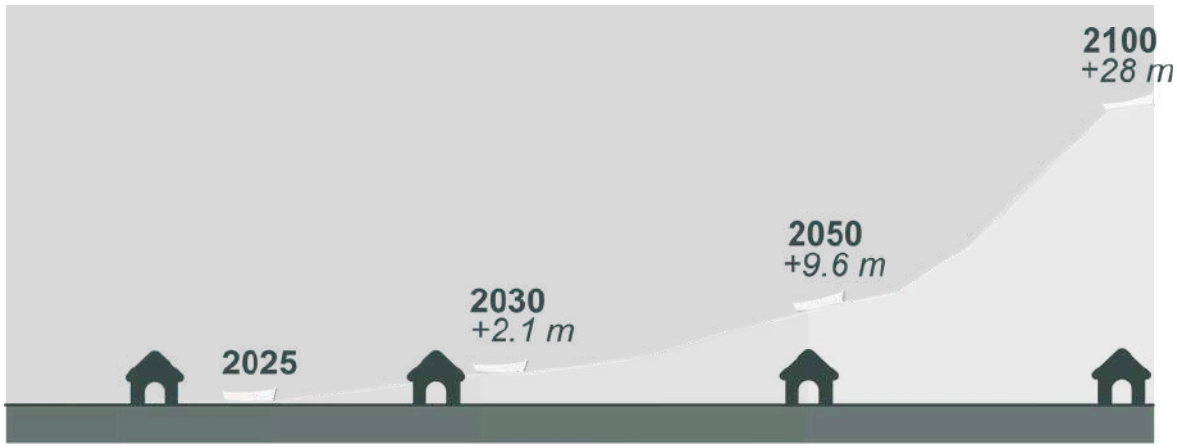


Figure 5. Predicted Tidal Flood Inundation Map (2021–2030)
Source: El-Fath et al. (2022)

Based on the analysis, Wonokerto District, which had already experienced significant tidal flooding with 760.93 hectares inundated in 2020, is projected to face complete inundation by 2030. This means that the entire district will likely be submerged due to the combined impacts of rising sea levels and ongoing land subsidence.

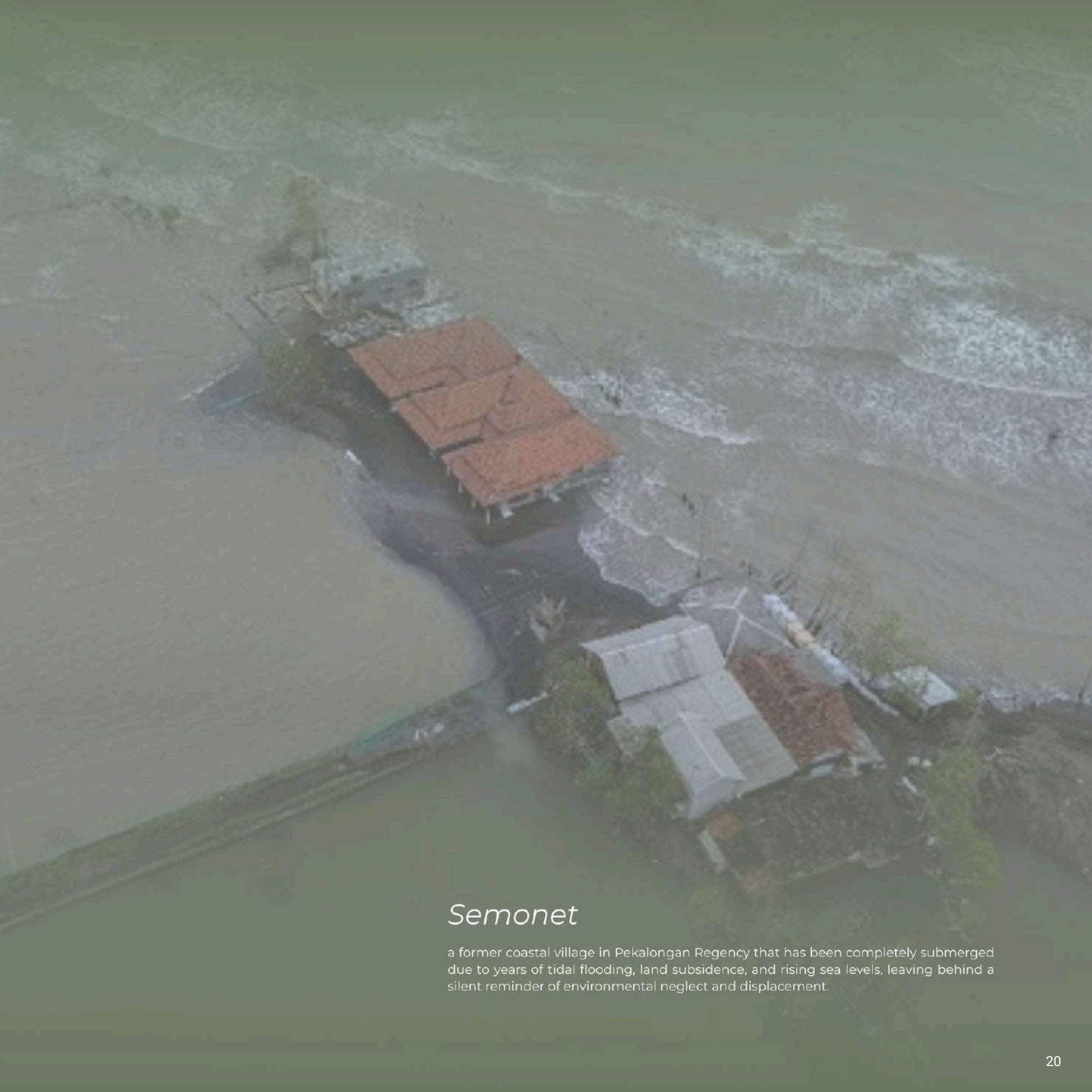
Land Subsidence and Sea Level Rise Projections in Pekalongan

Based on IPCC (Intergovernmental Panel on Climate Change) reports and BMKG, studies by LIPI, BIG (Geospatial Information Agency), and various academic sources:



Year	Land Subsidence (m)	Sea Level Rise (cm)	Combined Relative Impact (m)
2030	2.15	3.6 – 4.4	~2.1 meters
2050	9.34	10.2 – 12.4	~9.6 meters
2100	27.3	26.7 – 32.4	~28 meters

Table 6. Land Subsidence and Sea Level Rise Projection
Source: IPCC, BMKG, LIPI, BIG



Semonet

a former coastal village in Pekalongan Regency that has been completely submerged due to years of tidal flooding, land subsidence, and rising sea levels, leaving behind a silent reminder of environmental neglect and displacement.

Ditelan Abrasi, Permukiman 96 KK Dusun Simonet Pekalongan Resmi Hilang dari Peta

Media Indonesia • 6 July 2023 16:16



Eko Puji S
Local Guide · 213 reviews · 11 photos

★★★★★ 2 years ago

Semoga desa Semonet tidak hilang,,dan kalaupun misal ga terselamatkan mudah2an pemerintah setempat memberikan area pemukimn baru bagi warga yg tersisa di sana

SEMONET

5.0 ★★★★★ (5)

Permanently closed

Kisah Kampung Mati Simonet Pekalongan, Ditinggalkan Penduduknya Karena Banjir Rob

Dulu Dusun Simonet merupakan kampung yang ramai. Tapi kini tak ada satupun warga yanga bermukim di sana.

Rabu, 03 Jan 2024 09:45:00

Permanently closed

Scan for more information

WONOKERTO

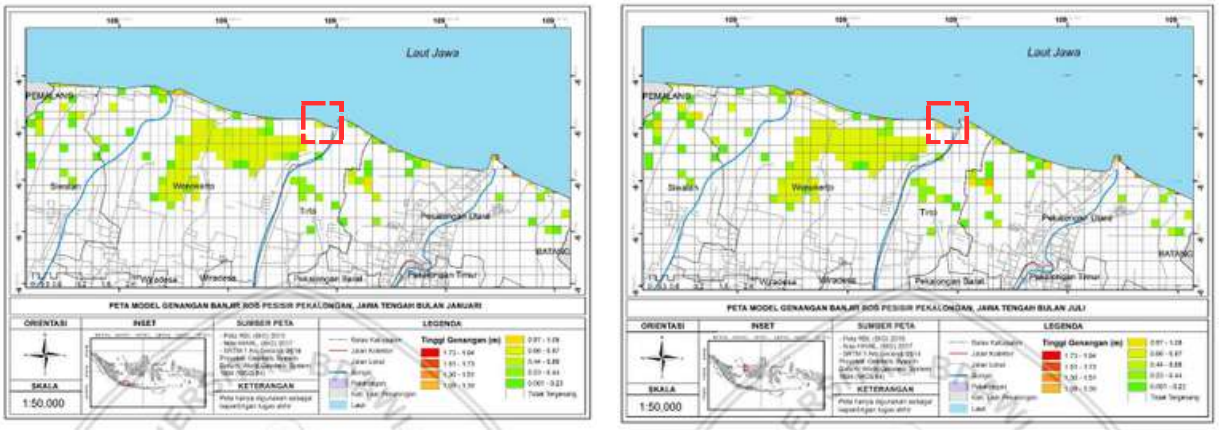


Figure 6. Tidal Flood Inundation Map for January and July
Source: Cahyaningtias, I. A. (2018).

Wonokerto District experiences the most extensive tidal flooding throughout the year. This condition occurs not only because of its low elevation but also because the district has the longest stretch of coastline, reaching 5.8 kilometers, which makes the coastal area highly susceptible to widespread inundation during high tides.

One of the hamlets that affected is **Dusun Semonet,** in Semut Village, Wonokerto that situated at a very low elevation and has been abandoned by its residents, who were forced to leave due to the uninhabitable conditions, including persistent inundation, damage to homes, and the loss of basic infrastructure,

DUSUN SEMONET



Dusun Semonet

Geographical Context

-6.8426503, 109.617606

Dusun Semonet is located in Semut Village, Wonokerto District. Among the four hamlets in Semut Village, Dusun Semonet is the most severely affected by tidal flooding due to its position directly along the shoreline. Before the erosion began, Semonet had a total area of 124 hectares, but this area continuously decreased to around 12 hectares by 2023 (Said, S., 2023), and now, according to Google Maps, it measures only about 5 hectares.



2018



2020



2022



2024



Satellite imagery from Google Earth over the past six years (2018–2024) provides clear visual evidence of the dramatic transformation of Dusun Semonet. In 2018, the area was still identifiable as a coastal village with visible clusters of homes and an expansive network of fish ponds (tambak), which supported the community's aquaculture-based livelihood. However, year by year, the imagery reveals a steady encroachment of seawater into the land.

By 2022, large portions of the fish ponds had already been inundated, and residential structures began to disappear or fall into disrepair. The transition between 2020 and 2022 marks a significant loss of land, as seawater overtook not only the ponds but also roads and remaining structures.

By 2024, the entire area is visibly submerged, with no remaining signs of active habitation. The transformation captured through satellite images confirms the total abandonment of Dusun Semonet, highlighting the irreversible impact of tidal flooding and land subsidence.

These changes serve as a powerful and sobering reminder of the urgent need for resilient coastal planning and the protection of vulnerable communities from future displacement.

Figure 7. Aerial View of Semonet Village
Source: Google Earth Pro

Demographic Profile of Dusun Semonet

Population

According to the Head of Semut Village, the population of Dusun Semonet once consisted of 180 households with a total of 265 residents. However, as the tidal flooding (rob) worsened, the majority of residents decided to leave the area, leaving behind only 9 households or 25 people in 2022 (Said, S., 2023). Based on the most recent data from 2024, there are now no residents left in Dusun Semonet (Merdeka.com, 2024).

According to research conducted by Said (2023), the age range of heads of households in Dusun Semonet falls between **47 and 67 years old**. This age range includes both productive age and elderly individuals. Those in the productive age group are still actively engaged in income-generating activities, which often motivates them to live close to their sources of livelihood.

Length of Residence

"Saya asli sini, sampe sekarang alhamdulillah betah disini, dulu disini tuh jauh dari laut, masih banyak orang, kalo ke laut kira-kira masih 1 km, kalo sekarang keluar rumah aja udah air"

Residents who have lived in Dusun Semonet since birth feel they are already familiar with the settlement's conditions, and this sense of familiarity makes them believe they can continue to endure the challenges. This suggests that the community has become accustomed to the problems present in the area.

In addition to the length of residence, the presence of relatives or family members in the area fulfills individuals' need for social interaction and affiliation.

Education

The residents who remained in Dusun Semonet mostly had only completed elementary school. In fact, some did not finish elementary education at all, and one resident even stated that they were illiterate (Said, S., 2023).

This data indicates that the education level in Dusun Semonet is relatively low. This is largely due to financial limitations and the demands from parents for their children to contribute to the family income after completing elementary school. In general, communities with low education levels tend to have lower income levels, reducing their chances of living in better areas. This is evident in Dusun Semonet, where the low level of education contributed to residents' decisions to remain in a flood-affected area.

Livelihood

The residents of Dusun Semonet **primarily worked as fishermen and fish farmers,** professions deeply tied to their coastal environment. Fishing was conducted either individually near their homes or collectively using larger boats that ventured further offshore. In addition to fishing, many residents managed fish ponds (tambak ikan), cultivating species like catfish and shrimp. These livelihoods enabled the community to sustain themselves in the area, as their economic activities were closely connected to the surrounding coastal and marine resources.

Religion

In Dusun Semonet, the entire population adheres to Islam. This is supported by the presence of only a small prayer facility (mushola) in the area.

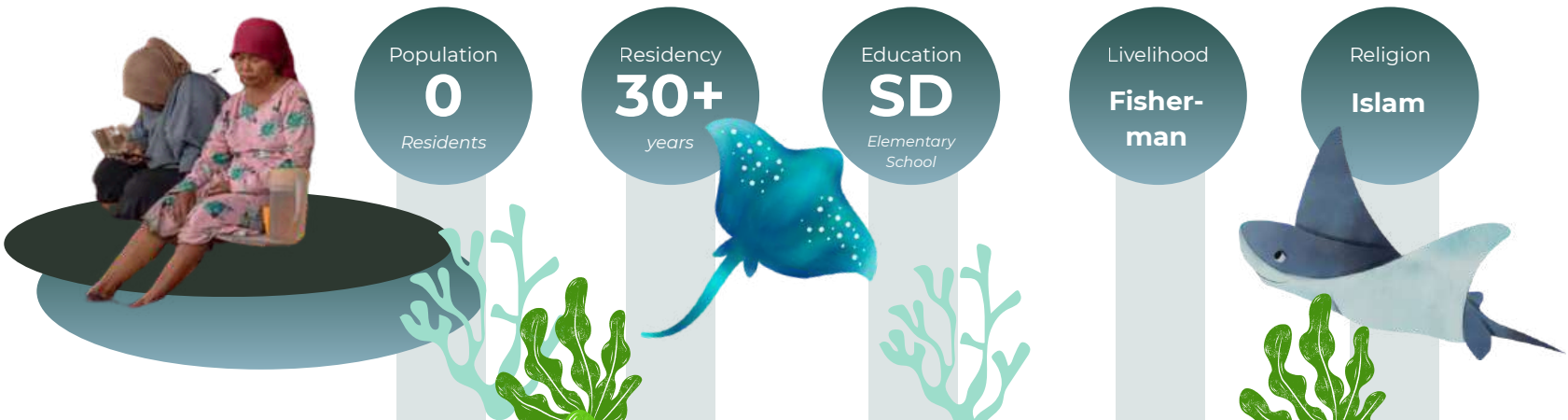
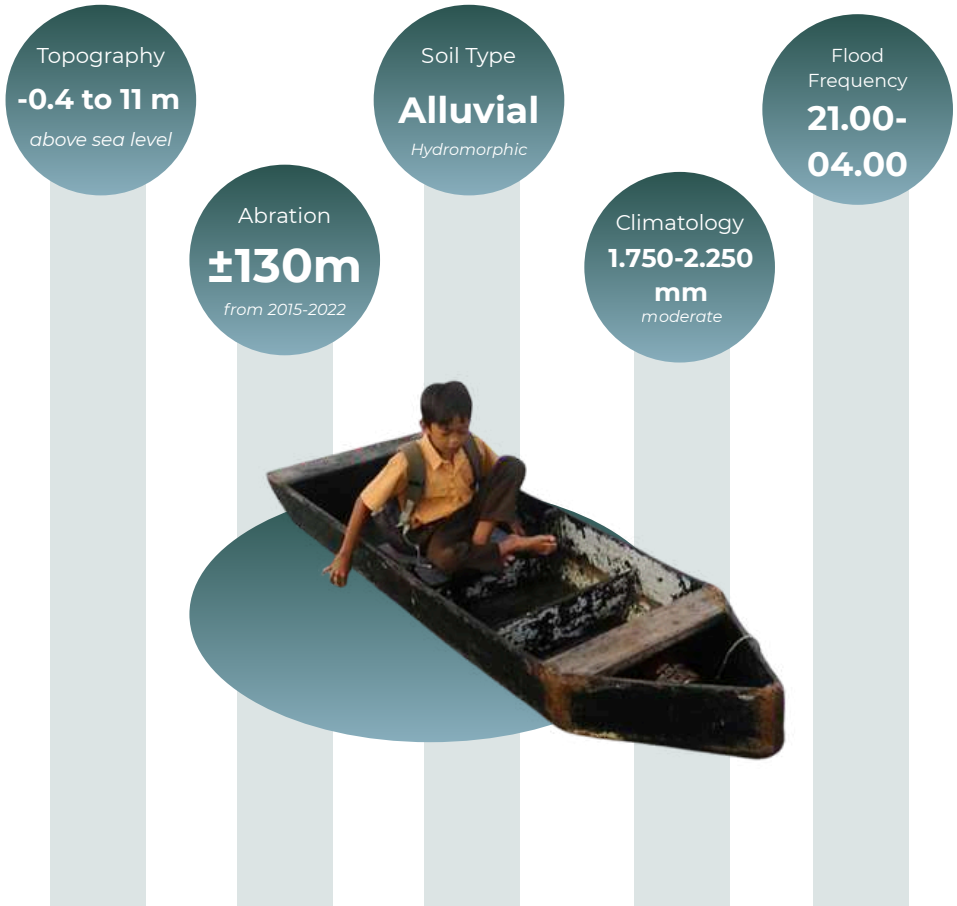




Figure 8. Aerial photo of houses affected by abrasion
Source: jateng.tribunnews (2021)



Environmental Profile

Topography

According to data from Bappeda and the processing of the National Digital Elevation Model (DEMNAS), the elevation of Dusun Semonet ranges from approximately -0.4 to 11 meters above sea level. This is because Dusun Semonet is the outermost area that directly borders the Java Sea, with most of its territory used for fish ponds.

Based on research conducted by Said Salim (2022), Dusun Semonet has experienced a shoreline shift inland toward residential areas by approximately ±130 meters over a 7-year period from 2015 to 2022.

Soil Type

The soil type throughout Dusun Semonet is hydromorphic alluvial soil. This type of soil has low to high productivity and is commonly used for fish farming, settlements, and rice cultivation.

Climatology

According to data from the Central Statistics Agency (BPS) of Pekalongan Regency, annual rainfall in Dusun Semonet ranges from 1,750 mm to 2,250 mm. From this data, the average monthly rainfall is around 145–188 mm, which falls under the moderate classification.

Tidal Flooding Frequency

Tidal flooding (rob) in Dusun Semonet typically occurs between 9:00 p.m. and 4:00 a.m., with varying water levels depending on the tidal cycle. During the rainy season, flooding can last much longer—sometimes for several days.

Building Infrastructure

According to interviews with local residents, tidal flooding (rob) in Dusun Semonet began to worsen significantly around 2015 and has continued to do so until today. As a result, the entire area—including residential zones, fish ponds, and agricultural land—has merged with the sea.

"Kalo kondisi lahan di sini sudah sangat miring, bisa dianggap sudah menyatu dengan air, kalo Dusun Semonet ini ya sudah kena air semua"



"Kalo robnya ya udah lama, tapi kan dulu nggak separah ini, ini aja udah ditinggiin 4 kali dari tahun 2015.."

"Awalnya lahan disini masih luas, dulu ke utara masih ada sekitar 1 km, abrasi terus jadi makin sempit dan sekarang tinggal beberapa rumah aja"

The rob disaster has severely degraded the quality of housing in Dusun Semonet. This is evident in the permanent flooding of several houses, which were eventually abandoned by their residents. A few houses remain, most of which had been modified multiple times by their former occupants. Physically, the buildings are constructed with brick or concrete block walls, cement floors, and roofs made of tiles or asbestos. A smaller portion consists of semi-permanent structures using a combination of concrete blocks and plywood walls, asbestos roofs, and cement floors.

"Ya gini kondisinya, ini rumah udah ditinggin 4 kali, ini aja kalau rob udah sejajar sama lantai, mau ditinggiin lagi udah ngga ada biaya, pasrah aja.

Accessibility in Dusun Semonet

The tidal flooding has rendered the existing road infrastructure in Dusun Semonet unusable. As a result, residents rely on *gisik*—as their primary pathway. Gisik refers to beach ridges or sandbars formed by wave action parallel to the shoreline. These paths are made up of sand and gravel deposited through coastal sedimentation. In addition, some residents use boats as their main mode of transportation.







Figure 9. Condition in Dusun Semonet
Source: jateng.tribunnews (2021)

Population Data

Based on information available on the internet and research data, Dusun Semonet was originally home to 265 residents. However, due to the worsening tidal floods that progressively damaged the living environment, the population began to decline. By 2016, only 66 households or around 80 people remained. By 2023, the area had become completely uninhabited.

2005	180 KK	265 People
2016	66 KK	80 People
2021	36 KK	50 People
2022	9 KK	25 People
2023	0 KK	0 People

Kisah Kampung Mati Simonet Pekalongan, Ditinggalkan Penduduknya Karena Banjir Rob

Dulu Dusun Simonet merupakan kampung yang ramai. Tapi kini tak ada satupun warga yanga bermukim di sana.

Rabu, 03 Jan 2024 09:45:00

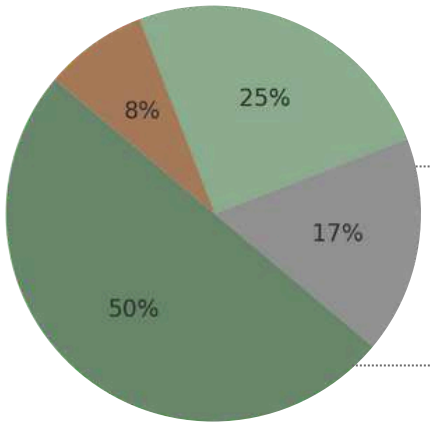
Zero Inhabitants Left



Livelihood of Dusun Semonet Residents

Although specific data on the exact number of fisherman and fish farmers is not available, it is stated that majority of residents rely on two main sources of income, fisherman and fish farmers.

Out of total 180 Households (KK), it is estimated that around



- *50% are Fisherman only*
- *17% are Fish farmers only*
- *25% are both fisherman and fish farmers*
- *8% are Other occupations (non fisheries)*

This estimation is further supported by findings from another study, which revealed that 56 percent of the community had no alternative sources of livelihood, indicating a strong dependence on the fisheries sector, either through capture fisheries or aquaculture.



Figure 11. Alternatif Mata Pencaharian
Source: Husna et al. (2025)

Fish Farming *(Budidaya Tambak)*

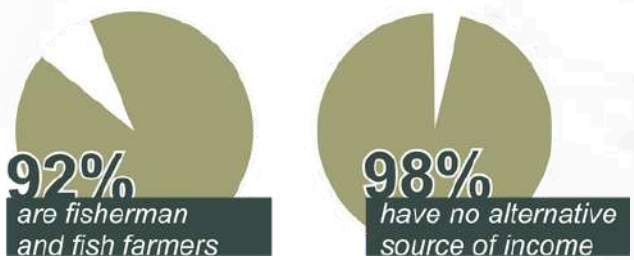
Common Fish Species

- **Vannamei Shrimp**
- **Tilapia (Nila)**
- **Bandeng**
- **Catfish (Lele)**

Fishing *(Perikanan Tangkap)*

Common Fish Species

- **Tuna**
- **Squid**
- **Mackerel**
- **Banyar**





Income Data of Dusun Semonet Residents

Before the relocation, the majority of residents in Dusun Semonet who worked as fishermen or fish farmers earned between Rp 20,000 and Rp 70,000 per day, with a realistic average of around Rp 40,000 to Rp 50,000.

Occupation	Net Daily Income	Estimated Monthly Income	Annual Income
Fishermen	Rp 40,000–70,000	Rp 1,200,000–2,100,000	Rp 14,400,000–25,200,000
Fish Farmers	Rp 20,000–40,000 (season and sales dependent)	Rp 600,000–1,200,000	Rp 7,200,000–14,400,000
Average	Rp 40,000–50,000	Rp 1,200,000–1,500,000	Rp 14,400,000–18,000,000

Expenses Data of Dusun Semonet Residents

Most residents lived in houses they owned themselves or on inherited or donated land, so rental expenses were generally non-existent. However, for those who rented, the cost was very low, around Rp 100,000–250,000 per month. Below is an estimate of the monthly and annual expenses of Dusun Semonet residents before they were relocated.

Expense Category	Daily Range (Rp)	Monthly Range (Rp)	Annual Range (Rp)
Housing	0 – 8,000	0 – 240,000	0 – 2,880,000
Electricity & Water	2,000 – 10,000	60,000 – 300,000	720,000 – 3,600,000
Food for Family	13,000 – 25,000	390,000 – 750,000	4,680,000 – 9,000,000
Other Expenses	10,000 – 20,000	300,000 – 600,000	3,600,000 – 7,200,000
Total	Rp 25,000 – 63,000	Rp 750,000 – 1,890,000	Rp 9,000,000 – 22,680,000

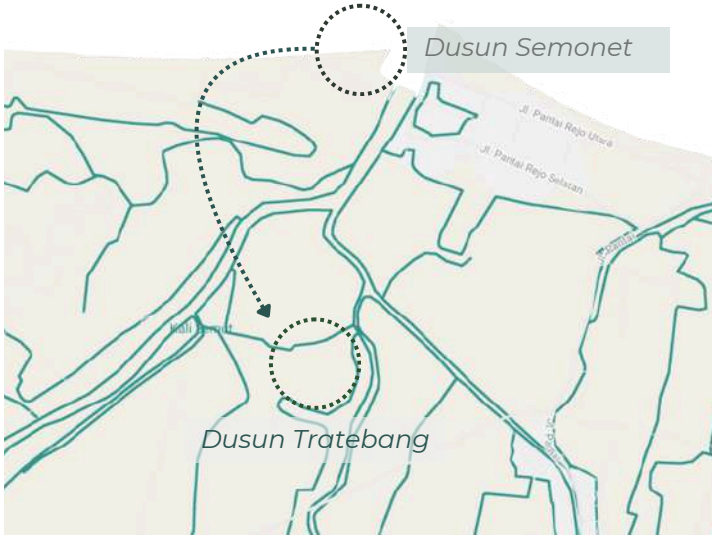
Based on the income and expenses data of Dusun Semonet residents, it is evident that **the gap between earnings and daily needs was very narrow and often insufficient, leaving no room to set aside savings.** As a result, they had no emergency funds to cope with economic risks or disasters that had already occurred. When tidal flooding (rob) worsened and submerged their homes, they lacked the financial capacity to relocate independently, making government-assisted relocation their only option.





In 2024, the Pekalongan Regency Government will relocate **66 households** from Simonet to a new location in Tratebang Village, Wonokerto District. On a plot of land measuring approximately 1 hectare, the government will provide each household with a new **64 m²** housing unit, complete with public and social facilities, along with the processing of land ownership certificates (SHM).

According to the Public Communication and Protocol Team (Prokompim) of the Pekalongan Regency Secretariat, the selection of the relocation site involved community participation from the start. The government has considered not only physical aspects but also the residents' livelihoods. It is also working in collaboration with the Mercy Corps organization to assess sustainable livelihood options—determining whether residents are willing or not to change their source of income, as they must adapt to the new environment.



RE-LOCATION

Government Relocated

66 KK

from Dusun Semonet to Dusun Tratebang

Figure 11. Relocation Program for the Residents of Semonet Hamlet
Source: Pemerintah Kabupaten Pekalongan (2024)

The Relocation Paradox:

Physically Safe, Socio-Economically Vulnerable

The long-term plan of the Pekalongan Regency government to relocate residents from Dusun Semonet to geographically safer locations is a reasonable form of structural mitigation. However, this approach raises major questions about the socio-economic sustainability of coastal communities, particularly fishing communities whose livelihoods are deeply tied to the sea and coastal ecosystems.

While physical relocation does reduce exposure to disaster risks, it often creates new risks in the form of lost livelihoods, social disconnection, and economic dependency. Many relocated residents eventually return to their original areas or live in a state of economic uncertainty.

Relevance to Legislation and the *"Build Back Better"* Principle

UU No 24 Year 2007 on Disaster Management and Government Regulations No 21 Year 2008 do not prohibit rebuilding in affected areas, as long as it is done with mitigation principles and resilience enhancement. In fact, the Build Back Better article in Government Regulation No. 21/2008 encourages post-disaster recovery to be carried out with improved quality and future safety.

This redesign represents a concrete form of Build Back Better: not merely rebuilding physical structures, but also strengthening the socio-economic and ecological resilience while preserving the community's connection to their original living environment.

Problem Statement

Despite the current reality that Dusun Semonet is no longer inhabited and has vanished from official maps, it holds a significant history. For years, many residents relied on the area for their livelihoods and chose to stay by raising their homes multiple times since 2015 to cope with the rising waters. Yet as conditions steadily deteriorated, ***they were eventually forced to leave—abandoning their own homes.***

This situation raises an important question:

Is it still possible to reimagine and redesign a submerged settlement, not just as a place to live, but as a resilient and meaningful space for those who once called it home?

Design Hypothesis

If the flooded village is redesigned to suit current conditions and the former way of living, then the community can continue their daily life and work in a safer and more stable place where they feel a sense of belonging again.

Design Problem Formulation Matrix by Bryan Lawson

	Practical	***Formal***	***Symbolic***	***Radical***
Regulation Undang-Undang Peraturan Daerah	Fulfilling the need for new housing for Dusun Semonet residents on their now-submerged land, with a design that adapts to water-based conditions.	Refers to Law No. 26/2007 (Article 35c) and Pekalongan City Regulation No. 9/2020, which promote disaster mitigation and sustainable development in flood-prone areas.	Integrates green open space (based on Minister of Home Affairs Regulation No. 20/2009) as a tool for disaster response and preserving the cultural identity of coastal communities.	Responds to Government Regulation No. 21/2008 by introducing adaptive housing on permanently submerged land, challenging traditional definitions of livable zones
User Displaced residents of Dusun Semonet	Provides livable housing that allows residents to remain and work in their original area, even under water, while maintaining access to water-based resources.	Maintains familiar kampung spatial patterns and supports core livelihood activities, such as fisheries and aquaculture.	Revives a sense of home and belonging through culturally familiar forms, materials, and spatial arrangements.	Proposes a new water-based lifestyle where water is no longer seen as a threat, but as a vital, integrated part of daily life and the living environment.
Client Owner : Pekalongan Government, PUPR, NGOs Commissioner : Dinas PU	Offers low-maintenance, flood-resilient housing that adapts to permanent inundation.	Aligns with existing spatial plans and infrastructure systems to ensure implementation is legal and efficient.	Supports local economic growth through multifunctional public spaces and integrated workspaces for fisheries and traditional crafts.	Encourages forward-thinking investment in elevated and adaptive construction methods that redefine the future of urban resilience.
Designer Architect	Designs modular units adaptable to dry and submerged conditions, with passive cooling and flexible circulation.	Balances modern building techniques with local architectural language to comply with regulations and enhance community acceptance.	Embeds cultural memory and maritime identity into spatial design, forms, and storytelling.	Explores elevated structural solutions as a new architectural response to post-submergence living.

Table 7. Design Problem Formulation Matrix by Bryan Lawson
Source: Author

Problem Mapping

Design for Reviving Post-Submergence Settlements in Dusun Semonet, Pekalongan

Main Issue

Dusun Semonet is now permanently underwater and uninhabited due to tidal floods, land subsidence, and rising sea levels.

Non-Architectural Issue

- Environmental: The coastline is eroding, the land is sinking, and sea levels are rising. These problems have caused Dusun Semonet to be flooded permanently.
- Social: People who lived in Dusun Semonet have been forced to leave their homes. They've lost their way of life, especially fishing.
- Economic: The local fishing economy was damaged. Many lost their fish ponds, boats, and other means of income.

Architectural Issue

- Loss of Homes and Land: The area is no longer livable, and all buildings are underwater. New ideas are needed to bring meaning and function back to the site.
- Declining Property Value: Houses that are no longer habitable experience a significant drop in property value, leading to economic losses for residents and discouraging investment in the area.
- Separation from the Old Village: It creates an architectural issue of lost spatial identity, where the new environment no longer supports the community's cultural, social, and livelihood patterns.

Problem Formulation

How can a new version of Dusun Semonet be built on its submerged site using resilient architectural strategies, so that it becomes a place for living, working, and staying connected to nature and water for people who once lived there?

Specific Problem Formulation

- How can housing and public spaces be designed to stand above water while remaining safe, comfortable, and affordable for residents?
- How can spatial and architectural design strategies integrate fishing activities with residential functions?

Design Limitations

This project focuses on reestablishing Dusun Semonet at its current, submerged location. It explores how living spaces, infrastructure, and community life can be reimagined to adapt to the presence of water. Instead of attempting to reclaim the land, the goal is to develop a new type of settlement that embraces and coexists with the aquatic environment.

Design Strategy

Using a Resilient Architecture approach, the new Dusun Semonet will be a water-based village that combines housing, fisheries, and community spaces. The design will turn challenges like flooding into opportunities for sustainable living.

Design Objectives

- Build a livable water-based version of Dusun Semonet on the submerged site.
- Bring back fishing and aquaculture as part of daily life and economy.
- Help the community adapt to their environment without losing their identity.
- Offer a model for rebuilding coastal villages affected by permanent flooding.

Problem Solving Methods

Design Method

Force-Based Design

Ensure the revived settlement can stand against ongoing environmental pressures. The design responds to site-specific forces such as permanent tidal flooding, land subsidence, and rising sea levels. Structure and infrastructure are planned with these challenges in mind.

Design for Reviving Post-Submergence Settlements in Dusun Semonet, Pekalongan

Forces Identification

Data Collection Method

Primary Data

- Field Observations – Documenting existing conditions of flood-affected areas, including housing, fisheries, and infrastructure.
- Interviews – Gathering insights from local residents, fishermen, and government officials on their experiences and adaptation strategies.

Secondary Data

- Literature Review – Analyzing coastal erosion, land subsidence, rising sea levels, and all that related data from research.
- Urban Planning Documents – Reviewing government policies, zoning regulations, and flood mitigation plans.
- Precedent Studies – Examining similar resilient housing models and architecture case studies.

Data Analysis Method

- Hydrological and Environmental Analysis – Evaluating sea-level rise, permanent tidal flooding, and land subsidence to inform appropriate design responses for submerged conditions in Dusun Semonet.
- Spatial Mapping – Analyzing the physical characteristics of the submerged site, such as water depth, previous settlement layout, and remaining infrastructure traces, to guide spatial planning and zoning.
- Socio-Economic Analysis – Assessing the impact of flooding on livelihoods, particularly in fisheries and aquaculture sectors.
- Comparative Study –Reviewing similar cases of water-based or flood-resilient communities (e.g., floating villages, stilt housing) to extract applicable architectural strategies for reviving Dusun Semonet.
- SWOT Analysis – Identifying the strengths, weaknesses, opportunities, and threats of redeveloping a permanently submerged site using resilient architectural approaches.

Select Response → *Response Exploration* → *Response Test* → *Assessment criteria*

Design Benchmark → *Design Schematic* → *Design Test* → *Design Development*

Design Test Method

Conducting basic structural analysis and material testing to ensure that the structures can safely withstand constant water exposure, flooding, and environmental forces. The method includes evaluating load-bearing capacity, buoyancy (if applicable), and durability of materials in wet and corrosive conditions.

Theoretical Framework

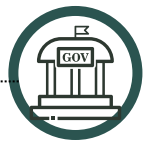
Context Understanding Stage



Studying the impact of tidal flooding, land subsidence, and sea-level rise on local fisheries-based livelihoods.



Identifying the social, economic, and environmental conditions affecting Dusun Semonet post-submergence.



Reviewing government efforts, including relocation strategies and disaster mitigation plans.

Design Study Stage

- Exploring theories of Resilient Architecture in submerged or permanently flooded environments.
- Analyzing case studies of floating and stilted housing solutions in flood-affected regions.
- Studying both traditional and contemporary approaches to water-based living in coastal communities.

Design Analysis Stage



Mapping site conditions, including water depth, sedimentation, and existing remnants.



Evaluating spatial and functional needs for housing, fisheries, aquaculture, and public spaces.



Analyzing structural and material potentials for long-term flood resilience in a submerged setting.

Conceptual Design Stage

- Formulating a design concept that blends housing, livelihood, and adaptation to permanent water presence.
- Developing massing strategies, spatial flow, and circulation suited to submerged terrain.
- Integrating sustainable water management, passive strategies, and emergency response elements.

Design Stage

- Producing detailed architectural outputs, including master plan, sections, elevations, and perspective drawings.
- Testing the design with basic simulations, structural feasibility, and material suitability in wet conditions.
- Refining the final proposal based on performance evaluations, feedback, and community needs.

Excellency, Originality

Title	***Design The Development of The Major Port of Sorong: Application of Multi-Hazard in Resilience Architecture Approach***	***Design of Water Colony Future Water Adaptive Settlement in Sudimampir Area Responding to Rising Sea Level in Banjarmasin***	***Design of Bontang Kuala Fishing Village as an Adaptive Habitation Strategy to Sea Level-Rise***
Writer	Eko Wahyu Nur Lestianto	Muhammad Thirafi Hadyan Syarief	Nur Afifah Rahmah
	20512013	18512096	20512076
University	Universitas Islam Indonesia	Universitas Islam Indonesia	Universitas Islam Indonesia
Published	2025	2022	2024
Location	Sorong, West Papua	Banjarmasin	Bontang Kuala, East Kalimantan
Approach	Resilience Architecture	Resilience Architecture	Adaptive Strategy
Topic	Designing major ports as maritime transportation infrastructure that can withstand and recover quickly from disasters, facilitate aid distribution, and support mass evacuations efficiently.	Designing a mixed-use area as a center of activity for Banjarmasin residents, capable of adapting to rising sea levels in the coming years, while shaping future settlements that ensure coastal resilience and support the city's evolution into a sustainable floating city.	Focusing on habitat design and arrangement of fishermen's settlements using adaptive strategies to survive the threat of rising sea levels.
Similarity	• Using the same approach	• Rising sea levels • Using the same approach • Floating Settlement	• Rising sea levels • Focus on fishing communities in areas vulnerable to tidal flooding • Adaptive Settlement
Differences	• Port building typology	• Location in Banjarmasin • Site on the riverbank, not on the coastal area	• Located in Bontang Kuala • Considering land limitations and population growth

Design Novelty

This project introduces a new settlement concept that brings life back to Dusun Semonet by building directly on its submerged site. Instead of avoiding water, the design embraces it, turning a once-inhabitable area into a resilient, livable, and productive space.

By using a Resilient Architecture approach, the design ensures that people can live and work in harmony with permanent water conditions. It creates hybrid structures that are elevated, stilted, and partially floating where needed, and includes water-based infrastructure that supports both aquaculture and marine fisheries.

The plan connects essential economic functions such as fish auction halls, small ports, and aquaculture processing areas with housing and public spaces. This turns daily interaction with water into an opportunity rather than a hazard. It also restores a sense of home, identity, and belonging for the original residents who were displaced due to tidal flooding, offering a dignified and sustainable alternative to relocation.

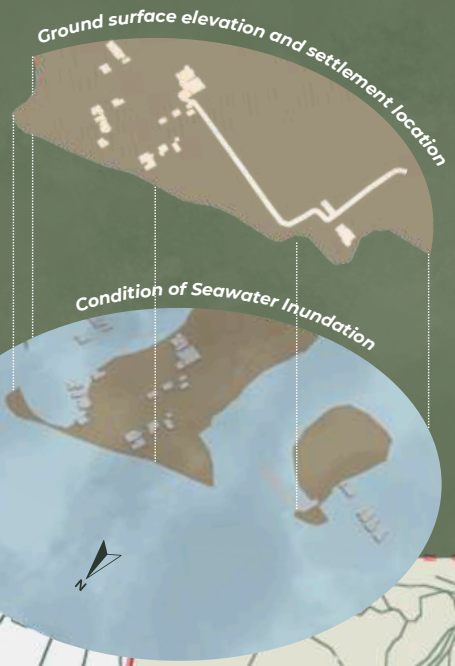
A New Chapter
for Dusun Semonet

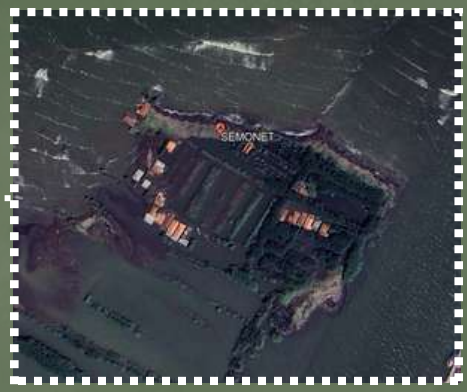
*What Was Lost, **Returned Stronger***

Design Problem Exploration
and Site Analysis

02

Coastal Map of Pekalongan Regency





Site Dusun Semonet
-6.8426503, 109.617606

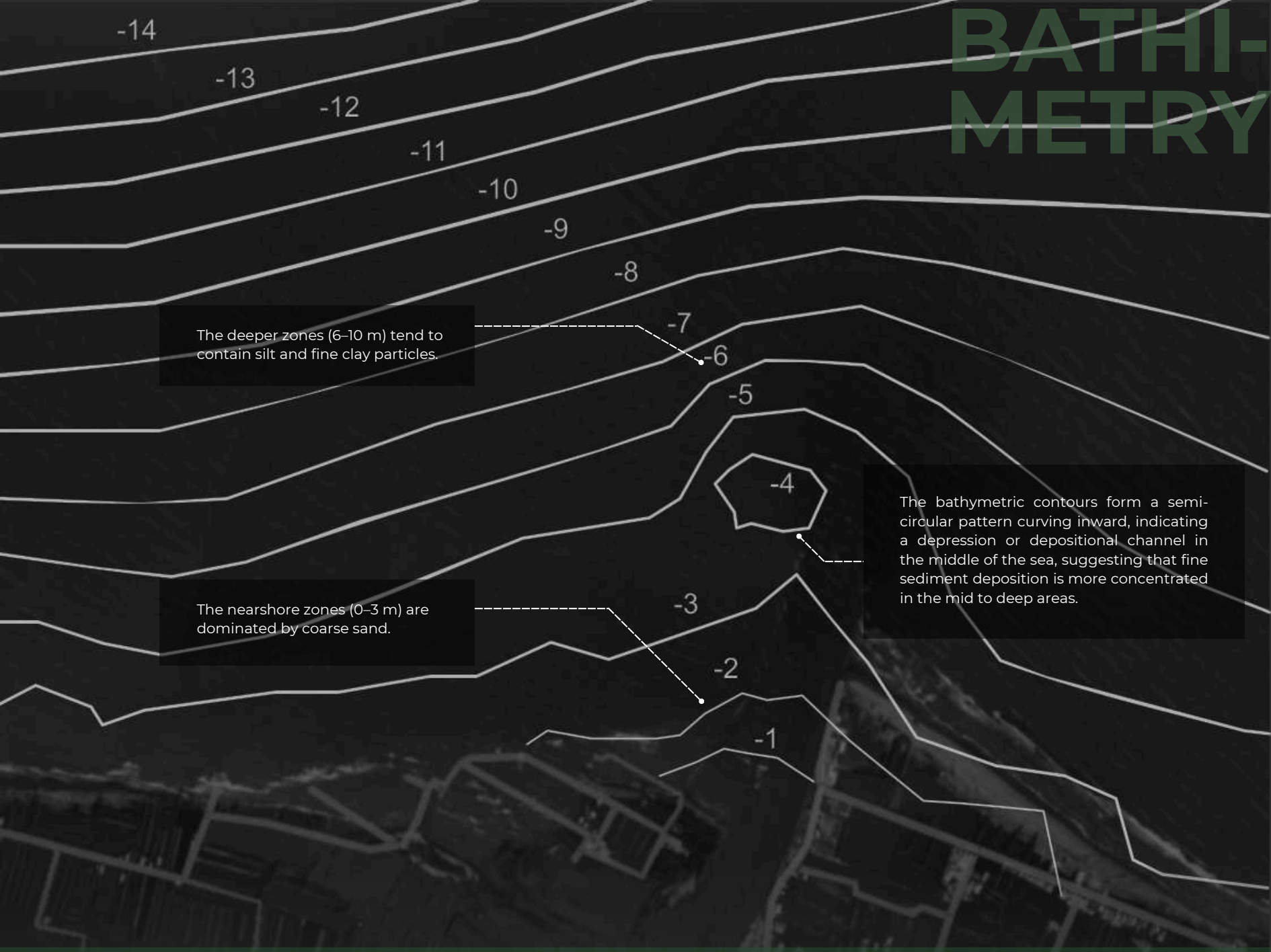


NO SCHOOL. NO MOSQUE.
NO RESIDENTS

Nearby Facilities

- Fish Auction Site
- Boat Harbor

BATHI-METRY



Bathimetry Data

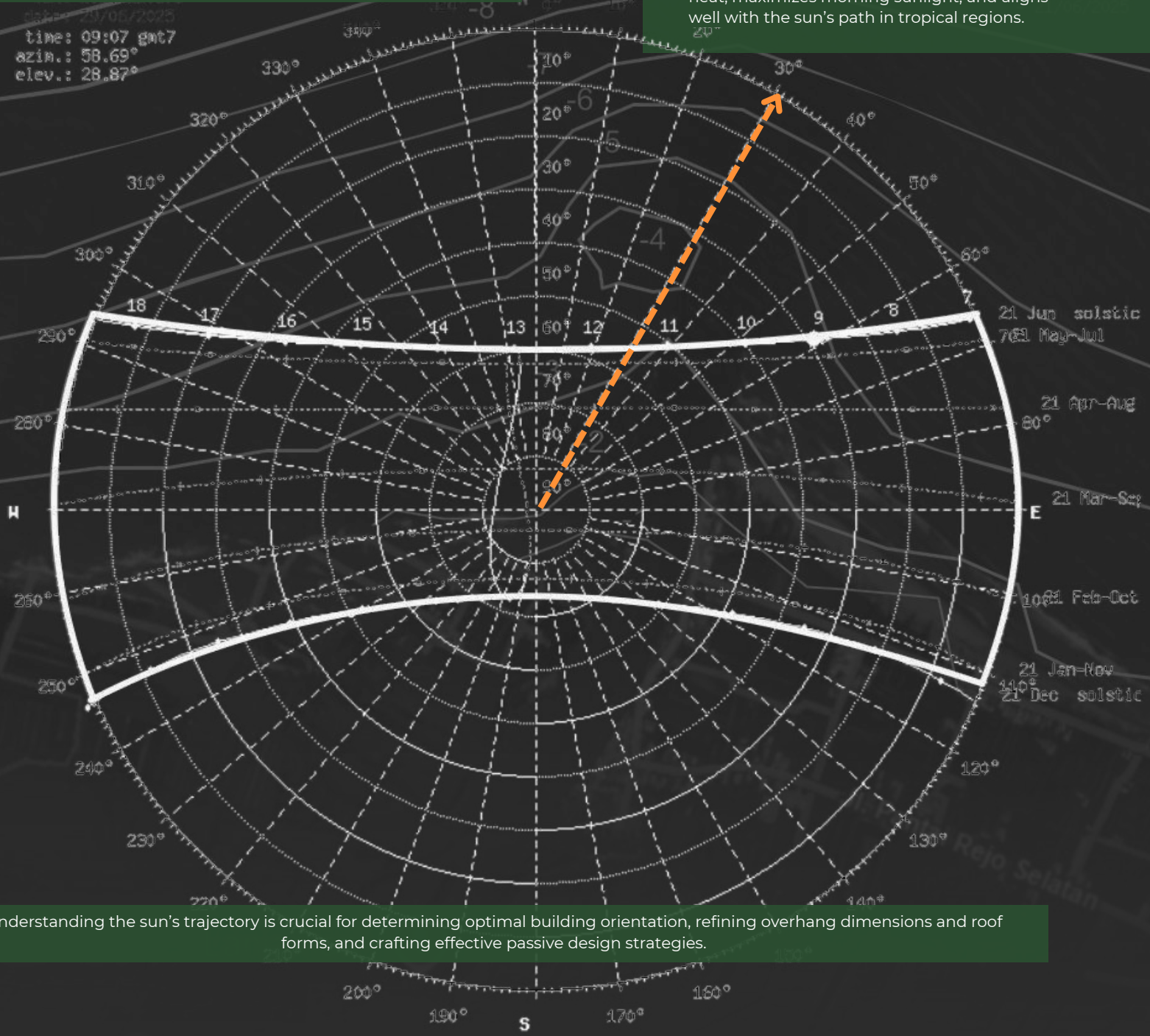
Based on data from the BATNAS (National Bathymetry) platform by the Geospatial Information Agency (BIG), using the Mean Sea Level (MSL) datum, the sea depth in the Wonokerto area ranges from -1 to -10 meters. The contour pattern reveals a gently sloping seafloor that gradually deepens toward the open sea. This gentle slope allows tidal flooding (rob) to penetrate further inland, as there are no significant topographic barriers to slow or block the movement of seawater.

SUN-PATH

Sunpath Data

At this location, the sun rises high in the sky each day, reaching a maximum elevation angle of approximately 80–90° at solar noon. Throughout the year, the sun's path forms a broad arc, extending from the northeast to the northwest during the dry season (southern hemisphere summer).

The ideal building orientation is northeast–southwest, as it helps avoid intense afternoon heat, maximizes morning sunlight, and aligns well with the sun's path in tropical regions.



Understanding the sun's trajectory is crucial for determining optimal building orientation, refining overhang dimensions and roof forms, and crafting effective passive design strategies.

WIND-ROSE


-14
-13
-12
-11
-10
-9
-8
-7
-6
-5
-4
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
750
500
250
1
Jl. Pantai Rejo Selatan
< 2 km/h
2 - 5 km/h
5 - 10 km/h
10 - 20 km/h
20 - 30 km/h

- Provide large openings on the north and northeast sides to capture morning sunlight.
- The ideal building orientation is northeast–southwest
- Incorporate overhangs or façade shading elements on the west and south sides to protect against afternoon heat.
- Place active spaces on the north side (facing the sea) to take advantage of brighter and cooler conditions.



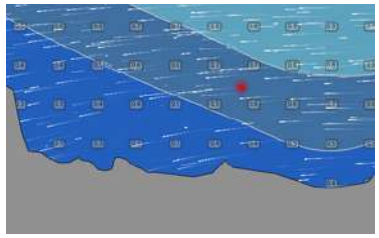
- Position service areas or buffer zones on the south and west sides, as these are hotter areas that require additional shading.

Wind Flow *(Aliran Angin)*



Figure . Wave Height and Sea Current Data of Pekalongan
Source: peta-maritim.bmkg.go.id/ofs/





East Monsoon	6 knot	14 knot
West Monsoon	3 knot	10 knot

Wave Data *(Gelombang Air Laut)*

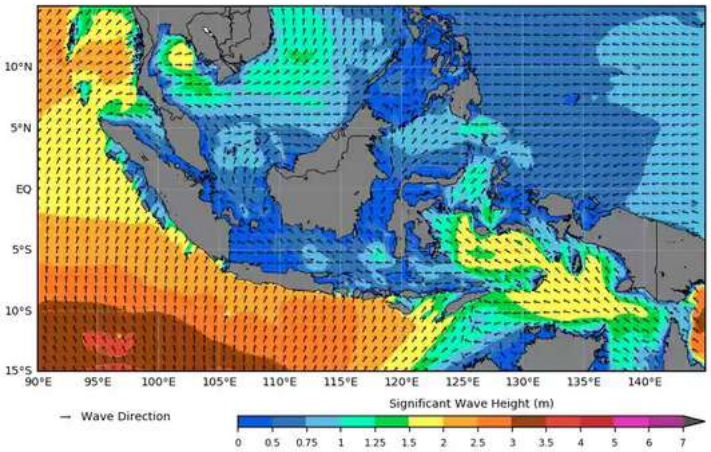


Figure . Wave Height and Direction Data During East Monsoon
Source: peta-maritim.bmkg.go.id/ofs/

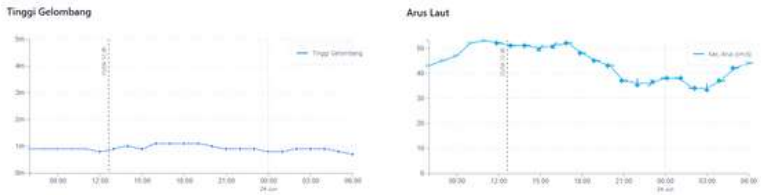


Figure . Wave Height and Sea Current Data of Pekalongan
Source: peta-maritim.bmkg.go.id/ofs/

East Monsoon	0.8 – 1.1 m	0.4 – 0.53 m/s
West Monsoon	1.25 – 2.5 m	0.5–1.0 m/s

Tidal Flow *(Arus Pasang Surut)*

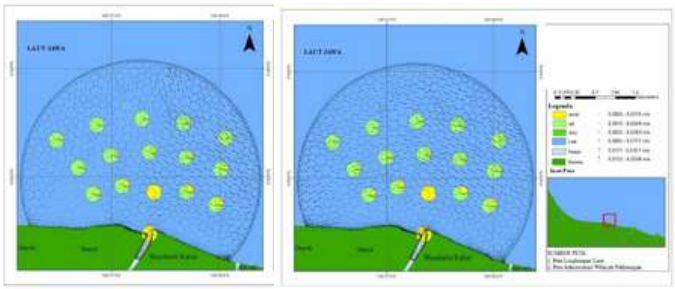


Figure . Pola Arus Pasang dan Surut di Wonokerto
Source: peta-maritim.bmkg.go.id/ofs/

High Tide (Pasang)	07.00-08.00 and 17.00-18.00	0.5-0.8 m elev
Low Tide (Surut)	00.00-01.00 and 12.00-13.00	0.1-0.4 m elev

The northern coast of Java experiences a semi-diurnal tidal pattern, which means that in one day, the sea level rises and falls twice. This cycle is influenced by the gravitational pull of the moon and the sun, as well as the local sea topography.

Climatic Condition

Temperature

Dusun Semonet has stable tropical temperatures, with the highest average high in March at 30.5°C and the lowest in July at 28.5°C. Average lows range from 23.5°C in April to 20.9°C in August, with cooler mid-year temperatures.

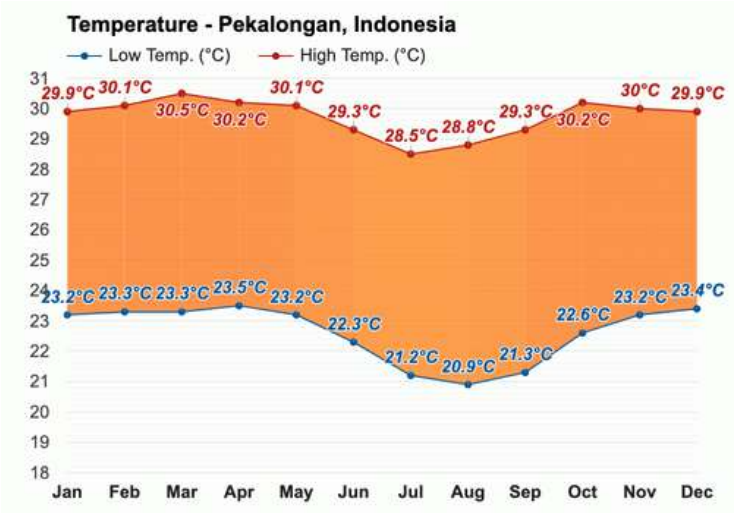


Figure 14. Temperature Data in Pekalongan Regency
Source: weather-atlas.com

Sea Temperature

Sea temperatures in Pekalongan remain warm throughout the year, with the highest average of 30.2°C in December and the lowest at 28°C in August, making the waters consistently suitable for swimming and marine activities.

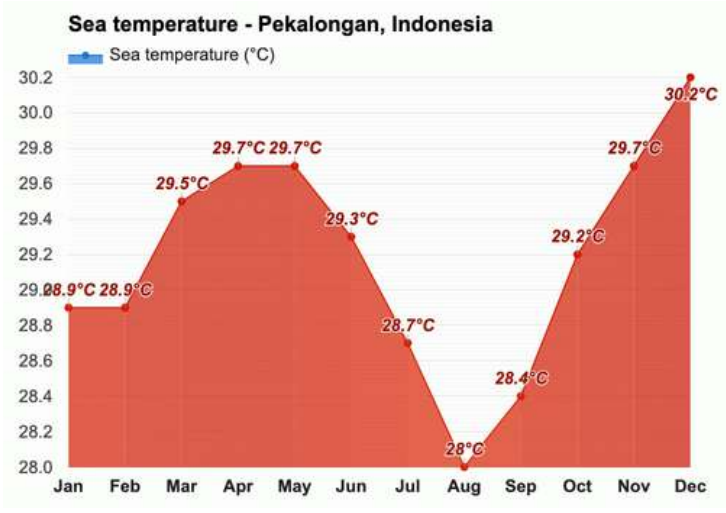


Figure 15. Sea Temperature Data in Pekalongan Regency
Source: weather-atlas.com

Wind

In Pekalongan, the average wind speed ranges from a low of 4.7 km/h in April to a high of 8.8 km/h in August, with the windiest conditions occurring in mid-year months and the calmest in early spring.



Figure 16. Wind Data in Pekalongan Regency
Source: weather-atlas.com

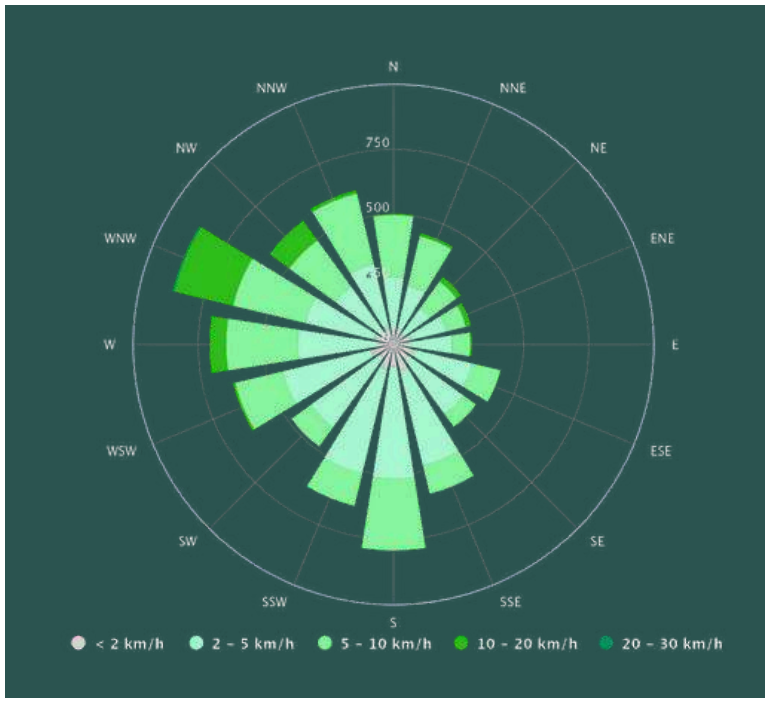


Figure 17. Wind Rose Data in Pekalongan Regency
Source: weather-atlas.com



Figure 18. Humidity Data in Pekalongan Regency
Source: weather-atlas.com

Humidity

Pekalongan experiences relatively high humidity throughout the year, with the highest average of 83% in June and July, and the lowest of 79% in September and October, maintaining a generally humid climate.



Figure 19. Rainfall Data in Pekalongan Regency
Source: weather-atlas.com

Rainfall

Pekalongan experiences its heaviest rainfall in January with 273mm, while August is the driest month with only 24mm of rainfall. The rainy season typically spans from January to April, with significantly lower rainfall from May to August, before increasing again in the latter part of the year.

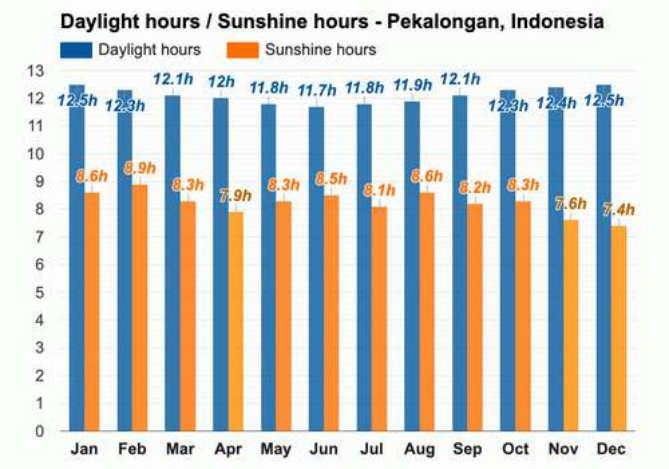


Figure 20. Daylight Hours Data in Pekalongan Regency
Source: weather-atlas.com

Daylight Hours

In Pekalongan, daylight duration remains fairly consistent throughout the year, ranging from 11 hours and 42 minutes in June to 12 hours and 30 minutes in December. Sunshine is also fairly consistent, with February receiving the most at 8 hours and 54 minutes, and December the least at 7 hours and 24 minutes. The area enjoys relatively long daylight hours and ample sunshine, with some variation between months.

Site Regulation

Minister of Public Works and Public Housing Regulation No. 28/PRT/M/2015 on the Determination of Borderlines (Setbacks)

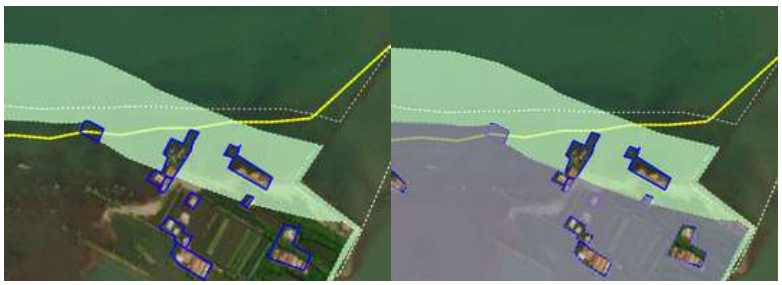


Figure 12. Dusun Semonet Zoning Based on RDTR
Source: aisitaru.pekalongankab.go.id (2025)

According to the Spatial Information System of Pekalongan Regency (AiSITARU), Dusun Semonet is still marked as a land area for aquaculture and housing.

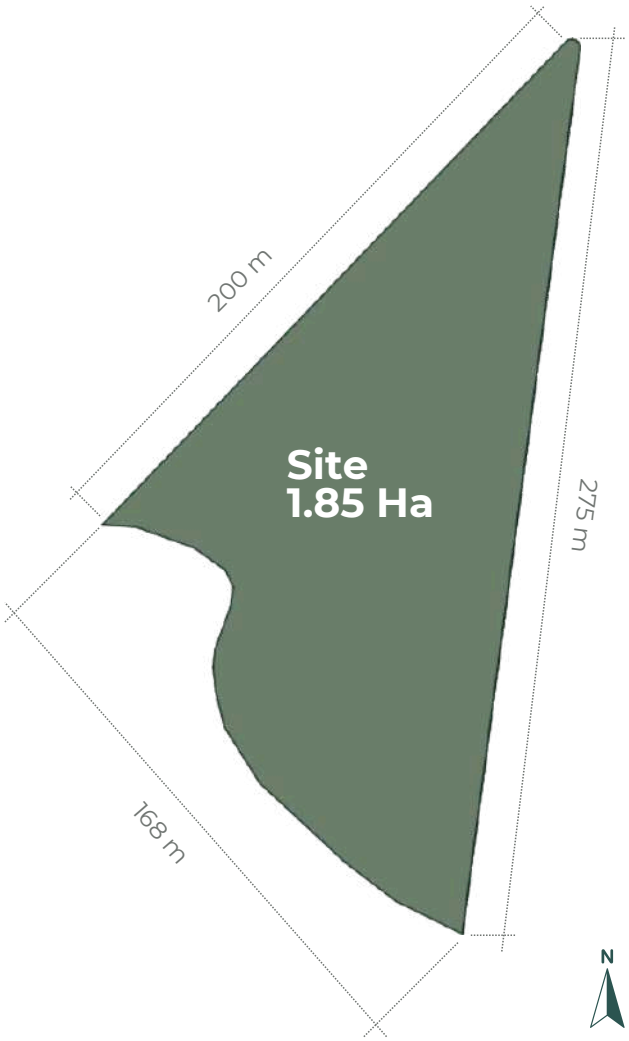
But because the area is now permanently underwater due to flooding, sinking land, and rising sea levels, rules for building on land like KDB and KLB don't really fit anymore. The situation calls for new rules that consider living and building on water. So, the regulations should change to support designs that can handle these water conditions in Dusun Semonet.



Site
Setback (based on aisitaru.pekalongankab.go.id)

Site Measurement

Since the site is in a disaster-prone area at high risk of permanent submergence, land-based rules like KDB (Building Coverage Ratio) and KLB (Floor Area Ratio) no longer apply directly. However, they can still be used as conceptual references. In this context, the concept of Dynamic FAR becomes relevant, allowing floor area to be adjusted over time in a more flexible way.



Building Coverage Ratio *(KDB)* → Platform Coverage Ratio (PCR)

$$\text{PCR} = \left(\frac{\text{Building footprint area}}{\text{Total platform area}} \right) \times 100\%$$

$$\text{Building Footprint Area} = \frac{PCR}{100\%} \times \text{Platform Area}$$

$$\text{Building Footprint Area} = \frac{60}{100} \times 18.500 = 0{,}60 \times 18.500 = \boxed{11.100\,\text{m}^2}$$

Building Footprint Area = 11,100 m²
This means that 60% of the 1.85-hectare platform is occupied by building footprints.

Floor Area Ratio *(KLB)* → Floating Floor Area Ratio (FFAR)

$$\text{FFAR} = \frac{\text{Total floor area}}{\text{Total platform area}}$$

$$\text{Total floor area} = \text{FFAR} \times \text{Total platform area}$$
$$= 1.5 \times 18.500 = 27.750\,\text{m}^2$$

Maximum Floor

Ministry of Public Works Regulation No.5 of 2007

"(3) Stairs shall be used in walk-up flats (rusun) up to five (5) floors, and for buildings of more than five (5) floors, they must be equipped with an elevator or escalator."

This means that the maximum number of floors allowed for walk-up flats is five floors. If the building exceeds five floors, it must be equipped with vertical circulation systems such as elevators or escalators.

Previous Typology Study

The housing typology that once existed in Dusun Semonet primarily consisted of grounded houses built from brick or local timber. While initially suited to the area's geographical conditions, over time the village faced land subsidence and sea-level rise, leading to frequent tidal flooding (rob).

In response, some residents attempted to elevate their homes by raising the floor level or adding new structural layers as a form of self-initiated adaptation. However, around half of the residents were unable to do so, largely due to economic limitations, lack of access to flood-resistant building materials, or the technical skills required. As a result, many houses became permanently waterlogged, damp, and no longer met basic standards for livability

This situation highlights the limitations of conventional grounded house typologies in vulnerable coastal areas and underscores the urgent need for redesigned housing that is more adaptive to climate change and the evolving conditions of coastal settlements.



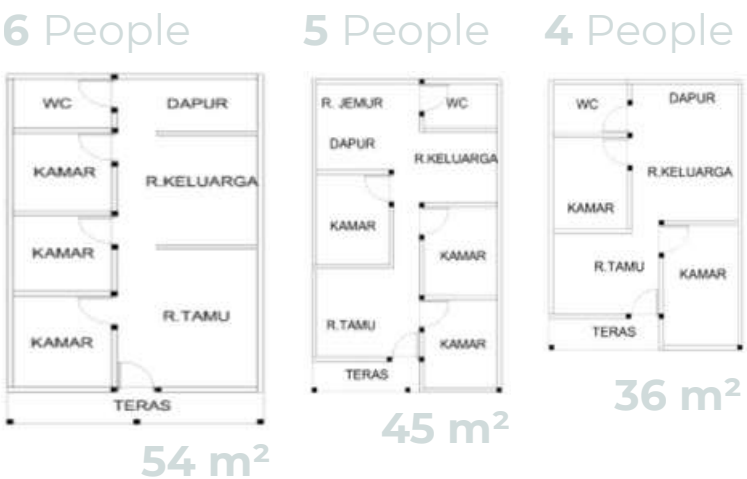
Figure 11. Upaya Peninggian Rumah
Source: Husna et al. (2025)





Figure 21. Sinking Houses due to road elevation efforts
Source: iklimku.org

Dwelling Size Analysis



- The houses in Dusun Semonet previously reflected a typical coastal housing typology found in informal seaside settlements. They were simple, standalone structures without a distinct architectural identity, unlike the more recognizable stilt houses of fishing communities in Kalimantan.
- An analysis of coastal housing typologies revealed that the housing conditions in Dusun Semonet did not meet basic habitability standards. While some residents tried to adapt by elevating their homes to avoid tidal flooding, this often led to a decline in both comfort and health quality.
- Therefore, a complete improvement is necessary through the implementation of a resettlement strategy that includes the construction of stilted houses. These homes should be designed to adapt to tidal flooding while also being integrated with the area's primary road network. (Mu'afa & Nugroho, 2022)

Analysis Design SWOT

Strengths

1. Adaptable to tidal flooding, land subsidence, and sea level rise.
2. Enables residents to remain in their original location despite environmental challenges
3. Supports local economic sustainability through floating net cages (keramba jaring apung)
4. Modular system allows for flexible layouts and future expansion

Weaknesses

1. High initial construction and long-term maintenance costs
2. Limited access to basic utilities such as clean water, electricity, and sanitation
3. Requires technical capacity building for construction and maintenance at the community level
4. Challenging logistics for transporting and assembling modules

Opportunities

1. Can become a model for climate-resilient coastal settlements
2. Potential for eco-tourism and environmental education based on innovative design
3. Opportunities for collaboration with government, NGOs, and academic institutions
4. Encourages innovation in modular stilt house systems and off-grid infrastructure

Threats

1. Extreme weather events may exceed the structural resilience of the design
2. Emergency response (rescue, evacuation, firefighting) is more difficult on water
3. Legal uncertainty regarding water-based land tenure and unclear regulatory support
4. Lack of skilled local labor to construct and maintain resilient infrastructure



Resilient Architecture Approach

Resilience is the capacity to anticipate, respond to, and recover from various disruptions while adapting to evolving conditions and thriving in new environments. This concept has become a fundamental component of urban governance and planning (Ervin et al., 2024).

The resilience approach, also known as resilience thinking, has proven valuable in urban planning and governance, particularly in disaster preparedness and response. When applied holistically, it integrates ecological, built environment, economic, and social factors into urban system planning (Mehmood, 2016). However, resilience is not solely about disaster response. In today's increasingly complex world, resilience thinking has emerged as a crucial strategy for urban planning and governance, enabling cities to address a wide range of challenges (Ascott & Kenny, 2019).

Core Principle of Resilient Architecture

01

Redundancy

Incorporating multiple alternatives to perform a specific function. This principle involves providing backup structural support or secondary energy systems. By designing with redundancy in mind, a building can maintain critical functions even if the primary system fails.

02

Robustness

Utilizing durable materials and construction methods to prevent structural failure. Strength is essential in withstanding physical challenges. A resilient design may include reinforced concrete, corrosion-resistant materials, and structural strategies that redirect stress away from critical areas.

03

Resourcefulness

The ability to handle crises through responsive and well-planned design strategies. Effective resource management before, during, and after a disaster can determine whether a building remains functional or collapses.

04

Integrative Design

Merging architectural, engineering, and ecological knowledge to develop holistic solutions. The complexity of applying a multidisciplinary approach in resilient architecture demands a broad and in-depth understanding from designers to create structures that can effectively withstand various challenges.

Design Criteria

- Evacuation routes must remain functional during high tides and flooding.
- Energy systems should have independent backups that can operate off-grid.
- Water supply must be maintained through multiple sources
- Buildings must use modular components for easy repair, replacement, or upgrading

- Substructures must resist saltwater corrosion and prolonged submersion.
- Structural systems must withstand both lateral and vertical loads from wind and water.
- Materials at lower levels must be weather-resistant and durable.
- Superstructures should be lightweight and easy to reinforce or adapt.

- Systems and materials must be easy to assemble, maintain, and modify by local residents.
- Buildings must include spaces that can function for multiple or emergency purposes.
- Passive design elements must be optimized for thermal comfort and lighting.
- Resource networks (water, power) must be organized for efficient use and simple maintenance

- Foundations and materials must be compatible with wet and saline soil conditions.
- Site layout must preserve natural water flow and reduce land alteration.
- Ecological functions (water absorption, shade) should be supported through vegetation.
- The design process must integrate local knowledge, culture, and community input.

Design Guideline

- Elevate all circulation paths and docks above the highest projected tide level for 2100.
- Use non-slip decking material and reflective path markers to ensure visibility in low-light or flood conditions.
- Ensure platform widths allow for simultaneous two-way movement during emergencies (minimum 1.8 m).
- Emergency assembly zones must be placed on high-elevation platforms with direct access from all clusters.

- Integrate hybrid systems combining solar PV panels with battery storage and wind turbines.
- Provide a minimum of 3-day autonomous power capacity per cluster during outages.
- Use decentralized energy storage systems at the housing cluster level to reduce single-point failure risks.

- Combine rainwater harvesting systems with modular desalination units powered by renewable energy.
- Use elevated water tanks (minimum 500 liters per household) to ensure gravity-fed supply when pumps are offline.
- Design distribution piping to be accessible for inspection and resistant to saline corrosion.

- Use prefabricated structural frames (e.g., glulam + steel joints) designed for vertical expansion.
- Wall panels, floors, and service modules should follow standardized dimensions for plug-in replacement.
- Detail junctions for quick disassembly and upgrades without requiring heavy machinery.

- Use precast concrete columns treated with marine-grade epoxy coatings for durability.
- Embed sacrificial anodes at footing zones for additional corrosion protection.
- Ensure no untreated metal parts are exposed below the freeboard line.

- Apply a regular platform grid (e.g., 6×6 m) to distribute loads evenly and avoid weak zones.
- Reinforce all structural joints to resist uplift and shear from storm surges and strong winds.
- Design anchoring systems with redundancy in footings to resist scouring and overturning.

- Use fiber-reinforced concrete or marine-grade FRP for exterior components within splash zones.
- Elevate timber or composite elements above the wave splash height to prevent decay.
- Apply protective coatings to all exposed surfaces and specify maintenance intervals.

- Use glulam timber or composite panels for upper floors to reduce structural load.
- Design floors with allowance for additional stories (up to 5 floors) using lightweight prefabricated systems.
- Avoid heavy cladding or wet-construction finishes at upper levels.

- Prioritize dry construction techniques with minimal specialized tools.
- Provide visual manuals and community training for maintenance routines.
- Design service access hatches for plumbing and electrical systems.

- Provide foldable or open-plan spaces within housing units to adapt for storage, relief distribution, or temporary shelter.
- Ensure public buildings (e.g., prayer halls, schools) have secondary egress and open sides for ventilation and flexible use.
- Use movable partitions and furniture for space adaptability.

- Position windows and vents to promote cross-ventilation from sea to land.
- Use wide eaves, shading devices, and reflective roof coatings to minimize heat gain.
- Prioritize translucent materials or clerestory windows to maximize daylighting.

- Use open-grid ducts under platforms for cable and pipe routing with inspection ports.
- Cluster resource systems (e.g., solar inverter, water filter) for each housing group to reduce redundancy.
- Use color-coded piping and smart meters to facilitate monitoring.

- Anchor precast concrete columns to deep footings designed for soft coastal substrates.
- Avoid using untreated timber or low-grade metals in substructures.
- Provide inspection shafts near foundation zones for regular checks on settlement and corrosion.

- Follow original tidal and drainage paths when laying platform zones.
- Avoid mass backfilling; instead, use stilted platforms that allow tidal flow underneath.
- Integrate green corridors and open water channels throughout the settlement.

- Use native mangroves, pandanus, and vetiver grass for shoreline stabilization and cooling.
- Plant vegetation buffers along circulation routes to provide wind breaks and shade.
- Allow for permeable zones where vegetation can grow between platforms.

- Conduct participatory design workshops involving all resident groups before finalization.
- Reflect cultural building styles in roof forms, ornamentation, and spatial arrangements.
- Use local construction practices where possible to promote community ownership.

Resilient Architecture

Resilient architecture is a design approach that helps buildings and communities withstand, adapt to, and recover from disasters and environmental changes through strong structures, efficient use of resources, and inclusive spaces. Socially inclusive strategies ensure that everyone in the community, regardless of age, gender, income, ability, or status, can access and benefit from the built environment.

This concept presents several challenges, especially considering that Dusun Semonet is no longer suitable for live.
The challenges

What groundwork must be done to ensure the buildings can remain durable for years to come?

How to make the housing affordable for the community?

How to create a new, comfortable living environment?

Precedent Studies

What groundwork must be done to ensure the buildings can remain durable for years to come?

Cerucuk Matras Bambu as Soft Soil Reinforcement

Soil in northern coastal regions tends to be soft and unstable, which often results in significant land subsidence when subjected to heavy loads. To improve its strength and ensure the safety of structures or embankments, reinforcement methods are necessary.

One such method is the Bamboo Pile Mat System *(Cerucuk Matras Bambu),* it is a soil reinforcement method that combines vertical bamboo piles *(cerucuk)* driven into the ground with woven horizontal bamboo mats laid on top. This system helps strengthen soft soil by increasing bearing capacity and distributing structural loads more evenly.



Figure . Perkuatan Cerucuk Lapis 1, 3, dan 5 Matras Bambu
Source: Faradila (2023)

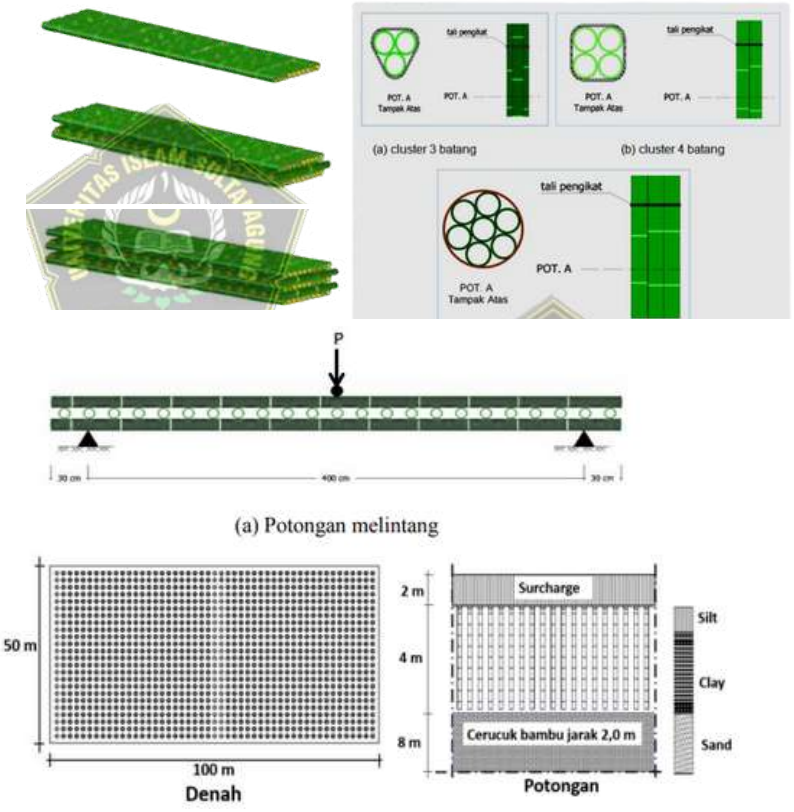


Figure . Lapisan Matras Bambu
Source: Bambang Widodo (2023)

Advantages

1 Effective Load Distribution

- The bamboo mat (horizontal weaving) helps spread building loads evenly across the soil, preventing pressure from concentrating in one spot and reducing the risk of uneven ground lowering.

2 Helps Prevent Ground Lowering

- The system helps slow down the natural process of soil compression or ground lowering that may occur over time under building loads.

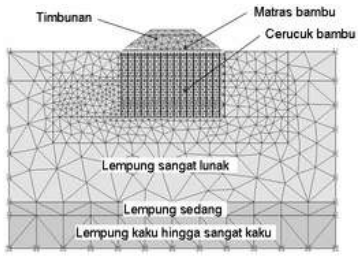


Figure . Load Distribution
Source: Kimpraswil (2002)

3 Minimal Environmental Disruption

- No deep excavation is needed, unlike other foundation systems.

Disadvantages

1 Dependent on Construction Quality

- The system's strength depends heavily on the quality of the bamboo, treatment process, and careful installation.

2 Shorter Lifespan

- Studies (Nugroho & Ando, 2001) show that treated bamboo placed in direct contact with the ground usually lasts about 5 to 10 years. In tropical coastal or swampy environments, such as northern coastal Java, the lifespan may drop to as low as 3 to 7 years if the bamboo is not properly protected.

3 Limited for Supporting Permanent Heavy Vertical Structures

- The system's strength depends heavily on the quality of the bamboo, treatment process, and careful installation.



Figure . Pembangunan Jalan Tol Semarang-Demak
Source: google.com

Cerucuk Matras Bambu in ***Demak-Semarang Toll Road Project***

Context and Challenges

The Demak–Semarang toll road runs through coastal and lowland areas in Central Java that are highly prone to:

- Tidal flooding (rob)
- Land subsidence
- Soft and saturated soils
- Saltwater intrusion

These geotechnical challenges demanded a ground treatment solution that was cost-effective, environmentally friendly, and adaptable to large-scale infrastructure. These conditions are very similar to those found in Semonet, where the land is also slowly being reclaimed by the sea, and any construction must address both ground instability and chronic coastal flooding.

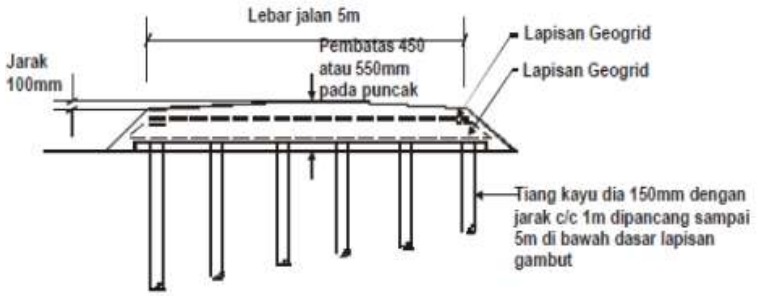


Figure . Konstruksi Tiang Matras
Source: Bambang Widodo (2023)

Purpose and Function in the Project

In this toll road project, the bamboo mattress pile system was used as a transitional ground improvement method, not as the final structural foundation. Its main functions were:

- **Soil Improvement** — It provided initial ground stability, helping to support the weight of temporary fill materials during preloading.
- **Consolidation Acceleration** — The bamboo piles helped drain excess water from saturated soils, speeding up consolidation and improving soil strength over time.
- **Load Distribution** — The woven bamboo mat spread the weight of embankments evenly, reducing the risk of local ground failure or slope instability.
- **Flood Protection (Tidal Barrier Support)** — In addition to road embankments, this method was also used in the construction of temporary or semi-permanent tidal barriers, helping to resist water pressure and stabilize dike structures in low-lying flood-prone zones.

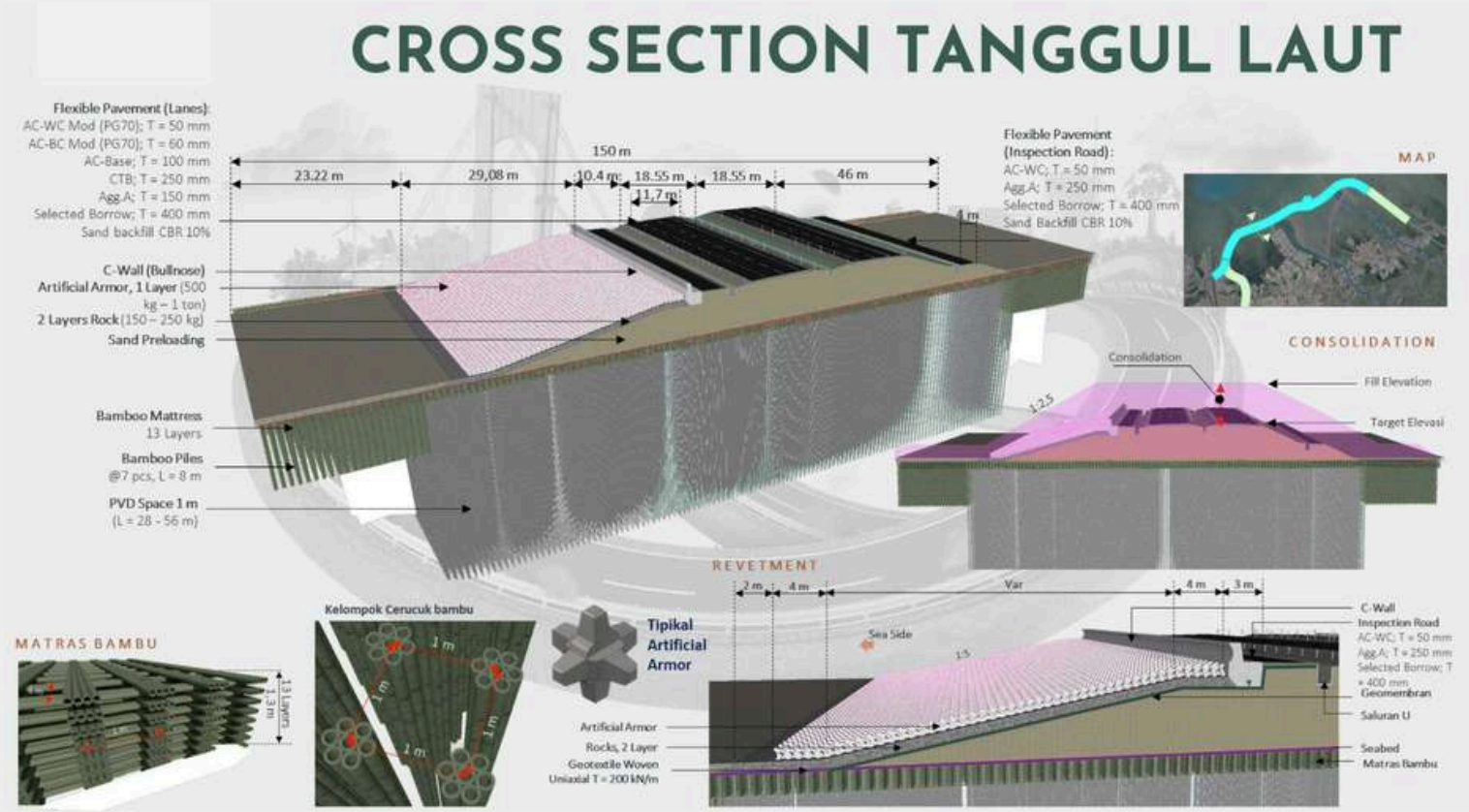






Figure . Konstruksi Jalan Tol Semarang-Demak
Source: google.com

Temporary Ground Improvement

Although it was implemented in a large-scale infrastructure project, the bamboo mattress pile system was not designed to function as a permanent load-bearing foundation. Instead, it served as a temporary ground improvement method aimed at increasing the bearing capacity of soft and compressible soils, which are often found in coastal and lowland areas.

The primary function of the bamboo mattress was to prepare the subgrade for the construction of more permanent pavement layers. These permanent layers were installed only after the ground reached a sufficient level of consolidation. The structural layers that eventually carried the final loads of the toll road included:

- Geotextile membranes, which act as separators, filters, and reinforcements between the subgrade and the aggregate layers
- Sub-base and base course materials, which are typically made of compacted granular aggregates to provide strength and distribute loads efficiently
- Asphalt pavement, which serves as the final surface layer and provides durability, resistance to weathering, and a smooth surface for vehicles

Once the consolidation process was complete and these layers were in place, the bamboo mattress no longer played an active role in load-bearing. It remained embedded within the subgrade as a passive element, while the structural loads of the toll road were fully supported by the engineered pavement system above.

Projected Performance Period

(Based on Studies and Similar Projects)

1. **Initial Soil Stabilization Function**

   The bamboo mattress functions effectively during the soil consolidation phase, typically within the **first 2–5 years** after construction. After that, the structural load is carried by the permanent pavement layers (geotextile, sub-base, base course, and asphalt).

2. **Resistance to Long-Term Land Subsidence**

   - In areas where land subsidence rates reach 10–20 cm per year (as observed in parts of Semarang and Demak), within **10–15 years**, the road may experience structural or functional damage if regular monitoring and maintenance are not performed.
   - With supporting systems such as drainage, elevated roadbeds, and tidal flood barriers, the effective service life of the road could reach **15–30 years,** though periodic elevation adjustments may still be necessary.

3. **Resistance to Tidal Flooding**

   - Without active flood protection systems (such as sea walls or pumping stations), sections of the road may become submerged in **less than 10 years,** especially if elevation design does not account for sea level rise and ongoing subsidence.

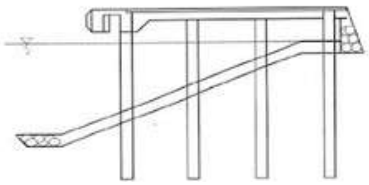
The bamboo mattress reinforcement is only effective in the short term, around 2 to 5 years, to help stabilize soft ground during early construction. The long-term durability of the toll road against land subsidence and tidal flooding depends on good elevation planning, flood protection, and regular maintenance. With proper measures, the road can last 15 to 30 years, but it will still need upgrades over time to stay safe and functional.

Precedent Studies

Pier Construction (*Konstruksi Dermaga)*

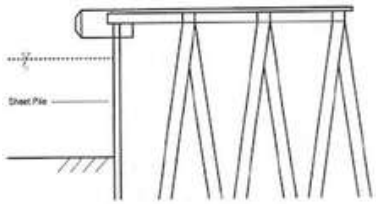
A pier is a platform supported on pillars or girders, used as a landing stage for ships and boats. It serves as a key structural component of a port, facilitating the transfer of goods and people between land and sea (U.S. Army Corps of Engineers, 2008)

Common structure types



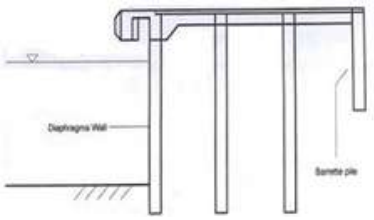
Deck on Pile

All loads including berthing and mooring forces are transferred to the piles; the seabed below follows its natural slope



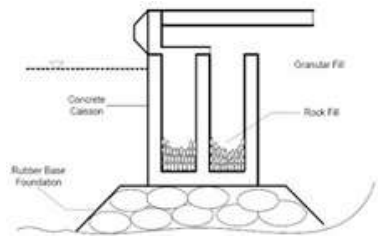
Sheet Pile

Uses retaining walls, good for steep coasts, may need anchors or piles, not suited for strong waves.



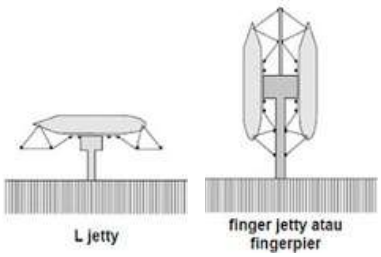
Diaphragm Wall

Uses angled concrete blocks with anchors to hold loads, builds fast but needs experts and special tools, not for wave-prone areas.



Caisson

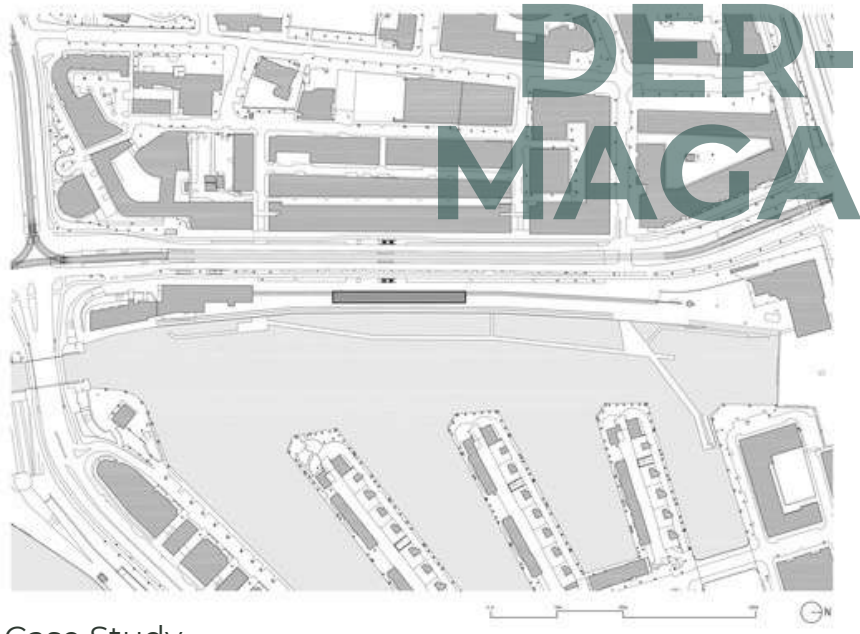
Caisson jetty uses heavy blocks placed on weak soils, easy to prefab but needs expert work and seabed prep, not for rough waves.



Dolphin

Dolphin Jetty is a light offshore structure with a bridge, used for ferries or bulk, dolphins hold ships, jetty head handles loading.

Figure . Jenis Struktur Dermaga
Source: blastingandgeoandcivileng.blogspot.com



Case Study
Port of **Rotterdam**

Location : Rotterdam, Netherlands
Operational Since : 14th century (Developed significantly in 19th)
Area: ~12,500 hectares
Structure Type : Combination (Diaphragm walls, Deck on Piles)

Structural System

Pile Type	Usage	Description	Service Life
Steel tubular piles (1.4 – 2.0 m Ø)	*Heavy quay walls, deep-sea structures*	*High load capacity, marine-grade durability, supports cranes and large vessels*	*Reliably serve 40–70 years*
Prefabricated concrete piles (0.4-0.6 m Ø)	*Light structures, support platforms*	*Suitable for lighter loads, faster installation, used in non-primary areas*	*≥50 years*

Port of Rotterdam



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XVII European Conference on Soil Mechanics and Geotechnical Engineering
ECSMGE 2019 Reykjavik

Full-scale load testing on long prefabricated concrete piles in the Port of Rotterdam

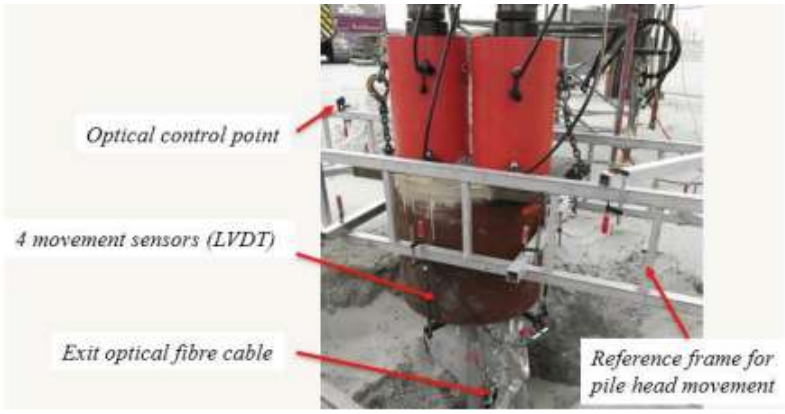


Figure . Test Site Instrumentation
Source: Matić et al. (2019)

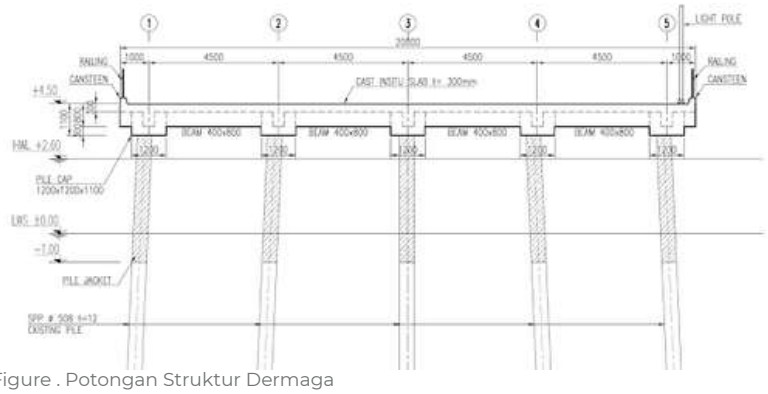


Figure . Potongan Struktur Dermaga
Source: ridadesyani.blogspot.com

In situ load tests were conducted in the Port of Rotterdam. In this study, full-scale static load tests (SLT), were conducted on four prefabricated piles (36m long), in order to optimize the design of a new quay wall. Since the piles were loaded in different time periods, the effect of aging was additionally investigated in this study.

Testing Frames

The pile load tests followed a strict process. Each time they added more weight, they held it for at least an hour, or up to three hours, until the pile stopped settling too much (met a creep criterion). Before adding the next bigger load, they'd briefly reduce the weight to 200 kN for 15 minutes. They increased the load by 500 kN or 1000 kN steps. The test continued until the pile failed, which meant the bottom of the pile moved 50 mm. The load applied right before this failure point was recorded as the pile's ultimate load capacity, and then the test for that pile ended.

ULTIMATE LOAD CAPACITY PER PILE

8.800 kN to 12.000 kN

Or equivalent to the load carried by a 3–5 story apartment building.

Pier Cons-truction Stages

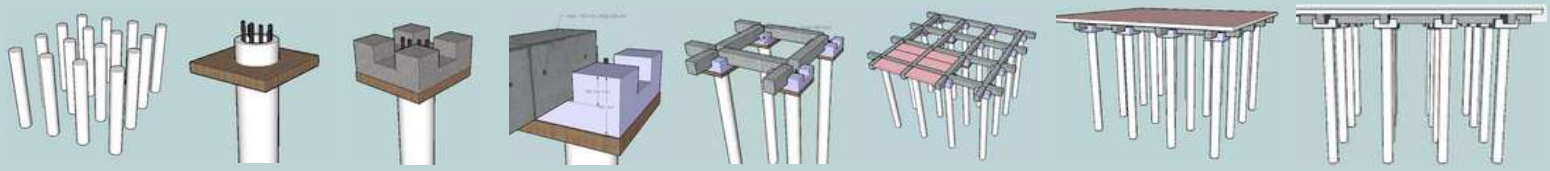


Figure . Tahapan Konstruksi Dermaga
Source: ridadesyani.blogspot.com

What *groundwork must be done to ensure the buildings can remain durable for years to come?*

The design concept focuses on enabling the residents of Dusun Semonet to return and sustainably live in their original settlement, which has long been threatened by tidal flooding and land subsidence. Since the design aims to reintroduce housing, which are significantly heavier than ordinary-grounded houses, a careful attention must be given to ground conditions.

The soil in the site is soft, unstable, and prone to further sinking. Therefore, the construction process begins with soft soil reinforcement using *cerucuk matras bambu*, a technique that involves densely packed bamboo piles functioning as mat to evenly distribute loads and stabilize the ground.

Once the ground is stabilized, construction continues with a pier construction that lifts the entire building above ground level, allowing for water movement beneath the buildings and reducing flood exposure.

01 ***Cerucuk Matras Bambu***
To distribute loads and stabilize the ground

+

02 **Pier Construction**
Structure that remains strong for decades

Precedent Studies

How to make the housing affordable for the community

‘The Pitstop’ Modular Housing

The Pitstop was the winning entry in the 2016 Innovative Youth Housing Design Competition and Construction, organized by the Hong Kong Institute of Architects. The project emphasizes adaptable living environments, offering flexible spaces and room configurations tailored to individual preferences and lifestyles. The design brief required a single unit measuring 3×5 meters with a floor-to-floor height of 3.7 meters, intended for youth aged 18–34, along with 500 m² of shared communal facilities.

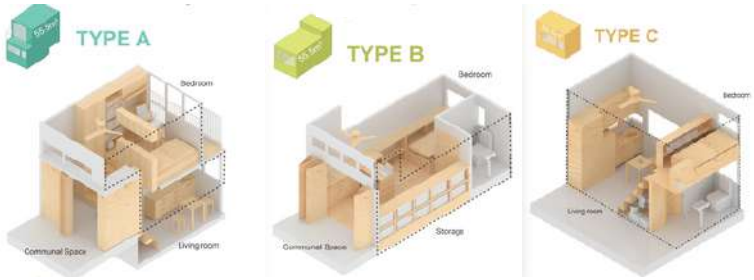


Figure . Pitstop Modular Housing
Source: dezeen.com

Construction & Modular Concept

- Composed of three interoperable prototype units, each with different heights and volumes to create flexibility and variety
- Modular units feature a movable wall that connects private space to communal areas, allowing expansion of living space through shared facilities
- The design celebrates co-living, where individual units can be joined or remain separate, supporting diverse levels of sociability

Material

- Construction approach emphasizes lightweight modular design, though specific structural materials (e.g., steel, timber) aren’t explicitly detailed in public sources

Why it is affordable?

- Modular Method (Prefabricated units are built off-site and assembled on-site, saving time and construction costs)
- Temporary and Reusable Structure (The structure is demountable and movable, allowing long-term flexible use)
- Demonstrates efficient use of very small footprints while maintaining mental and spatial comfort through vertical volume and light.

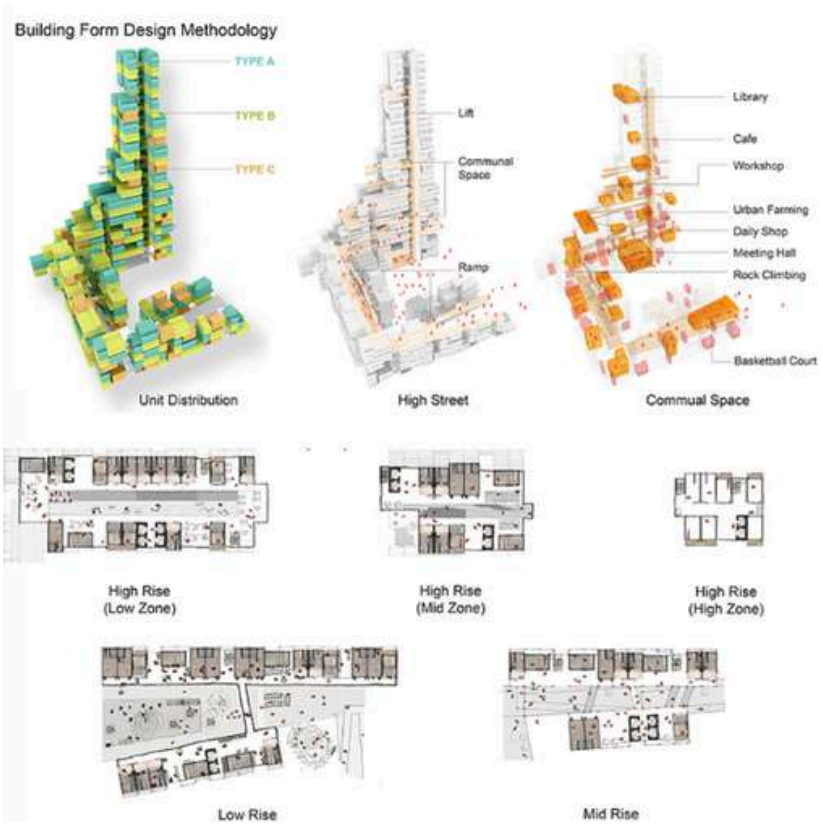




diagram translating the needs of the youths to building form

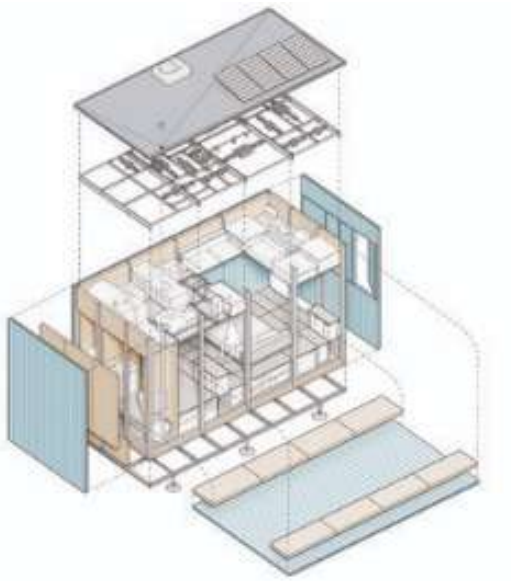
Modular Housing Prototype



Figure 26. Modular Housing
Source: archdaily

WHY is it relevant to Dusun Semonet?

- **Speed of Construction:** If Dusun Semonet faces housing shortages, requires rapid post-disaster rebuilding or needs to quickly scale up housing for community development, modular construction's speed is a major advantage.
- **Resource Efficiency & Sustainability:** Reducing on-site waste, using local and sustainable materials where possible (like bamboo or responsibly sourced timber), and implementing energy-efficient designs can greatly benefit Dusun Semonet's environmental footprint and long-term living costs.
- **Adaptability to Community Needs:** As highlighted in the article, modular homes can be a "blank canvas" that adapts over time. This is crucial for communities where family sizes or economic needs change, allowing residents to modify their homes without extensive reconstruction.



WHICH parts of the design are useful?

- **"Blank Canvas" for Customization:** The idea that modular housing offers a balance between standardization and customization is key. It means a basic, structurally sound module can be provided, and then adapted by residents to suit their cultural practices, family size, and aesthetic preferences. This is more empowering than a fully pre-designed, unchangeable home.
- **Emphasis on Durability and Resilience:** The article's underlying theme of robust, quality-controlled construction translates directly to building homes that can withstand local climate conditions and potential natural disasters.

HOW can be implemented?

1. **Pilot Project Development**
2. **Local Material Sourcing & Pre-fabrication**
3. **Community-Led Interior Customization**

Design Advantages

Modular Housing

In general, the concept of modular architecture can be defined as a design object based on specific modules, with identical forms that are repeated over and over. Le Corbusier also stated in the Modular Theory that 'modular' is not just a number, but also a measuring tool that can calculate distance, surface area, and volume (Monindra, 2016).

In the book Prefab Architecture by Ryan E. Smith, the foundation of prefabricated architecture consists of three main elements:

1. **Prefabricated Materials** (concrete, steel, wood, shipping containers, etc.)
2. **Modular Components** (both structural and non-structural components)
3. **Prefabricated Structural Systems** (precast systems, structural steel, etc.)

Design advantages of modular housing:

1. **Mobility and Reusability**
   - Relocatable: Modules can be disassembled and relocated when necessary, making them ideal for disaster zones or temporary settlements.
   - Reusable structures: Modular components can be reused in other projects, extending the material life cycle.
2. **Responsive to Contextual Challenges**
   - Adaptive for difficult sites: Suitable for flood-prone, remote, or hard-to-access areas, as module delivery is easier than conventional construction.
   - Emergency housing solution: Perfect for quickly providing shelter in disaster zones or as transitional housing.
3. **Scalability and Design Flexibility**
   - Easily expandable: Buildings can be extended horizontally or vertically by adding new modules as needed (e.g., growing families or increasing population).
   - Simple reconfiguration: Modules can be rearranged or repurposed for different functions, such as converting a home into an office or clinic.
4. **More Measurable and Efficient Costs**
   - Budget control: With most of the process happening in a factory, project costs are easier to predict and manage.
   - Reduced material waste: Factory production optimizes material usage, minimizing waste.

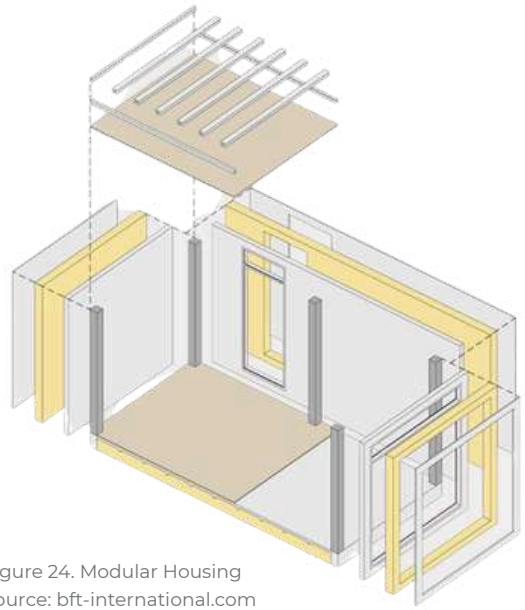


Figure 24. Modular Housing
Source: bft-international.com

How to create a new, comfortable living environment

Post-Katrina Housing

New Orleans, USA



Figure 25. Katrina Hurricane in New Orleans
Source: www.npr.org

Post-Katrina Housing in New Orleans refers to a range of efforts to rebuild and rehouse communities devastated by Hurricane Katrina in 2005, with a strong focus on sustainable, resilient, and equitable redevelopment. One of the most notable initiatives was the Make It Right Foundation, founded by actor Brad Pitt, which concentrated its work in the Lower Ninth Ward—one of the areas most severely affected by flooding after the levees broke.

WHY is it relevant to Dusun Semonet?

The Post-Katrina Housing case is highly relevant due to its similarities with Dusun Semonet's context:

- It addresses post-disaster recovery after severe flooding caused by levee failure.
- Located in a low-lying coastal area vulnerable to tidal flooding and sea level rise.
- Focused on rebuilding vulnerable communities, integrating social, economic, and ecological aspects.
- Aims to balance environmental safety with the sustainability of local livelihoods.

HOW can be implemented?

1. **Adaptable stilt houses**
2. **Use of local, moisture-resistant materials**
3. **Involving residents in the re-planning process**
4. **Cluster-based planning with dual access routes (land and water)**

WHICH parts of the design are useful?

1. **Elevated Housing**

Homes were raised on stilts to adapt to periodic flood risks.



Figure 26. Before and After Katrina Housing Typology in New Orleans
Source: thearchitectstake.com

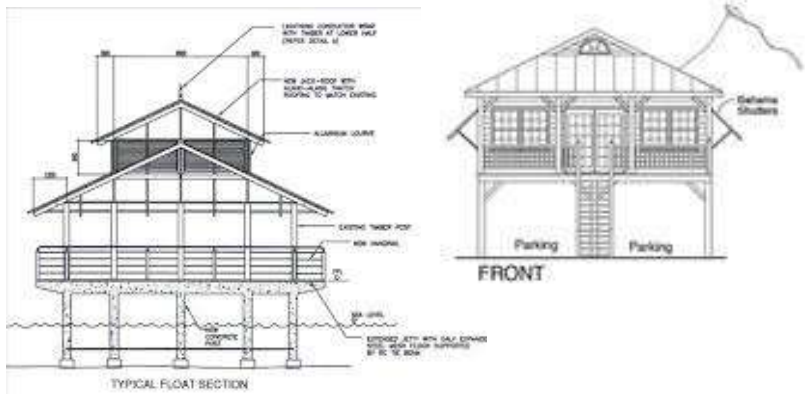


Figure 27. Modular House on Stilts
Source: pinterest.com

2. **Resilient and Eco-Friendly Materials**

The use of water-and termite-resistant materials, along with passive systems for energy efficiency such as
1. Fiber-Cement Siding
2. Treated or Engineered Wood Products
3. Metal Roofing
4. Recycled Plastic and Composite Decking
5. Concrete and CMU Foundations

3. **Community-Based Design**

Residents were directly involved in the design process, emphasizing empowerment over charity.

4. **Modular and Adaptable Construction**

Modular layouts allowed for flexible construction and adjustments based on family needs.

Precedent Studies

How to create a new, comfortable living environment

Tonle Sap Lake-Floating Village

Cambodia



Figure 28. Tonle Sap Lake-Floating Villages
Source: pelago.com

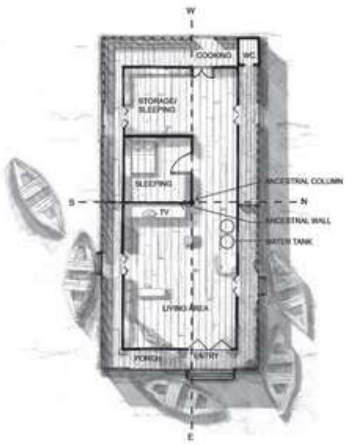
Most of the houses in Tonle Sap's well-known villages like Kampong Phluk and Kampong Khleang are actually built on high stilts, not truly floating. These stilt houses stand about 6–10 meters tall to stay above the floodwaters during the rainy season. There are also some floating structures (on bamboo rafts or barrels), especially in areas like Chong Khneas, but they're fewer and often used for schools, markets, or churches.

WHY is it relevant to Dusun Semonet?

- **Environmental Adaptation:** Tonle Sap's floating villages are designed to cope with seasonal flooding and drastic water level changes, as the lake can expand up to five times its dry-season size and water levels can rise over 7 meters, by building houses on tall stilts or floating platforms
- **Sustainable Design Practices:** The use of renewable, locally sourced materials (like bamboo) and low-impact building techniques from Tonle Sap provides a model for creating eco-friendly, sustainable architecture in Dusun Semonet, especially for a community-focused, resilient design.
- **Resilience to Climate Change:** The floating villages of Tonle Sap offer a unique example of resilience, where communities can adapt to shifting water levels. This adaptability is valuable when planning for areas like Dusun Semonet that may need to be flexible in response to climate impacts.

WHICH parts of the design are useful?

1. **Stilted Construction**
   Why Relevant: Dusun Semonet also faces flood risks. This shows that permanent stilt construction is more structurally reliable than full-floating houses, especially for long-term living.
2. **Flexible Access and Circulation**
   Why Relevant: Dusun Semonet may also need dual modes of circulation depending on the season.
3. **Water-based Livelihood Integration**
   Why Relevant: Many residents of Dusun Semonet are also reliant on water-based livelihoods like fishing.



HOW can be implemented?

1. **Adaptation instead of Relocation**
2. **Housing can respond to flood rhythms**
3. **Infrastructure for dual-season access**
4. **Integration of water-based livelihood**

Design Advantages

Stilt Construction

The stilt house is an old tropical house found in Indonesia, especially on river banks or sea coasts. Stilt houses are a type of building that is synonymous with fishing villages. The stilt house can be divided into two: the land stilt house and the fisherman stilt house. Based on its purpose, the stilts on the land aim to avoid dangerous animals and withstand earthquakes. Meanwhile, fishermen's stilt houses aim to avoid sea/river water when it overflows or during high tides (Rukayah et al., 2023).

Unfortunately, the existing building typology in Dusun Semonet has not yet adopted stilt construction. As a result, residents were forced to abandon their homes after repeatedly elevating their ground-level structures in an attempt to cope with rising water levels. The absence of a resilient architectural response such as stilt-based housing left the community vulnerable, highlighting the urgent need for a typological shift that aligns with the environmental realities of the site.

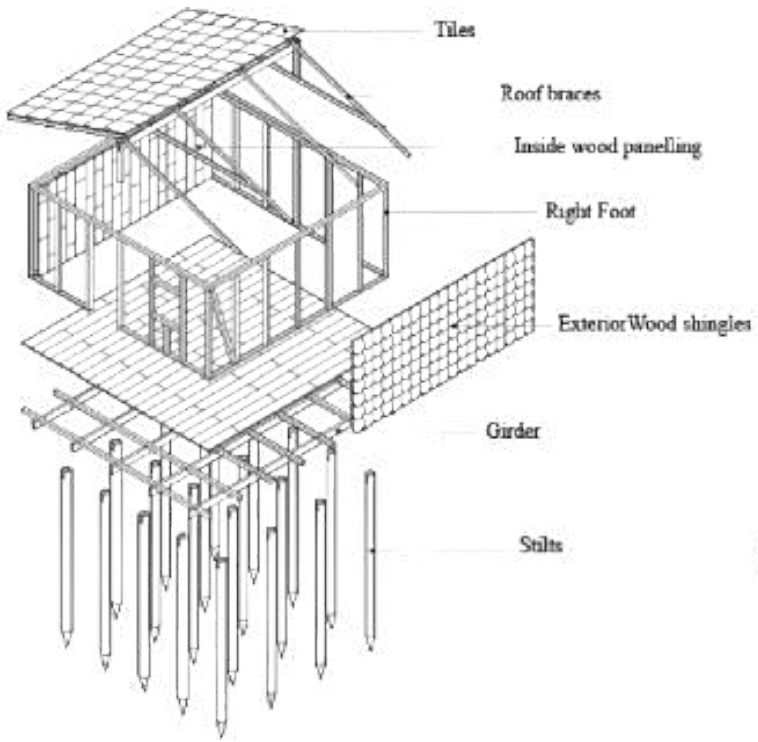


Figure 23. Vernacular Architecture and Wood Construction
Source: link.springer.com

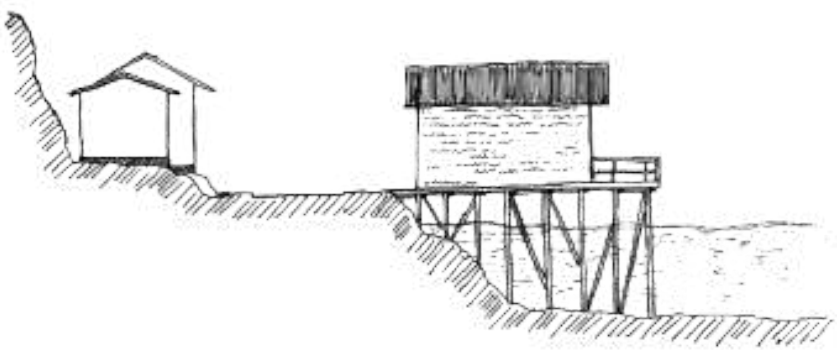
1. Adaptation to Persistent Flooding
   - The area faces continuous tidal flooding (rob) and is already submerged in many parts. Building on stilts elevates homes and infrastructure above water level, protecting them from direct water contact and allowing daily life to continue even during high tides.

2. Preservation of Community's Connection to Water
   - The residents' livelihoods—primarily fishing and aquaculture—are water-based. Stilt construction allows homes and workspaces to remain close to the sea, maintaining physical and functional proximity to their economic activities without the need to relocate inland.

3. Minimizing Land Displacement and Costs
   - Rather than investing in new land or massive land-raising efforts, stilt structures enable construction on the existing submerged or semi-submerged site. This reduces land acquisition costs and minimizes disruption to established social ties and spatial memory.

4. Flexibility and Modular Growth
   - Stilt systems can support modular housing and community structures that can be expanded vertically or horizontally based on future needs. This offers resilience not only to water but also to social and demographic changes over time.

5. Proven Vernacular Precedent
   - Many traditional coastal and riverine communities in Indonesia and Southeast Asia use stilt architecture to live harmoniously with water. This proven strategy aligns with local climatic conditions, cultural familiarity, and available materials, making it both practical and culturally relevant.



Precedent Studies

How to create a new, comfortable living environment

Keramba Jaring Apung



Figure 34. Floating Net Cages
Source: aquatec.com

Floating Net Cages *(Keramba Jaring Apung* are a form of a mariculture, a fish farming system conducted in marine or brackish waters using floating frames and nets to contain the fish. This system enables aquaculture to continue even when traditional fishponds have been lost or damaged due to disasters such as tidal flooding or coastal erosion.

Aspect	***Mariculture***	***Aquaculture***
Water Type	Marine (seawater, coastal areas, open ocean)	Freshwater or brackish water (rivers, lakes, ponds, or artificial tanks)
Species Cultivated	Marine fish (e.g., tuna, grouper, snapper), mollusks (e.g., oysters, mussels), crustaceans (e.g., shrimp, lobster), seaweed	Freshwater fish (e.g., tilapia, catfish, carp), shrimp, ornamental fish
Cultivation Methods	Floating net cages, offshore farms, rack systems for shellfish, seabed farming	Ponds, raceways, recirculating aquaculture systems (RAS), cage farming in freshwater bodies
Challenges	High exposure to natural environmental conditions (currents, storms, salinity changes), higher initial investment	Water quality management, land use conflicts, disease outbreaks
Environmental Impact	Can affect marine ecosystems if not managed properly, risk of escapes altering local biodiversity	Can lead to eutrophication in freshwater bodies, requires careful waste management



Raft Construction

- Frame Materials: Wood, bamboo, or anti-rust coated iron; typical size 6×6 m or 8×8 m.
- Floatation: 200-liter plastic drums, styrofoam, or fiberglass; 8–9 floats (6×6 m), 12 floats (8×8 m); partially filled with carbide for buoyancy.
- Fasteners: Bamboo rafts use 4–5 mm wire or PE rope; wooden/metal rafts use bolts.
- Anchoring: 25–50 kg anchors (iron or concrete); rope diameter 0.5–1.0 inch; rope length at least twice the water depth.

Net Construction

Net Pockets:

- Outer Net: Protection from predators (larger mesh).
- Inner Net: Fish containment (adjusted for fish type & maintenance).

Mesh Size:

- Fine net: 0.5 cm
- PE nets: 1.0–1.5 inch
- Spare Nets: 6 total per unit (3 used, 3 spare).
- Sinkers: 2–5 kg (stone, lead, or concrete) at each net corner for stability.

Net Depth:

- *Ranges between 1–2 meters, depending on fish type, site conditions, and maintenance access.*

Species

The species that can be further developed are vannamei shrimp and milkfish, (bandeng) as they are capable of thriving in brackish to marine water. This is also supported by existing data showing that vannamei shrimp is currently the main aquaculture commodity being cultivated in traditional ponds.



Pemkot Pekalongan Sokong Teknologi Budidaya Ikan Keramba Apung

Jurnalis Pangannews

Saturday, 10 June 2023 10:10 WIB

Para Petambak Di Pekalongan Diminta Menggunakan Sistem Jaring Tancap dan Jaring Apung Untuk Antisipasi Rob

Selasa, 25 Juli 2023 Lina Kasih Zona JOSS 0

Alignment with Government Programs

The transition from traditional fish ponds to floating net cages is considered appropriate, as it aligns with interventions by the Pekalongan City Government.

These include the use of floating and staked fish cages to boost aquaculture productivity, especially in flood-affected areas. Fish farming is adapted based on water salinity—brackish outside the parapet and fresh within. Cultivation methods are adjusted accordingly, using species like tilapia, freshwater milkfish, or shrimp. Staked ponds use bamboo supports, while floating cages rely on buoyant materials like drums or foam to remain functional even during tidal flooding.

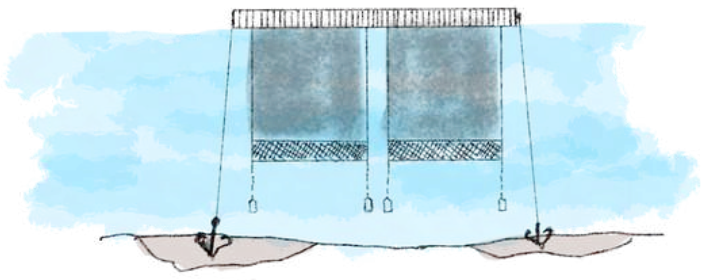
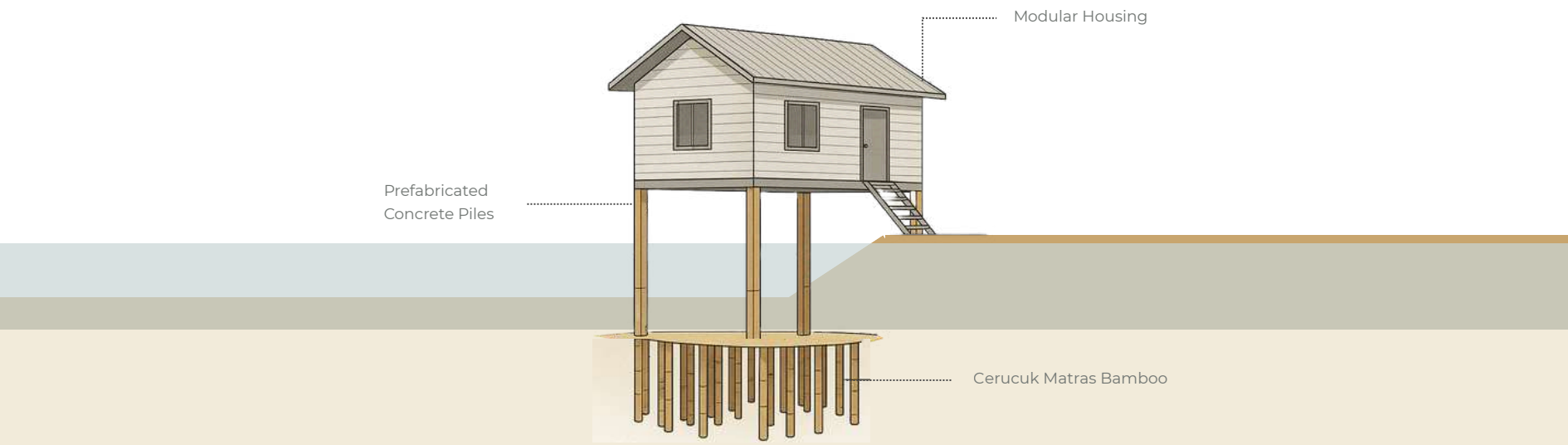


Figure 35. Floating Net Cages Sketch
Source: Author

Summary of Design Problems

The main challenge in rebuilding Dusun Semonet is to create housing that is resilient, affordable, and adaptable to tidal flooding, land subsidence, and sea level rise. Because the ground is unstable, buildings can no longer use standard foundations. Instead, the solution is to build stilt houses. The process starts with a bamboo mattress (cerucuk matras) to stabilize the soft soil, followed by foundation pillars. The main structure uses prefabricated concrete piles, chosen for their strength and resistance to water. Houses are built using a modular system, so residents can build gradually with local materials, making the process more affordable and easier to maintain.



Design Results and Justification

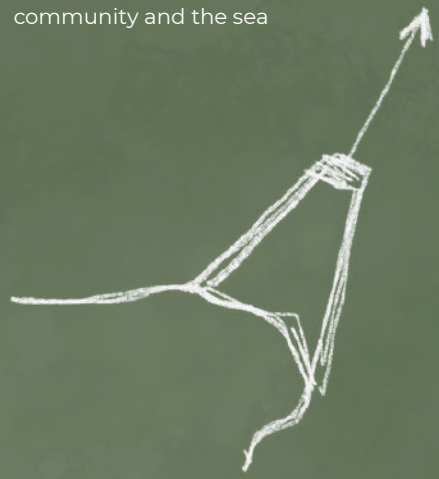
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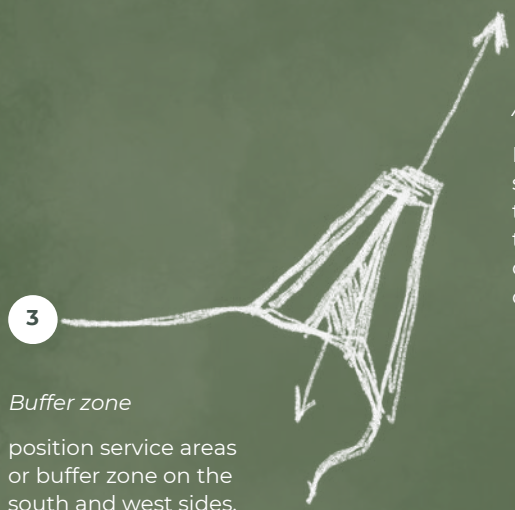
Zoning Exploration



1 The building located at the northernmost area, directly bordering the sea, serves as a narrative statement that this design is prepared to adapt to the changes

2 Building orientation towards north, opens up uninterrupted views of the ocean, reinforcing connection between community and the sea





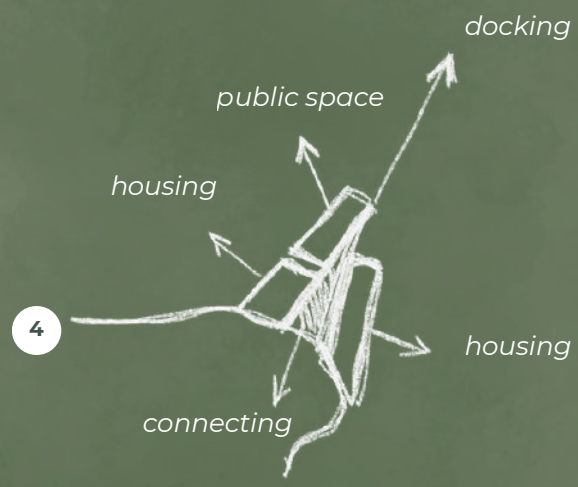
3

Active Zone

Place active spaces on the north side to take advantages of brighter and cooler conditions

Buffer zone

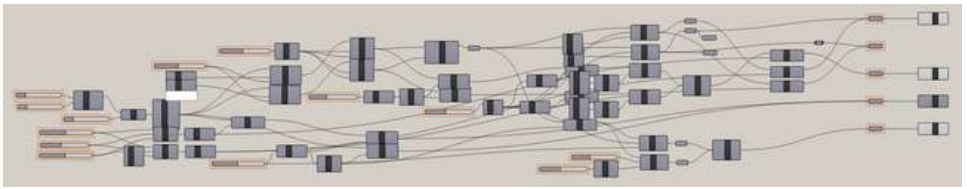
position service areas or buffer zone on the south and west sides, as these are hotter area that requires additional shading



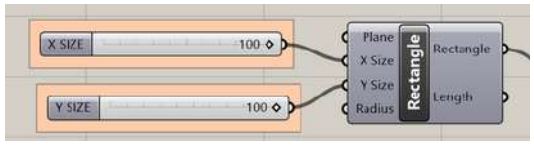
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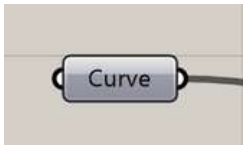
Rhino Grasshopper: Parametric Multi-Floor Building Structure

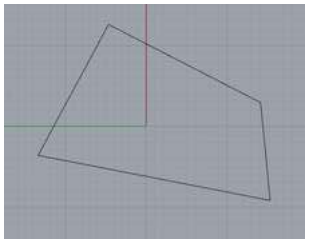
With the intended concept, the building will consist of multiple floors and will remain adaptable for future development, adjusting to rising sea levels. This script automatically generates and controls the building form and structure across multiple floors.

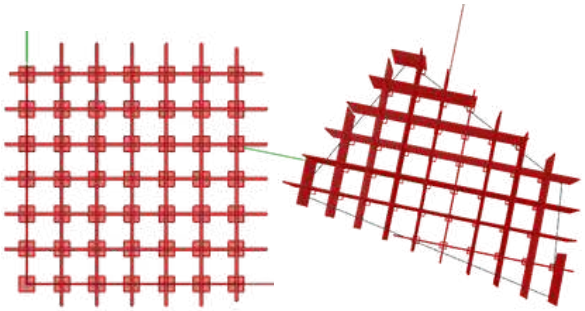




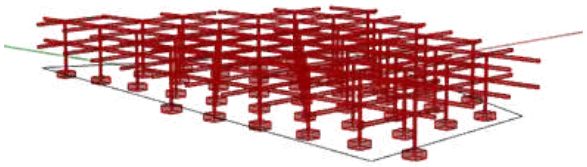




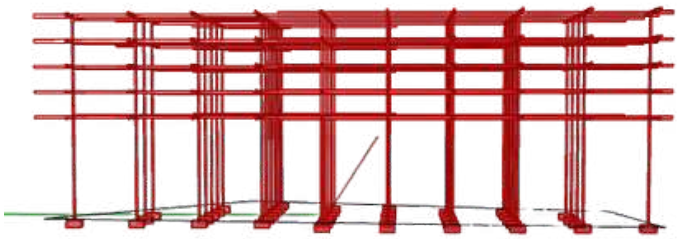




adjustable form



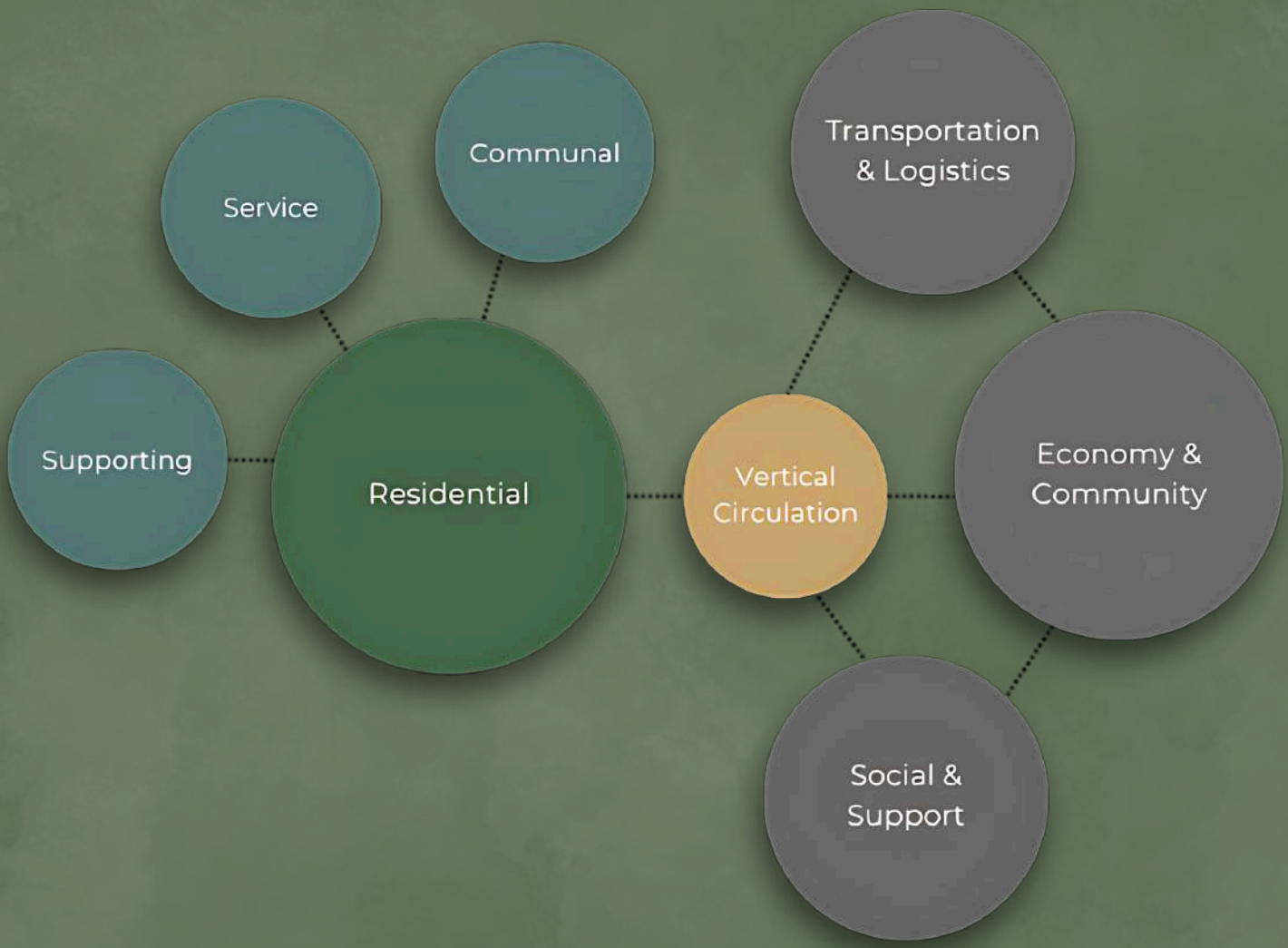
adjustable floor



adjustable height per-floor

Based on the design guideline that requires the lowest floor to be elevated at least 2 meters above the current ground level, this design adopts a height of 3 meters. This elevation is considered a safe threshold to anticipate sea level rise projected between 2030 and 2050, while also allowing for the development of up to four floors in the future.

Facilities to be Provided



Room Programming

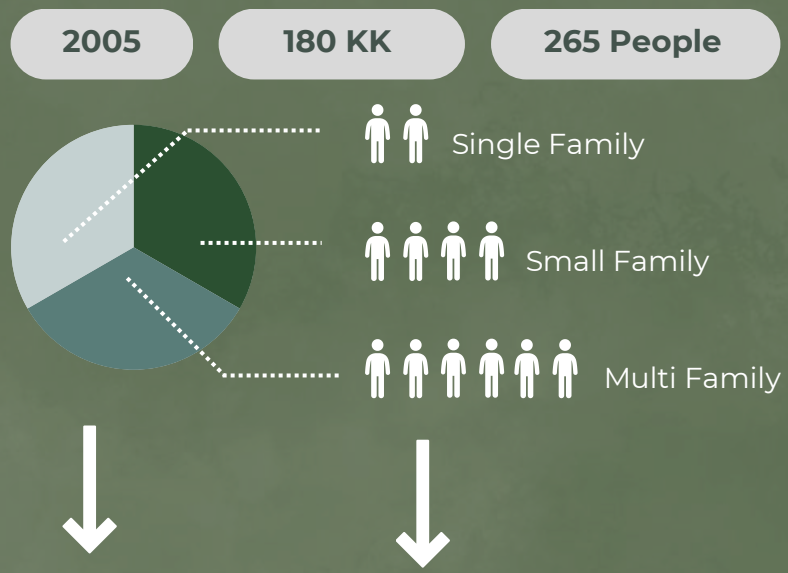
Category	Room Name	Area per Unit (m²)	Quantity	Placement / Function
Residential	Type 36 Unit	± 36	200 unit	Each floor, arranged symmetrically along corridor
Vertical Circulation	Emergency Staircase	± 12	2 (1 per block)	Positioned at corners or near ramp
	Ramp	Width 1.5–2 m, L = ±24 m*	2 (1 per block)	Accessible route, connects floors, ideal slope 1:12
Communal	Block Lobby	± 20	2 (1 per block)	Entrance transition area
	Multipurpose Room	± 60–100	1 (shared)	Located on ground floor of one block
	Prayer Room (Musala)	± 30–40	1	Can be standalone or combined with multipurpose room
	Management Office	± 12–20	1	Ground floor, near main entrance
Service	Corridor	Width ±1.8–2 m	Each floor	Main horizontal circulation
	Mechanical & Electrical Room	± 9–12	1 per block	For utilities like electrical panels and water systems
	Temporary Waste Area (TPS)	± 12–15	1	Central waste collection, near service access
	Shared Laundry-Drying Area	± 20–30	1 per block	On rooftop or top floor
Supporting	Security Post	± 6	1	At main gate or entrance
	Community Kiosks/Shops	± 6–9	2–4 units	Ground floor near lobby
	Playground / Open Space	Variable (50–80)	1	Between blocks or site side
	Health Post / Small Clinic	± 12–16	1	Can share space with multipurpose room (flexible use)

Room Programming

Category	Room Name	Estimated Area (m^2)	Main Function / Description
Transportation & Logistics	Main Dock	Variable (min. 100)	Mooring area for fishing boats and fish distribution
	Fish Unloading Area	± 50–80	For unloading the catch, directly connected to the market
	Cold Storage / Refrigerated Room	± 20–30	Temporary fish storage to maintain quality
	Weighing and Sorting Room	± 20	For weighing and classifying the fish catch
	Floating Net Cages (Keramba Apung)	Water surface area ± 200–400	Aquaculture system for cultivating fish in open water
Economy & Community	Open / Semi-Open Fish Market	± 100–150	Market area for selling seafood, flexible and easy to clean
	Food Stall / Small Eatery	± 6–12/unit	Selling cooked or processed seafood by locals
	Traditional Fish Processing Area	± 30–50	For producing salted fish, boiled fish, smoked fish, and other processed seafood
	Workshop / Training Room	± 30–40	Education for fish processing, training for community-based economy
Social & Support	Community Hall / Multipurpose Room	± 60–80	For community meetings, training, or emergency shelter
	Prayer Room (Mushola)	± 30	Place of worship for local residents
	Public Toilet & Shower	± 15–20	Sanitary facilities for visitors and workers
	Fishing Gear / Fish Cleaning Area	± 10–15	For washing fishing equipment and seafood
	Rainwater Harvesting (RWH) System	As needed	Supports clean water supply in isolated area
	Security & Information Post	± 6–9	Access control and visitor information center

Population Assumption

Dusun Semonet was originally inhabited by 180 households, with a total population of 265 residents. This number of households is used as the reference point, as it represents the village's original community. To anticipate natural population growth, the design proposal includes the provision of 200 housing units. Based on data and reasonable assumptions, around 50 percent of households consist of 3 to 4 members, 30 percent consist of 5 to 6 members, and the remaining 20 percent consist of 1 to 2 members.



Housing Unit Type	Occupant	Block A		Block B	
Single Unit	1-2	20	40	46	92
Small Family Unit	3-4	20	80	46	184
Multi Family Unit	4-6	20	120	48	288
		60	240	140	564

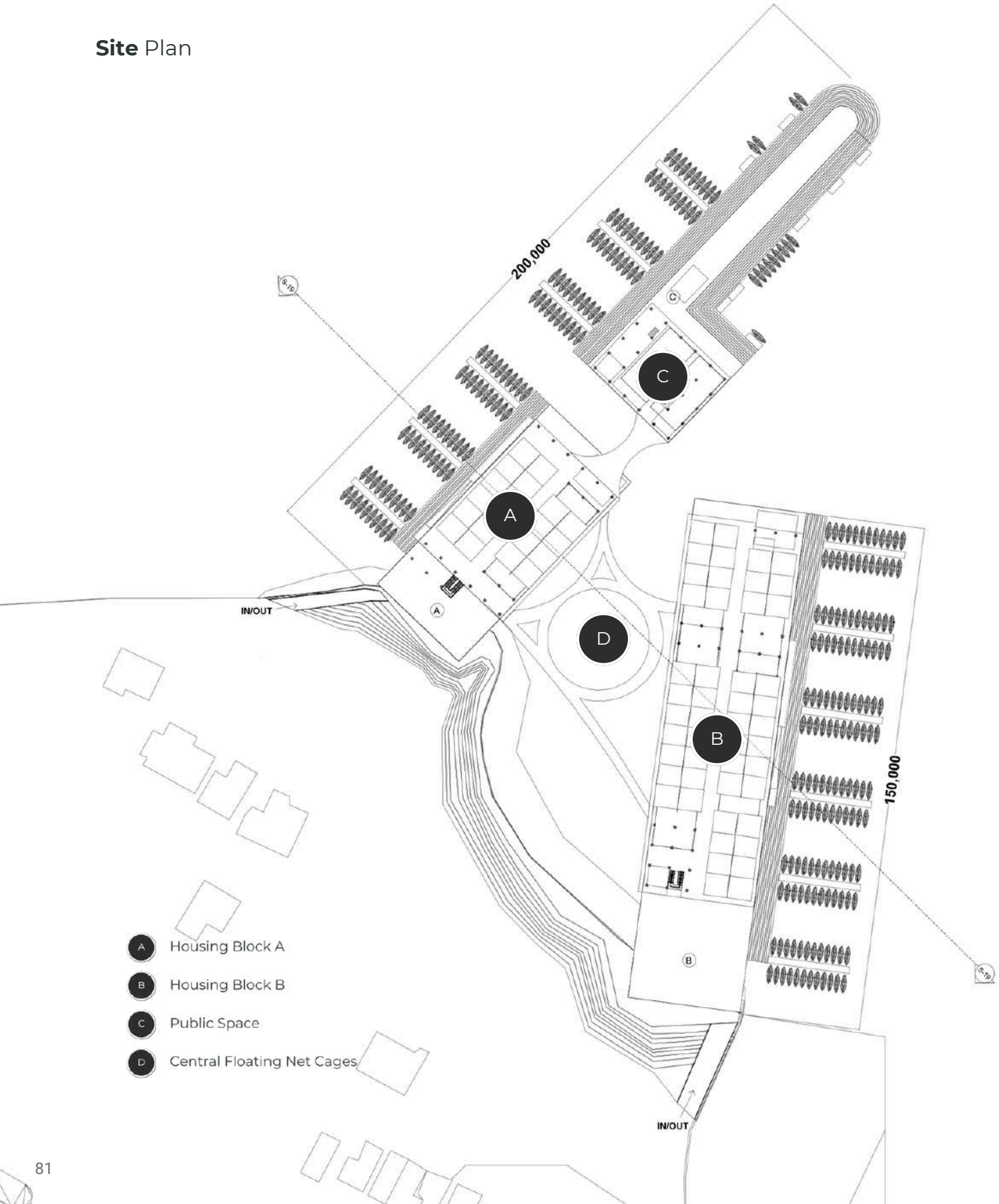
200 *Unit Housing*

±800 *People*

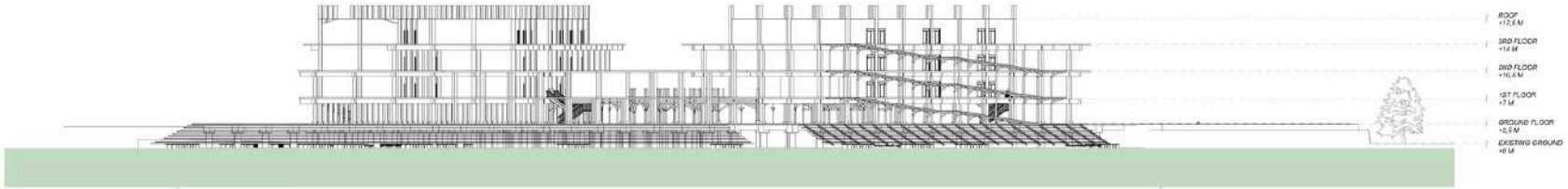
≈3x from Original Population

These demographic characteristics guide the creation of three housing types: single-unit housing, small family units, and multi-family units. In total, the design is planned to accommodate up to 200 housing units, with a capacity of approximately 800 occupants. This figure is nearly three times the village's current population, addressing future growth.

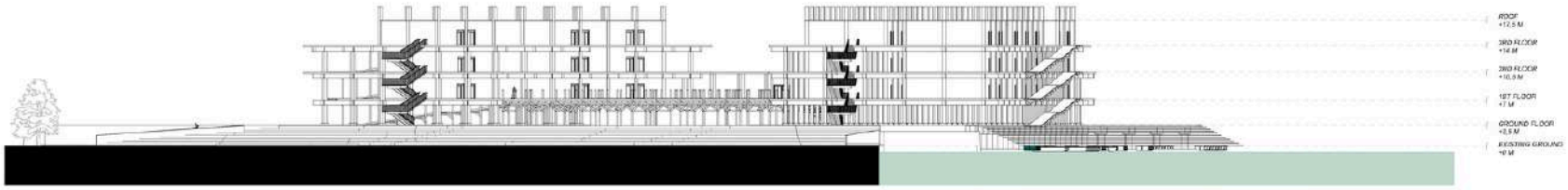
Site Plan


200,000
150,000
A
B
C
D
IN/OUT
IN/OUT
A Housing Block A
B Housing Block B
C Public Space
D Central Floating Net Cages

Building Elevation



NORTH ELEVATION 1:500



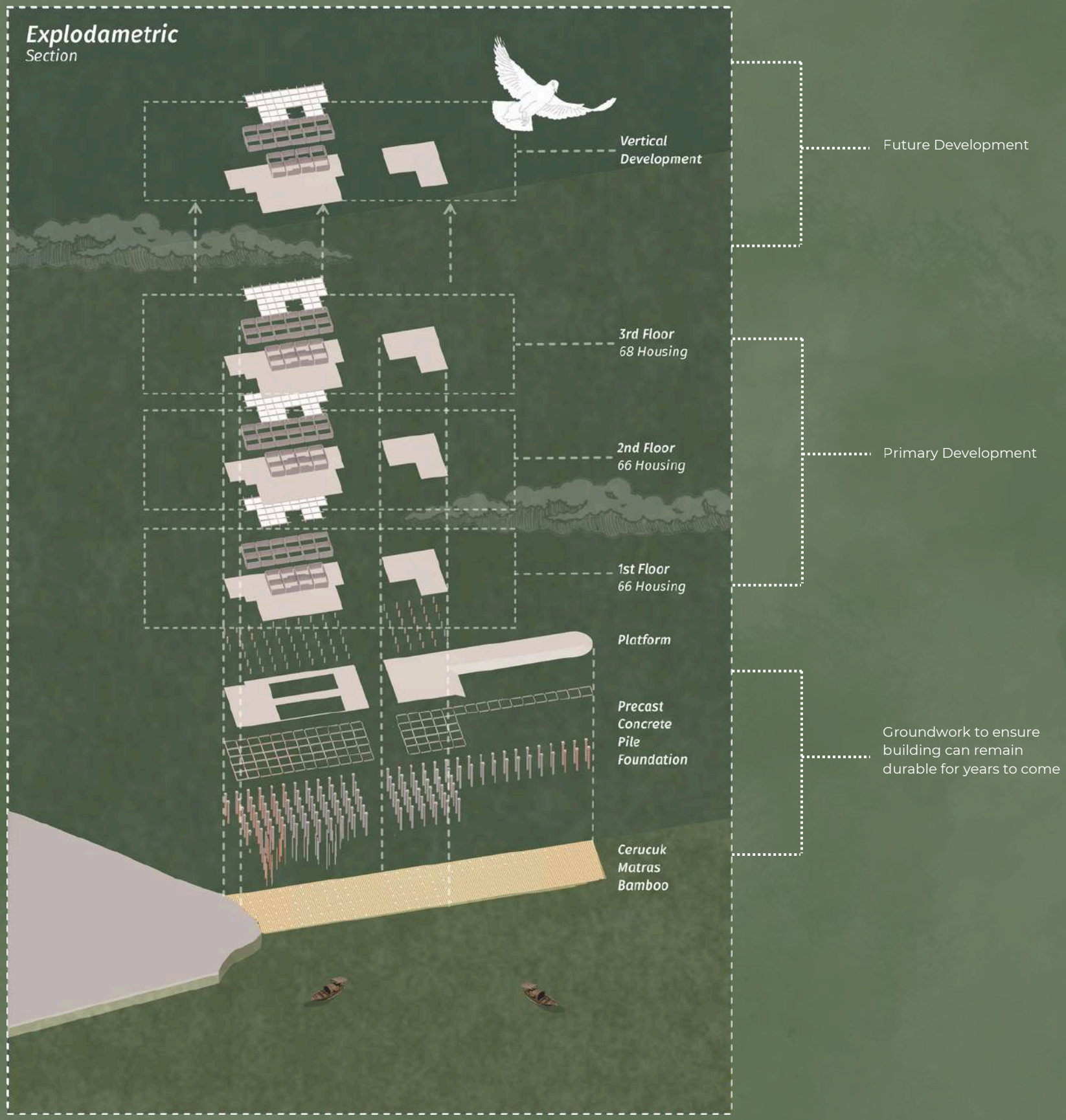
SOUTH ELEVATION 1:500



EAST ELEVATION 1:700

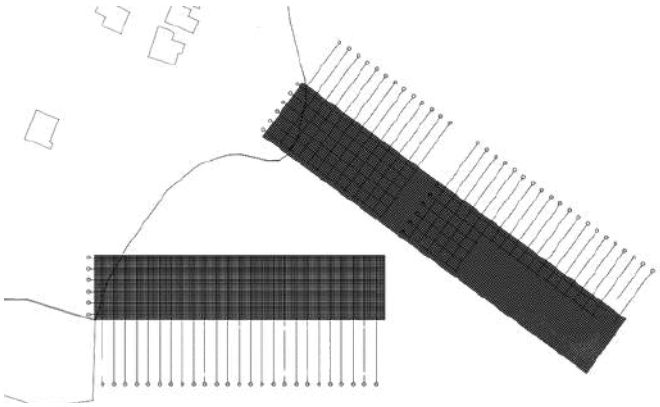


WEST ELEVATION 1:700


Explodametric
Section
Vertical Development
3rd Floor
68 Housing
2nd Floor
66 Housing
1st Floor
66 Housing
Platform
Precast Concrete Pile Foundation
Cerucuk Matras Bamboo
Future Development
Primary Development
Groundwork to ensure building can remain durable for years to come

Detail *Cerucuk Matras Bamboo*

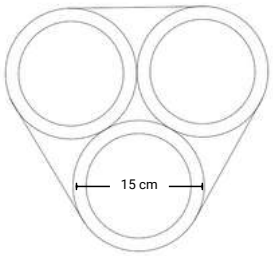
As part of the effort to distribute structural loads effectively, construction begins with the installation of a bamboo mat foundation *(cerucuk matras bambu)* laid across the seabed. This technique serves to stabilize the soft marine soil and prevent excessive settlement, allowing the structure to withstand environmental conditions for an extended period. Once this preliminary reinforcement has ensured adequate soil stabilization, a pile foundation, similar to those commonly used in pier construction is installed to support the superstructure securely.



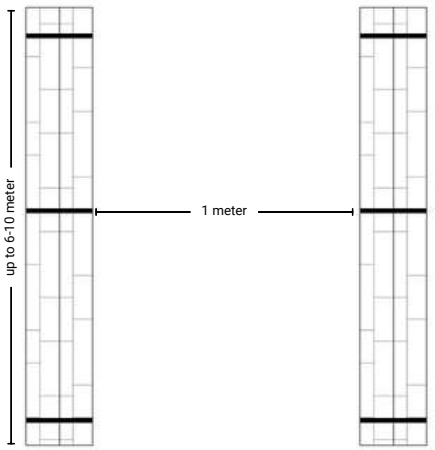
A

Detail Cerucuk

3 bamboo poles with a diameter of 15 cm are installed at a depth of **6–10 meters** below sea level



Top View Section

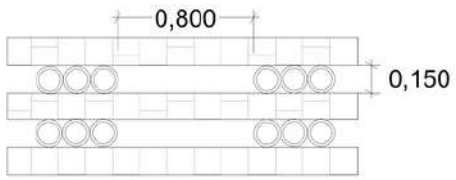


Side View Section

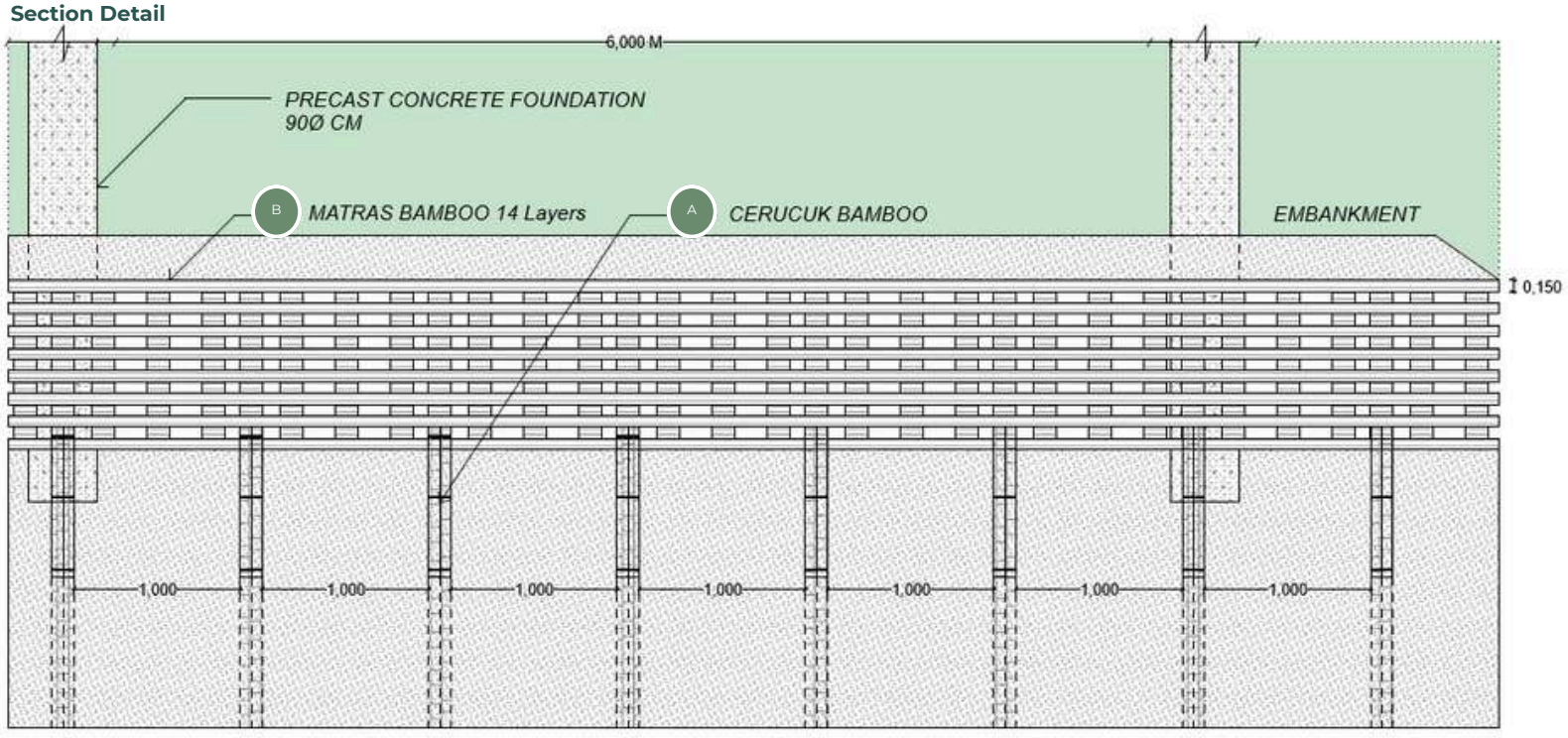
A

Detail Matras

The mat consists of 3 to 14 layers of bamboo, with approximately 80 meters of spacing between each mat. Each layer is arranged in alternating horizontal directions.



Section Detail

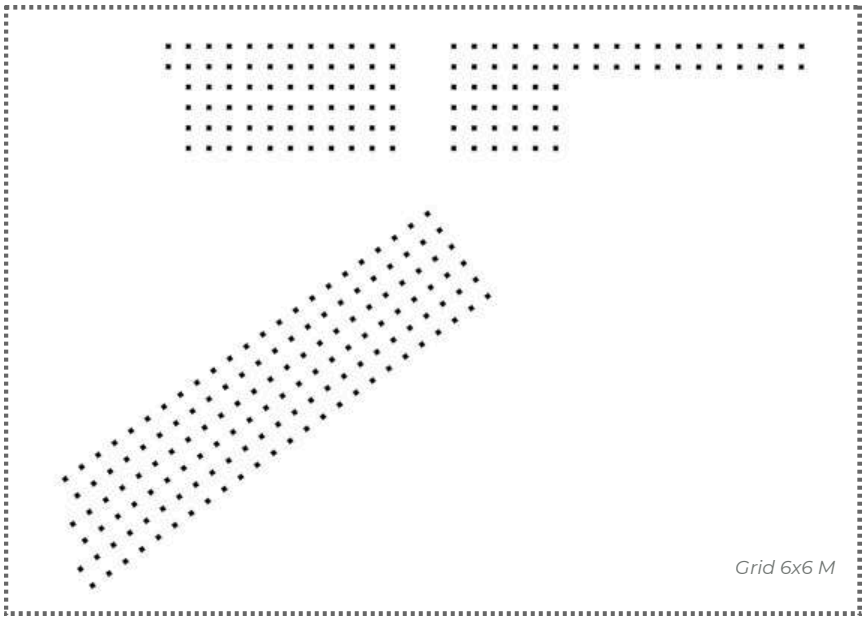


Foundation Detail

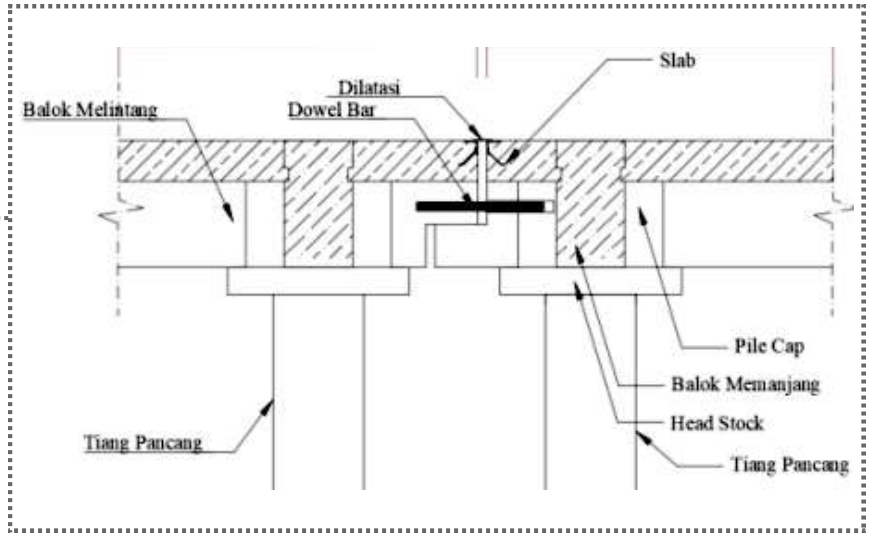
The foundation system in this design uses precast concrete columns with a diameter of 90 cm and a depth of 6 meters, spaced 6 meters apart, following structural methods similar to those used in pier construction.

In comparison, prefabricated concrete piles with diameters of 40 to 60 cm are commonly used for lighter structures, offering an ultimate load capacity of 8,800 to 12,000 kN, which is equivalent to supporting a 3 to 5 story apartment building. However, the larger column size in this project is purposefully chosen to withstand higher structural loads and direct exposure to coastal conditions, including seawater and unstable soil. With appropriate engineering treatments such as corrosion-resistant coatings, waterproofing, and consistent maintenance, this foundation system ensures long-term durability and is expected to remain stable and functional for 50 years or more while supporting future vertical development.

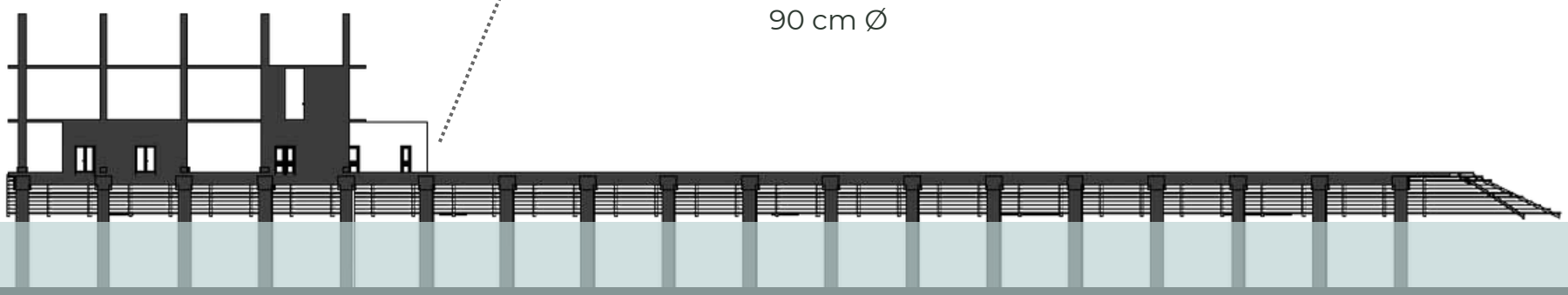
Foundation Plan



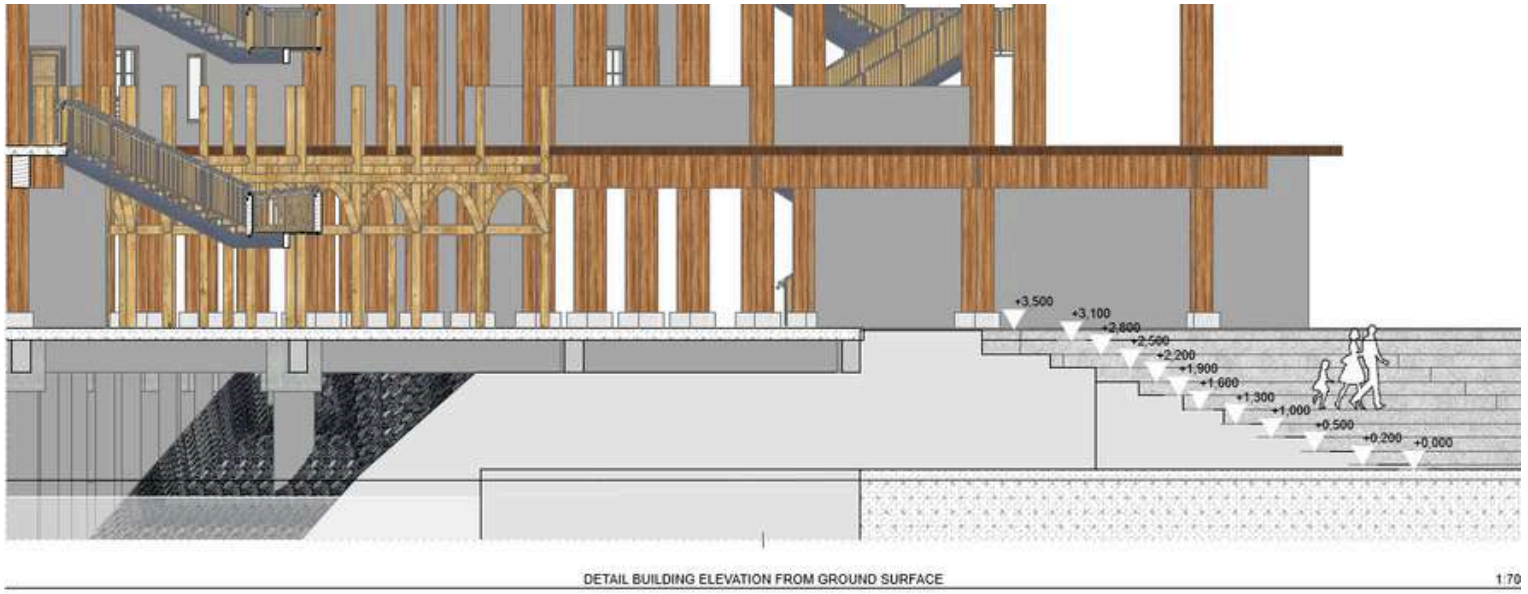
Detail Section



Prefabricated Concrete Pile
90 cm Ø



Building Elevation



3.5 Meter

The buildings will be constructed at an elevation of 3.5 meters above the current ground level, a height carefully determined as a safe threshold to withstand the combined relative impacts of land subsidence and sea level rise projected through the year 2030. In addition to this elevated base, each floor will be designed with a floor-to-floor height of 3.5 meters, providing sufficient vertical clearance.



Column Materiality



GLULAM 50x50 cm

Glulam (Glue Laminated Timber) is an engineered wood structural material made by bonding several layers of timber boards (lamina) together with moisture-resistant adhesives under high pressure.

A 50X50 cm glulam column is considered large and capable of bearing significant structural loads.

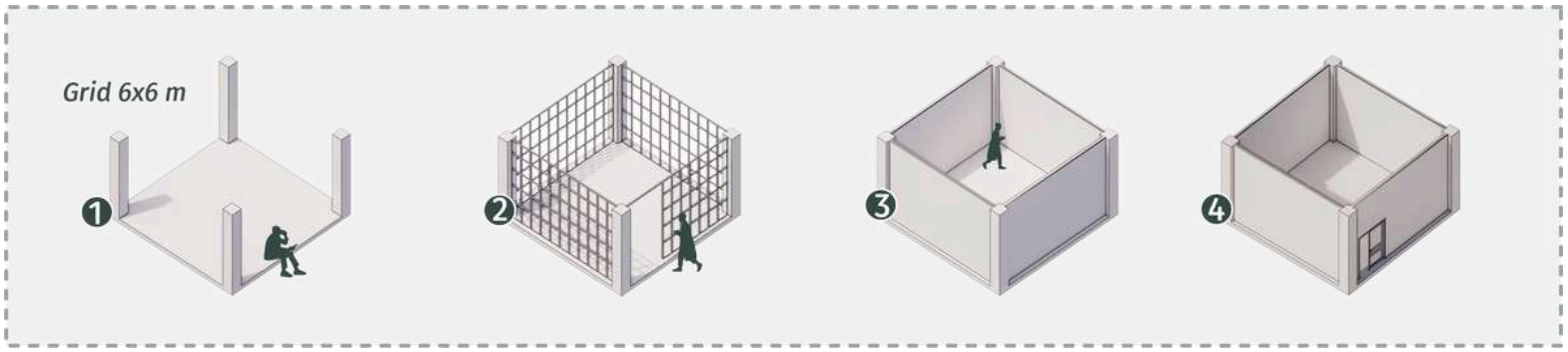
Parameter	Typical Value
Cross-sectional area	2,500 cm²
Compressive strength (GL28h class)	Around 1.6–2.0 MPa effective, depending on slenderness ratio and height
Axial load capacity (short column)	Can reach 400–500 kN, depending on end fixity and bracing
Typical column height	With a floor height of 3.5 m, this column size is structurally adequate if properly braced



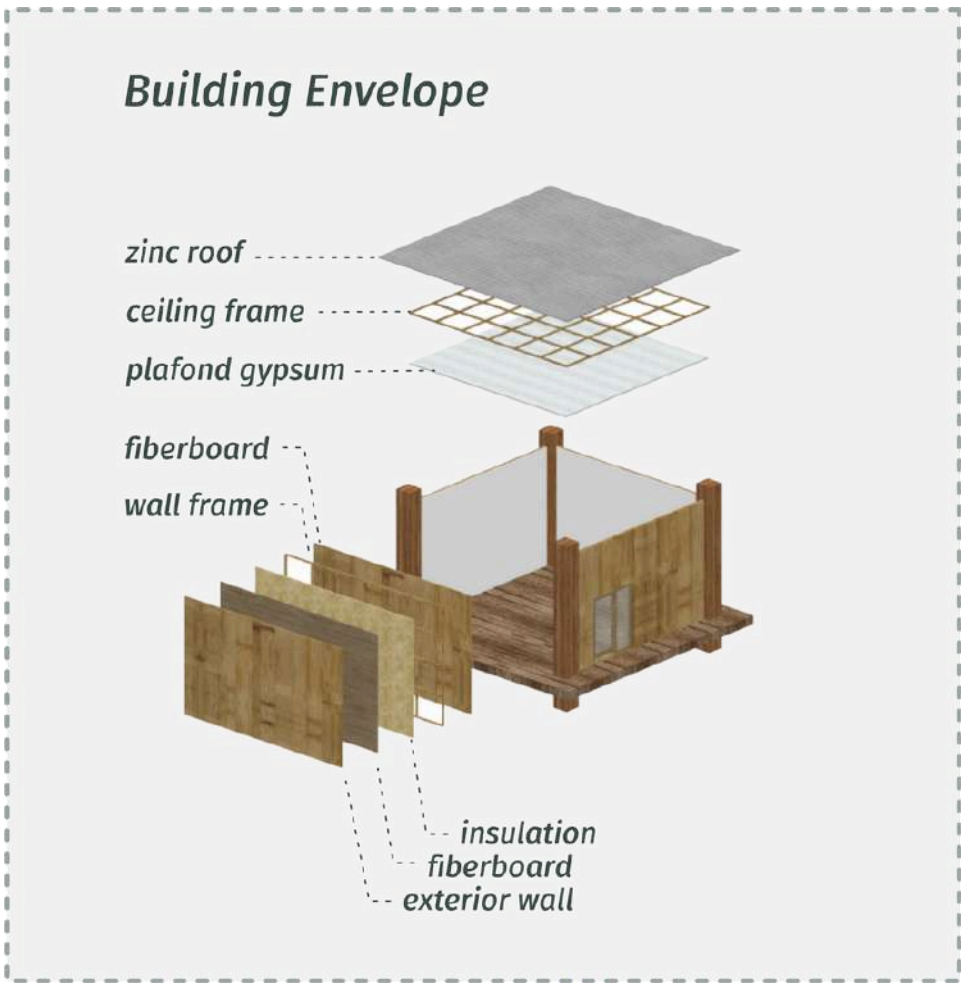
Figure 35. Glulam
Source: Google, 2025

Unlike solid wood like Bengkirai, which is commonly used in stilt houses in Kalimantan, that is hard to find in Pekalongan. Glulam on the other hand, can be locally produced in the site using fast-growing plantation wood such as pine or damar. It offers greater strength, dimensional stability, and resistance to humidity, making it a more practical and climate-adaptive choice for modern coastal architecture.

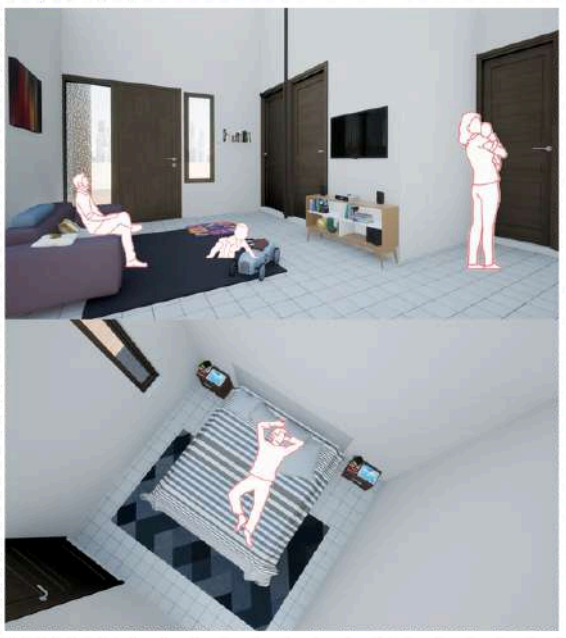
Housing Unit



A 6x6 grid of structural columns is provided as the framework for housing units. Within this grid, residents are given the flexibility to adapt and customize their living spaces according to their individual needs, allowing for future adjustments as their circumstances evolve.



The building envelope is designed to be flexible, allowing residents to adjust it according to their needs. However, the standard configuration includes wall frames layered with insulation, fiberboard, and an exterior wall finish. For the roof, a flat zinc roof is used, supported by a ceiling with a gypsum board finish. This flat roof system also allows for future vertical development without requiring major demolition, making the structure more adaptable over time.



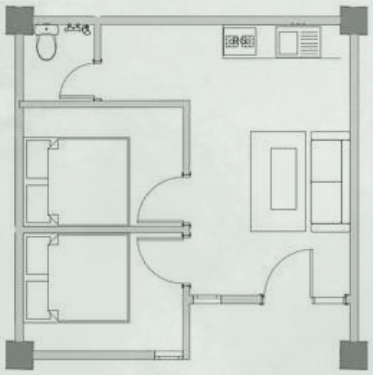
Housing Type



First Floor

Single Unit

1-2



Second Floor

Small Family Unit

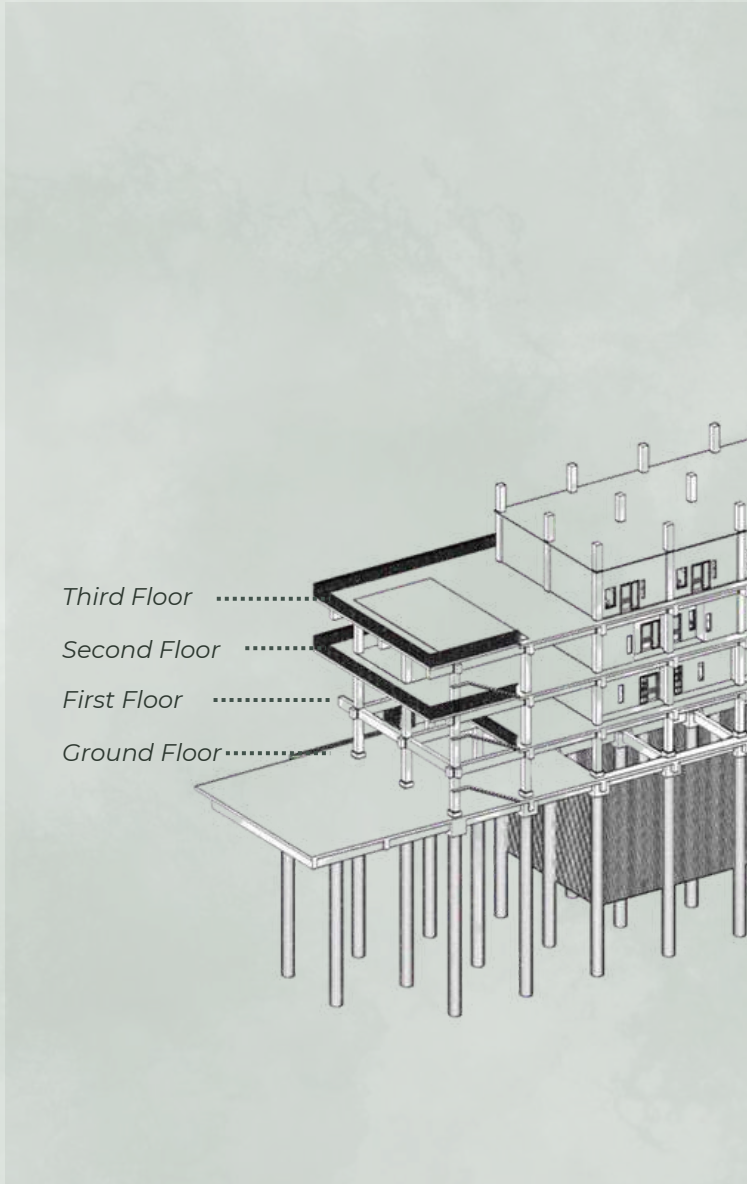
3-4

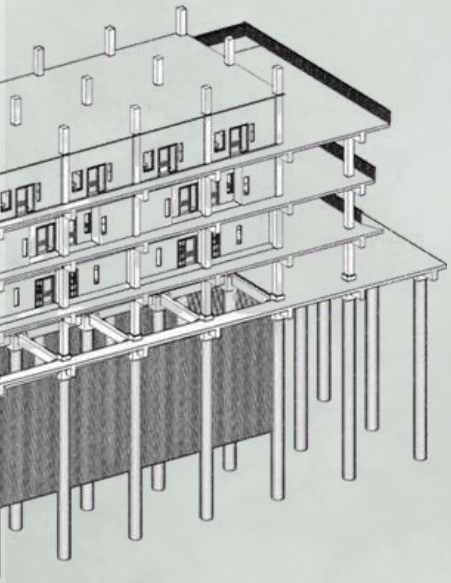


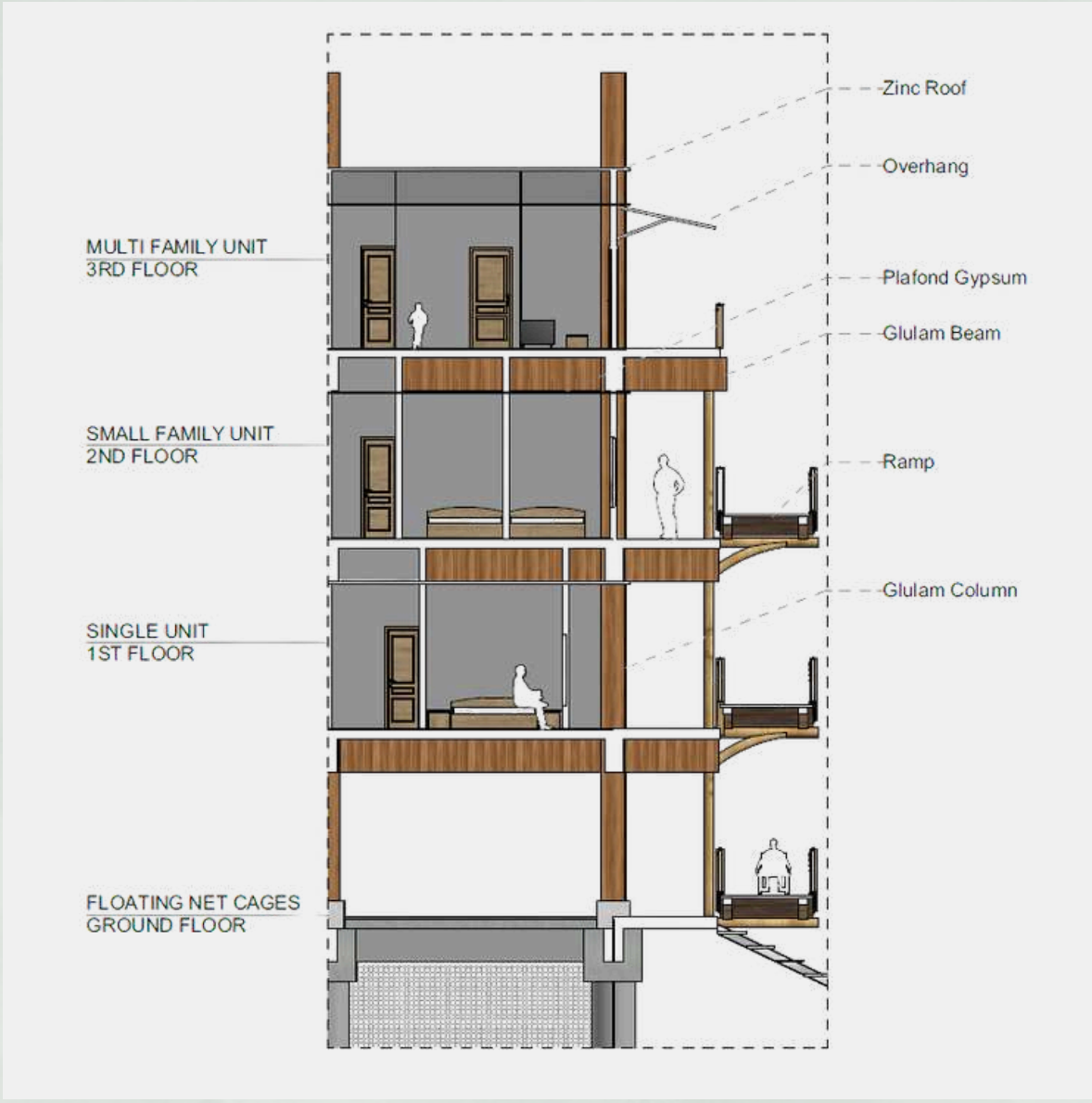
Third Floor

Multi Family Unit

4-6







Although each housing unit has the same size of 36 sqm, the distribution of unit types across floors is part of an **adaptive strategy** in response to environmental risks, particularly sea level rise. **The first floor is designated for single or couple units (1 to 2 people), so that in the event of flooding or rising sea levels, the number of directly affected residents can be minimized.** The second and third floors are allocated to small families (3 to 4 people) and larger families (4 to 6 people), respectively, as these groups require greater protection due to their larger household size.

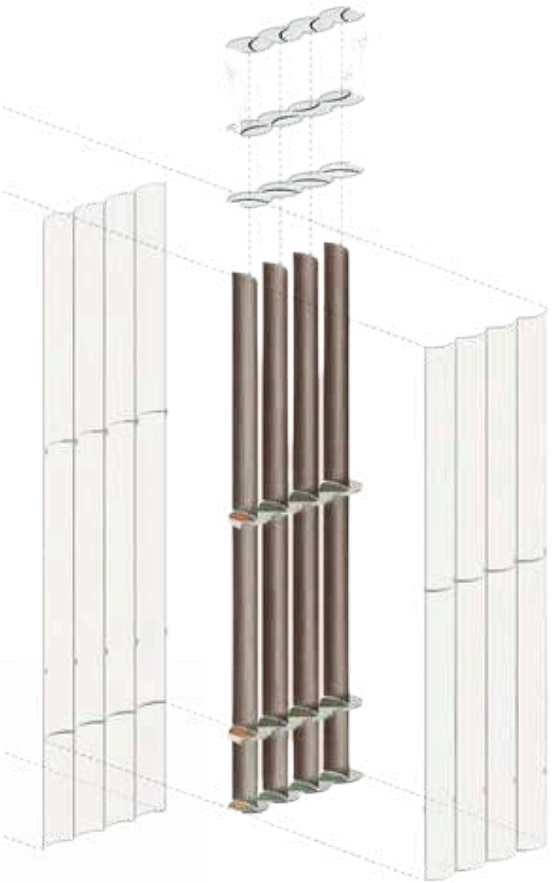
This layout also considers evacuation efficiency, structural load distribution, and daily circulation patterns. At the same time, all units are designed with an open-plan layout that allows residents to freely organize their interior spaces based on their own needs and preferences. In this way, the design provides a spatial framework that is context-responsive.

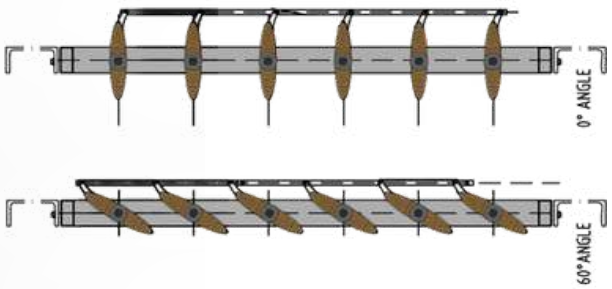
Wind Flow Response



A response to the windflow is addressed through the use of wooden louvers as facade elements, functioning as screens or secondary skins. These louvers help filter and diffuse sea breeze, preventing direct impact on the building's outer walls, while also reducing heat from sunlight and casting artistic shadow patterns within the interior. The wooden louvers are rotatable, allowing users to open or close them based on the time of day or environmental conditions, providing both climatic flexibility and visual expression.

Wooden Louvers

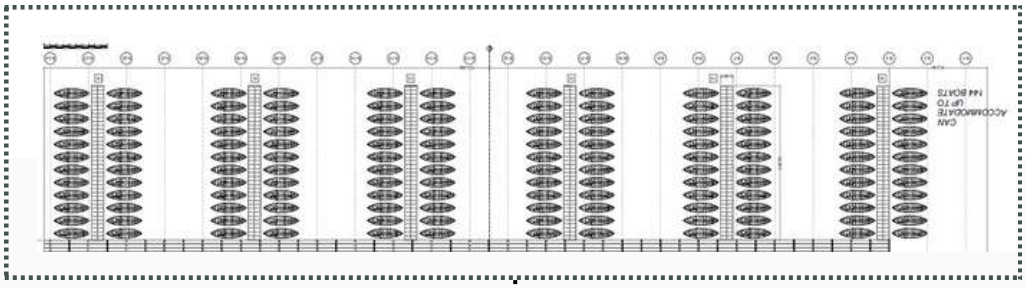






Docking

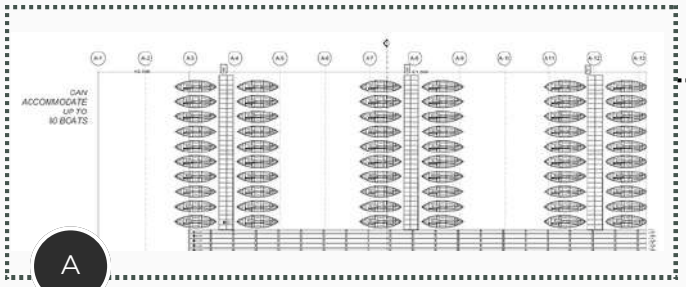
Providing the same number of docks as housing units is one way to support a new and more adaptable life at sea. This ensures that every household has easy access to boats for daily needs and work, showing that the design fully supports living in harmony with the ocean environment.



B

Housing Block B

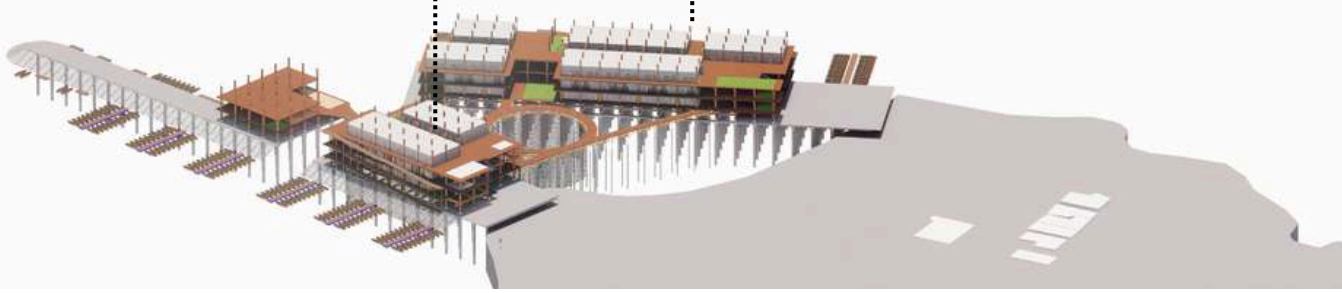
Can accommodate up to 144 boats, matching the number of housing units.

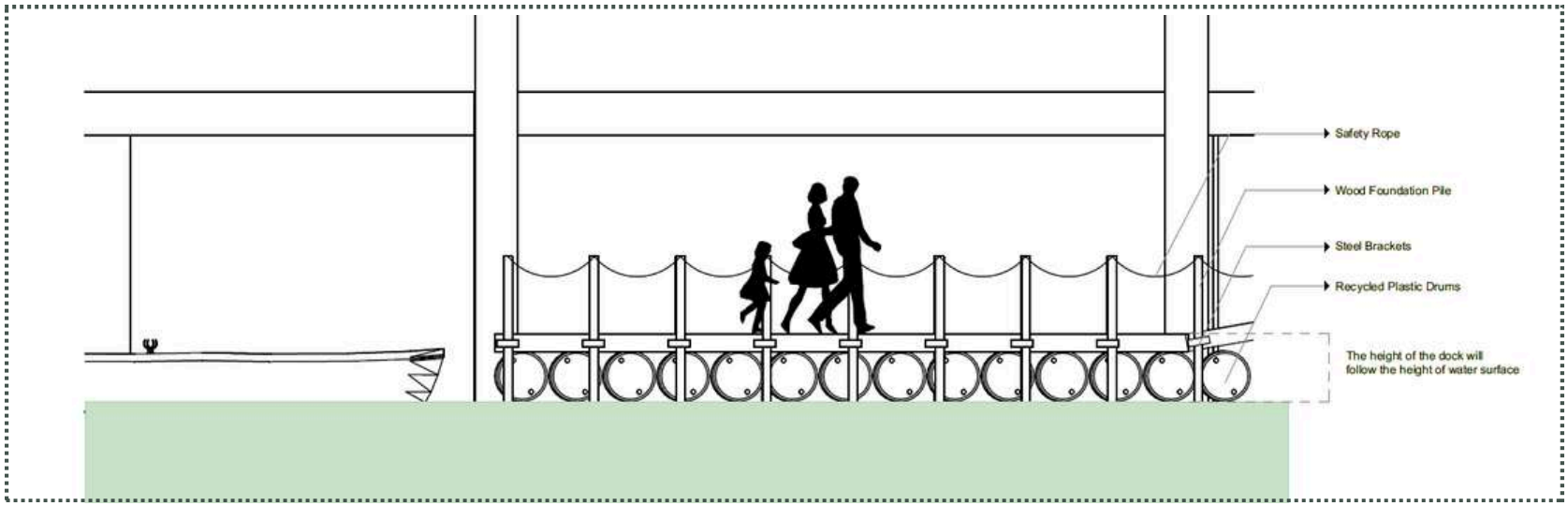


A

Housing Block A

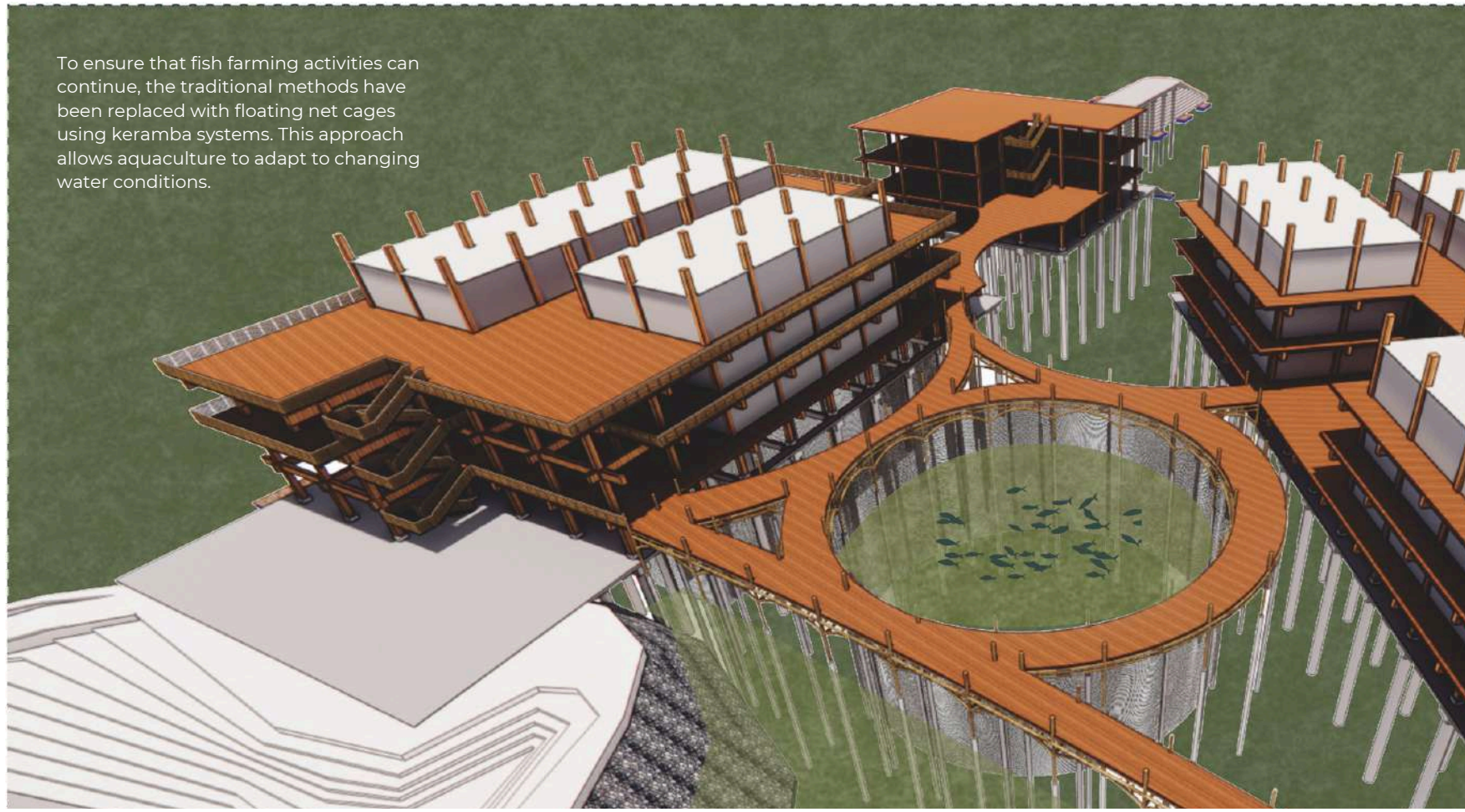
Can accommodate up to 60 boats, matching the number of housing units.





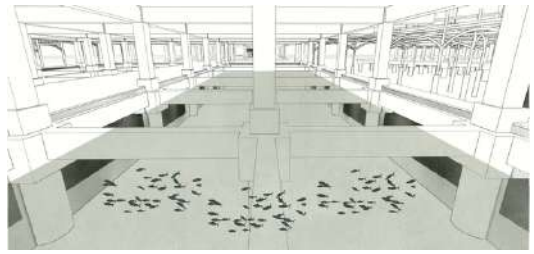
Floating Net Cages

To ensure that fish farming activities can continue, the traditional methods have been replaced with floating net cages using keramba systems. This approach allows aquaculture to adapt to changing water conditions.

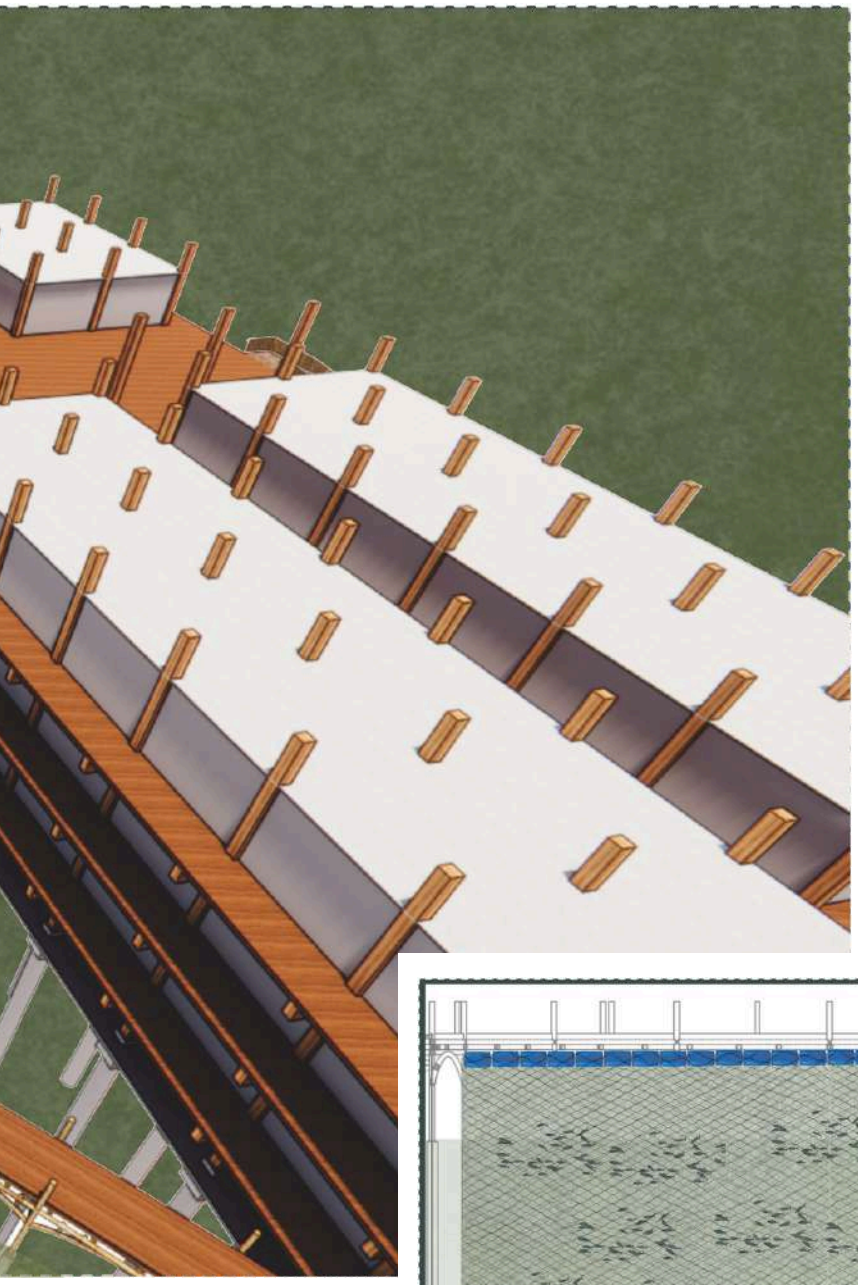




Ground Floor Floating Net Cages



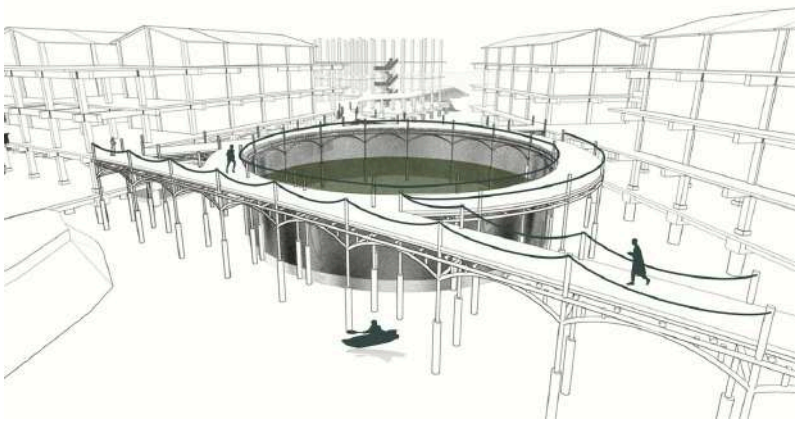
Each housing block has floating net cages on the ground floor, right below the living units. These cages support the residents' daily livelihood by giving them easy access to fish farming. With this setup, residents can feed, maintain, and harvest fish without needing to go far, which helps ensure a steady source of food and income while living at sea.

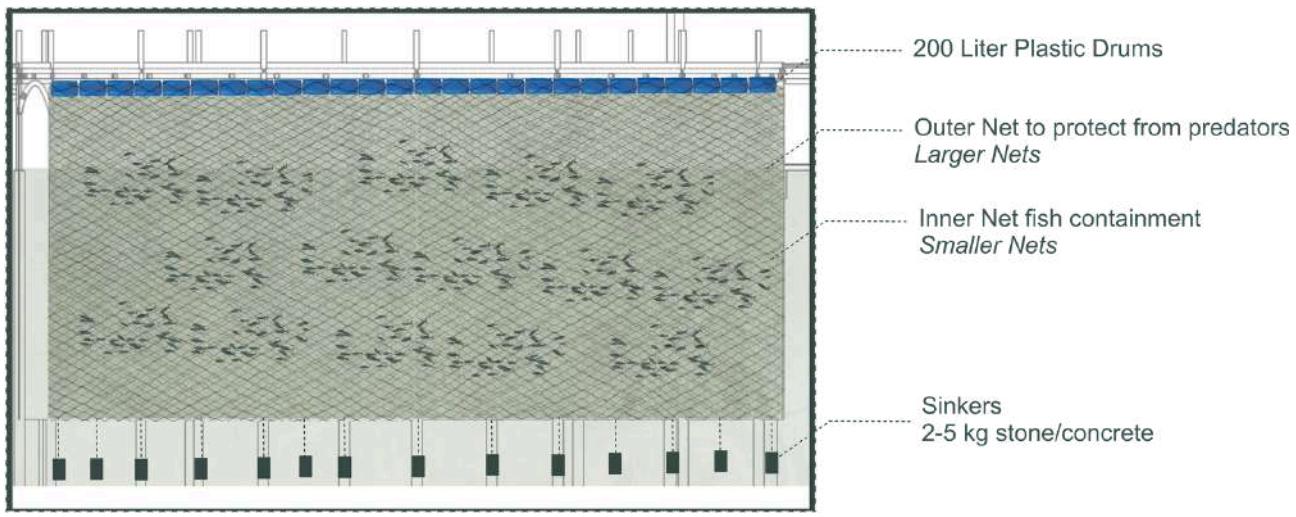


Central Floating Net Cages

In addition to these individual net cages, a larger circular central floating net cage is placed in the middle of the settlement. Unlike the smaller units below each housing block, this central cage is designed for collective use. It is intended for farming larger or different species that require more space and coordinated care, such as groupers or sea bass, which may not be suitable for the smaller-scale cages attached to individual units. The central cage also functions as a social and economic hub, promoting cooperation among residents and potentially serving as a shared income-generating facility for the community.

Together, the decentralized and centralized systems create a balanced aquaculture strategy that supports both household-level self-sufficiency and collective economic resilience.



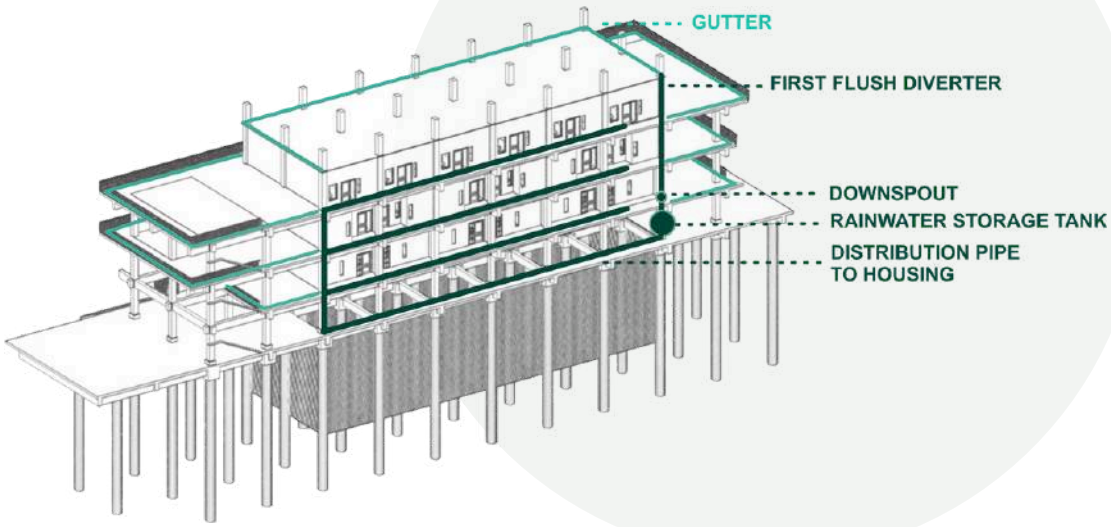


Utility System Design

Clean Water

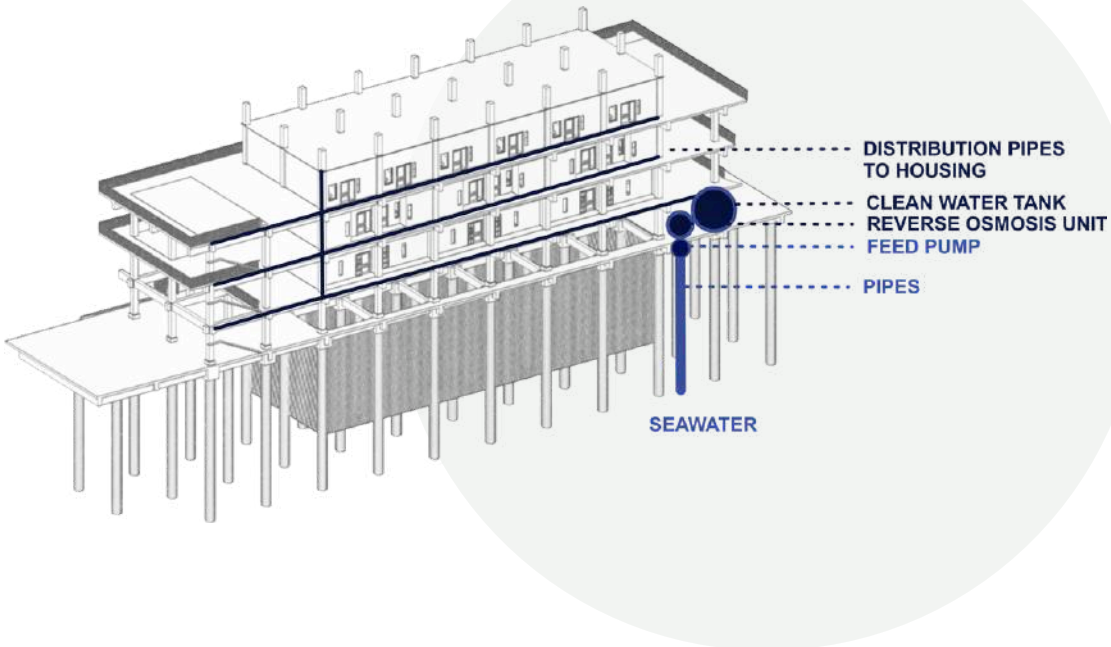
Rainwater Harvesting System

Each building is equipped with gutters that collect rainwater, which is then directed into a central storage tank. The collected water is filtered and distributed for daily non-potable use, helping to reduce reliance on external water sources.



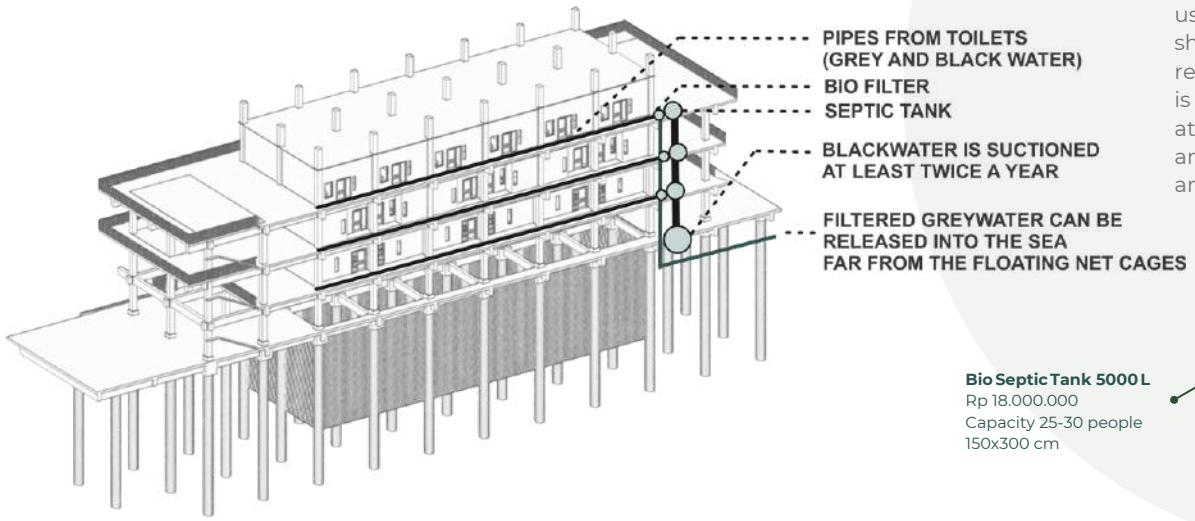
Seawater Desalination

Given the coastal location, seawater is the most accessible water source. However, it requires proper treatment through a desalination process to make it safe for daily use. This system ensures a sustainable and continuous supply of clean water, especially in areas with limited freshwater availability.



Utility System Design

Waste Water



Waste Water System

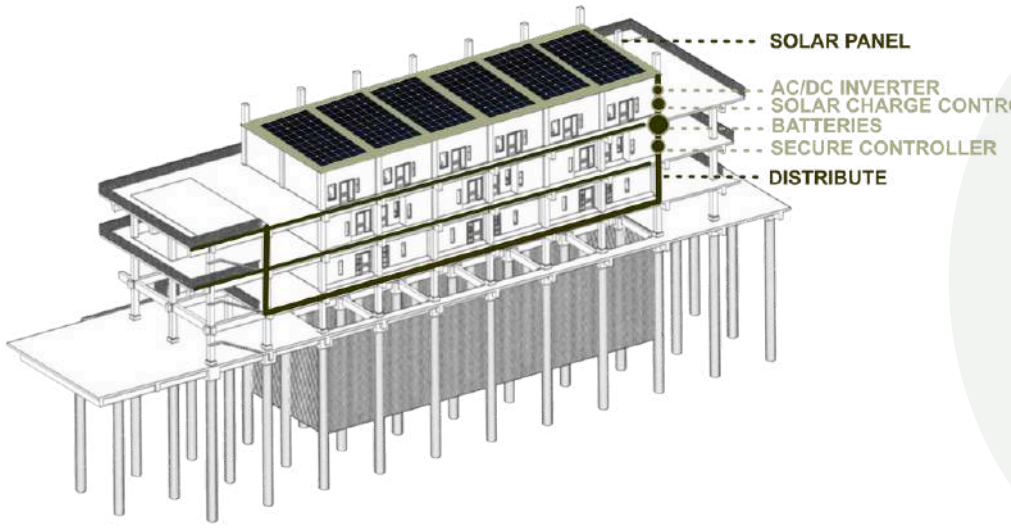
The wastewater system filters and collects used water on each floor. Greywater from showers and sinks is treated and safely released into the sea. Blackwater from toilets is stored in separate tanks and suctioned out at least twice a year to keep the system clean and safe. This setup helps maintain hygiene and protect the coastal environment.

Bioseptic Modular HDPE

Bio Septic Tank 5000 L
Rp 18.000.000
Capacity 25-30 people
150x300 cm



Electricity



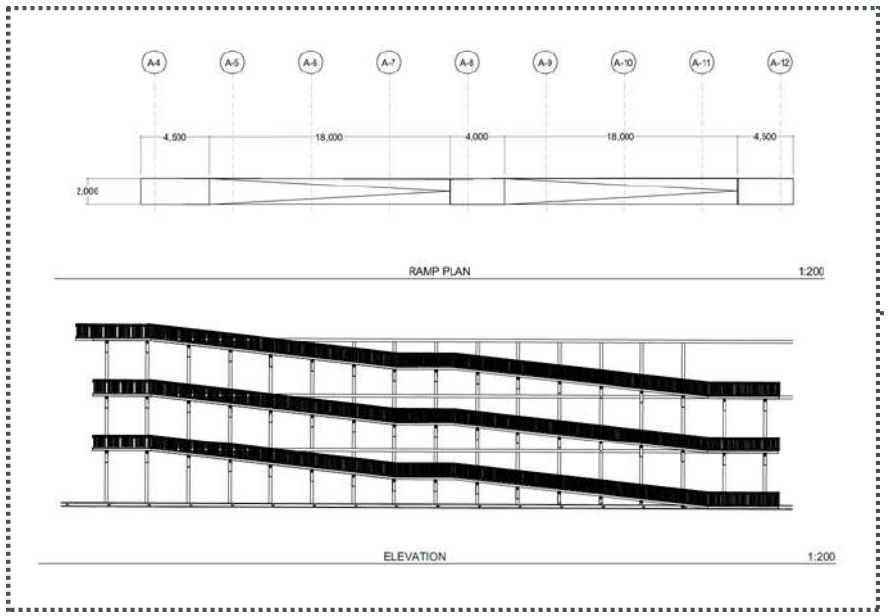
Solar Microgrid

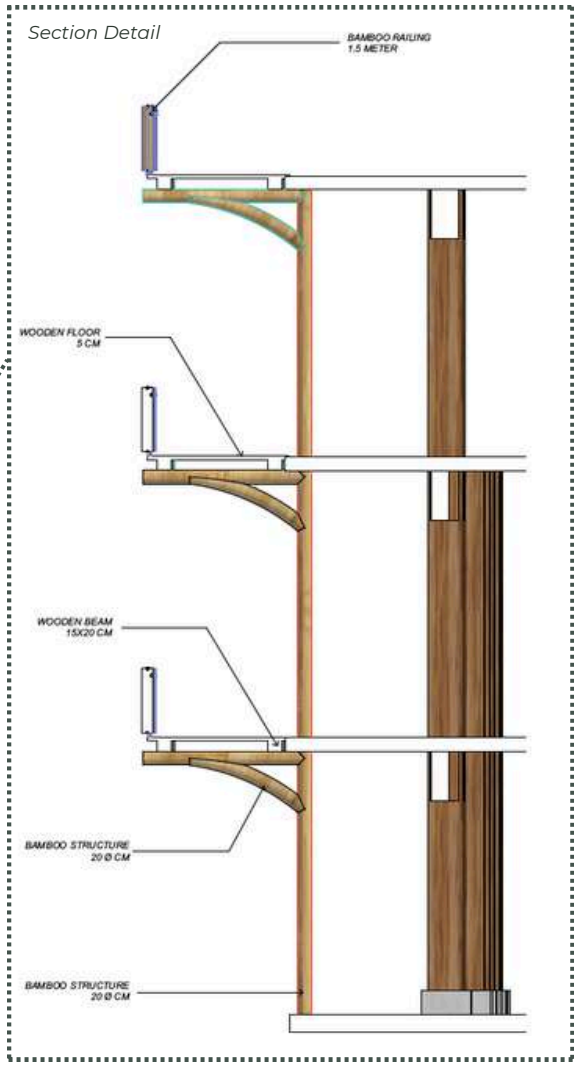
A solar microgrid is a community-scale electricity network powered by solar energy rather than from Indonesia's National Electricity Provider or PLN. It functions like a shared utility: large solar panels and batteries that installed in a central hub, from which electricity is distributed via local wiring to houses.

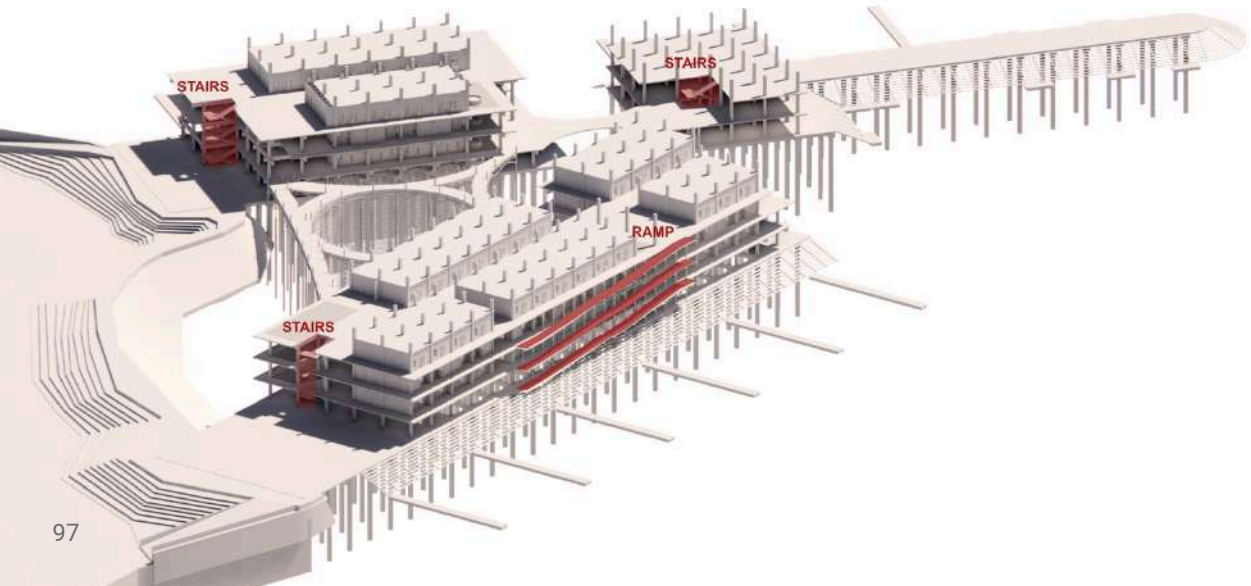
Accessibility System Design

Each building block is equipped with a vertical circulation system consisting of staircases that connect all floors, ensuring smooth movement between levels during daily use or emergency situations. In addition to the stairs, ramps are also integrated into the design to provide universal access, allowing individuals with limited mobility, elderly occupants, or those using wheelchairs to navigate the building safely and comfortably. This inclusive circulation strategy supports both daily functionality and emergency evacuation, making the design more resilient and accessible for all users.

Ramp



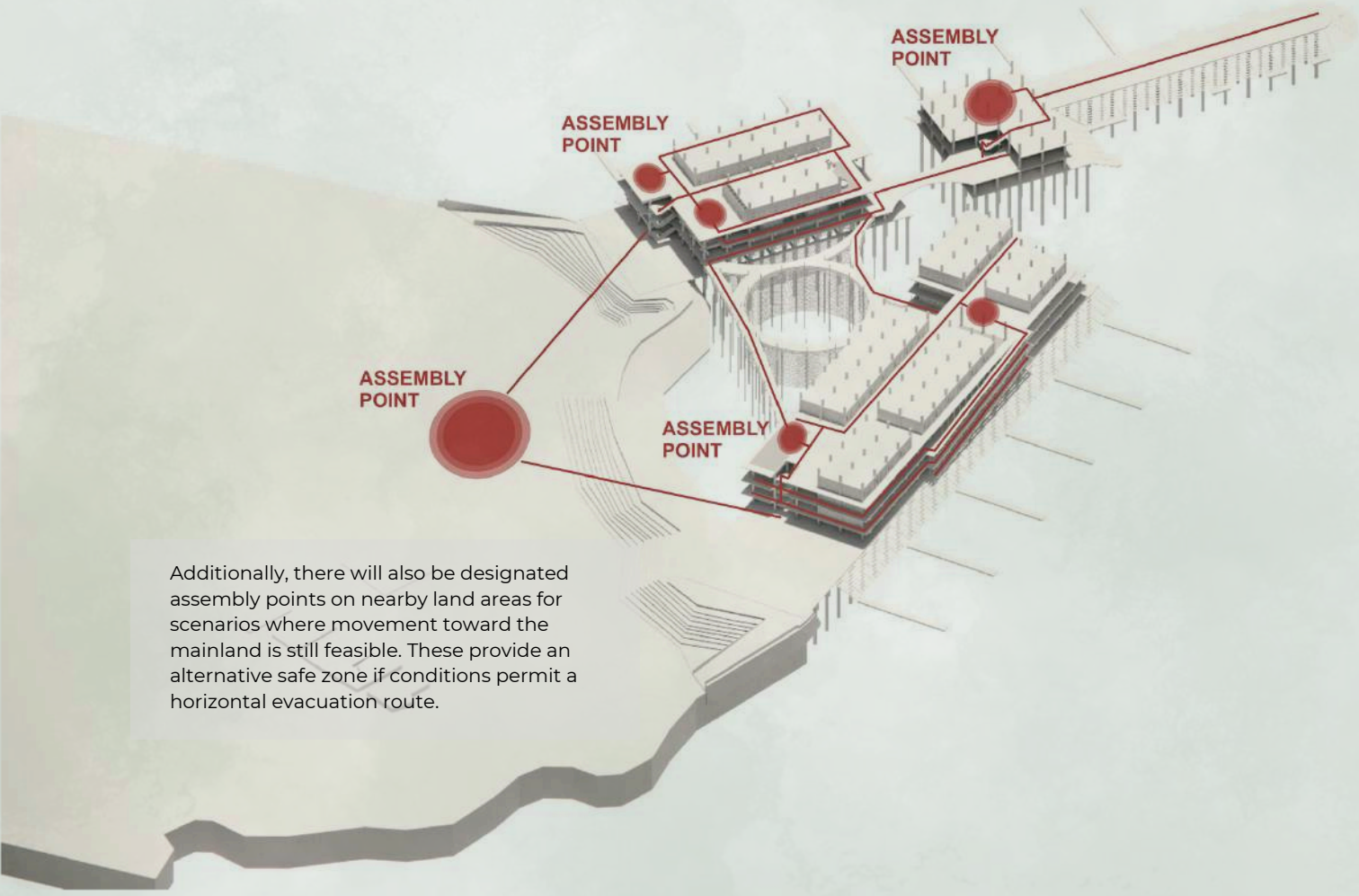




Safety System Design

Emergency Routes

Each building block will have its own assembly point located on the top floor. This decision is made to ensure that in the event of a flood or rising sea levels, occupants can immediately evacuate vertically to a safer height. Since the buildings are positioned in an offshore or coastal area, reaching land quickly may not always be possible during emergencies, making vertical evacuation a critical part of the design strategy.

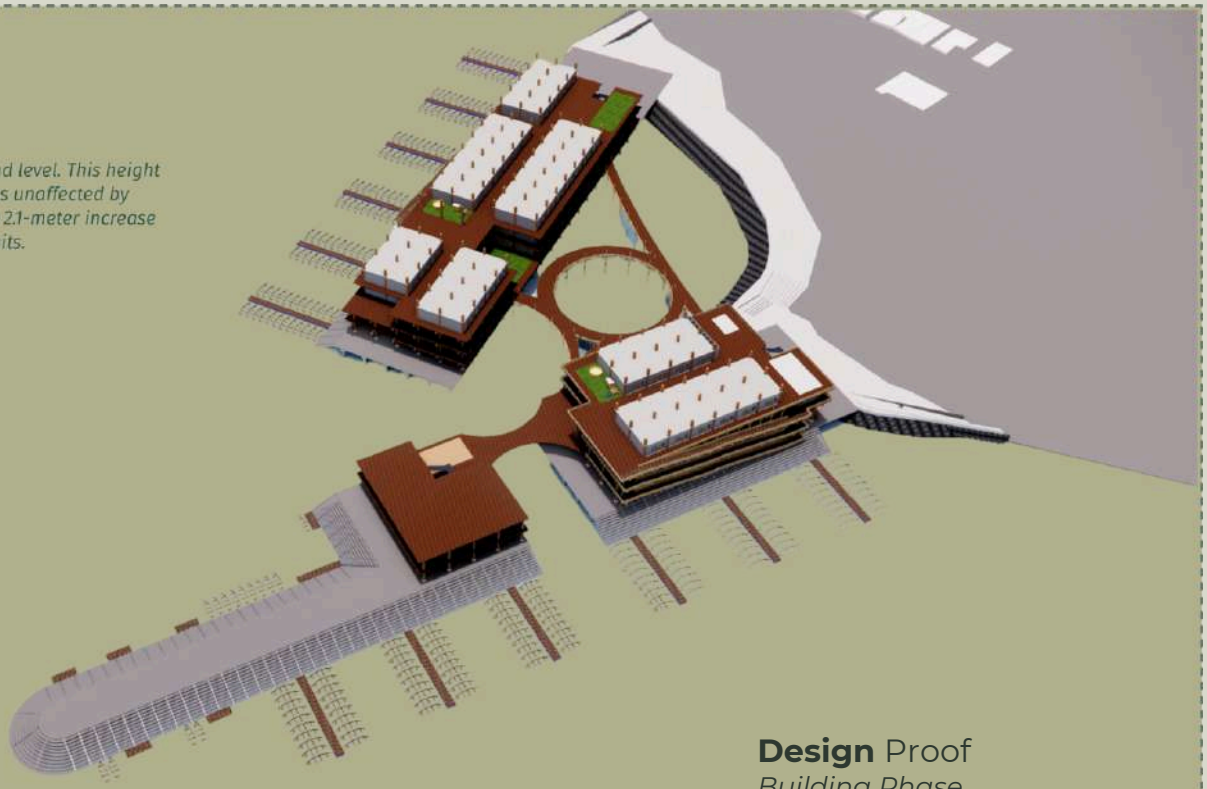


Additionally, there will also be designated assembly points on nearby land areas for scenarios where movement toward the mainland is still feasible. These provide an alternative safe zone if conditions permit a horizontal evacuation route.

2030

+2.1 m

The housing design is elevated 3.5 meters above the current ground level. This height has been strategically determined as a safe threshold that remains unaffected by projected sea level rise through the year 2030. At that time, even a 2.1-meter increase in sea level will not compromise the structure or the residential units.



Design Proof
Building Phase

2050

+9.6 m

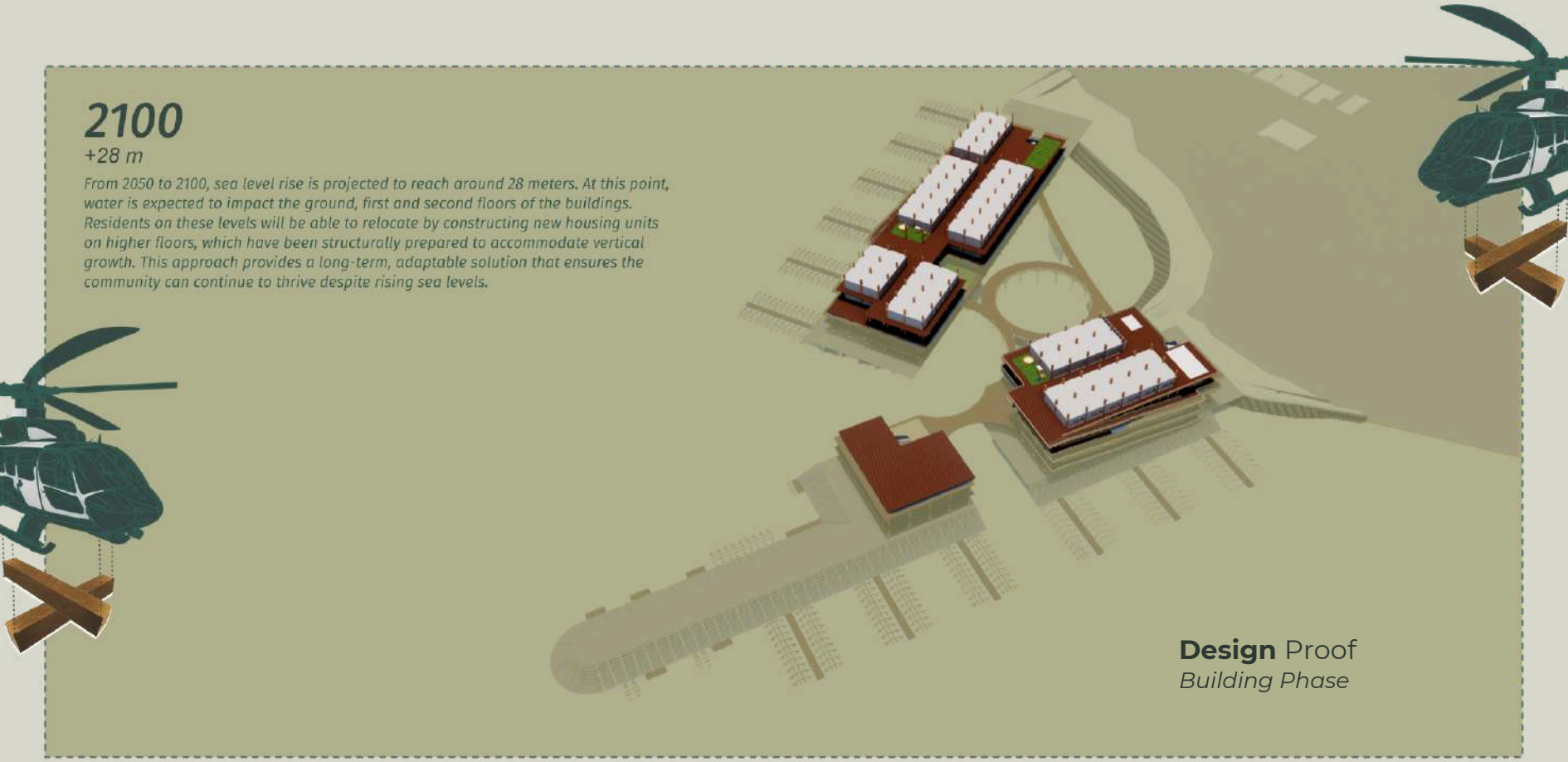
Between 2030 and 2050, sea levels are expected to rise by approximately 9.6 meters. Only the ground floor, which is intentionally allocated as a void space for floating net cages, will be affected. The housing units above this level will remain safe and fully operational. This period also marks the planned phase for vertical expansion, allowing for the construction of additional floors as needed.



2100

+28 m

From 2050 to 2100, sea level rise is projected to reach around 28 meters. At this point, water is expected to impact the ground, first and second floors of the buildings. Residents on these levels will be able to relocate by constructing new housing units on higher floors, which have been structurally prepared to accommodate vertical growth. This approach provides a long-term, adaptable solution that ensures the community can continue to thrive despite rising sea levels.



Design Proof
Building Phase



Design Evaluation

04

Design Evaluation

1st Jury : Prof. Dr.-Ing. Ir. Ar. Ilya Fadjar Maharika, MA., IAI.
2nd Jury : Dr. Ar. Yulianto Purwono Prihatmaji, S.T., M.T., IPM., IAI.

Structural Solution
Glulam, as the main material, is not proper for the location (seaside)

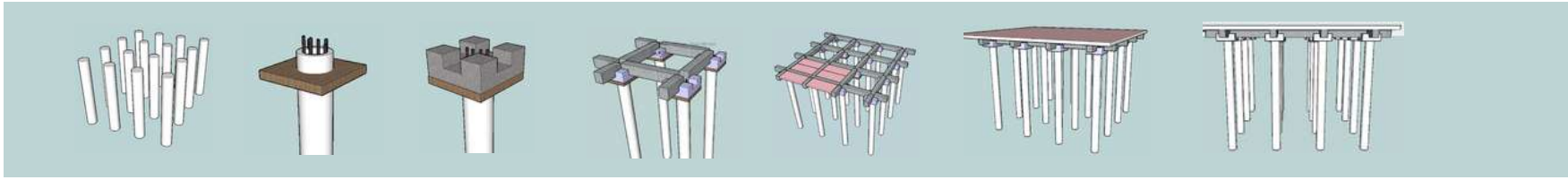
The selection of glulam as the main structural material is considered less appropriate for a building located in a coastal environment. Although glulam has advantages such as sustainability and aesthetic qualities, its performance is highly vulnerable when exposed to high humidity, saline air, and direct contact with seawater. In the coming years, with the projected sea level rise, the lower part of the structure has the potential to be submerged. This condition will accelerate material degradation, where glulam is prone to swelling, decay, and loss of structural strength. While corrosion is more commonly associated with metals, in the case of glulam, the risk lies in fungal attack, delamination, and deterioration due to continuous saltwater exposure. This makes glulam unreliable as a long-term solution for structural elements in seaside settlements

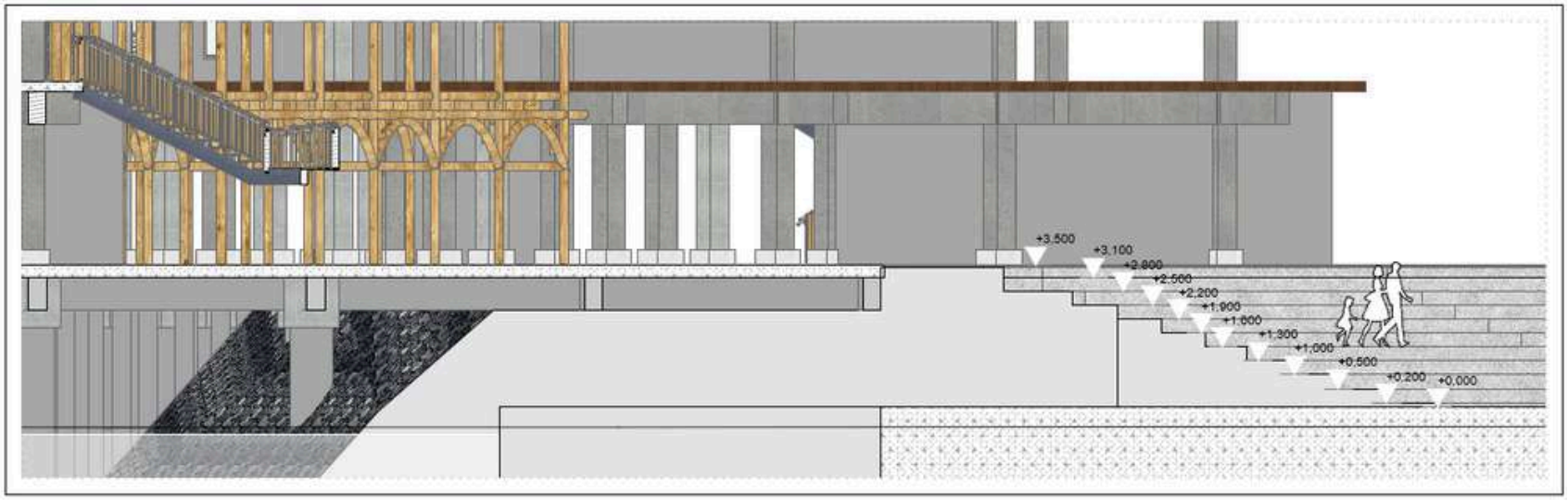
Therefore, an alternative structural solution is recommended by **integrating the same material between foundation and vertical structural elements,** using prefabricated reinforced concrete.

Glulam 50x50 CM

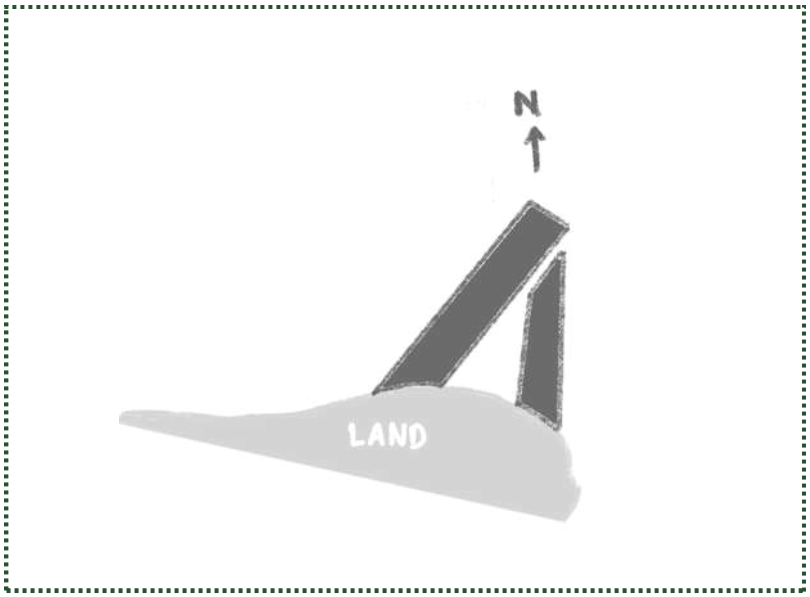
↓

Prefabricated Concrete Column and Beam



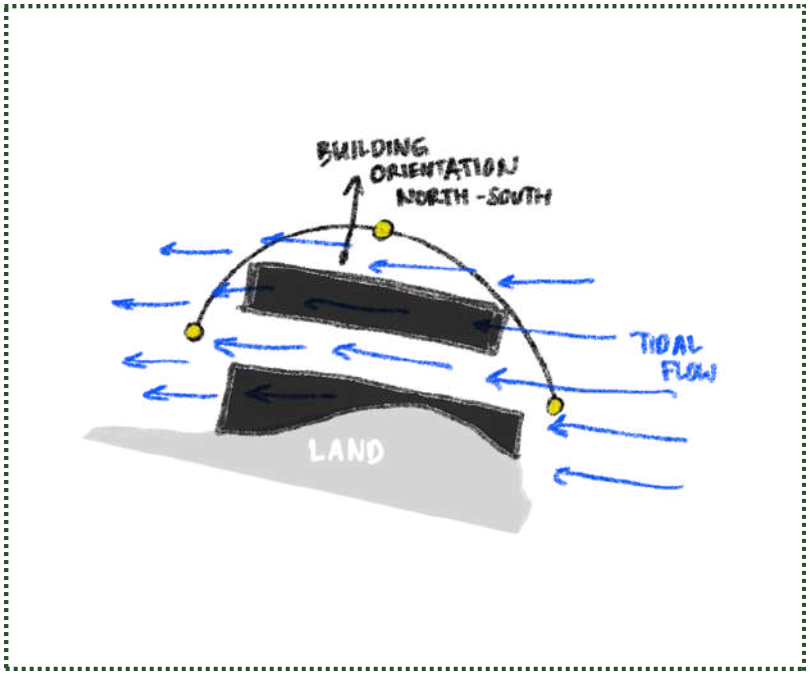


Building Orientation
Building orientation should be determined based on tidal flow and all related data



The initial building orientation still places the long façade facing east and west. This approach reflects a misunderstanding of proper building orientation principles and does not yet incorporate tidal flow data or potential tsunami threats, which are critical in coastal areas, particularly along the northern coast of Java.

Reconsidering this orientation is therefore necessary, not only to align with accurate environmental analysis but also to build the narrative that the design is prepared to adapt to changing coastal conditions.



A north–south orientation, with the longer sides facing north and south, is preferable as it reduces exposure to the harsh afternoon sun, improving comfort and energy efficiency.This orientation also aligns with the east–west tidal flow, making the building more adaptive to natural water dynamics.

North-south Orientation

- **Sun Path**
- **Tidal Flow**

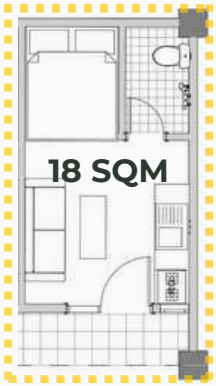
For tsunami-related considerations, no official data or studies have indicated a significant tsunami risk along the northern coast of Java, particularly in Pekalongan. In this region, the more frequently recorded hazards are flooding and landslides rather than tsunamis. Given the relatively low tsunami risk, orientation decisions can place greater emphasis on sun path and tidal flow analysis, which are more relevant to the site's environmental context.

Type of Housing
Needs to adjust with the characteristics of families

First Floor

Single Unit

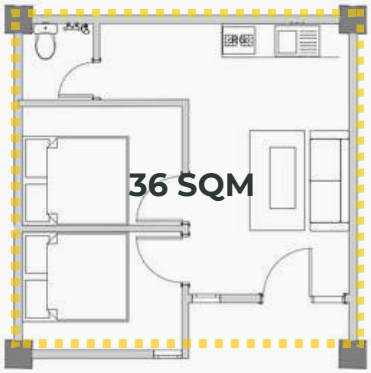
1-2 **18 SQM**



Second Floor

Small Family Unit

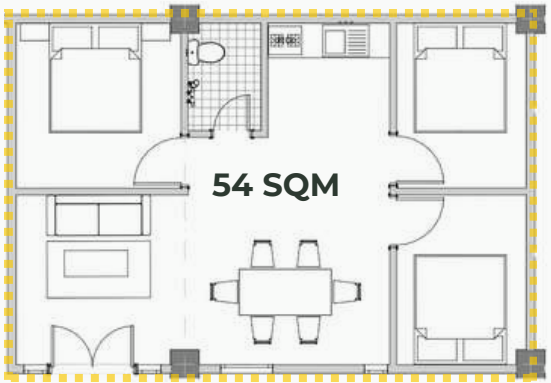
3-4 **36 SQM**



Third Floor

Multi Family Unit

4-6 **54 SQM**



Previously, all housing units were designed with the same size of 36 sqm, regardless of the number of occupants. This created significant disparities in personal space allocation. As a result, residents in a single unit enjoyed far more space per person, while those in a multi-family unit experienced overcrowding. If six people shared the space, each person would only have about 6 sqm.

To create a more balanced and equitable living arrangement, the unit sizes can instead be based on a standard allocation of **9 sqm per person.** This adjustment ensures fairer distribution of space, improves comfort, and better accommodates the varying needs of different household types.

Block A		Block B	
40	80	92	184
20	80	46	184
14	84	30	180
74	**244**	**168**	**548**

242 Unit Housing

±800 People

≈3x from Original Population

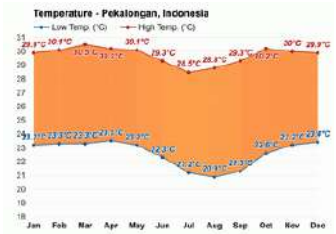
Waste Water System
Requires more innovative wastewater system so it does not rely on regular suction

Vermifiltration

Vermifiltration is a wastewater treatment method that relies on the interaction between epigeic earthworms and microorganisms to remove contaminants. Vermifiltration offers benefits such as environmentally friendly wastewater treatment, low energy consumption, minimal land requirements, and the potential for integration into dense housing designs such as apartment buildings. (S.S.Y. Saapi, et al)

However, this system has limitations

- Temperature changes: earthworms thrive best in the range of 20–30°C. Extreme heat or cold reduces their biological activity.

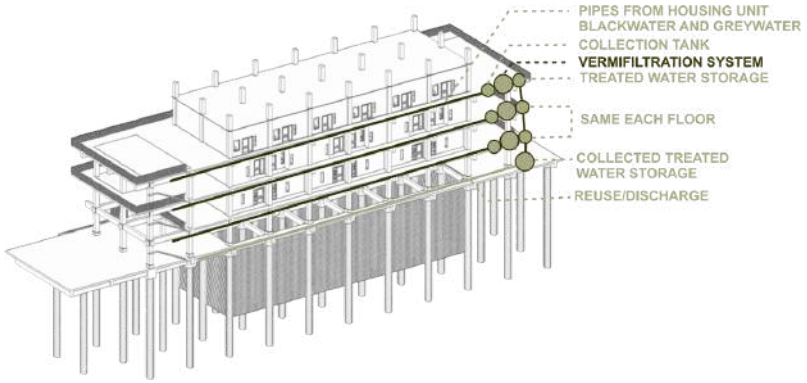


In Dusun Semonet, temperatures usually fall between 23 °C and 33 °C. Extreme heat events like those in desert climates are unlikely to occur, but high humidity poses a greater concern.

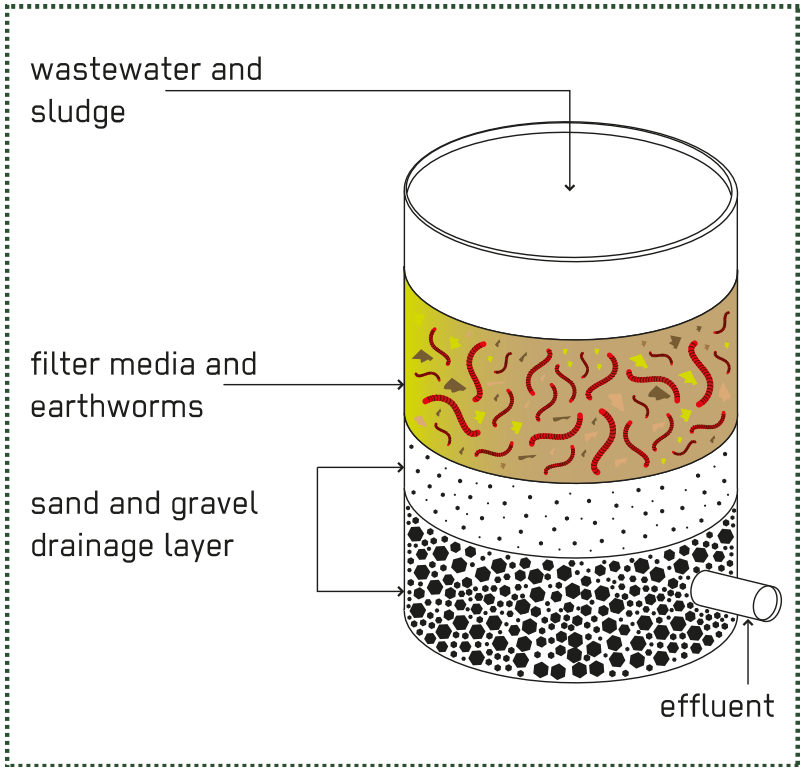
- pH shifts: the system works best at near-neutral pH (6.5–8). Highly acidic or alkaline wastewater can harm or kill the worms.
- Toxic chemicals: excessive detergents, disinfectants, or industrial chemicals may damage microorganisms and kill the worms.
- Overloading of organic waste: if the wastewater volume exceeds the filter's capacity, decomposition becomes inefficient and may cause odors.

Module Calculation
Module diameter 2.14 m, depth 1.5 m, Area module 3.6 m²

Block	Floor	No. of Residents	Required Modules	Total Volume (m³)
A	1ST	40	2	10.8
	2ND	80	4	21.6
	3RD	84	5	27
B	1ST	184	10	54
	2ND	184	10	54
	3RD	180	9	48.6



Vermifiltration System



With this system, both greywater and blackwater can be treated directly, reducing or even eliminating the need for regular septic pumping. This is particularly beneficial for coastal areas where road access is limited or already cut off.



Attachment

05

Direktorat Perpustakaan Universitas Islam Indonesia
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F. (0274) 898444 psw.2091
E. perpustakaan@uii.ac.id
W. library.uii.ac.id

SURAT KETERANGAN HASIL CEK PLAGIASI

Nomor: 2720279033/Perpus./10/Dir.Perpus/VII/2025

Bismillaahirrahmaanirrahiim

Assalamualaikum Wr. Wb.

Dengan ini, menerangkan Bahwa:

Nama	: Raisa Maranta Saika
Nomor Mahasiswa	: 21512183
Pembimbing	: Ir. Wiryono Raharjo, M.Arch., Ph.D.
Fakultas / Prodi	: Teknik Sipil dan Perencanaan/ Arsitektur
Judul Karya Ilmiah	: Desain untuk Menghidupkan Kembali Pemukiman Pasca Tenggelam di Dusun Semonet, Pekalongan

Karya ilmiah yang bersangkutan di atas telah melalui proses cek plagiasi menggunakan **Turnitin** dengan hasil kemiripan (*similarity*) sebesar **6 (Enam) %.**

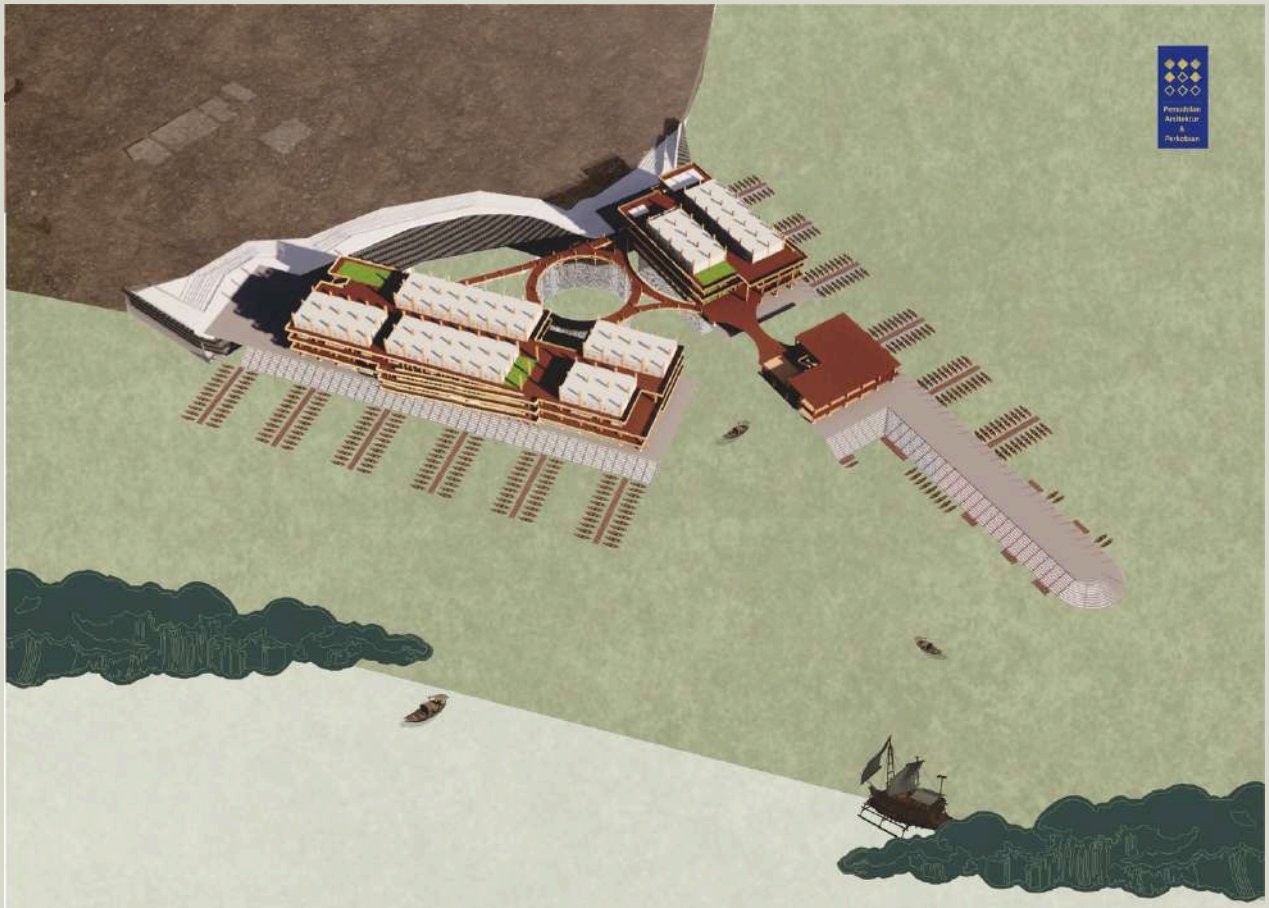
Demikian Surat Keterangan ini dibuat untuk dapat dipergunakan sebagaimana mestinya.

Wassalamualaikum Wr. Wb.

Yogyakarta, 7/25/2025
Direktur

UNIVERSITAS ISLAM INDONESIA
DIREKTORAT PERPUSTAKAAN
YOGYAKARTA

Muhammad Jamil, SIP.



Design for Reviving Post-Submergence Settlements

SEMONET

Dusun Semonet was once a small but lively hamlet in Northern Pekalongan, where hundreds of people depended their lives to the ocean. But over time, the land began to sink, and the sea kept rising. Water flooded their homes, roads disappeared, and eventually, people were forced to leave, abandoning their homes. This design explores the possibility of creating a new version of Dusun Semonet on its now-submerged land, allowing former residents to return to the place they called ***home***.

The Fading Coastline



2005
180 KK / 256 People

2016
66 KK / 80 People

2023
0 KK / 0 People

Zero Inhabitants Left

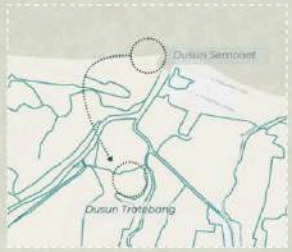
Scan for more information

Combined Relative Impact
(Land Subsidence and Sea Level Rise)

Reports and experts predicted that in 2030, sea level will rise by around 2 meters and continue increasing, reaching up to 28 meters by 2100.

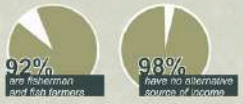


The community relies on the fisheries sector for their livelihood
They have raised their homes multiple times to adapt to the recurring tidal floods
Most of them have no savings, making them dependent on government relocation projects

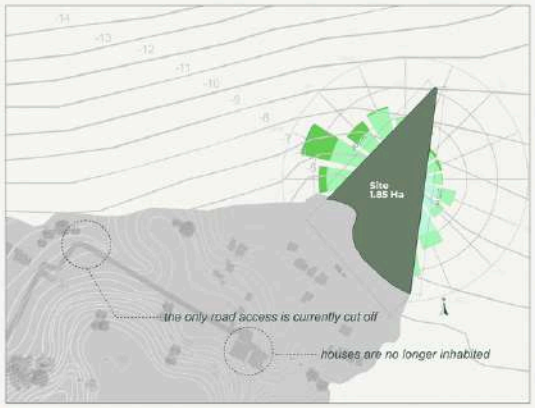


Government will relocate them to Dusun Tratebang that far from Dusun Semonet, their source of livelihood

Relocation Paradox
It may physically safe, but socio-economically vulnerable



Site Analysis



Tidal Flow

High Tide	(07.00-08.00 and 17.00-18.00)	0.5-0.8 m elev
Low Tide	(00.00-01.00 and 12.00-13.00)	0.1-0.4 m elev

Building Footprint Area : 60% x 1.85 ha : 11.100 m²
Floating Floor Area : 1.5 x 1.85 ha : 27.750 m²
Maximum Floor : Ministry of Public Works Regulations No. 5 of 2007 "Maximum number of floors allowed for walk-up flats is 5 floors. If exceed, it must be equipped with vertical circulations (elevators or escalators).

Rationale Behind Site Selection
The choice of the northernmost location serves as a narrative that this area is the most affected. Through this design, it becomes a symbol of the community's readiness to adapt to ongoing changes.

Resilient Architecture Approach

① Redundancy	incorporate multiple alternatives
② Robustness	utilizing durable material and construction methods
③ Resourcefulness	effective resource management in all conditions
④ Integrative Design	applying multi-disciplinary approach

Population Assumption

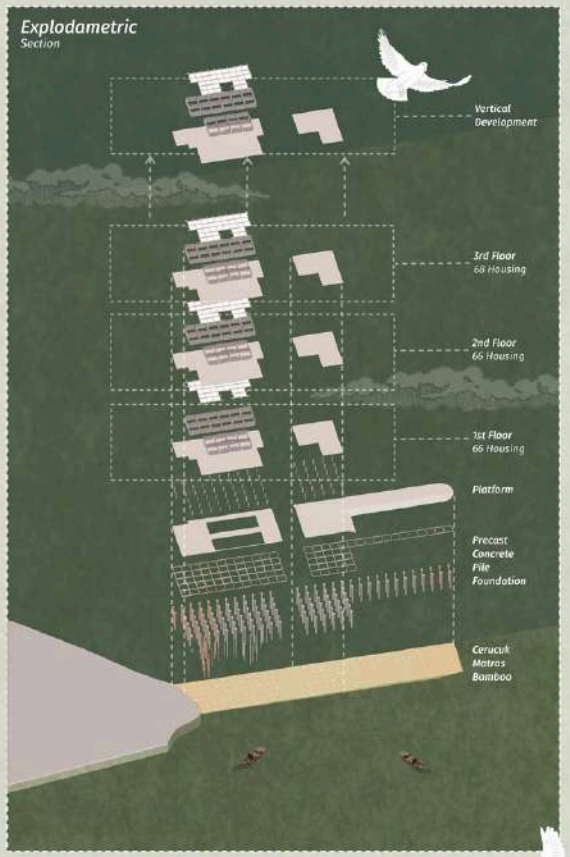
Single Unit	
Small Family Unit	
Multi Family Unit	

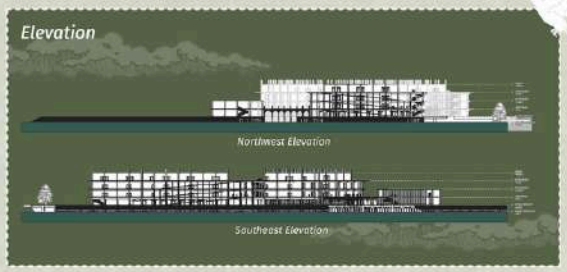
200 UNIT HOUSING
±800 PEOPLE
±3x from Original Population

Block A	
20	40
20	80
20	120
60	240

Block B	
46	92
46	184
48	288
140	564

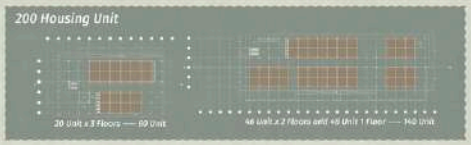


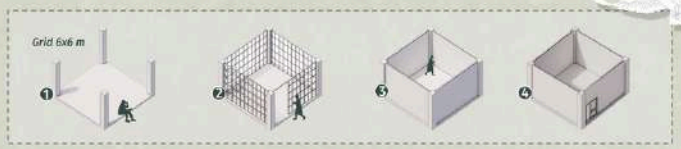


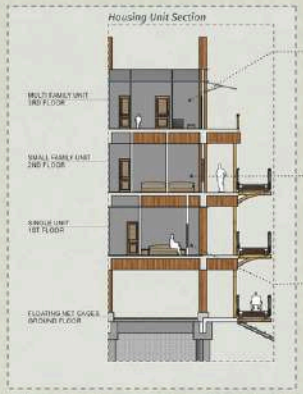


Housing Unit

A 6x6 grid of structural columns is provided as the framework for housing units. Within this grid, residents are given the flexibility to adapt and customize their living spaces according to their individual needs, allowing for future adjustments as their circumstances evolve.





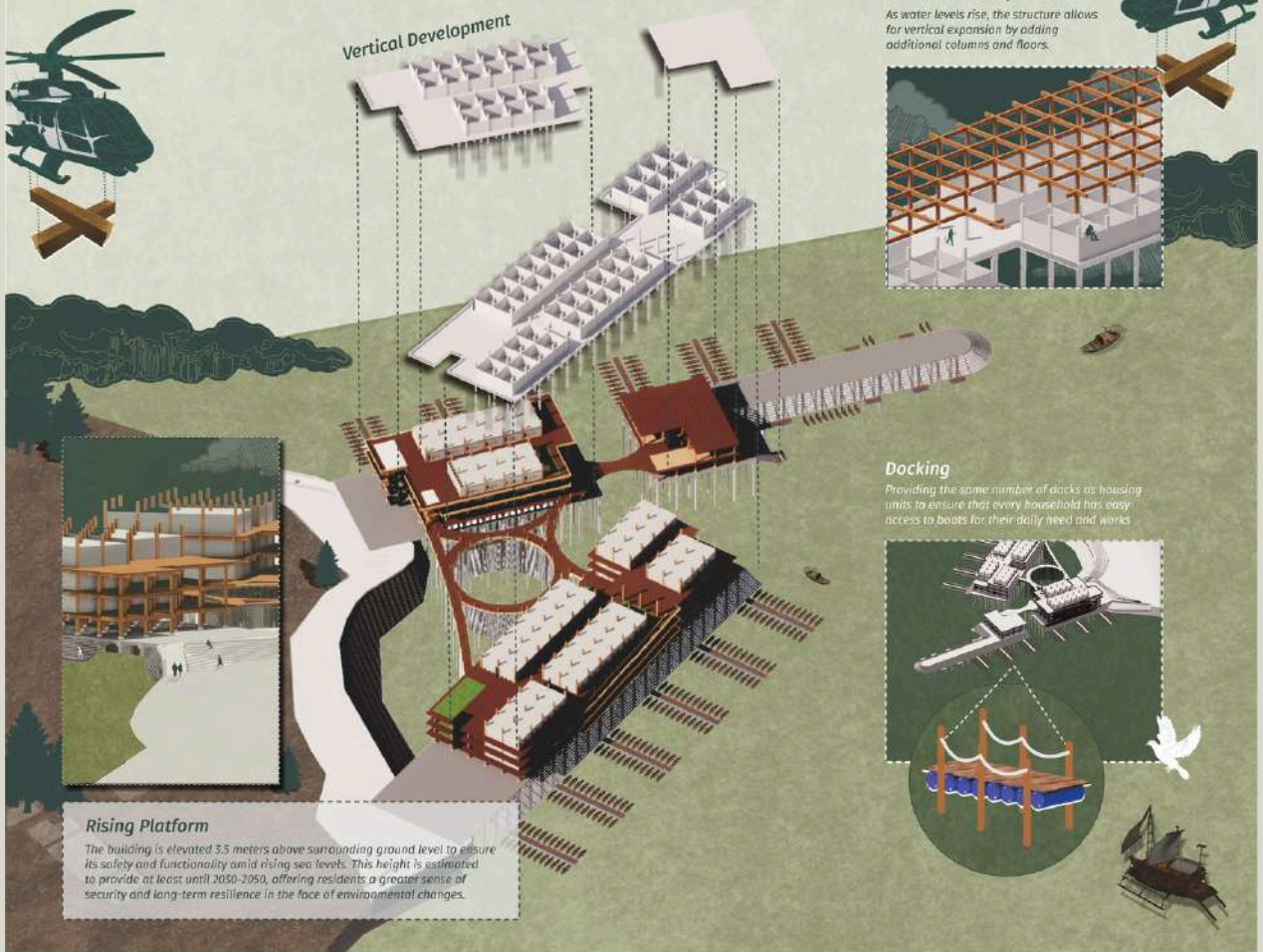








Each 36 sqm unit is arranged in an adaptive layout. Smaller households are placed on the first floor to reduce the number of people likely to be affected first by sea level rise projected between 2030 and 2050. Larger families are placed on the upper floors for better protection, and all units use an open-plan layout that residents can adjust based on their needs.





Ramp
To ensure universal accessibility, each building is equipped with ramps that connect every floor, allowing people of all ages and abilities to move safely and comfortably throughout the building.



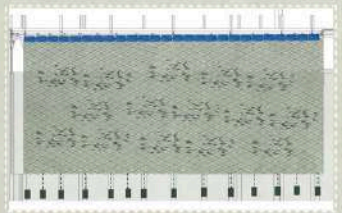
Public Facilities
To support the current condition, where road access has been disconnected, essential facilities are provided to keep daily activities running. These include a fish auction market, a place of worship, and a school.



Floating Net Cages
To ensure that fish farming activities can continue, the traditional methods have been replaced with floating net cages using keramba systems. This approach allows aquaculture to adapt to changing water conditions while maintaining the community's primary source of livelihood







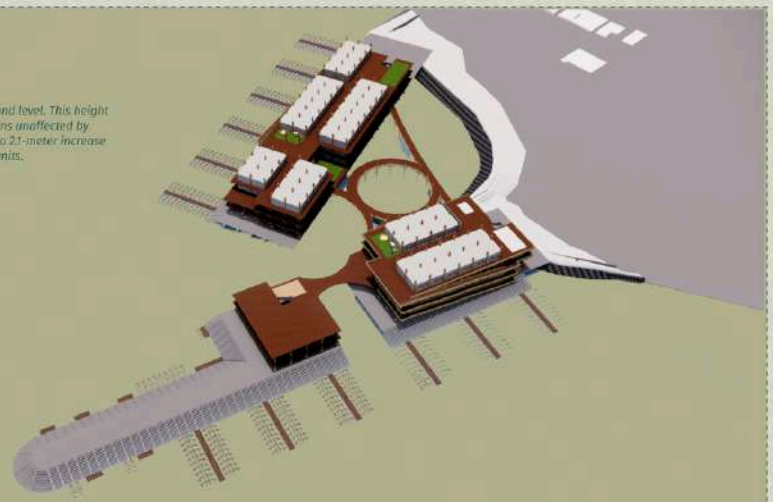




2030

+2.1 m

The housing design is elevated 3.5 meters above the current ground level. This height has been strategically determined as a safe threshold that remains unaffected by projected sea level rise through the year 2030. At that time, even a 2.1-meter increase in sea level will not compromise the structure or the residential units.



2050

+9.6 m

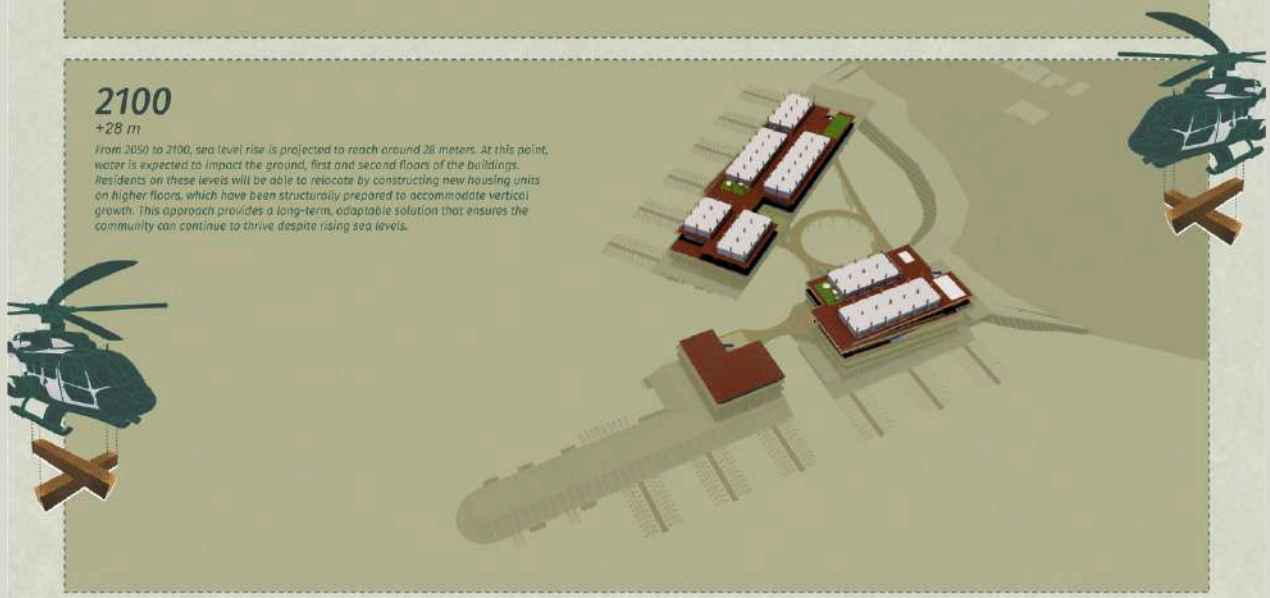
Between 2030 and 2050, sea levels are expected to rise by approximately 9.6 meters. Only the ground floor, which is intentionally allocated as a void space for floating net cages, will be affected. The housing units above this level will remain safe and fully operational. This period also marks the planned phase for vertical expansion, allowing for the construction of additional floors as needed.



2100

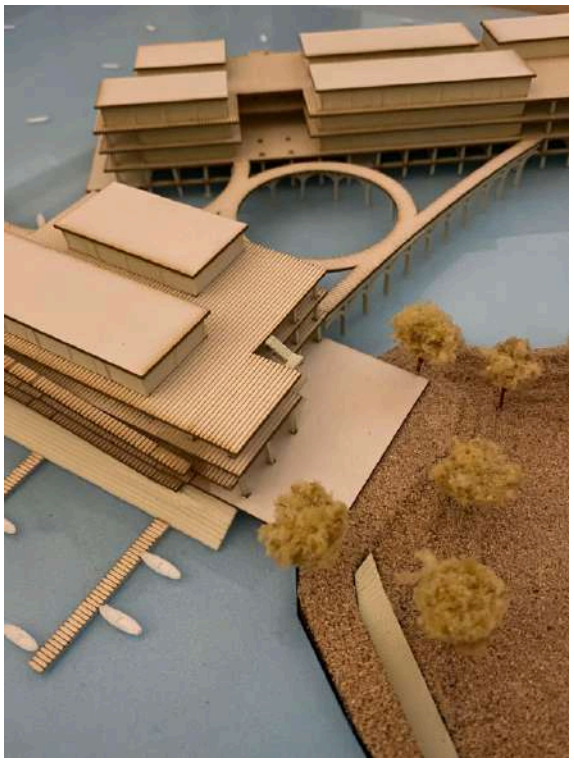
+28 m

From 2050 to 2100, sea level rise is projected to reach around 28 meters. At this point, water is expected to impact the ground, first and second floors of the buildings. Residents on these levels will be able to relocate by constructing new housing units on higher floors, which have been structurally prepared to accommodate vertical growth. This approach provides a long-term, adaptable solution that ensures the community can continue to thrive despite rising sea levels.

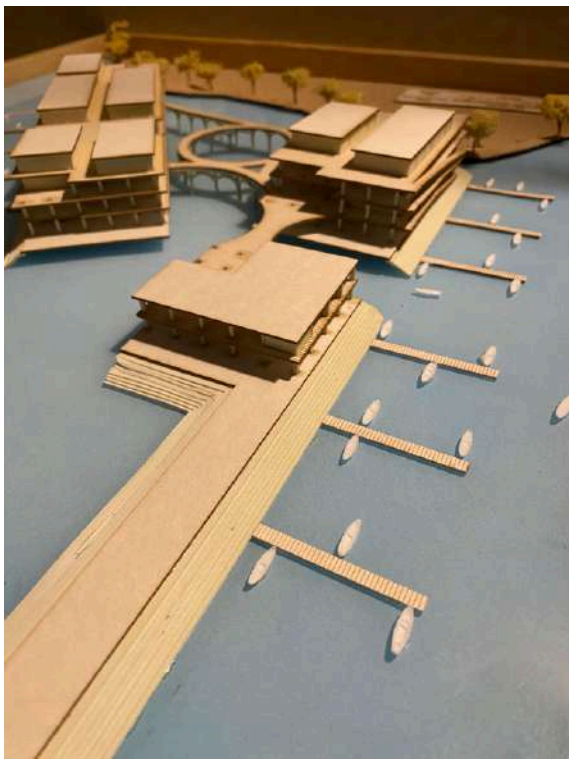


Attachment — Maquette













Notes Response

No	Notes from Jurys	Adequate Response	Revised Part (Page)
DESIGN BRIEF			
Dr. Ar. Yulianto Purwono Prihatmaji, S.T., M.T.M IPM., IAI.			
Google Classroom	Who is the owner and commissioner of this project? Is there any reference for the design & location selection?	The owner can be Pekalongan City Government, PUPR, NGOs. (1) Commissioner can be Dinas PU (1) The site location was chosen in the most affected area, Dusun Semonet, which has already disappeared from the map and been left uninhabited due to years of abrasion and disconnected access.(2)	(1) 34 (2) 21
	How is the relationship with the local stakeholders in Pekalongan?	The Pekalongan government has made efforts to relocate residents from Dusun Semonet to Dusun Tratebang (1) However, based on projections, the relocation site in Dusun Tratebang will also be affected by tidal flooding (2). Therefore, this design is an effort to return the community to Dusun Semonet and create housing that is prepared to adapt to the projection of Pekalongan's submergence. (3)	(1) 31 (2) 18 (3) 33
	How important is the living hub with a resilient arch? Explain your finding problem of fisheries!	The living hub with a resilient architecture approach is very important because it provides not just housing, but also a safe, adaptable space that supports the daily life and livelihood of flood-affected communities.	35
	What are the design challenges of this project and what are the proposed design solutions?	Design Challenge: accessibility issue, the existing road are submerged and the ground conditions that not suitable to live (1). The proposed design solution is to revive the settlement to suit current and future conditions and their former way of living so they can continue life in a safer and more stable place (2)	(1) 42 (2) 38
SIMSADA	-		
Offline Seminar	Based on responses during the offline seminar, there were several questions regarding the amphibious concept and the site selection	It no longer adopts amphibious living but instead uses a stilt structure, since amphibious housing requires precise calculations to ensure the buildings can float, and if the concept is applied to the entire village, the cost would become very high.	70
Prof. Dr. -Ing. Ir. Ar. Ilya Fadjar Maharika, MA., IAI			
SIMSADA	Still problematic with the scoping of the problem is whether it will design a housing type or reconsolidate the sinking kampung?	The decision to reconsolidate the sinking kampung rather than only designing a single housing type is based on the scale and complexity of the problem to addresses the broader dimensions of resilience, including collective housing (1), infrastructure, public spaces, and the fisheries-based livelihood system (2)	(1) 80 (2) 93, 94
Offline Seminar	What types of facilities are included in the design?	Residential, communal, service, supporting, circulation, transportation and logistic, economy and community, social and support	77
	When it comes to the floating structure—does it resemble a boat-like system, or is it based on another concept?	It has changed and no longer uses a floating structure. Instead, the design adopts a stilt structure, which is considered more feasible for the scale of an entire kampung. Stilt structures provide long-term stability, are more cost-effective than floating systems, and are easier to maintain by the local community.	82

No	Notes from Jurys	Adequate Response	Revised Part (Page)
DESIGN COMPREHENSIVE			
Dr. Ar. Yulianto Purwono Prihatmaji, S.T., M.T.M IPM., IAI.			
Google Classroom	Explain how you designed this project, and its relation to the PAP Lab.	The design becomes relevant to PAP Lab because the issue addressed falls within the scope of urban problems (tidal flooding) (1) which is predicted to submerge the entire area of Pekalongan (2).	(1) 13 (2) 17, 18, 19
	Mention and explain the design concept developed from the study of the architectural problems of your project.	Design Concept : Reviving the lost settlement of Dusun Semonet (1) through a resilient architecture approach, realized by implementing an Elevated Modular Settlement. The concept aims to restore the community in its original coastal location, which has been abandoned due to submergence, by introducing a settlement system that can adapt to future tidal flooding and sea-level rise (2)	(1) 24 (2) 33
	Mention and explain the design criteria and design guidelines that you obtained from the design concept of the project being worked on.	Design criteria (1) and design guideline (2) are formulated based on the chosen approach, which is resilient architecture. This means that every aspect of the design—ranging from housing typology, structural systems, circulation, and public facilities—is evaluated against the four core principles of resilience: redundancy, robustness, resourcefulness, and integrative design.	(1) 55 (2) 56
SIMSADA	Respon to all notes in GC. Define design issues and problems more clear and develop related design criteria, design guideline and related concepts to solve design problems.	Semonet is now permanently underwater and uninhabitable due to floods, land subsidence, and rising sea levels (1). Design criteria, guideline, (2) are formulated based on Resilient Architecture approach.	(1) 21 (2) 55, 56
Offline Seminar	Response for wind flow	Providing wooden louvers as an adjustable response. The use of wooden louvers allows residents to control natural ventilation, daylight penetration, and privacy according to changing conditions. They function as a passive design strategy that reduces heat gain during the day while still allowing airflow, improving indoor comfort without relying heavily on mechanical cooling.	91
Prof. Dr. -Ing. Ir. Ar. Ilya Fadjar Maharika, MA., IAI			
SIMSADA	Need to study explicitly about the options of living on the shore to have sound theoretical ground	By 2030, the entire Pekalongan Regency area will be submerged (1), including the relocation site (2). Therefore, the design concept is to return the community to their original area, Dusun Semonet, and revive it with a design that integrates water as part of the environment rather than a challenge (3)	(1) 18 (2) 31 (3) 33
	Pay attention to building materials in a sea location, especially those prone to corrosion.	Using prefabricated concrete material as used in port construction (1). Prefabricated concrete is chosen for its durability, strength, and proven resistance to harsh coastal conditions such as saltwater exposure, abrasion, and continuous moisture. (2)	(1) 62, 63 (2) 85
	Pay attention to the aspect of affordability	The population has been increased to three times the previous size, making it more affordable and allowing for long-term growth.	80
Offline Seminar	Studying advanced construction technologies	Studying a case study on bamboo mat foundations (cerucuk matras bambu) used in the Semarang–Demak toll road (1), as well as studying the construction methods applied in ports (2).	(1) 58-61 (2) 62-64
Ir. Wiryono Raharjo, M.Arch., Ph.D.			
SIMSADA	Please consider the issue of housing affordability and the possibility of increasing the number of targeted households (KK).	The population has been increased to three times the previous size, making it more affordable and allowing for long-term growth.	80

No	Notes from Jurys	Adequate Response	Revised Part (Page)
FINAL DEFENSE			
Dr. Ar. Yulianto Purwono Prihatmaji, S.T., M.T.M IPM., IAI.			
Google Classroom	Present the Design Challenges, Design Criteria, Design Guidelines, and Design Concept for your project.	Design Challenge: The main challenge is accessibility, since the existing roads are already submerged and the ground conditions are no longer suitable for living. This means the settlement cannot rely on conventional land-based infrastructure, and new systems of circulation. (1) Design Criteria, Guideline, and Concept: These are further detailed in the design report, where the criteria establish measurable goals for resilience, the guidelines translate them into specific strategies (2)	(1) 42 (2) 55, 56
	Describe a design indicator of reviving post-subemergent settlements and prove it in your design	Design indicator : • Connectivity with livelihood → The design ensures residents remain connected to their fisheries-based economy by providing access to the sea, aquaculture facilities, and supporting infrastructure. (1) • Housing remains safe from sea inundation → Elevated stilt structures keep homes protected from tidal flooding for the coming years, ensuring safety and habitability. (2) • Community can adapt in the long term → The modular system and resilient infrastructure allow the kampung to grow, adjust, and sustain itself as environmental and social conditions change (3)	(1) 93, 94 (2) 86 (3) 99, 100
SIMSADA	-		
Offline Seminar	Requires more innovative wastewater system so it does not rely on regular suction	Using vermifiltration with earthworms to decompose waste, installed on each floor. Each floor includes a compact vermifilter unit that receives blackwater and greywater after basic screening.	106
Prof. Dr. -Ing. Ir. Ar. Ilya Fadjar Maharika, MA., IAI			
SIMSADA	Structural solution. Glulam, as the main material, is not proper for the location (seaside)	Replacing the previous glulam material with prefabricated concrete columns and beams, the same as those used in the foundation structure. The decision to shift from glulam to prefabricated concrete responds to the specific challenges of a coastal environment where constant exposure to saltwater, humidity, and abrasion would compromise the durability of timber-based materials.	103
	Type of housing, needs to adjust with the characteristics of families	Changing the unit sizes: Single Unit becomes half the previous size (18 sqm), Small Family Unit remains the same (36 sqm), and Multi-Family Unit becomes 1.5 times the original size (54 sqm). The variation in unit sizes also supports future adaptability, allowing families to upgrade or downsize according to their economic conditions and growth, while keeping the overall settlement inclusive and resilient.	105
Offline Seminar	Building orientation should be determined based on tidal flow and all related data	An alternative building orientation positions the longer facade facing north and south to align with tidal flow and sunpath orientation. By orienting the buildings this way, the design minimizes direct east–west solar exposure, reducing heat gain and improving indoor thermal comfort, which in turn lowers dependence on mechanical cooling. At the same time, aligning the layout with the tidal flow allows water to move more naturally around the settlement, reducing pressure on structural elements and preventing blockages that could worsen flooding impacts.	104

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What was Lost,
Returned Stronger