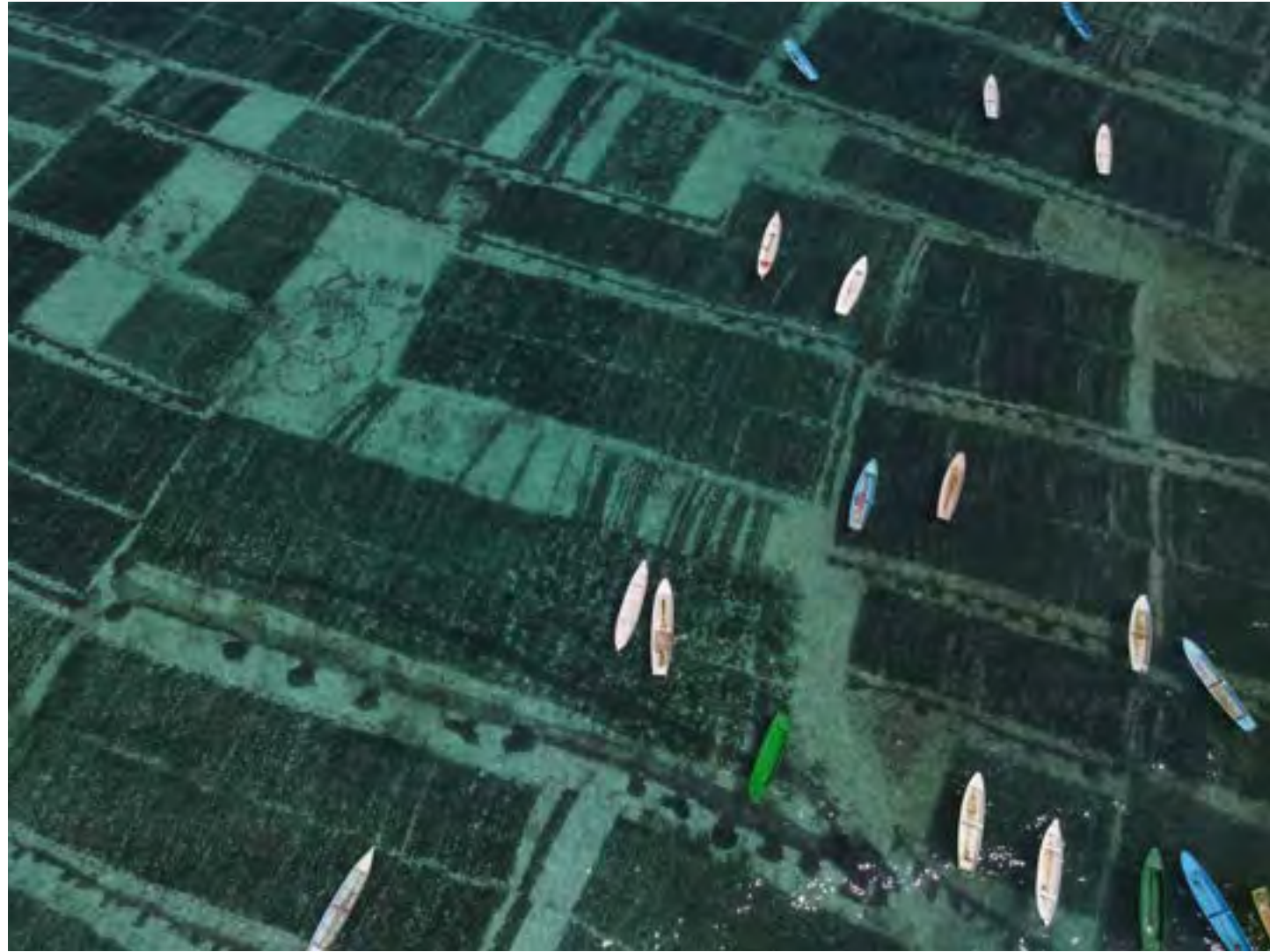


On Coastal Resilience:
Marine Agriculture in the Lombok Strait

AKPIA Travel Grant Award 2022

Latifa Alkhatat + Sasha McKinlay



PART 1 Analysis

By Sasha McKinlay

P4

PART 2 Reflections

By Latifa Alkhatat

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Unless otherwise stated:

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Content obtained from primary, on-site research in Lembongan , Nusa Tenggara, Indonesia

PART I: Analysis

Indonesia is both the most populous Islamic nation and the second largest producer of farmed and wild seaweed in the world, yet it is frequently economically and academically overlooked as a site for exploration. However, with one of the longest national coastlines in the world, millions of Indonesian people are at the forefront of the fight against the destructive effects of climate change on the world's oceans. With this in mind, the government has made a substantial pledge to commit to a new Blue-Green economy that forefronts the needs and potentials of its coastal communities. Seaweed cultivation has been globally identified as a means of targeting these social, economic and environmental agendas. Thus, Indonesia is uniquely placed to pioneer culturally and environmentally sustainable practices that empower coastal resilience and food security in a time of urgent climate uncertainty.





Over the last few decades, with the onset of climate-altered marine conditions, fisher-communities along Indonesian coastlines have been supplementing their incomes from receding fish yields by harvesting seaweed. However, in the aftermath of the Covid-19 pandemic, we find a burgeoning local blue-green economy predicated on the super-crop. In Indonesia, seaweed cultivation has the potential to strengthen coastal economies and communities, sequester carbon on a globally-relevant scale; and take a significant step towards food security.

Nevertheless, there are several critical systemic challenges to the success of the seaweed industry in Indonesia. These include a convoluted and fractured supply-chain, the adoption of unsustainable farming practices (often the use of disposable plastics as farming tools contributes to marine plastics); and price volatility due to a lack of quality assurance at the primary level.

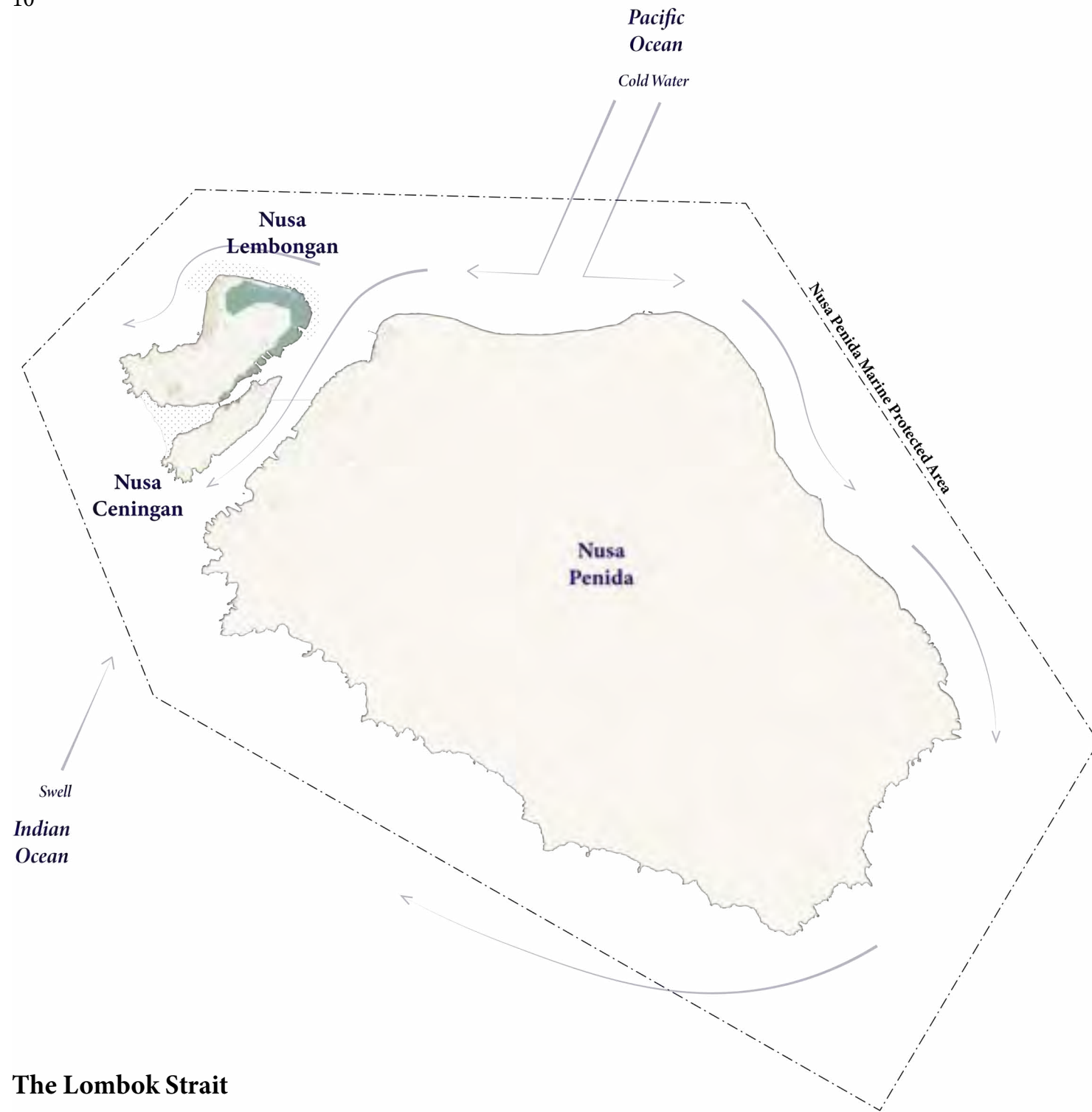
Furthermore, with the end of Covid-19 travel restrictions, the tourist populations that have come to dominate the beaches of Indonesia have returned to claim these coastlines once more. While the pandemic had temporarily disrupted the pipeline to employment in the tourist industry, veterans and newcomers alike are turning their attention back to what was once the most lucrative employment opportunity.



Farming in the Indonesian Throughflow

This research is centered on the seaweed farms of the Nusa Islands, a cluster of three small islands between the more well-known tourist destinations of Bali and Lombok. Though only a fraction of Indonesia's seaweed production is contributed by the Bali region, its status as one of the most popular tourist destinations makes it a critical site of study for the friction between tourism and seaweed farming.

The Nusa Islands are caught in the convergence between two major Oceans, where warm, relatively fresh water from the Pacific must squeeze through the Indonesian archipelago to meet the waters of the Indian Ocean. This current is a phenomenon of global climate significance called the Indonesian Throughflow, it is the main upper branch of the global heat/salt conveyor belt. A main arm of the throughflow passes through the Lombok Strait, where the Nusa Islands are located.

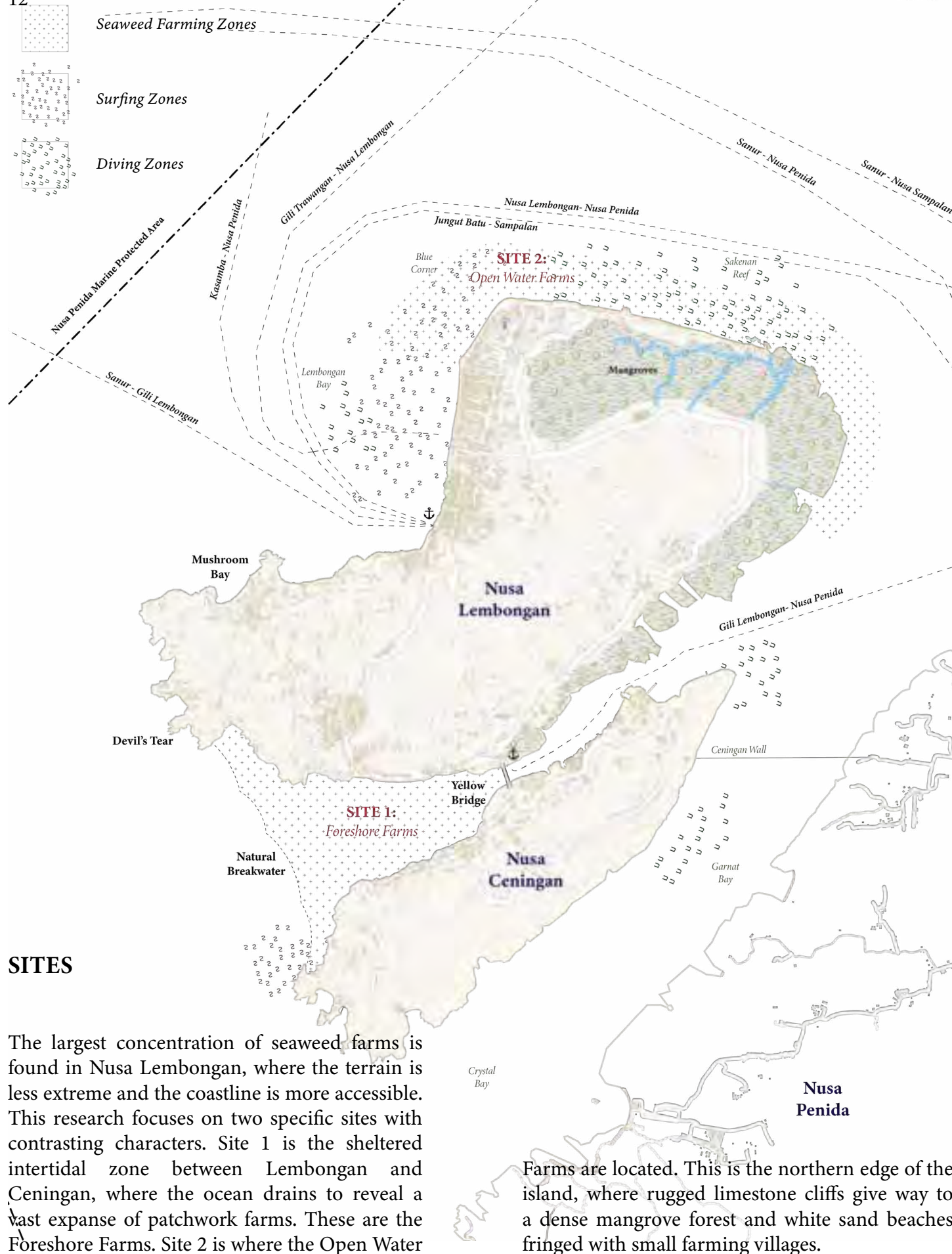


The Lombok Strait

The Indonesian Throughflow is responsible for producing the specific conditions that benefit seaweed farming and tourism in the Nusa Islands. The current from the Pacific brings freshly warmed, nutrient-rich water, encouraging an impressive marine biodiversity. As well as attracting divers and snorkelers from around the world, the current also mediates the factors that determine a successful seaweed harvest, including temperature, salinity, oxygen content, acidity and current speed.

Above land, the swell from the Indian Ocean can be seen dramatically colliding with rugged limestone cliffs, performing an impressive demonstration of the might of the ocean beneath.





SITES

The largest concentration of seaweed farms is found in Nusa Lembongan, where the terrain is less extreme and the coastline is more accessible. This research focuses on two specific sites with contrasting characters. Site 1 is the sheltered intertidal zone between Lembongan and Ceningan, where the ocean drains to reveal a vast expanse of patchwork farms. These are the Foreshore Farms. Site 2 is where the Open Water

Farms are located. This is the northern edge of the island, where rugged limestone cliffs give way to a dense mangrove forest and white sand beaches fringed with small farming villages.



The vast intertidal zone between Lembongan and Ceningan is a unique condition for seaweed farming. It is protected from swells and currents by a natural breakwater and is the ideal depth for farming at low tide.

Image by Latifa Alkhayat



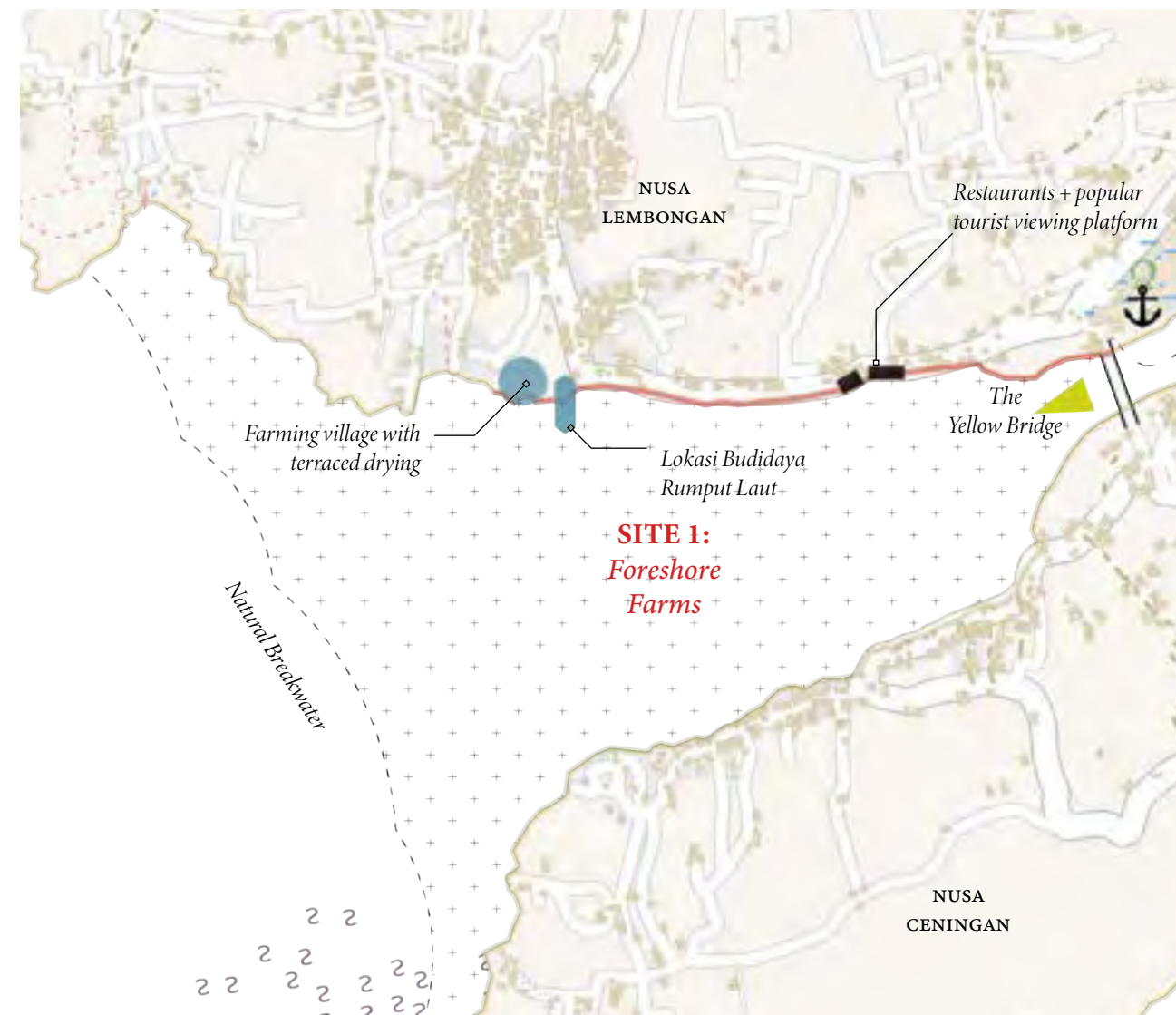
Foreshore Farms in the Lombok Strait

Image by Latifa Alkhayat



Foreshore Farms

The foreshore farms are found in the vast intertidal zone between the islands of Lembongan and Ceningan. At low tide, the ocean drains almost entirely, revealing a patchwork of thriving seaweed farms. The conditions found here are entirely unique: protected on one side by a natural breakwater, the inlet is sheltered from strong currents and large swells, allowing seaweed farms to flourish.



Seen from the infamous ‘Yellow Bridge’ (a tourist’s cautionary warns that the bridge is known to collapse frequently and without warning), the umbilical cord that connects the two islands, an onlooker would be completely unaware of the thriving seaweed farms and vibrant aquatic communities beneath the surface. Seaweed farming dominates the borders of this relatively narrow inlet. However, farming conditions and their relationship to the urban landscape varies between the northern and southern edge.

The Northern Edge // Foreshore farms from Lembongan

Lembongan’s border with the inlet has a more defined edge. Reckoning with steeper topography, the farming activities have a more organized quality. Lembongan farmers have a primary access point to this space in the form of a large concrete stair that branches from the crook of a main road. A solid stone gate welcomes visitors to the ‘Site of Seaweed Cultivation’ and attributes its

infrastructure partners, BRI Bank. The stairs are the site of seaweed cultivation at all times of day. At low tide, it is a conveyor belt for the exchange of freshly harvested seaweed and newly prepared propagation lines. At high tide, families and friends gather around harvest baskets to prepare their haul for propagation and drying.

Farming in the Flat

The stairs lead directly to a wide ‘beach’ that is revealed at low tide. On the flat, young men can be seen ‘beating’ nylon rope and plastic string against large rocks. Our guides through the farm explained that this helped slow down the degradation of the lines and prevent disease in the crop. Beyond the flat, seaweed is arranged into geometric axes that stretch into the horizon.



View from the Yellow Bridge at high tide (left) and at low tide (right). Farms are completely concealed at certain times of day. The landscape changes entirely when the inlet drains at low tide.

With a diversity of colours on show: reds, greens, browns; and a gradient of conditions: stationary farms run aground, gently bobbing lines in ankle-deep water, and the shadow of seaweed beneath the surface of the knee-deep inlet centre; there is a diverse patchwork of seaweed cultivation in view when the basin drains.

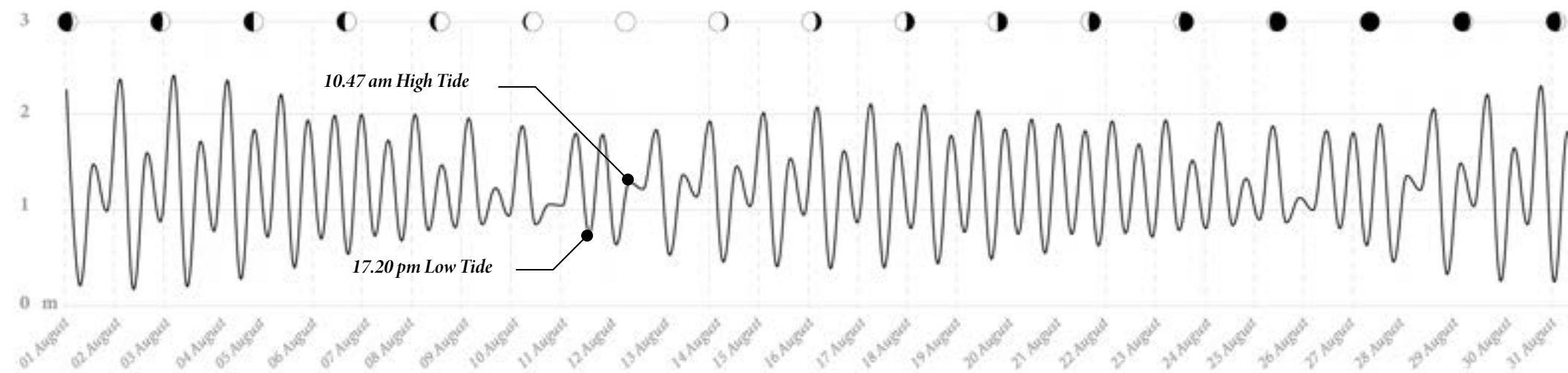
Though a bustling centre of cultivation activity, most foreshore farmers we spoke to claimed that they also maintained at least part-time employment in the tourist industry, describing a different landscape at high tide. As farms are typically family-owned and run, they explained that older members of the family usually farmed full time, while younger members were able to contribute during peak-times (at low tide twice a day) when harder labour and more hands are useful.

While foreshore farmers generally enthuse about their farming conditions, open water farmers claim that the inlet has become polluted from boat traffic and tourist activity near the farming site. Foreshore farmers however, have a similarly assertion about the open water site.



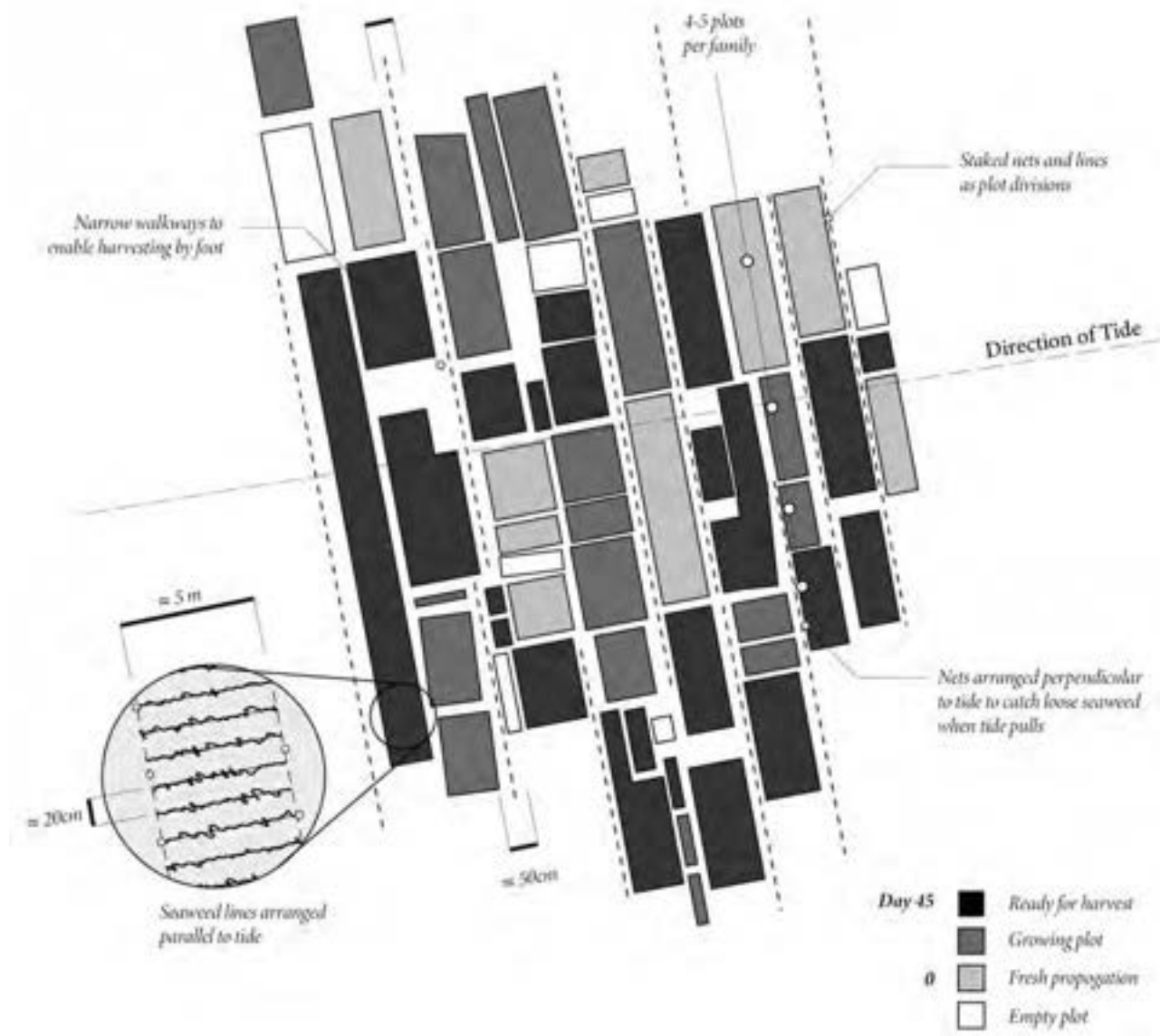
Left: Foreshore farms concealed by high tide. Small boats pass freely above the farmed areas.

Right: The Foreshore farms are revealed at low tide. Boats are left marooned.



The tidal chart for Lembongan in August (left) can also be seen to outline the employment activities of local residents.

Most residents we spoke with explained that they had returned to seaweed farming in the wake of the Covid-19 pandemic, as the tourist industry deflated. With the return of the tourist population, they have found a new normal. They primarily tend to their seaweed at low tide, while maintaining full-time employment in tourism. The tidal chart demonstrates how the two industries may find balance.



Farming Administration

Farms are family owned and run businesses which are loosely administered by a 'village chief' (kepala desa). The chief's primary responsibility is to uphold a distinctly Indonesian social code that governs vernacular organizations (urban, agricultural and otherwise) referred to as 'gotong royong' or 'mutual self help'. Gotong Royong dictates communal responsibility to its members and vice versa. Within this system, informal and sometimes unspoken negotiations of sharing, 'borrowing'; or claiming, land and materials may take place to ensure optimal resource management. While gotong royong usually ensures the harmonious operation of the farming site,

the chief will mediate disputes, including claims to farming plots.

The foreshore farms are organized in clusters of family plots, arranged perpendicular to the direction of the tide. This enables narrow buffer zones between plots to become walkways from one island to the other, these are lined with fishing nets to catch loose seaweed. Seaweed lines are also consequently oriented parallel to the axis of the tide, most likely to decrease resistance to the flow of water, and therefore reducing the risk of breakage.





Mbak Ilu's Mother-in-law harvesting seaweed in the deeper section of the inlet. In the middle of the channel, farmers may use their boats in the shallow waters to harvest and prepare new lines for propagation.

Harvest Harvest was generally conducted on foot or in row boats in the central regions of the inlet. Few farmers wore protective footwear despite the frighteningly armored sea urchins, sea snakes and eels that are commonly found in the intertidal zone. The only required tools are a rattan basket, wooden stakes, nylon line, plastic bags or string, and some freshly picked seaweed for propagation.

When invited to take part in the harvest, one finds the most valuable skill is learning the quick release knot farmers use to secure seaweed to their lines. This technique was a small measure to ease the especially labor intensive work of seaweed farming.



Plastic string or repurposed plastic bags used to secure seaweed to nylon line.



Harvested seaweed split for drying and for re-propagation. An example of collective farming activity on the central stair.

1.



2.



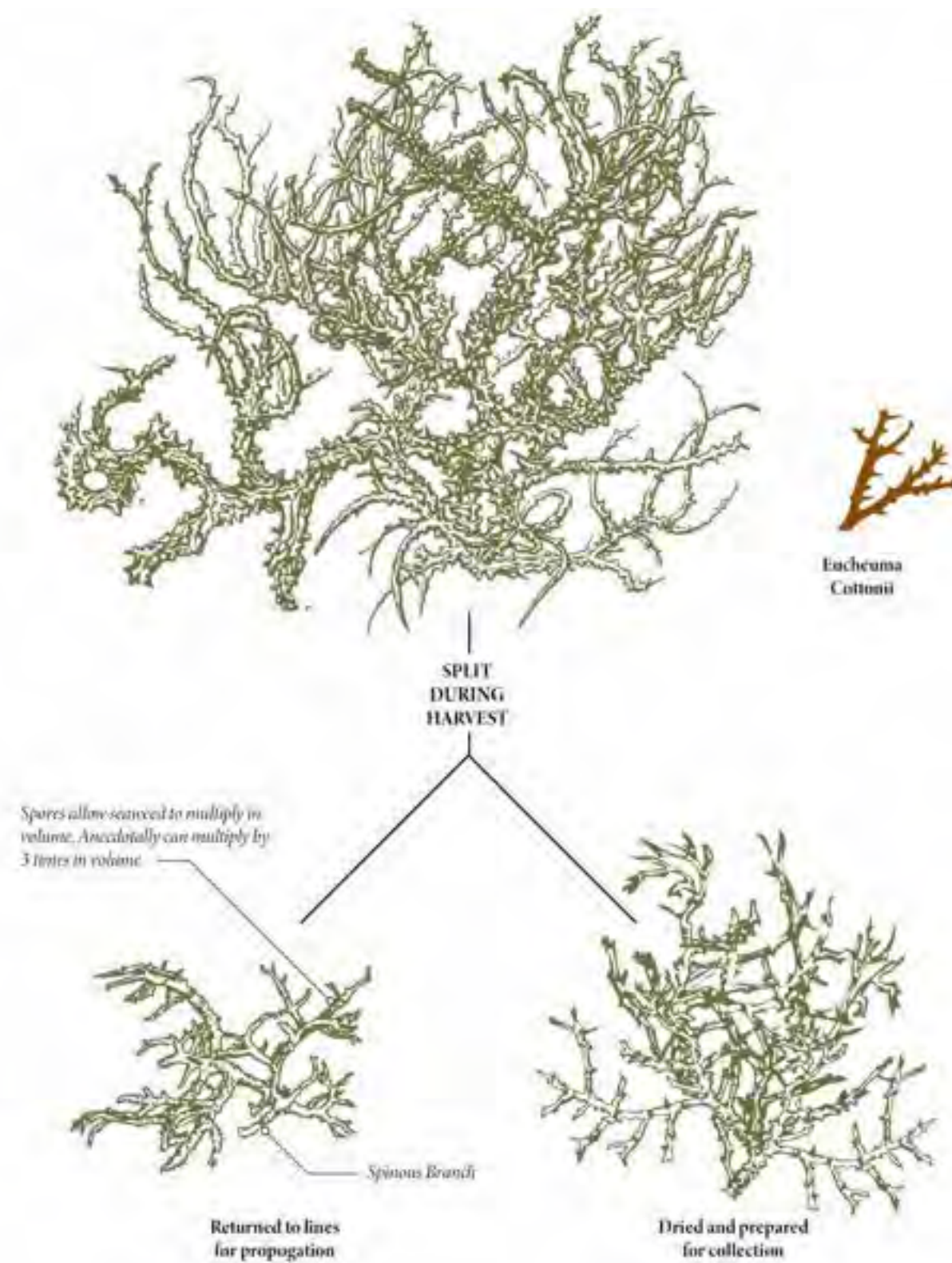
3.



4.



Quick release knot to secure seaweed to lines. Knots released by pulling single loop end.



Eucheuma Cottonii is the variety of seaweed produced in the nusa islands, and indeed most of Indonesia. This variety is used to produce carrageenan, a common food thickener.

Seaweed farming was introduced to the Nusa Tenggara region in the 80s, when spores were brought into the country. Today, harvests are

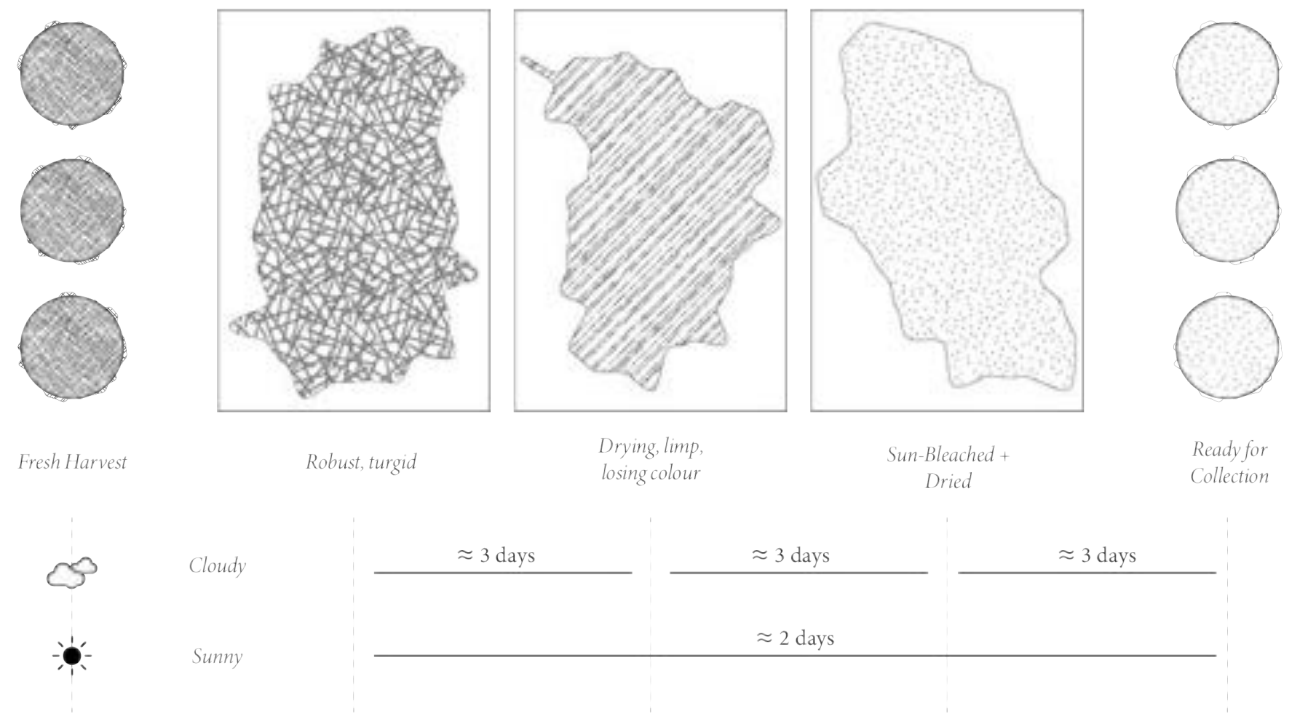
split, as the spores on the branches of the seaweed enable easy propagation. The seaweed is said to triple in volume on the lines.



Foreshore Villages + Drying

The main farming villages associated with the foreshore farms are accessed via an offshoot of the central concrete stair. Here, harvested seaweed is heaped onto tarp in a central clearing, which is bordered by the homes of the farmers. The seaweed pile is dried via sun exposure, it is frequently redistributed on the tarp as it begins to dry and lose volume. The waterproof tarp is used to cover the produce in the evenings to protect it against potential rainfall.

The drying process is known to take up to 10 days in average conditions, determining the cadence of contact with the local salesman who purchases dried seaweed. All of the interviewed farmers had an awareness that their product would eventually make its way to China, but they were unaware of the details of the entire supply chain.





1 *Propogated + Growing*



2 *Harvested 'Green' Seaweed*



3 *Drying seaweed*



4 *Sun-bleached, dried seaweed*

Transformation

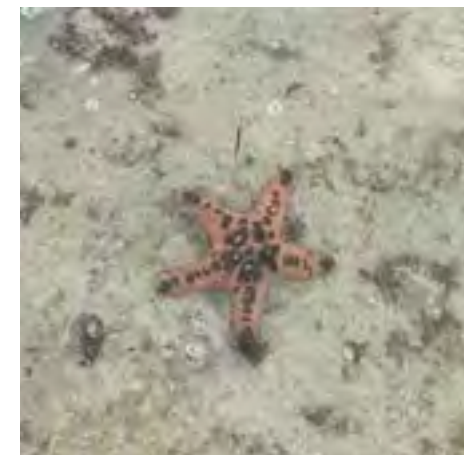
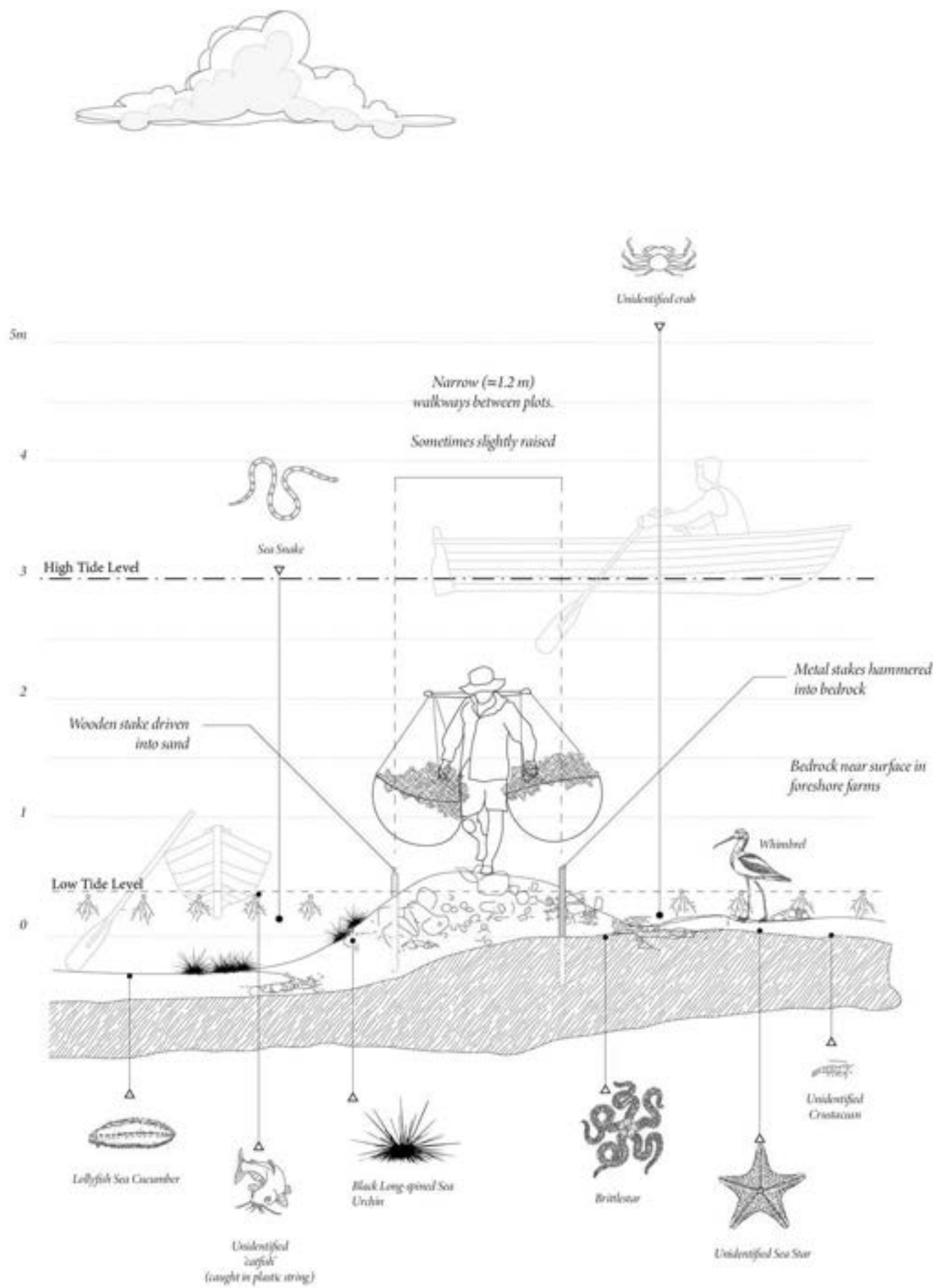
Eucheuma Cottonii seaweed, harvested in the Nusa Islands, undergoes a series of transformations throughout the farming process. When it is pulled from lines, it is a mighty tangle of vibrant forest green branches, firm and somewhat gelatinous. These structures are split into more manageable branches, for repropagation along nylon lines. The seaweed that is laid out to dry begins to lose color and turgidity when exposed to sunlight. At

the end of the drying process, it is sold as a white, dry and brittle product.

The value of the product is determined by weight and 'quality', which is loosely defined as the moisture content of the dried seaweed. This is evaluated by touch and a sight inspection of impurities. A 'drier' product will invariably receive a higher market price.



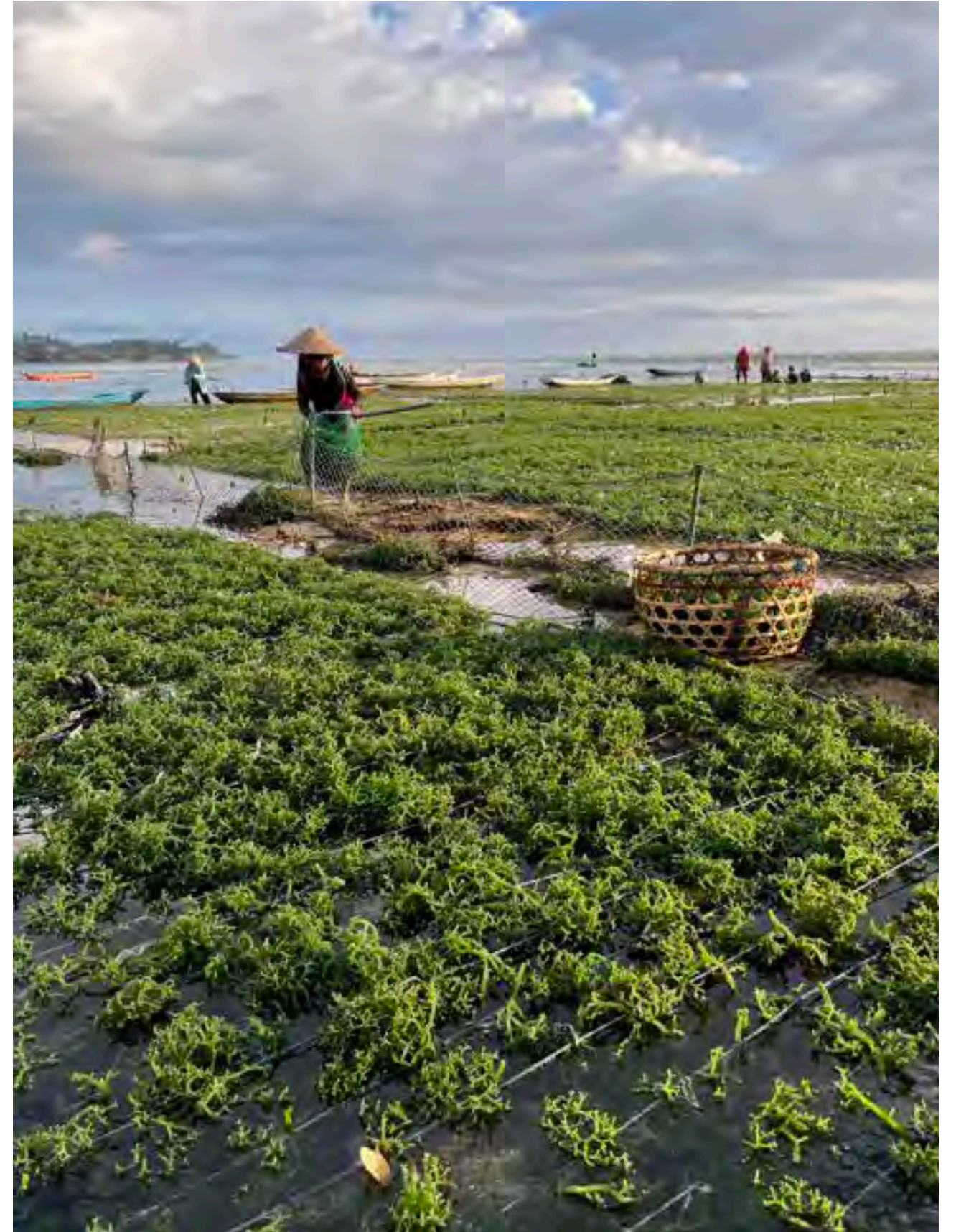
While the tourism and seaweed farming industries compete for the coastline, they have a complex and interconnected relationship, that is in negotiation for equilibrium. The seaweed farms of Nusa Lembongan are a cacophony of scents, geometries and textures. It is these elements that ultimately define the landscape of the island. In this way, Lembongan is uncompromising in its relationship with seaweed. Instead, the tourism industry has been able to build in flexibility to accommodate it.

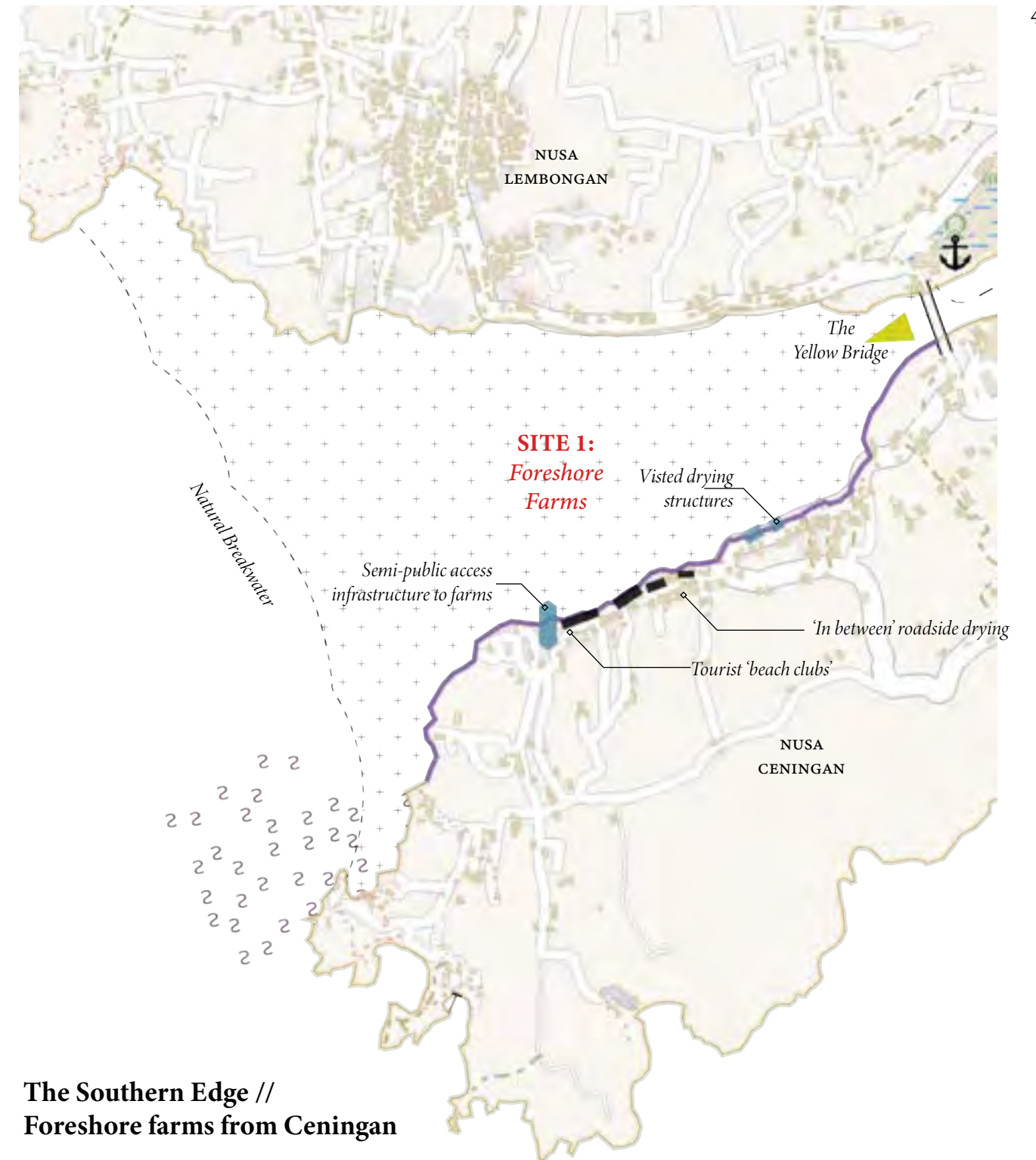


Habitat

The researched seaweed farms are all sited in the intertidal zones of Lembongan, thus they are a flourishing habitat for the Lombok Strait's rich biodiversity. At low tide, marine birds can be seen to join farmers in the seaweed trenches, rooting for small fish and crustaceans. This landscape appears vastly different at high tide, where all marine activity is concealed under the turbulent surface of an ocean on the move.

Left: Images of marine life captured in the seaweed farms of Lembongan. From the top: Unidentified Sea Star, Lollyfish Sea Cucumber, Black Long-spined Sea Urchine, Unidentified 'catfish' caught in plastic string. A sea snake was also sighted but was not captured. Eels are reportedly common but were not seen during the visits.





The Southern Edge // Foreshore farms from Ceningan

The farming operations along the southern edge of the inlet differ from their northern neighbors. Ceningan's more gradual transition to the water enables farming villages to be more disparate, informal and visible to the uninformed visitor. The topography similarly opens up the coastline to encroachment from tourism: dotted along this edge is a mixture of small tourism establishments and farming sites.



Nuclear Farms

On this side, drying similarly occurs in the central clearing of a family complex. However, these appeared more removed from other similar organisations, thus enforcing the nuclear nature of the family business.

Forging a relationship with tourism

The southern edge is thronged with 'beach clubs': small food and drink establishments, sometimes furnished with a pool and a handful of deck chairs. These are a modest luxury, appropriate to the scale and genre of the Ceningan tourist scene. At high tide, these clubs capture a typical post-card idea of 'paradise'. At low tide however, a unique view laden with this unusual, unearthly crop is revealed. This transformation is the crux of the allure of Lembongan to tourists around the world.

A few of the southern edge foreshore farmers described a more direct relationship with tourism, owning or working in an adjacent beach club, enabling them to switch between jobs with ease throughout the day.



An infinity pool on the southern edge of the inlet gives the illusion of joining seamlessly with the foreshore farms. These moments demonstrate the complex and interdependent relationship between seaweed farming and tourism in the Nusa Islands.

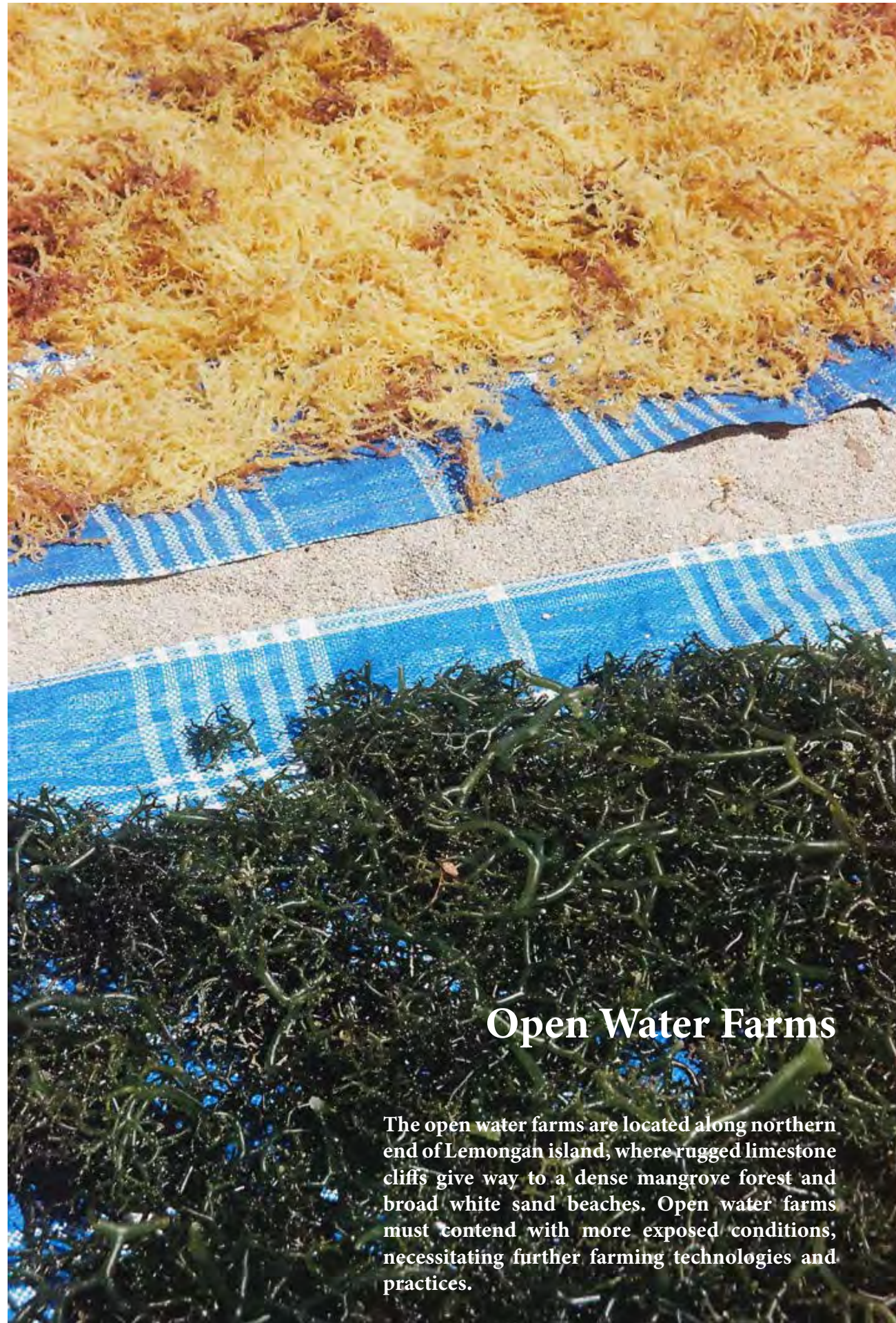


Seaweed drying occurs informally throughout the island, occupying the spaces 'in between.' Moments captured here are emblematic of this dynamic. Notably, drying sites along the southern edge are situated primarily along a main road that skirts the inlet which is otherwise populated by farmers houses and occasionally punctuated by 'beach clubs'.



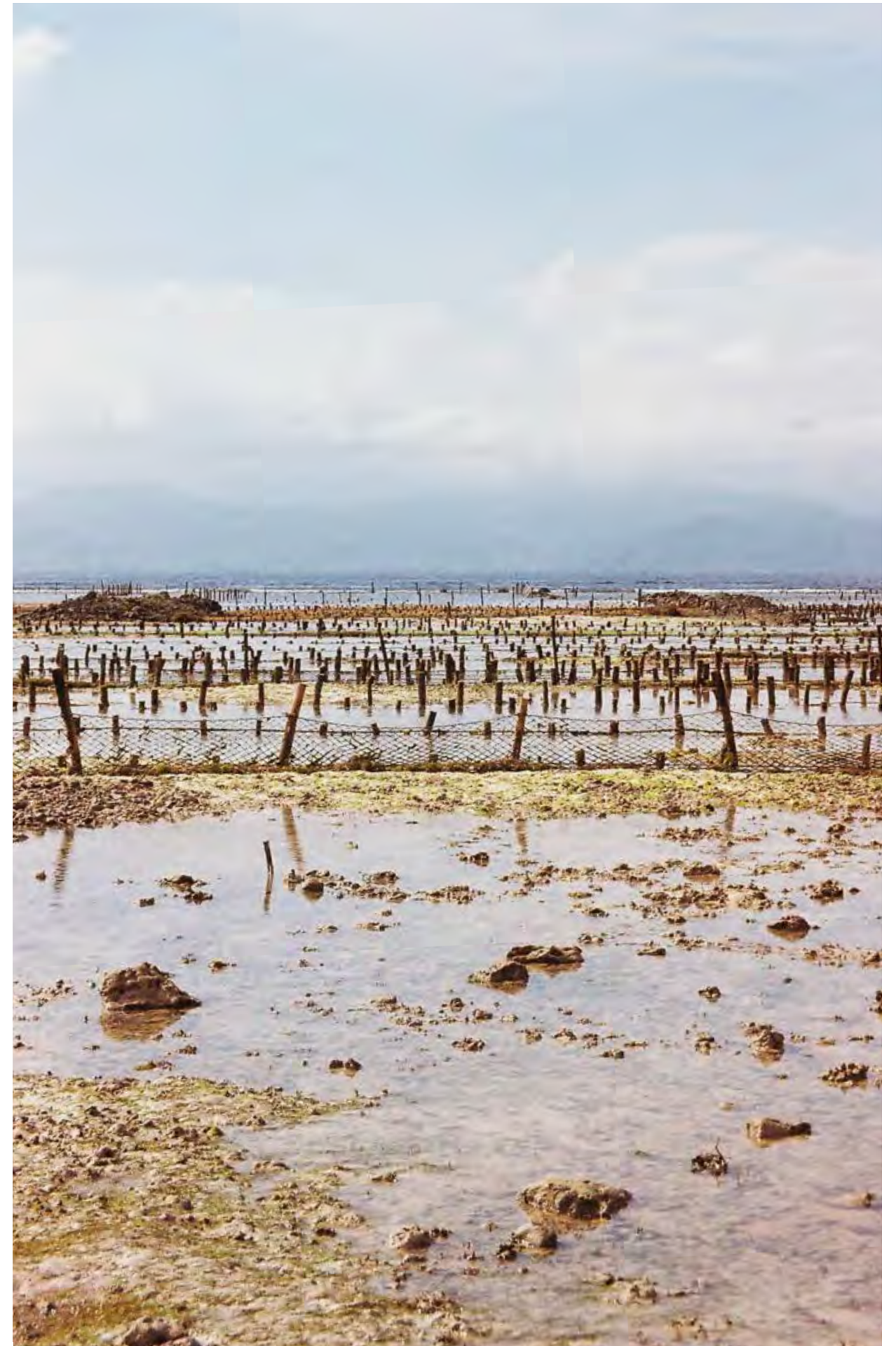
In-Between

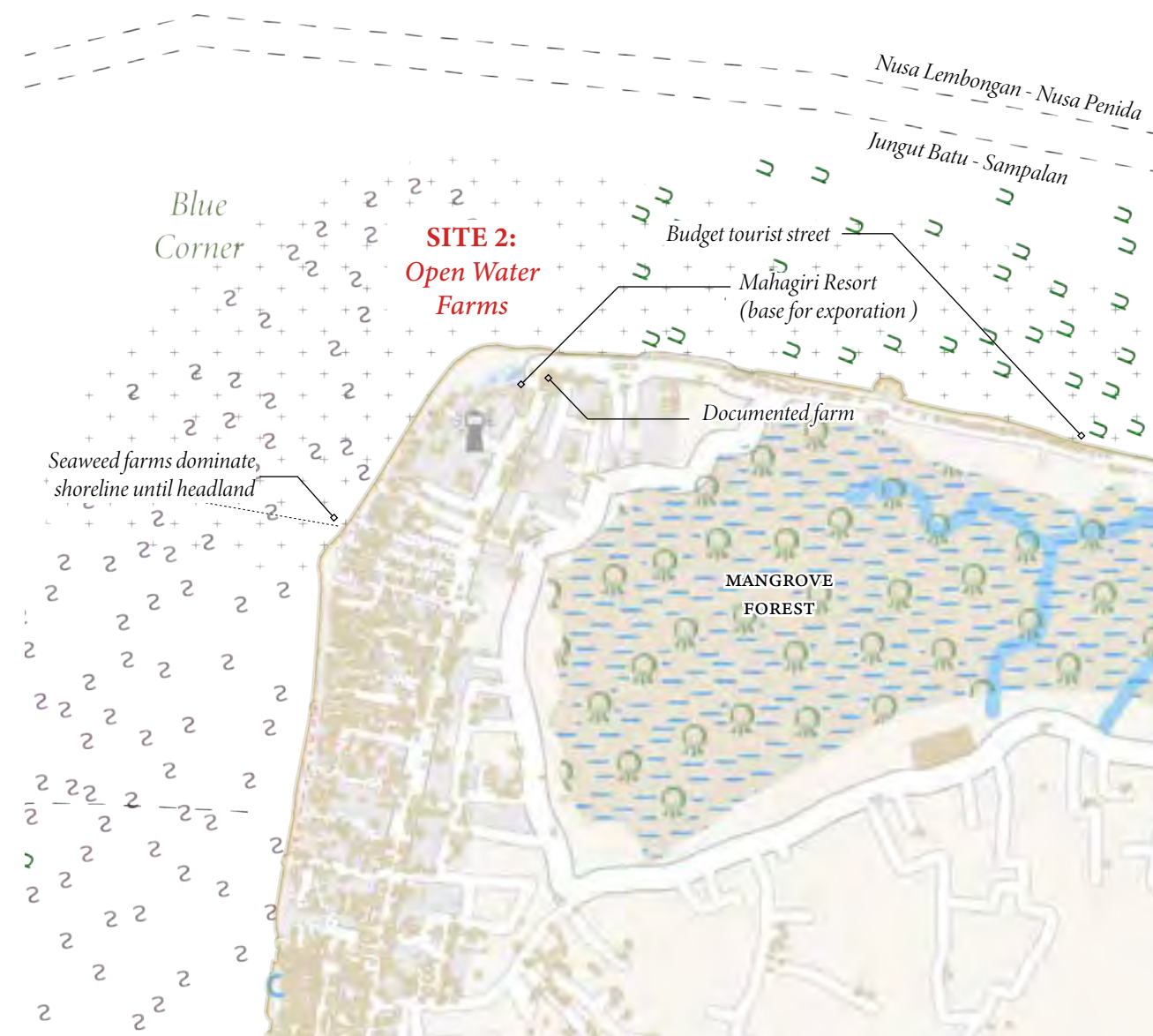
Farming on the southern edge takes on a more informal character, occupying the 'in between' spaces in the urban form. The sifting and sorting process takes place sporadically along the coast, whether in public sheltered spaces or between the farmers' homes. The drying process spreads across the island, taking over any flat surfaces that can be found. At times, dried Cottonii is a carpet that covers side walks, surrounds homes and even takes over asphalt parking spots; a demonstration of the thriving and ephemeral nature of the industry. There is growth, yet it does not permanently occupy designated areas, allowing for shifting use of those in between spaces.



Open Water Farms

The open water farms are located along northern end of Lemongan island, where rugged limestone cliffs give way to a dense mangrove forest and broad white sand beaches. Open water farms must contend with more exposed conditions, necessitating further farming technologies and practices.





Open Water Farms // North Lembongan

The coastal condition of northern Lemongan transforms from a thick mangrove forest towards the east, to small mangrove copses with a narrow beach, to eventually meet a wide expanse of white sand beach at the western bend. While the majority of open water farms are located at the sandy bend, this area is clearly prime real estate for the tourist industry. White sand beaches along Lembongan’s western coast are dominated by small hotels. However, it appears that the encroachment of tourist resorts ends at the northern bend, allowing the open water farms that exist here to thrive relatively undisturbed.



Open Water Farms + Tourism

A single tourist establishment exists at the site of the open water farms. It is a large resort and beach club, which is much larger and nearer to the 'traditional' model of tourist infrastructure. It is complete with a large amorphous pool, furnished with lounging tourists with fluorescent cocktails and fruit drinks. Unlike the beach clubs that witness the foreshore farms to the south, this resort lays claim to a wide sandy beach that fades into an endless body of water. Despite a perfect setting, it was apparent that the resort could not claim the water itself for its visitors (for snorkeling, swimming, paddleboarding, etc.). The ocean was rather completely empty of tourist activity, populated only by clumsy red flag that described the plot lines of an invisible farm below.

Farmers at this site seemed to be of an older demography, and less interested in joining the tourism workforce. Similarly, tourist activity at this end of the island seemed to foreground seaweed farming far less than their cousin operations in the south. It appeared that the industries were more disconnected at this site, the relationship could be characterized as 'tolerant' rather than 'complementary'. Nonetheless, the language of contrast between aquaculture and tourism continued there.

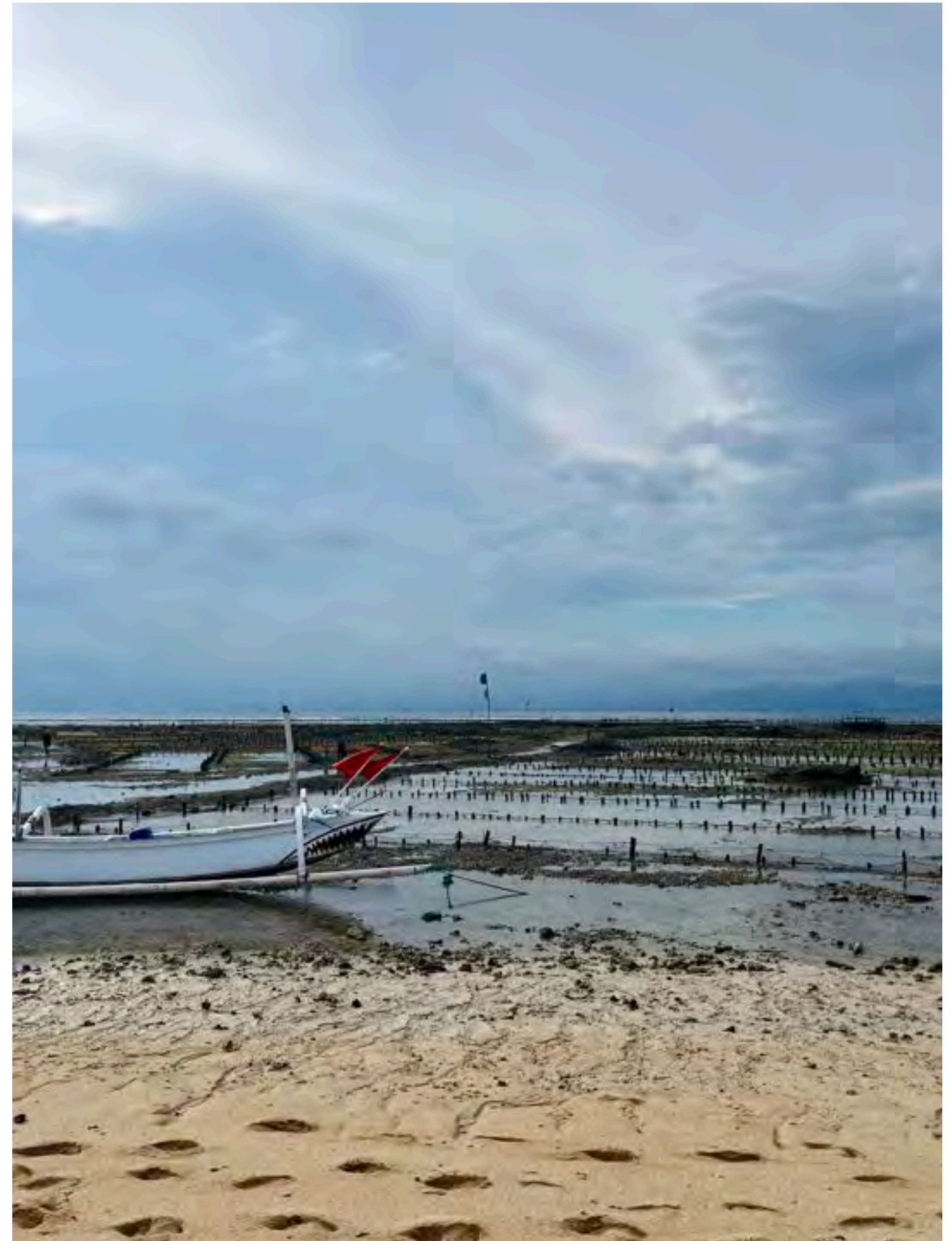


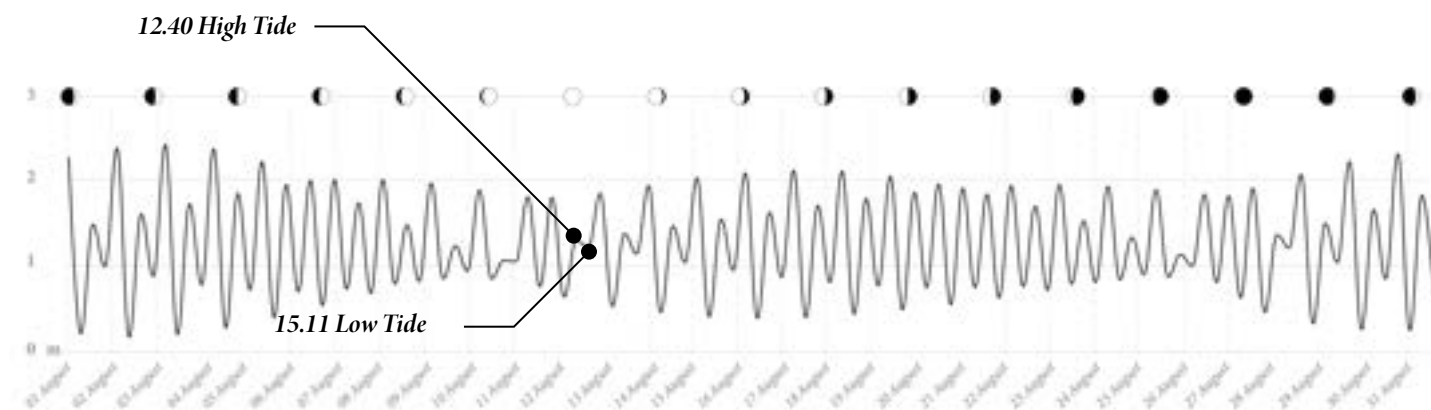


Claiming the Ocean

The crystalline waters of northern Lembongan were conspicuously devoid of tourist activity. The only tell-tale sign of an alternative use, are tall, ad hoc flags that indicate enterprise below the surface. Low tide reveals another incredible grid of longlines teeming with seaweed, hiding in plain sight.

The broad beach and shallow slope of the intertidal zone of the open water farms, makes the tidal variation at this site appear less extreme as its southern counterpart. The farms at this site are typically completely exposed at low tide.





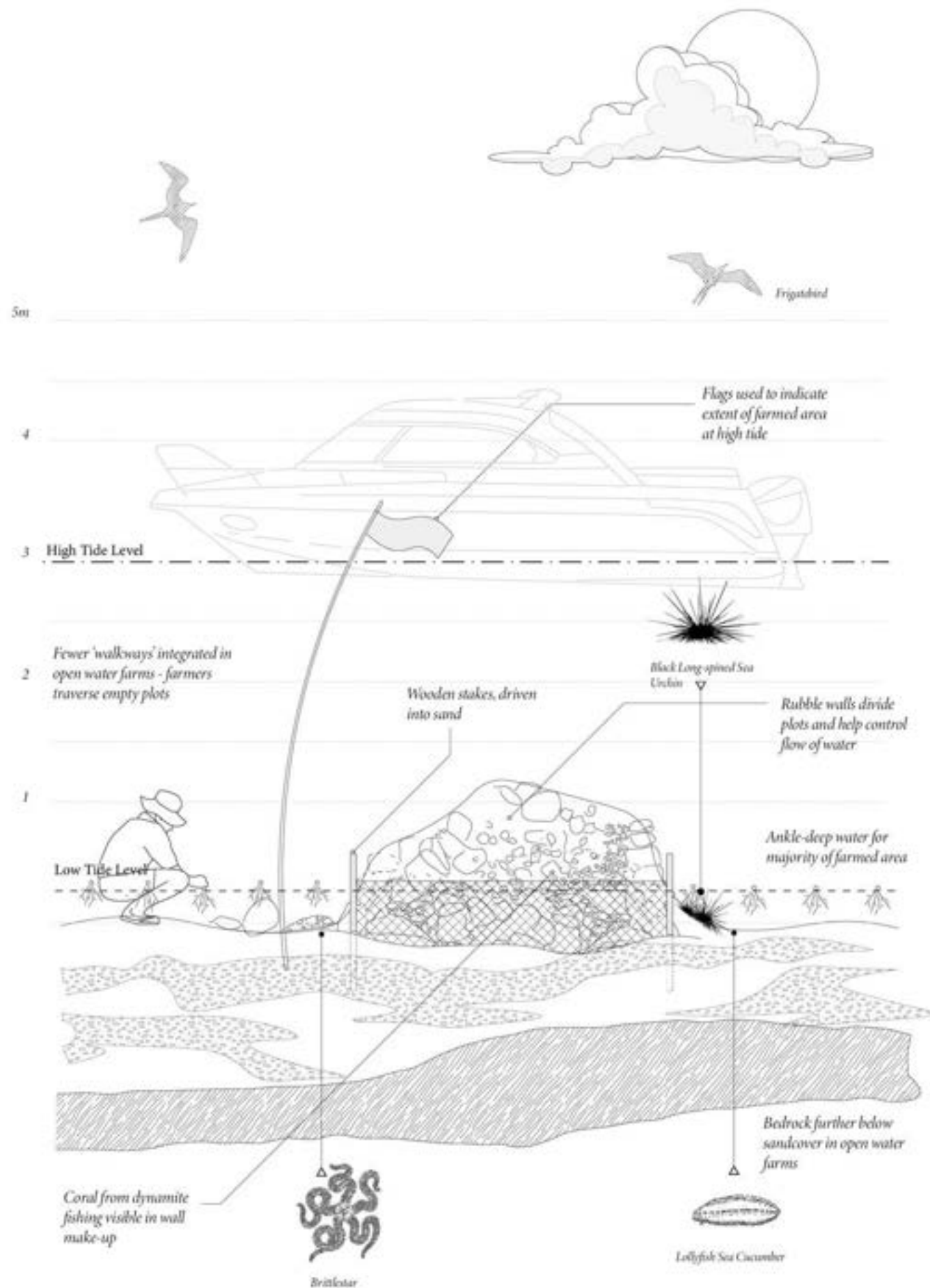
The broad beach and shallow slope of the intertidal zone of the open water farms, makes the tidal variation at this site appear less extreme as its southern counterpart. The farms at this site are typically completely exposed at low tide.



Harvest

As well as the typical harvest practices described here, open water farming demands more engagement from farmers. Given the exposed ocean conditions, seaweed branches are frequently dismembered in the surf and carried away. Open water farmers have consequently developed a practice of scaling the coastline in the off-peak hours to collect the loose seaweed that litters the beach. Farmers would collect these lost branches in folds of their shirt or in a large handheld fishing net. It was unclear whether farmer travelled the entire length of the farmed area, or whether each family limited its activity to an allowed territory.

While the landscape of the open water farms was again animated by farmers at low tide, bending and rising with the movements of the harvest, these activities appear more distant, and more nuclear still. The majority of the open water farmers working during these visits were solitary or working in pairs.



Vernacular Technologies

The rough ocean conditions of the open water farms similarly necessitated additional vernacular technologies, learned on site and in practice, to ensure a successful harvest. The most notable technology was a family of 'hitching posts', which a farmer explained was used for harvesting when the water was especially high. These structures were of varying heights, so that farmers' boats could be anchored despite varying ocean conditions.

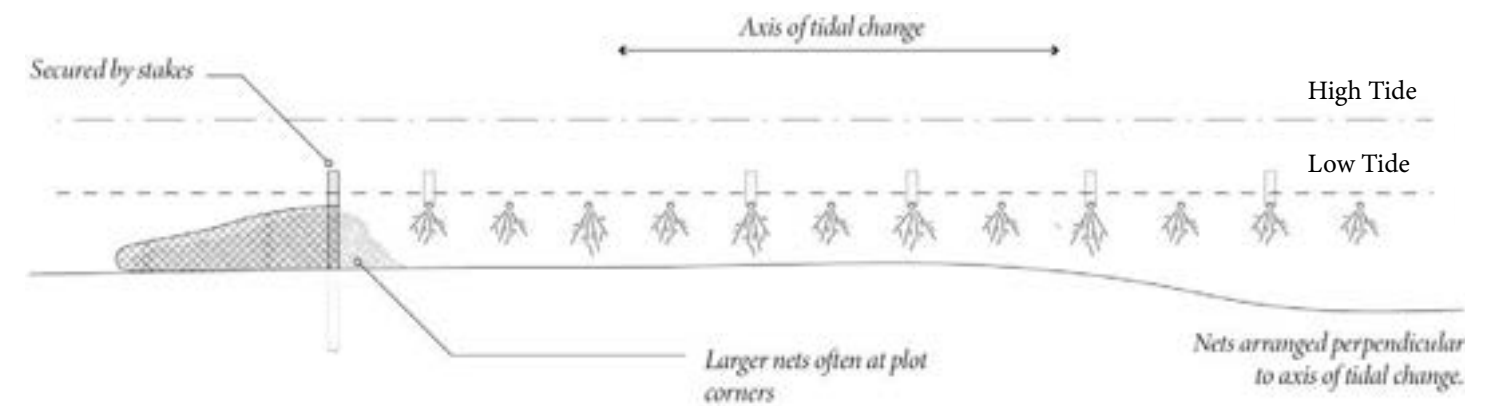
Otherwise, low rubble walls and nylon fishing nets were widely used to help control the flow of water and catch loose seaweed.

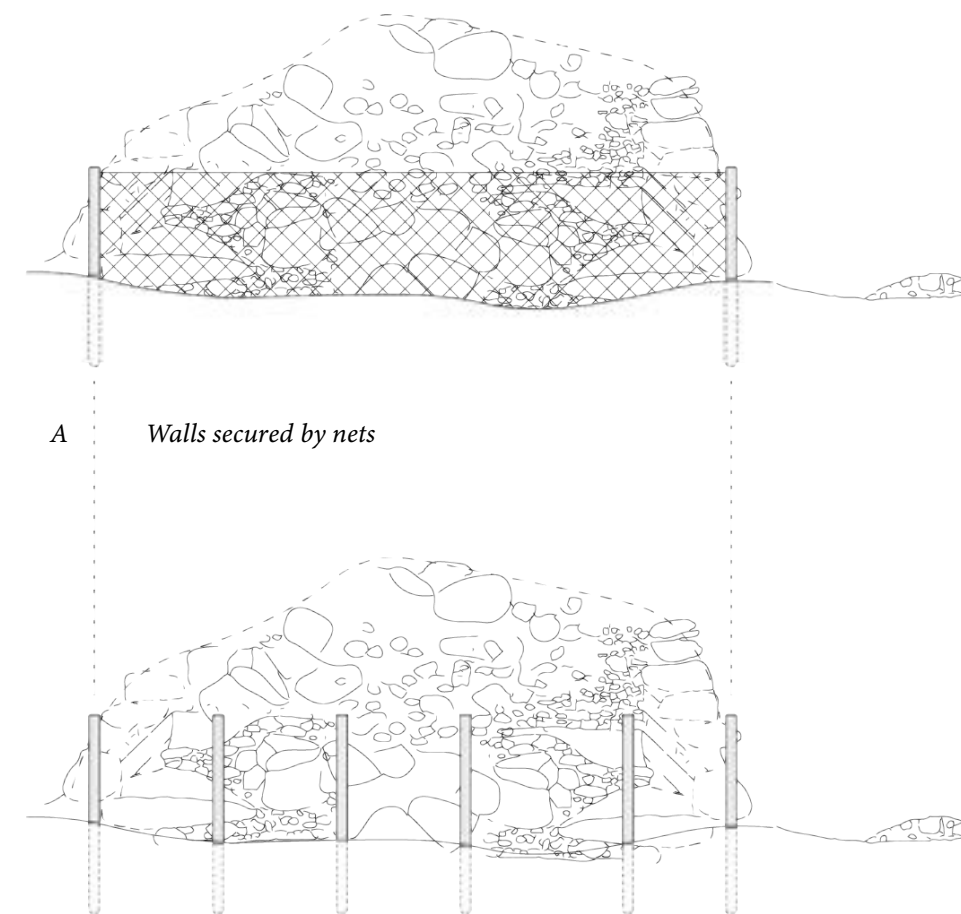


Nets

Nylon fishing nets appeared to be the workhorse of the open water farms, ensuring that farmers were able to recover seaweed that had become detached in the surf. Given that this was a commonplace occurrence, farmers would otherwise lose a large proportion of their yields. While farming plots in the open water farms were completely enclosed by fishing nets, larger 'pockets' were fashioned at the corners where seaweed was likely to collect with the movement of the tide.

The difference observed between the open water farms and lagoon farms was that farmers were also collecting untethered seaweed as the waves brushed in. Some walked along the coast picking up even the smallest of *Cottonii* stems, others scooped them with a net as the waves curled in.





A Walls secured by nets

B Walls supported by wooden stakes

Walls

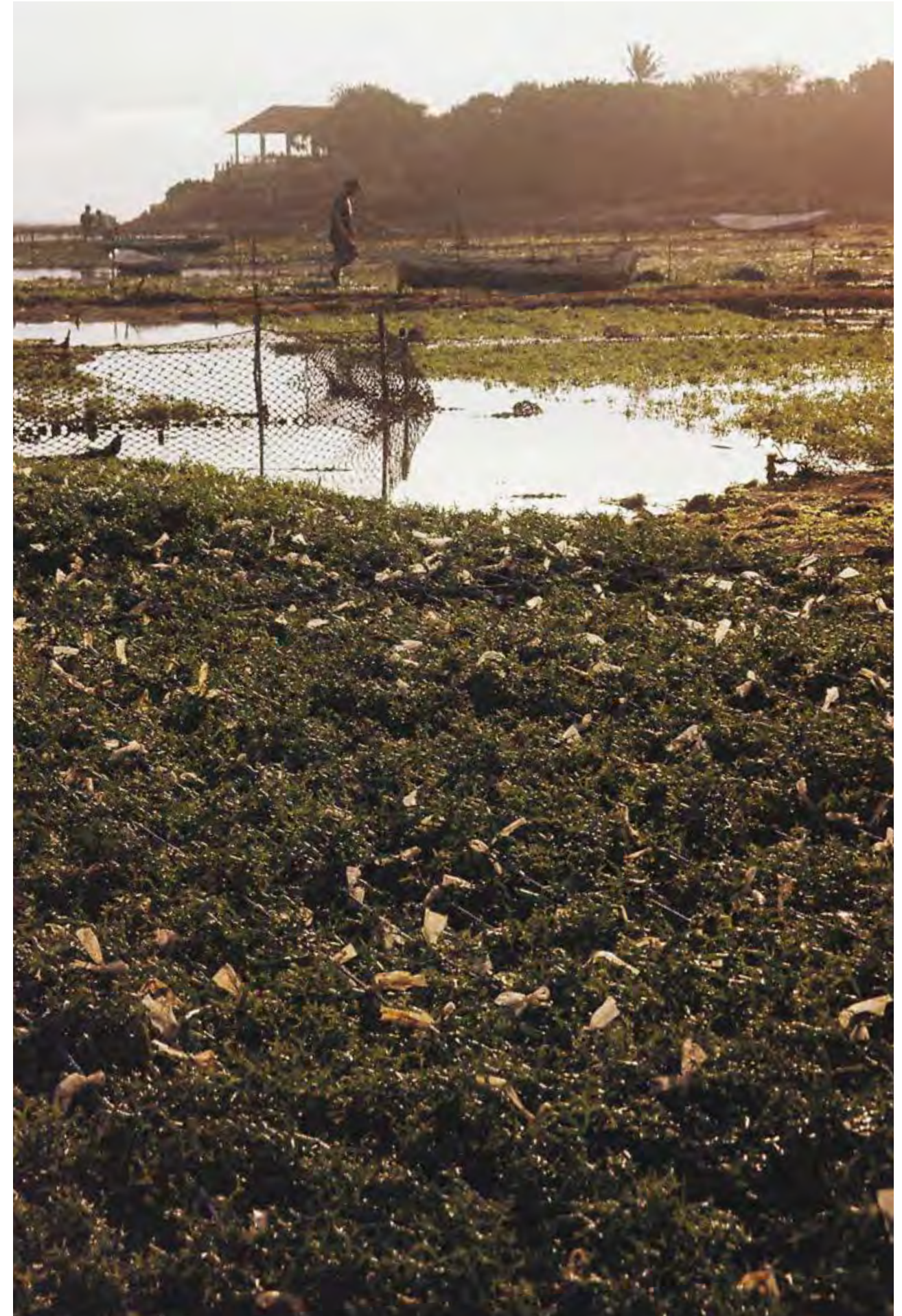
Low rubble walls were a dominant feature of the open water farms. They were clearly composed of the ruins of dynamite fishing and otherwise destroyed coral reefs. They are consolidated either by wooden stakes, driven into the sand, or secured by fishing nets. These describe more permanent plot boundaries between operations, perhaps enforcing the more solitary nature of farming in this region. However, they may also be used to control the flow of water (and loose seaweed) when the tide pulls, and disturb especially rough surf.



PART II: Reflections

A sustainable and flourishing industry

As Covid-19 levels fell and the tourism industry rose once more, it was surprising to see farmers retain their dedication to aquaculture. Despite the physically demanding nature of the practice, it is increasingly worthwhile for them to continue their activities in the seaweed industry. What was more surprising was the number of young farmers on the field. A large motivation for this is the growing demand for Cottonii, predicated by increasing popularity of vegan diets and carrageenan based cosmetics. For instance, agar, an alternative to gelatin is made of a type of Cottonii grown on the island. The price was 15,000 IDR per kilogram in 2016, and increased to 37,000 IDR in only five years. This also exemplifies the large impact of shifting consumption practices across the globe, on very specific ecologies and landscapes far removed from them.





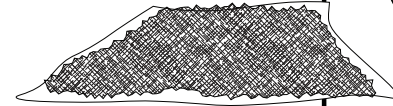
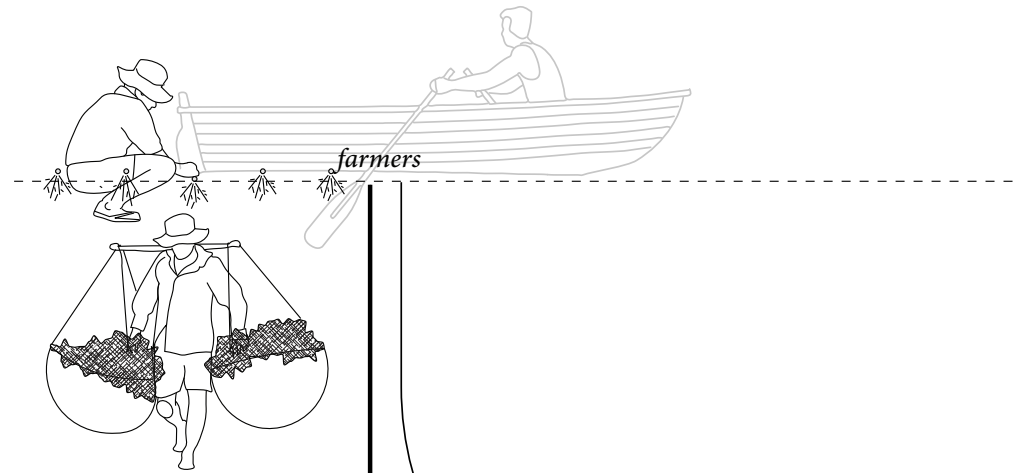
Value Added Production- Comparisons to Zanzibar

The income from the seaweed industry in Lembongan is purely from the selling of the primary raw product. The only processing it goes through is drying. There is potential for the community in Lembongan and further out in the country to benefit from value added products in the form of cosmetics or food. Lessons can be drawn from the work of Dr Flower Msuya in Zanzibar in this regard. Dr Msuya played an instrumental role as a marine biologist who advocated for the growth of the *Cottonii* industry. Her work on socioeconomic resilience empowers communities by encouraging farming and localized production of

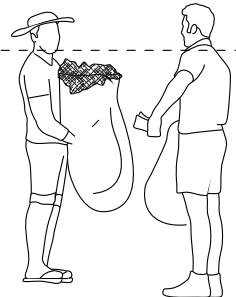
goods like food seasoning, powders and jams, further down the supply chain. These hold a much higher value per kilogram than the raw dried seaweed, and currently, importing countries like China and Korea benefit from that added value more than the exporter; Indonesia. In Lembongan, where tourism coexists with the seaweed industry far more than Sulawesi, where the region is less catered for tourists, there is high potential to engage visitors with the industry through the sale and use of seaweed products on the island, from hotels to restaurants.

Current Chain

Lembongan



collectors
traders(village)



raw material

Java

collectors
traders(regional)

traders and processors
(middlemen)

price per kg

traders, quality control
(nation wide)

China
Korea

distributors

producers

retailers

Worldwide

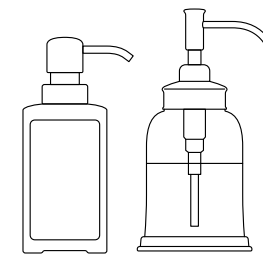
consumers

process and refined product

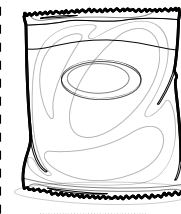
Elongating and convoluting Cottonii's
time within Lembongan



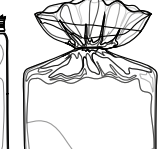
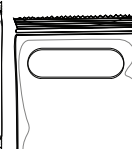
farmer to consumer within
Lembongan or the Bali region



consumer



Cottonii based
consumables;
food products
and cosmetics





Hardships and areas for improvement

The most laborious tasks in the farming process is the tying and untying of individual *Cottonii* cuttings for the propagation process. Whilst some farmers did this on a boat at the farm site, others carried the seaweed lines to the coast and carried out the propagation process there. To ease this, initial ideas would be using assistive tools to fasten the cuttings more easily, such as knot tyers or loop twisters.

The research at hand was partly initiated by a drive to practice design; finding outlets for which architectural or technical solutions can serve communities based around seaweed farming. Conducting the fieldwork proved that much longer engagement was necessary, and such a design process would be lacking without direct dialogue with the farmers.

Smaller scale improvements include the tools previously mentioned, and training on possibility of value addition. Dr Msuya's work is a testament of the impact that a single individual can have on a coastline. Her influence caused the growth of farms along Zanzibar's coast. Similarly in Lembongan, multiple farmers generously shared tales of the industry, and often attributed its origins to a figure from Java who introduced the growth of *Cottonii* from the Philippines. Just as farming itself began from a small scale and grew, production and processing may potentially follow suit with some external initiation.



Communal care and social contracts

Lessons from witnessing the farming processes include subverting the contention around the use of plastics. Although nylon rope is used for tying cuttings to lines, the ropes in Lembongan go through multiple cycles of use, rather than being treated as single use, disposable tools. The plastic goes through multiple cycles of care, and the farmers encountered have a clear stance on keeping the waters clear of ocean plastics.



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Latifa, Sasha + Mbak Ilu



Mas Heron in the field





