Traditional Water Systems
Circular Water Stories lab

Bobbink, I.; Chouairi, A.; Naeema Ali, N.

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Traditional Water Systems

Circular Water Stories Lab

Flowscapes Garduation Studio

Landscape Architecture Master Track

Showcased projects:

Valli da Pesca: A centenary tradition of extensive aquaculture in the Venetian lagoon landscape.

Amina Chouairi

&

Legend of Kayalnilams: The Subtle Art of Making Something out of Nothing.

Naeema Ali

The research project Traditional Water Systems is conducted within the Circular Water Stories Lab, coordinated by dr. ir. Inge Bobbink. The Lab is part of the graduate studio Flowscapes in the master track Landscape Architecture here at the faculty of Architecture and the Built Environment.

The main challenge this research project wants to address is to study, understand, map and learn from indigenous and vernacular water systems all over the world to unveil different interrelationships between the investigated sites, their processes, their usages and their cultural meanings.

Australia, Cambodia, China, India, Indonesia, Italy, Mexico, Morocco, Spain, Taiwan, and The Netherlands host the fifteen traditional water systems analysed until now. The examples have provided the research group with relevant insights on how to read these landscapes, whose existence and functioning have always been intertwined with the main element that have shaped them: water.

"Traditional water systems are developed over a long period of time by trial and error and store a lot of knowledge, especially on adaptation to a new context. As a reaction on all kinds of change - population growth, use, climate etc. measures to retain, to infiltrate, to drain, to irrigate and to reuse water were developed. Many of these systems are still (partly) alive."
(Circular Water Stories Worldwide, 1st edition, 2019)

Keywords:
traditional water system, water element and waterworks, irrigation, drainage, inundation, collecting, retaining, cleaning, filtering, farming, comprehensive water design, living landscape and illustrative method.

VALLI DA PESCA:

A centenary tradition of extensive aquaculture in the Venetian lagoon landscape.

Fig. 1. Aerial view of Valle Paleazza, in the northern Venetian lagoon. The ponds closer to the central casòn di valle are peschiere di sverno, while the wide water surface on the right is a chiaro di valle.

by
Amina Chouairi
Architect & Urban Planner

Far away from the marbles and the golden mosaics of the city of Venice, there where the Venetian lagoon almost touches lightly the land, the extensive landscape of fishing valleys, a centennial aquaculture tradition, has its place. Since the XII century, these fishing and breeding ponds have been feeding the Venetian population inhabiting the mutable and unstable territory of the lagoon. Here, in the Venetian lagoon, water has always been the unique source of life and survival.

Water catchment area: from the Venetian plain to the Venetian lagoon.

On the regional scale, the most important feature to consider is represented by freshwater sources. The water catchment area discharging in the Venetian lagoon, directly providing freshwater to the fishing valleys, originates from two different locations: the "springs belt" formed by resurfaced waters; and the Euganean Hills, in the Paduan-Venetian plain.

During the past centuries, innumerable interventions conducted by the Republic of Venice, Serenissima, ensured the survival of the city of Venice by diverting many of the rivers, which were discharging into the Venetian Lagoon (as Brenta, Bacchiglione, Tagliamento, Sile and Piave rivers). This engineering decision reduced drastically the quantity sediment and fresh water reaching the lagoon, altering the hydromorphological balance in act.

The orange elements highlighted in the map are the areas occupied nowadays by the fishing valleys along the border of the Venetia lagoon (Linea di Conterminazione Lagunare, or the lagoon contermination).

Glossary

Avannotto / pesce novello:
Juvenile fishes and fry, fished in the open lagoon by or bought from nurseries during spring time to repopulate the fishing valley.
Barene:
From the Venetian dialect "baro", which means "bush, clump of grass"; piece of land emerging from the waters of the lagoon, mostly even in the phase of full waters, slightly higher than the medium sea level.
Chiaro di valle / Lago di valle:
Lit. "valley's clearing" or "valley's lake"; open water surface of the fishing valley where fishes grow during summer.
Capo valle:
Lit. "master of the valley"; the person in charge of organizing the activities in the fishing valleys, from the regulation of the water regime to employ seasonal workers.
Casòn di valle:
Fishing valley mansion. Initially piece of vernacular architecture evolved then into an object symbolizing the owners' power and wealth.
Cavana:
Lit. "hut"; storage used by anglers to store fishing tools (nets, buoys, etc.).
Colaùro:
Channel putting in communication the fishing valleys with the open lagoon.
Fraìma:
Fish migration from the Venetian lagoon to the Adriatic Sea. The word seems to resemble the French word "frimas", which literally means bitter cold or the Latin expression "infra hyemen", literally in winter (Fortibuoni, 2009).
Grisiole:
Light barriers made of weaved reeds, in the specific Phragmites australis.
Lavorièro:
Fixed trap located in the colaùro. It consists of a V-shaped trellis, placed, with the vertex towards the lagoon and the sides leaning against the banks. A crack in the vertex lead the fish, once penetrated, in the final stretch of the colaùro, which cannot go back or escape.
Pescenovellante:
Anglers specialized in capturing juvenile fishes and fry in the open lagoon.
Peschiera di sverno:
Lit. "winter pond"; communicating structure of deep canals where fishes are stored during winter. The significant depth is functional to maintain a higher water temperature on the sea bottom than outside.
Valle da pesca:
Lit. "fishing valley"; embanked spaces along the borders of the Venetian lagoon where the aquaculture activity takes place. Today the active fishing valleys are 15.
Valle a serraglia:
Early stage of fishing valleys, usually enclosed within a set of wooden poles and weaved reedbeds barriers.

These are 15 in total and are completely limited by embankments.

Yesterday: origins and evolution through time.

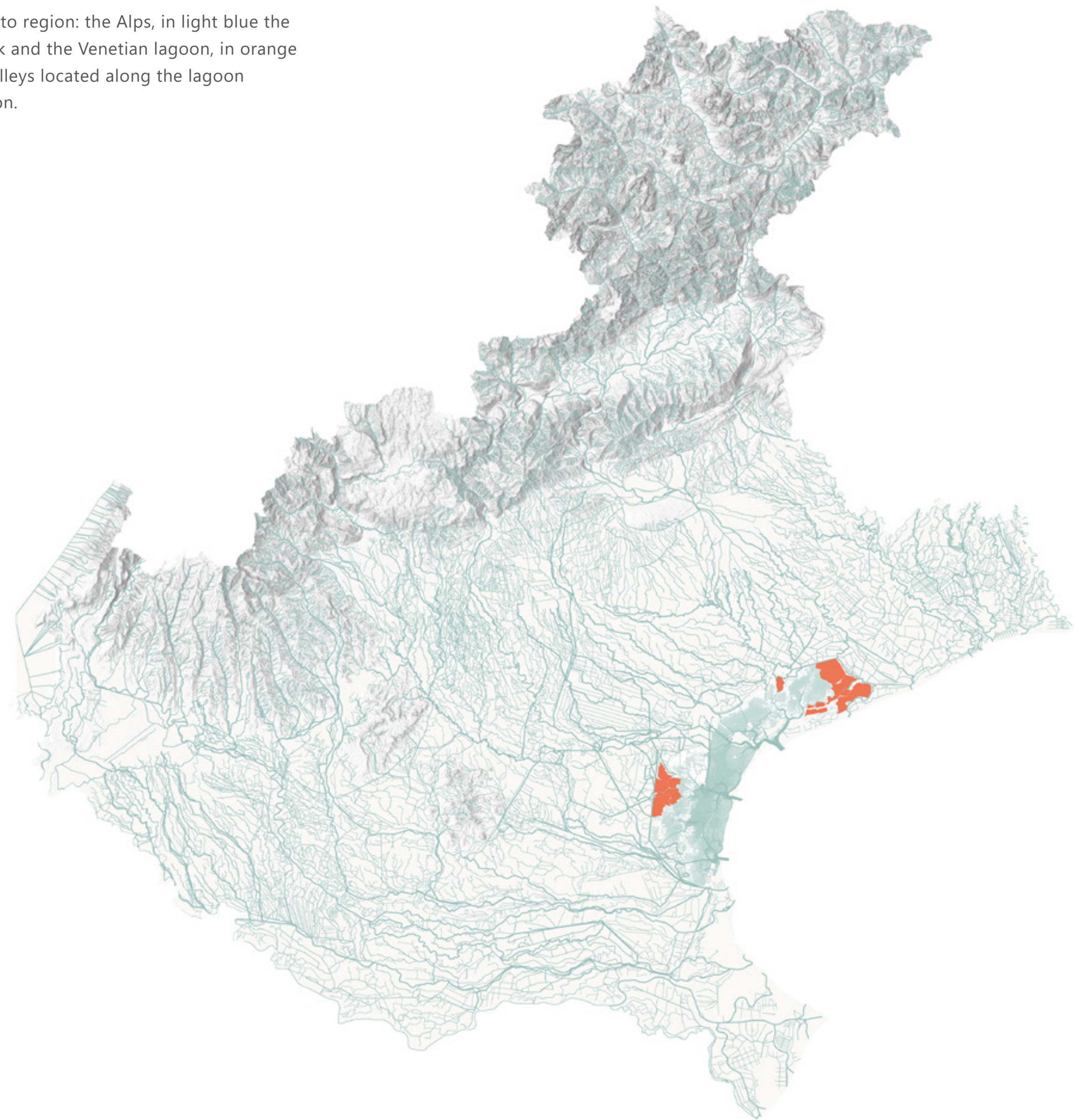
The origins of the fishing valleys are lost in the remote antiquity. A legend narrates that St. Mark the Evangelist, sailing through the waters of the lagoon, forced by a storm docked his boat at the banks of a valley already in good conditions (Fortibuoni, 2009, p. 143).

In ancient times, fishing activities were carried out mainly in the shallow waters of the Venetian Lagoon. Since the Roman Empire until the XV century, this system started to be implemented with nets and fixed structures, gaining the name of "enclosed waters" or "piscariae" (from Latin, literally meaning "of or pertaining to fish or fishing"), evolving afterwards in "valleys" or "fishing valleys" (stage 0). These primitive "open valleys" were in direct communication with the lagoon, taking advantage of its tidal fluctuations. They were located in shallow waters and, because of the cultivation carried out of bivalve molluscs (stage 1), they were also called "oyster valleys".

Around one century after, some valleys started to be temporarily closed and to be called "valli a serraglia semplici", simply enclosed valleys (stage 2). The technique used then was the creation of weirs, made of chestnut or larch wood poles planted in the seabed and "grisiole", light barriers made of weaved reeds. These grisiole were removed in spring to accommodate the natural migration of avannotti, from the sea to the lagoon; the grisiole were put in place again in autumn to prevent fishes from escaping, from the lagoon to the sea. Nevertheless, the ingenuity of this system was subject to sea storms and strong winter winds, which could ultimately result in the loss of caught fish.
To tackle the problems caused by the durability and perishability of the nomadic and tidal system, Venetians anglers reinforced their valleys with hard dikes (stage 3). These "semi-embanked valleys" were delimited by earth embankments windward, while still confined leeward by "grisiole". From this moment onwards, the fishing valleys were permanently transformed into managed systems, where, during winter, the undersized fishes were kept in winter fishponds, peschiere di sverno, instead of being sold anyway. In addition, the valleys no longer depended only on the natural setting and fishes' natural migration, but also on fry's sowing, captured in the lagoon by the "pescenovellanti", those fishermen specialized in fishing the juvenile larvae.

The final stage, still in function today, are the "embanked valleys" (stage 4), enclosed by elevated embankments and communicating with surrounding water bodies through sluices and movable gates. The valleys drew both brackish water from the Venetian Lagoon (through the so-

Fig. 2. Veneto region: the Alps, in light blue the water network and the Venetian lagoon, in orange the fishing valleys located along the lagoon contermination.



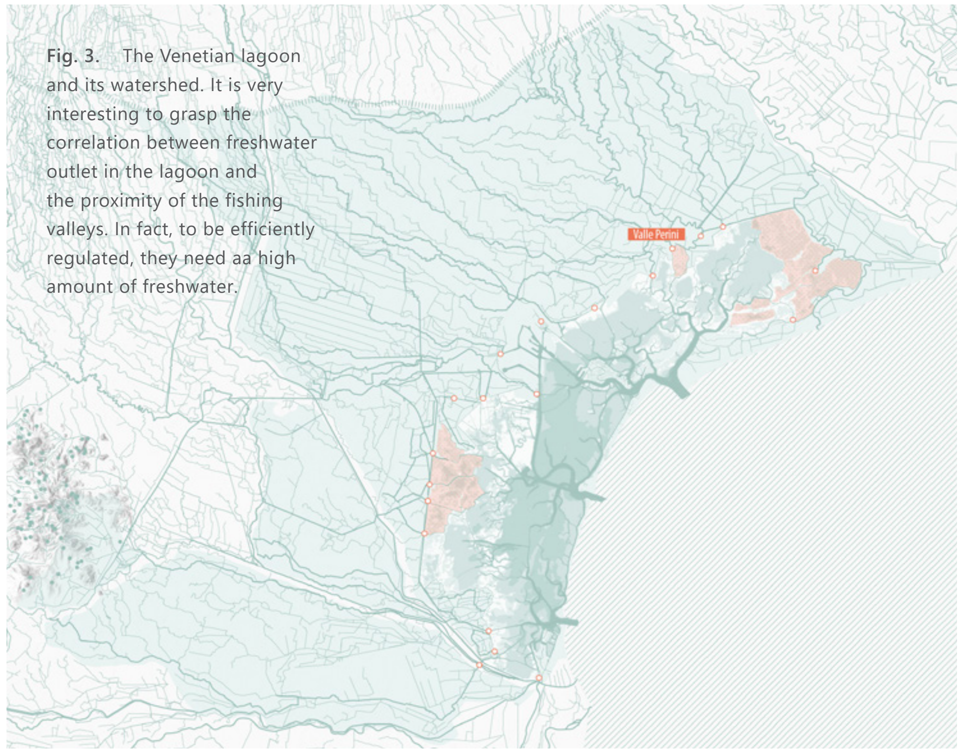


Fig. 3. The Venetian lagoon and its watershed. It is very interesting to grasp the correlation between freshwater outlet in the lagoon and the proximity of the fishing valleys. In fact, to be efficiently regulated, they need aa high amount of freshwater.

Fig. 4. Valle Perini in the northern lagoon, one of the best preserved of the whole lagoon.

Fig. 5. Close up on casòn di valle and the surrounding fishing ponds.

called "chiavica a mare", or sea sluice) and freshwater from streams discharging in their proximity (through the so-called "chiavica d'acqua dolce", or freshwater sluice).

In conclusion, the five stages, testify the evolution of the fishing valleys from a simple, nomadic, flexible and open fishing activity to a complex and multi-functional structure to breed and cultivate extensively fishes and molluscs.

Today: the structure of a tradition.

Since the first decades of the 20th century, the fishing valleys can be described as extensive polycultures, where the main activity of fish farming has been juxtaposed by farm animals breeding (as horses, sheep, hens, goats, cows, etc.), vegetable gardens and orchards (cultivating horseradish, radicchio, asparagus, artichoke, etc.), reeds, mulch, fertilizer and hay production. Despite relatively low production yield, if compared to other intensive aquacultures, this activity is associated with reasonably low management costs: fishing valleys in the Venetian lagoon are mainly family farms employing seasonal workers during the busiest seasons (spring and autumn). Recently, many of the fishing valleys have implemented their accommodation activity, providing a slower and lighter touristic alternative to discover the outer lagoon territory, in countertrend to the mass tourism suffocating the historical centre of Venice.
In the valleys, many channels are artificially excavated and maintained regularly, allowing the entire canalization network to flow towards the "lavorièro", a fixed trap located in the "colaùro", the canal putting in communication the enclosed valley with the open lagoon. Here, the fishes that responded to "the autumn call" (the introduction of salt water in the valley) are selected, based on their size, in order to be sold or wintered in "peschiere di sverno". The average depth of "chiari di valle", forming the central basin of the valley, is between 60 and 75 cm, while of greater depth (around 5 and 6 meters) are "peschiere di sverno", i.e. breeding ponds communicating with the central basin, where animals can find shelter from temperature changes, especially during winter times. "Peschiere di sverno", where the wintering period takes place, are composed by a series of parallel channels, 3 to 6 meters wide and 3 to 5 meters deep, arranged in such a way to expose the smallest possible surface to the prevailing winds (Bora from North-East and Sirocco from South-West). They are eventually protected by means of windbreaks made of tamarisk plants (Tamarix gallica) or artificial structures.

The main species bred in the valleys are sea bream, sea bass, mullet, eel, gobies, crabs, shrimps and schille since they are all euryhaline, i.e. they tolerate significant variations in water salinity. It has been estimated that the most important species in terms of production are sea bream (43%), followed by mullet (30%) and sea bass (18%) (Fortibuoni, 2009).

Seasonality and circularity.

In the fishing valleys of the Venetian lagoon, as in every aquaculture system, the

Fig. 6. (a) "Open valleys", in use from 15th century until the end of 19th century. (b) "Valli a serraglia semplici", simply enclosed valleys, in use from 15th century until the end of 19th century. (c) "Semi-embanked valleys", in use from 15th century until the end of 19th century. (d) "Embanked valleys", in use from 15th century until the end of 19th century.

most important variable to be considered is the succession of seasons, and the whole functioning is calibrated on this repetition. The water temperature and nutrient composition, the salinity gradient, the fishes' natural migrating instinct from the Adriatic sea to the lagoon in spring and vice versa during autumn, and the human actions of capturing, sowing, breeding, and selling are extremely complex and interconnected.

Spring:
From March to May, in the open lagoon, pescenovellanti know where to flush the juvenile fishes out. They hide nearby the inlets where the water is constantly fresh and flowing, in the shallow waters populated by tall and impenetrable seaweeds. They wait to fish during the nights, in the dark, in silence, with the help of faint lampare, fishing lamps.
Once the fishing comes to its end, it is time when seasonal workers to sow the larvae in the "seragio per il novellame", an impervious labyrinth where the fry acclimatize with the valley's conditions.

Summer:
From June to the end of September, inside the fishing valley, the capovalle is the main director of the scene. His decisions are unquestionable. He is in charge of controlling the whole system, from the water salinity (which easily rises due to the high evapotranspiration rate) to nutrients and oxygen levels regulation. In the humid air of summer, it is time for taking care, maintain, manage, adjust, fix and repair, small actions to ensure the valley's smooth procession.

Autumn:
From October to the end of December, the fraìma takes place. This natural migration instinct arises because of the progressive cooling of the waters and bring the shoals of fish populating the valley towards the lavorièri. In these traps, the fishes are captured by the workers and selected in relation to the species and the size: specimens suitable for marketing are sent directly to fish markets; small specimens, instead, are placed in peschiere di sverno where they will face the difficult winter season.

Winter:
From January until the beginning of March, takes place the most delicate phase regarding the fishing valleys management. During winter it is extremely critical to control the living conditions and protecting the ponds from potential predators, such as herons, cormorants, and seagulls.
The complex and almost legendary origin, the highly evolutionary tendency, and the multi-layered functioning and productivity make the fishing valleys the most antique and characteristic aquaculture system of the Venetian lagoon and of the whole Mediterranean Sea. It can be ascribed as a strong identity catalyser for the people involved in its management and, undoubtedly, as the most peculiar element of the productive heritage of the Venetian lagoon.

Landscape values.
Since the XX century, despite having been embanked for productivity reasons to limit losses, the current fifteen fishing valleys have allowed the conservation of peculiar traits and elements of the Venetian lagoon landscape. The barene, included within the valleys and at the same time protected by their embankments, have not suffered from erosion as the ones present in the open lagoon, and have been able to perform their supportive ecological role within the ecosystem.

Architectural values.
Casoni da pesca, fishing valley mansions, and cavane, fishermen's storages, represent two of the earliest examples of Venetian lagoon vernacular architecture. These elements of necessity were built from scratches by Venetian anglers in need for shelter for themselves, their boats and their working tools during the fishing season. Mainly constructed with very resistant wood, as chestnut or larch coming from Venetian Dolomites, the primitive examples were consolidated with clay and silt and their rooves made with reeds and thin branches. As time passed, these elements, but especially the valley mansion, became the symbol of power and wealth of the family owning the fishing valley, leading to some very interesting examples, as Casone di Valle Zappa in the southern Venetian lagoon.

Sustainability values
The main natural forces determining the functioning and the performance of the Venetian lagoon fishing valleys are fishes and water. Their seasonal movements are crucial for the water workers to define their role to intervene and profit from this interaction. With the passing of centuries, the fishing valleys have become more complex systems, not only made of aquaculture but also agro-production, agro-tourism and eco-environmental conservation (WWF site of Valle Averto, southern Venetian lagoon). In a succeeding manner, they ha ve been implementing their scope of action, tending to perform as more circular activities rather than linear systems.

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Fig. 7. The section here proposed aims to summarize the activities happening within a fishing valley during one year cycle.

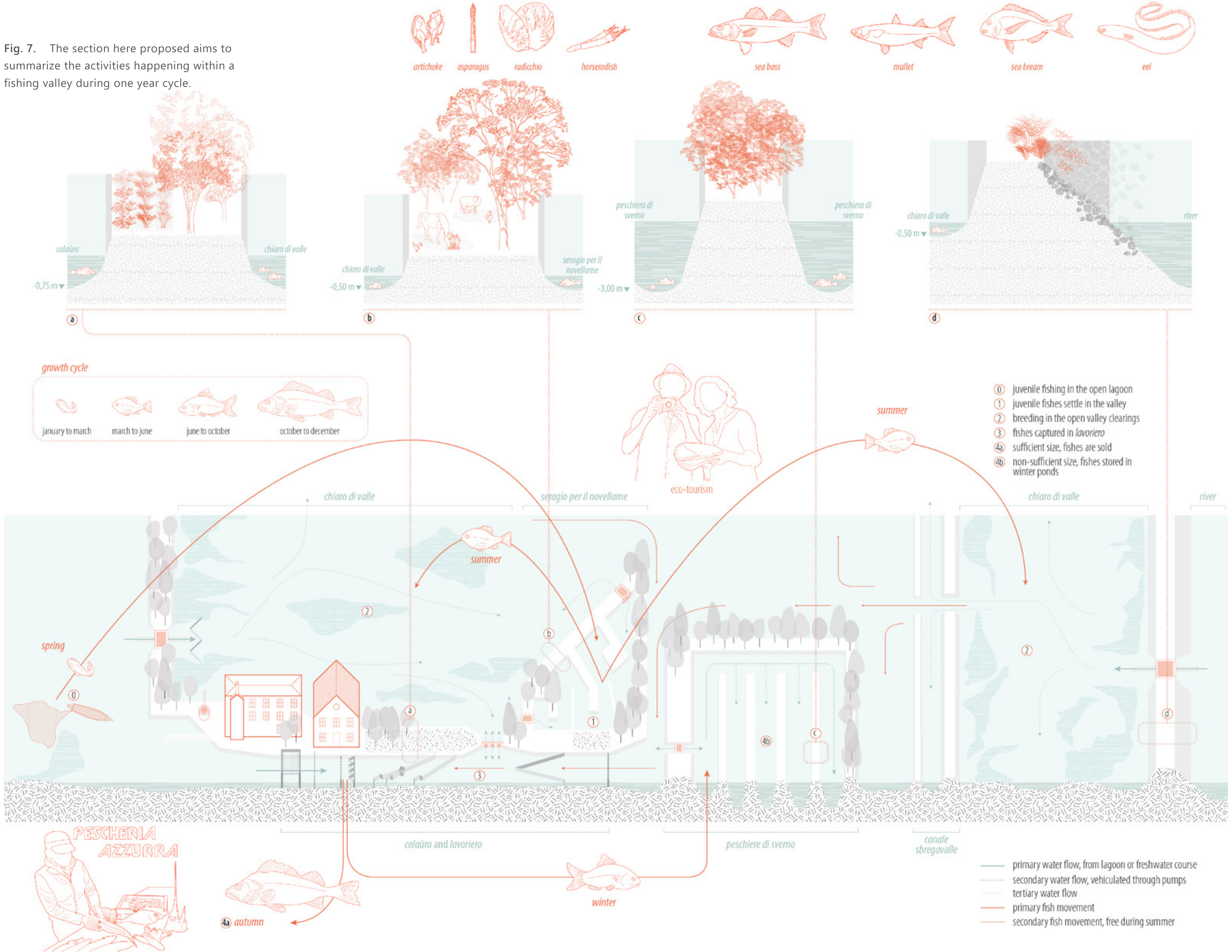
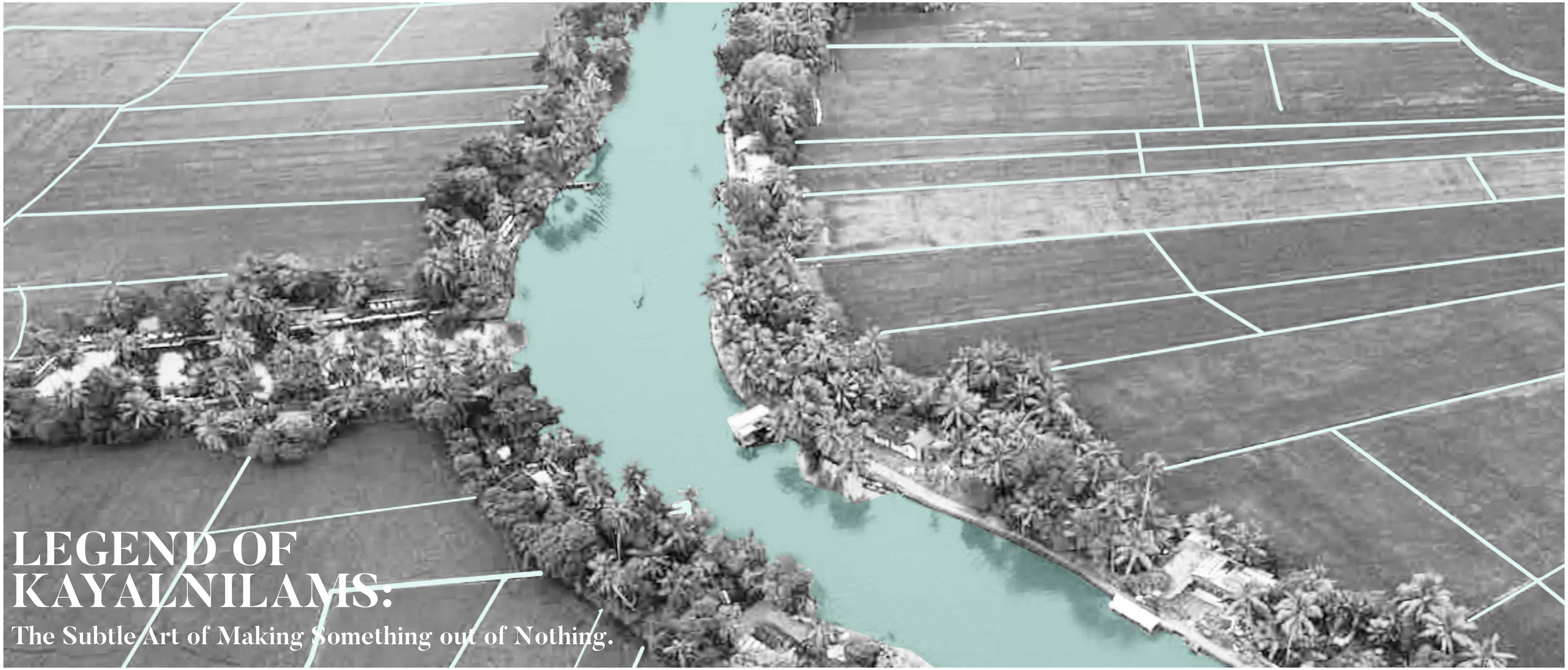



Fig. 8. Fraìma in late November.


Fig. 9. Juvenile fish sowing in Valle Perini.


Fig. 10. Summer: control water circulation, support food supply, manual restoration of channels, and algae expurgation.


Fig. 11. Winter: control water temperature and oxygen levels during the whole winter and protection from predators.



LEGEND OF KAYALNILAMS:

The Subtle Art of Making Something out of Nothing.

by
Naeema Ali
Msc Landscape Architecture

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> *The most modest imagination of the Kuttanad landscape would be that of a polder system laid with an intricate network of canals and water channels. Due to this resemblance with the Traditional Dutch landscape, Kuttanad is often referred to as the* ***"Holland of the East***.

Water and Land

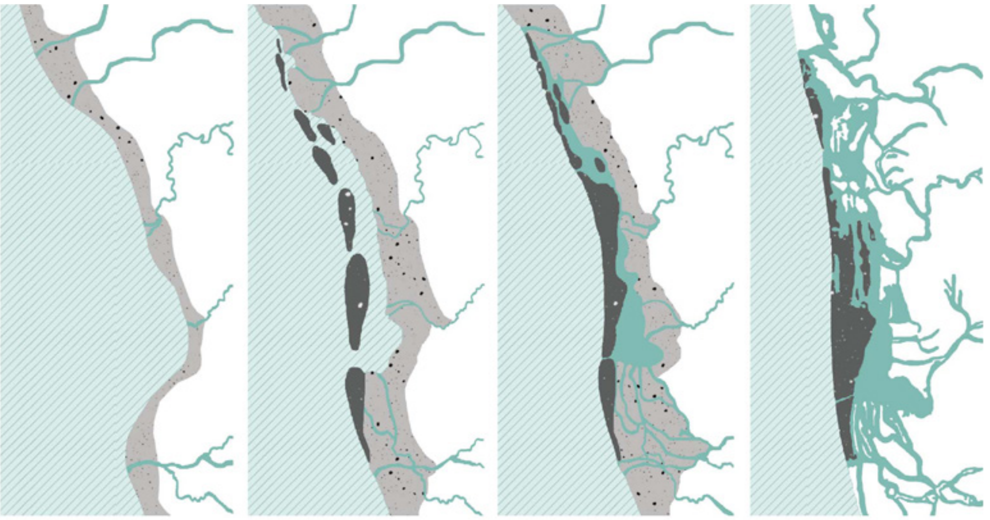
In an early passage from Waterland (Crick,1880), the narrator labels water as "Nothing," implying land and humans as "Something." This was more of a philosophical expression that can alternatively be inferred from the real-world processes like land reclamation. Land was always associated with value, stability, certainty and utility in contrast to water.

Subsequently, early civilizations and modern-day habitations fundamentally removed or controlled water. However, the traditional water systems did this in a more sustainable manner. These systems established an accumulative body of multigenerational knowledge, practices, skills and beliefs. Here, water management is a unit of cultural expression of the site-specific challenges faced by people, be it in terms of topography, climate or social hierarchy. These radical ingenuities tell us stories of how humans and nature exchanged roles between being makers and takers of the landscape.

One such traditional water system, where land and water assumed identities of being something and nothing respectively is the Kuttanad Kayalnilam Farming System: a long-established land-water utilization system that practices paddy farming below sea level for more than a century now. Located in a deltaic region, Kuttanad is a low lying-wetland (0.6 to 2.2 m below mean sea level) adjacent to the Vembanad backwater system in Kerala, India. The most modest imagination of the Kuttanad landscape would be that of a polder system laid with an intricate network of canals and water channels. Due to this resemblance with the Traditional Dutch landscape, Kuttanad is often referred to as the "Holland of the East".

Evolution of the Landscape

If we trace the genesis of this landscape, during the Pre-Holocene period this was a shallow embayment in the Arabian Sea. The rising sea level coupled with northward drifting littoral currents were responsible for the progradation of sand barriers across this embayment in the Early–Middle Holocene. Subsequently by the Middle- Holocene, a sand barrier system was developed parallel to the coastline which was later breached into barrier islands due to the reduced supply of sand. The resulting open lagoon setting, was transformed into a partly closed



If we trace the genesis of this landscape, in the Pre-Holocene period this was a shallow embayment in the Arabian Sea.

A sand barrier system was developed which was later breached into barrier islands due to the reduced supply of sand.

A partly closed lagoon was formed with limited inlet-outlet systems due to the constant supply of sediments

Eventually, major part of the lagoon silted up giving rise to a shallow fertile region at the mouth of the Lagoon.

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lagoon with limited inlet–outlet systems in the regressive phase of the Late Holocene due to the constant supply of sediments carried by the rivers. In due course, a major part of the Vembanad Lagoon was silted up giving rise to a shallow fertile region at the mouth of the Lagoon. This pristine landscape was later subjugated for the benefit of men and women and how they did this narrates the legend behind the existing cultural landscape of Kuttanad.

Birth of Kuttanad Kayalnilam Argosystem

The birth of the cultural landscape was marked by the onset of the land reclamation process, colloquially known as "Kayalkuthu". At first, an ostracized fabric of the society struck a chord of harmony with smaller patches of these wetlands. They reclaimed only as much as what was needed to feed their families. When the region encountered acute food shortage in the late 1800s, these virgin landscapes were considered as a gift from the backwaters. Over the years, they were consequentially brought to agricultural glory under the leadership of Joseph Murickan, the father of the modern-day agrarian landscape of Kuttanad. The singular unit of this landscape is the "Kayalnilam" an artificially created landform where land (something) was lifted out of water (nothing) through the collective toil of humans. The construction and functioning of these Kayalnilams demonstrates years of human strength, wisdom and ingenuity while dealing with water management.

Nearly 400 to 500 men were engaged in a year to complete the reclamation process of about 2000 ha of land. This labour-intensive process would start with identification of the shallow regions in the Vembanad Backwaters.

Kayalnilam construction

Step 1. Once the area is identified, the first step is to mark the boundaries. Then an array of long and stout coconut poles would be hammered deep enough into the lake bed in two rows, normally in 1.5m to 2.5m width, enveloping the entire area. Then they would be fenced with bamboo mats on either side to form a skeleton for the bund.

Step 2. Then the channels of the bund would be filled to the desired height, first with sand, followed by twigs, sedges like Typha and Sheoneplectus (Kora Pullu) and dead materials that were brought from distant places and interspersed with high quality clay that was dug from a depth of 20-25m from the lake.

Step 3. The final step is dewatering or to remove the excess water from the fields. Traditionally, water wheels of 10-12 feet diameter with blade width of 1 to 15 feet were used, which were pedalled manually by men. The water wheel ranges from 4-leaved to 18 leaved. Water is pumped out periodically into the surrounded lake or the canals.

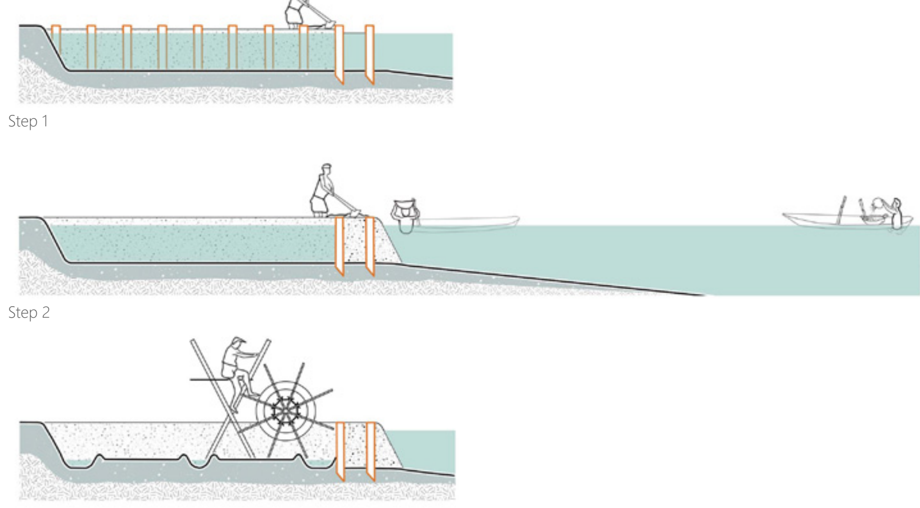
In this manner, a total of 4400 hectares of land (something) were reclaimed from the backwaters (nothing) between 1880 and 1945 in three phases. The reclaimed Kayalnilams were separated by canals or rivers forming an intricate network of paddy farm lands divided by the earthen bunds yet interlinked by water. Hence, Murickan and his men demonstrated their superior knowledge of hydraulics and deltaic region. They lived in lower order settlements adjacent to the paddy fields.

Living in uncertainty

However, they were stranded in between life and death. Every mother in Kuttanad was always prepared to rush out and jump into the waters to save her drowning child as they were enclosed by unfenced water all around them. Apart from this, they were constantly dreaded by the probability of an untimely call:

Achaayo…! Paadam Madaveene!!!
Lord…!
The bund has breached!!!

If this distress call was before the harvest, it was synonymous to their children drowning as the breached bunds would mean the forceful invasion of the water from the canals and rivers into the paddy fields rendering them drowned in a pool of misery for the coming year. They would even be deprived of grains for their daily supper. But as the story goes by there was a practise of human sacrifice based on the belief of death giving way to life. A section of these earthen bunds would have dead bodies stacked and buried in an exhilarating depth of mud to stop water from entering the paddy fields. Hence, these earthen bunds comparable to the traditional Dutch dikes were also a primary flood defence infrastructure.



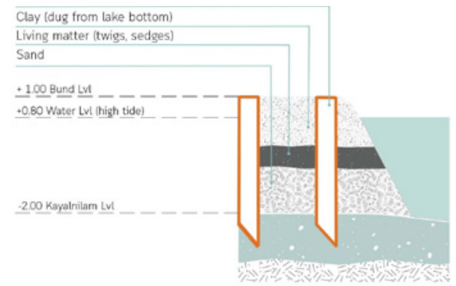


Fig. 1. The historic and cultural evolution of the landscape over periods; Source: Author
Fig. 2. The Kuttanad Kayalnilam Agricultural system; Source: Author
Fig. 3. The steps involved in the construction of the polder landscape, detailed intervention; Source: Author

The Water Calender

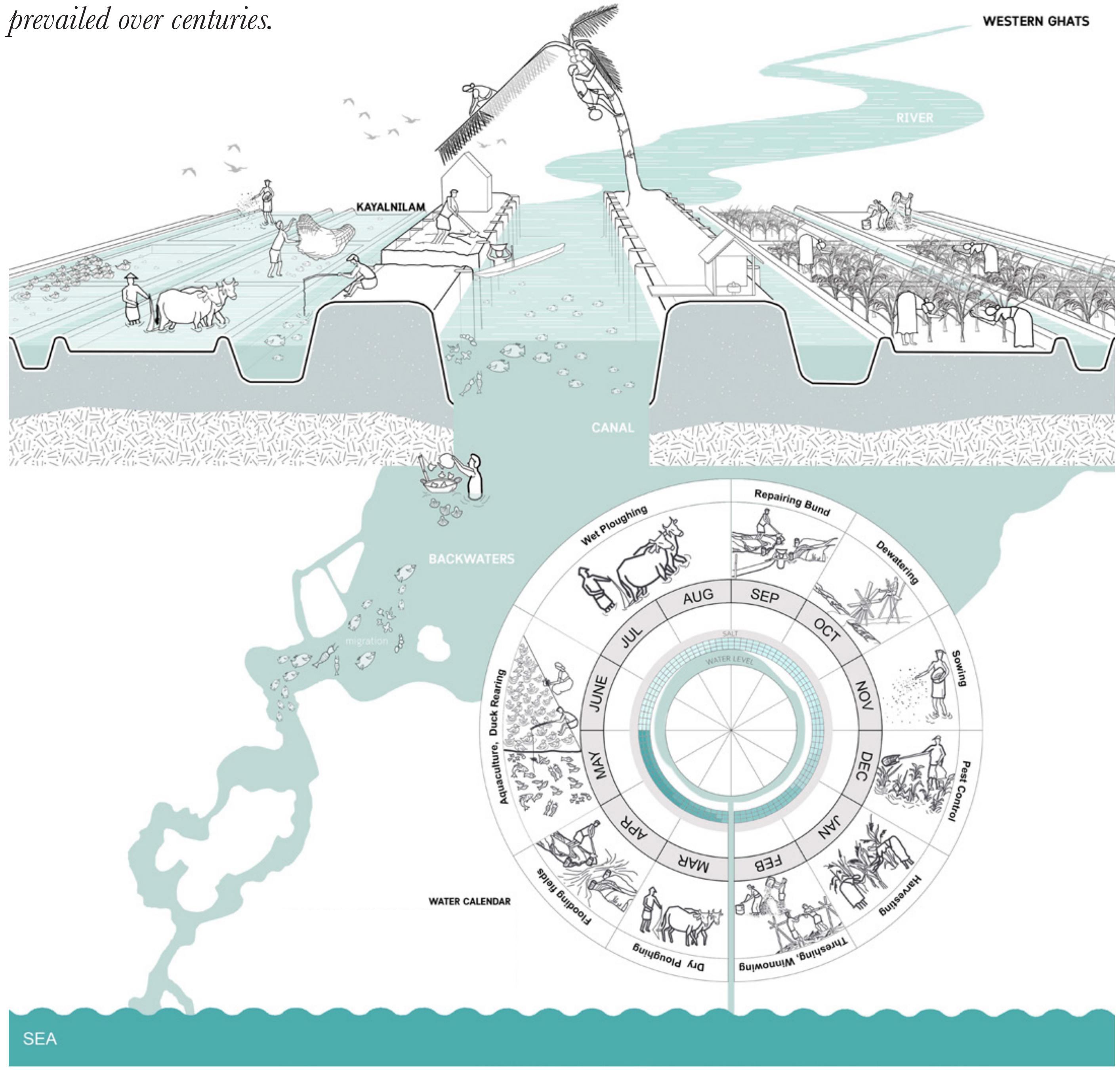
The calender projects a comprehensive outline of the interactions between the water, land and people across seasons in a particular year. This clearly defines the subtlety and circularity of these traditional water systems that have prevailed over centuries.

Nonetheless, what made this complex water management system built on the blood, sweat and tears of people more sustainable was its reliance on harmonizing the agricultural infrastructure and operations along with the lives of the people in line with the ecological rhythm of Kuttanad.

Rhythm of coexistence

This rhythm or the recurring patterns in the landscape was largely determined by the circular and cyclical movement of water and salt in the system. As a thumb rule, water flowed from the rivers and canals into the backwaters before being discharged into the sea. But this flow was reversed during summer due to the dwindling flow of the rivers. This marks the entry of salt from the sea into the low-lying areas due to tidal action. The salt which came across as a curse sealing the fate of the farmers however was a blessing for the fishermen due to fish migration from the sea.

Hence, the circle of life in Kuttanad was explicitly linked to this cycle of blessing and curse intermingling with the cycle of water and salt. Likewise, Kayalnilams also operated to optimize their performance within this spatio-temporal context specific to Kuttanad. When the salinity level rose, the Kayalnilams being unsuitable for paddy cultivation were flooded deliberately to create a watery landscape barely indistinguishable from the backwaters.



The Kayalnilams then became a source of a wide variety of fishes and made more room for ducks. With the onset of monsoon, the rivers flowed back into the sea and the wetlands continued to be a freshwater body collecting silt from the rivers. However, the increased levels of water also meant that the Kayalnilams remained drowned. During this period, the farmers would prepare the new ground enriched with silt for paddy cultivation with the help of simple tools and animals. When the water levels recede post monsoon, the remaining water was dewatered and taken out of the system and the agricultural activities would prevail. The crops were harvested just in time to welcome salt from the sea during summer and this marked the completion of a cycle of water and salt.

A complete set of these cyclical operations arranged in a time-based sequence is analogous to the modern-day cropping calendar. In this case, since these operations were based on the water cycle, we can label it as a water calendar. These kind of water calendars are quintessentially a cultural construct largely responsible for the intangible heritage behind these systems making it capable of resonating with the changing environmental conditions linked to the water cycle. This is an unparalleled quality of this traditional land-water (something-nothing) system and can be a model for the future direction of flexible and resilient landscapes. In short, taking a look back into these traditional water stories could be the key to solve the millennial conundrum of creating a symbiotic relationship between humans and nature amidst the wrath of the rising sea levels.

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Fig. 4. (a) Reclaiming polder along backwaters. (b) The reclaimed polder landscape. (c) Major and minor canals. (d) The inner canal

Fig. 5. The representation of coexistence and the water calender for activities all through a year.

Fig. 6. Sequence of Landscapes. Source: Author