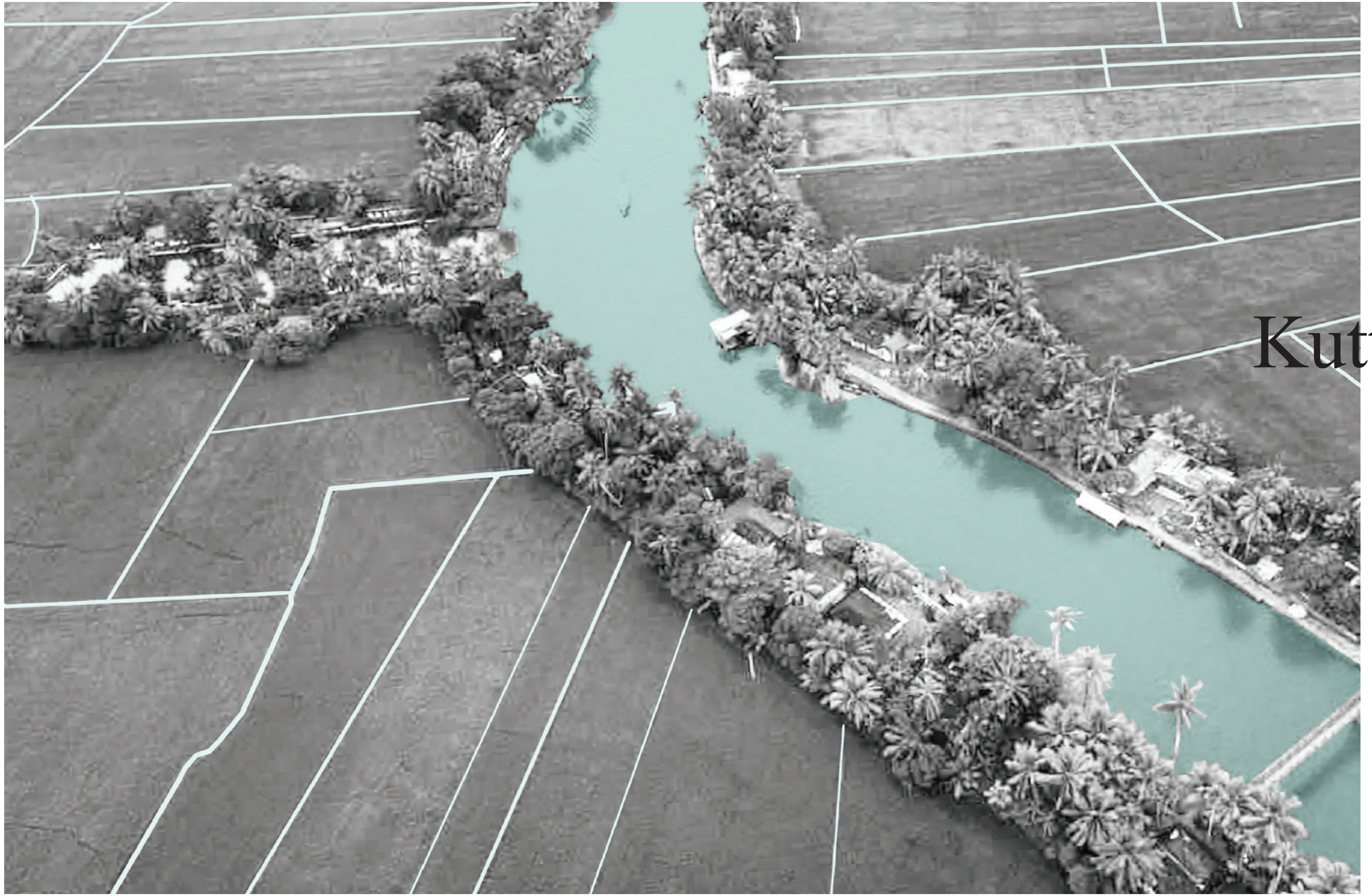


Kuttanad Kayalnilam Agrosystem

A traditional paddy farming system below sea level.

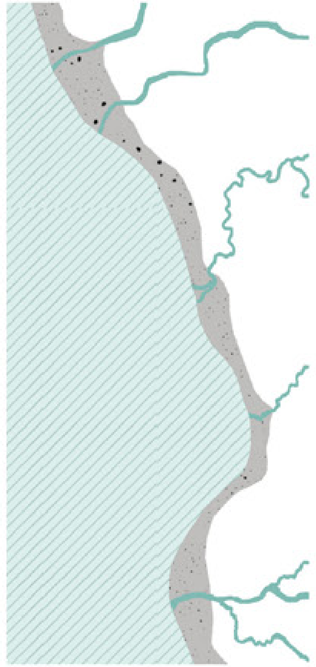
Naeema Ali

Figure 1 Aerial view of the agrosystem.

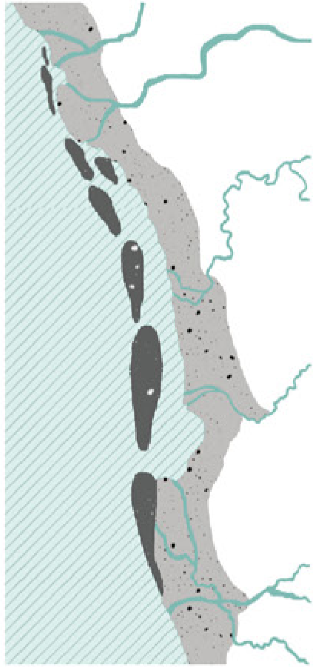
Context Overview.

Location: Kuttanad, Kerala, India
Landscape Type: Low-lying wetland
Area: 4400 hectares
Function: Land Reclamation, Paddy farming
Water Quality: Fresh to slightly brackish water

The Kuttanad Kayalnilam is a traditional water-land utilization system that practiced paddy farming below sea level for more than a century. It is located in the deltaic region of Kuttanad, a low lying-wetland (0.6 to 2.2 m below mean sea level) adjacent to the Vembanad backwater system.



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

The birth of the cultural landscape was marked by the onset of the land reclamation process, locally known as "Kayalkuthu". When the region encountered acute food shortage in the late 1800s, the virgin landscapes were considered as a gift from the backwaters and were brought to agricultural glory. The singular unit of this landscape is the "Kayalnilam"- an artificially created landform where land was lifted out of water.

Sea
Water body
Paddy Fields
Sand
Swampy Land

Kayalnilam
Reclaimed Land

0 5 10km
N

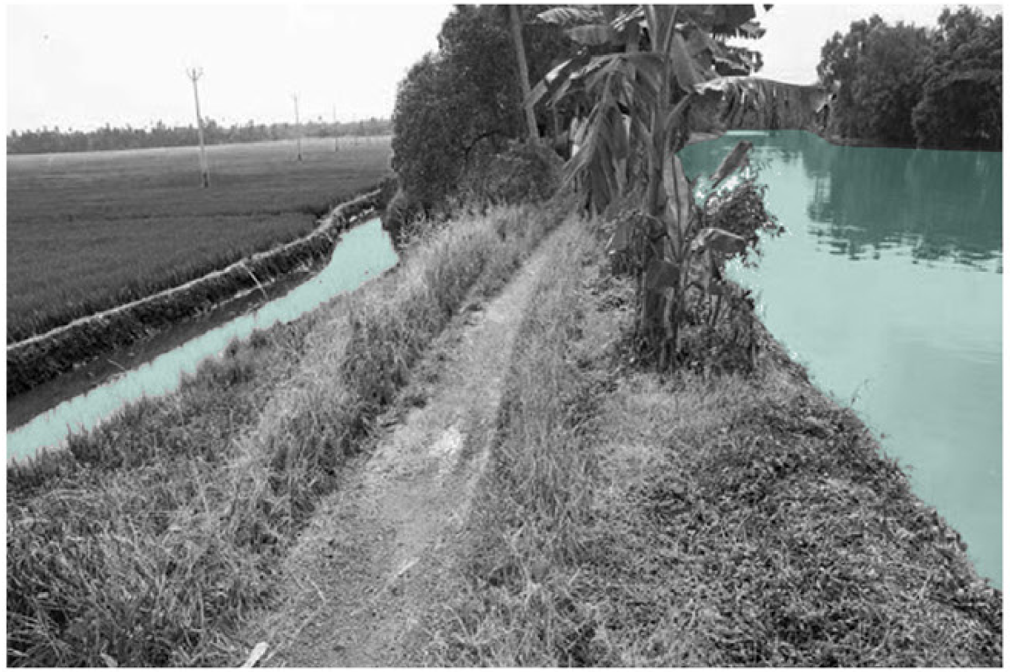
Figure 2: Kerala in India (Extreme left)
Figure 3: Natural Landscape, Pre-Holocene (Second from left)
Figure 4: Natural Landscape, Middle-Holocene (Third from left)
Figure 5: Natural Landscape, Late-Holocene (Third from right)
Figure 6: Natural Landscape, Early 1800 (Second from right)
Figure 7: Cultural Landscape (Extreme right)

Polder Landscape.

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 resemblantce with the Traditional Dutch landscape, Kuttanad is often referred to as the "Holland of the East".

Here, water management was quintessentially a unit of the cultural expression of the site-specific challenges faced by people, be it in terms of topography, climate or social hierarchy. In this case, the main challenge was to utilize the useless watery landscape adjacent to the backwaters. The low-lying landscape was subjugated for the benefit of men and women and how they did this narrates the legend behind the existing agricultural landscape of Kuttanad. These radical ingenuities tell us stories of how humans and nature exchanged roles between being makers and takers of the landscape.

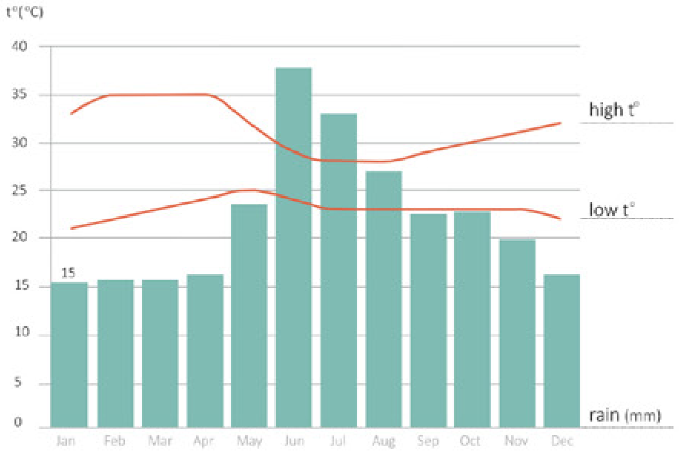
Figure 8: Reclaimed polder along the backwaters (Top left)
Figure 9: Reclaimed polder landscape (Bottom left)
Figure 10: Major Canal and Minor Canal (Top right)
Figure 11: Inner Canal (Bottom right)



Rhythm of Kuttanad.

Climatic Zone:	Tropical Monsoon
Max Temperature:	35 C
Min Temperature:	22 C
Annual Rainfall:	3000 mm
Relative Humidity:	Fresh to slightly brackish water
Dynamic:	Seasonal Flooding and Salinity Intrusion

The rhythm or the recurring patterns in the Kuttanad 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 Vembanad backwaters before being discharged into the Arabian sea. But this flow was reversed during summer, between February and May (pre-monsoon) due to the dwindling flow of the rivers and correspondingly increasing teperatures. This marks the entry of salt from the sea into the low-lying areas due to tidal action. With the onset of monsoon in the month of June, the water level in the rivers rises and the water once again flows from the rivers into the sea.



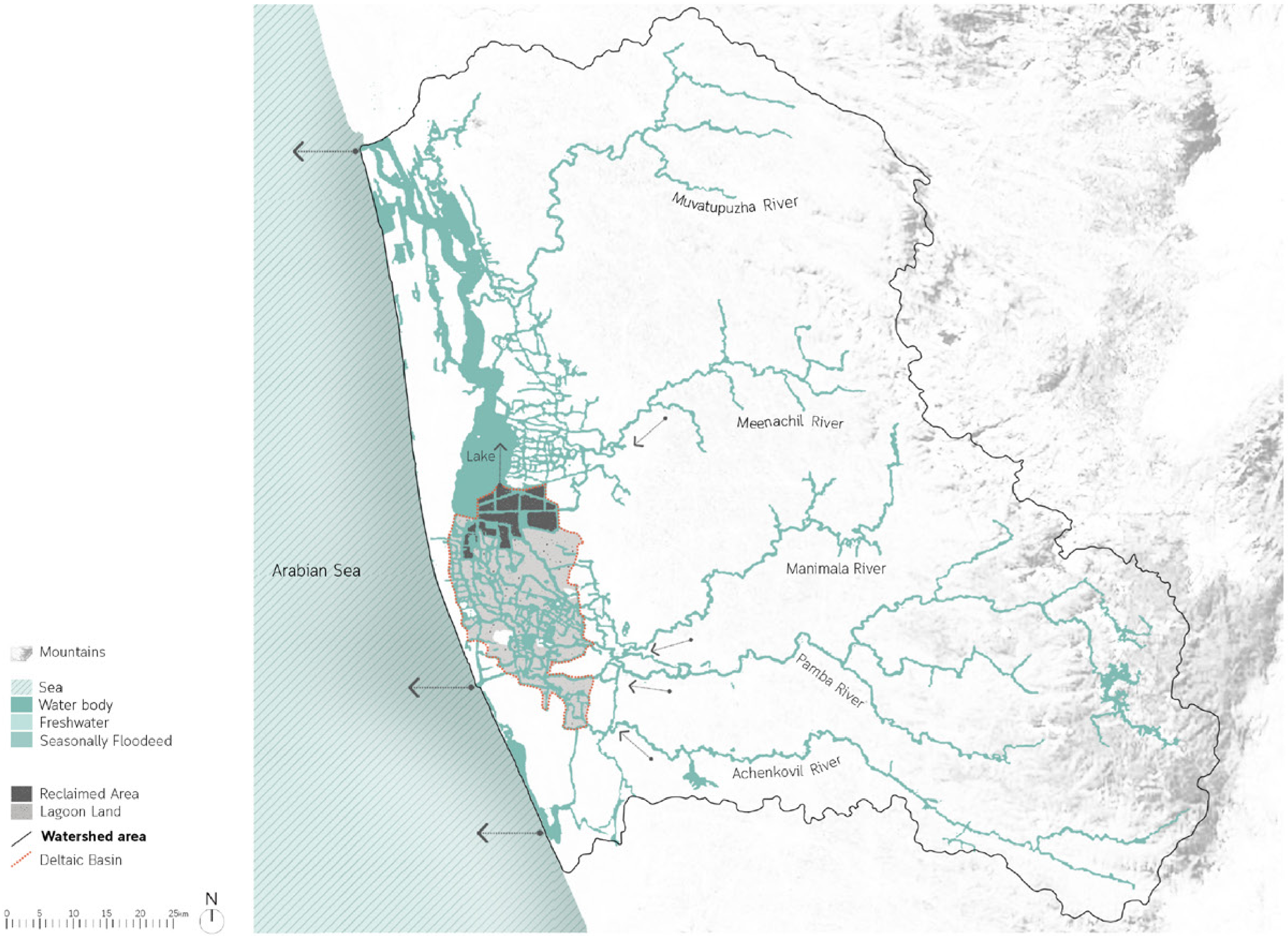
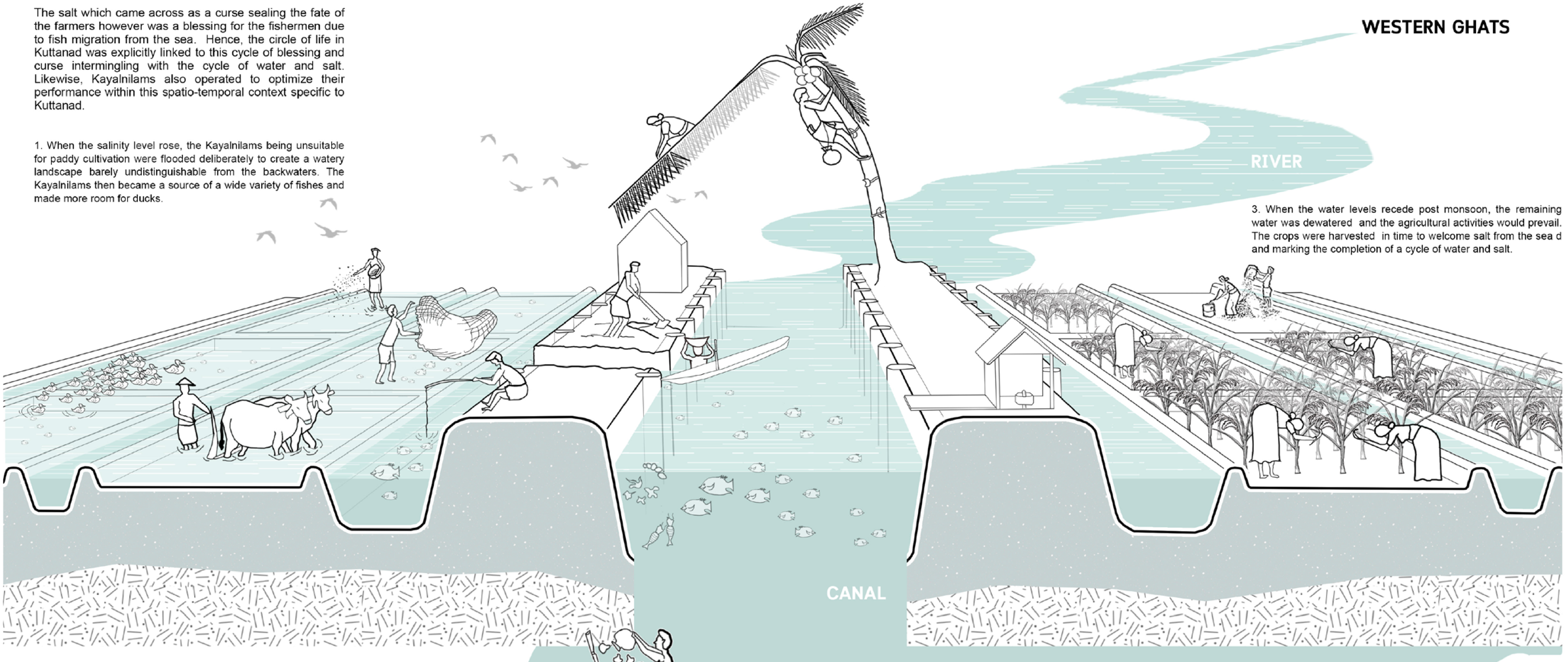


Figure 12: Climate graph (Extreme left)
Figure 13: Watershed (Middle)
Figure 14: Water and Salt Movement (Extreme right)

Circular and Cyclical Water System .

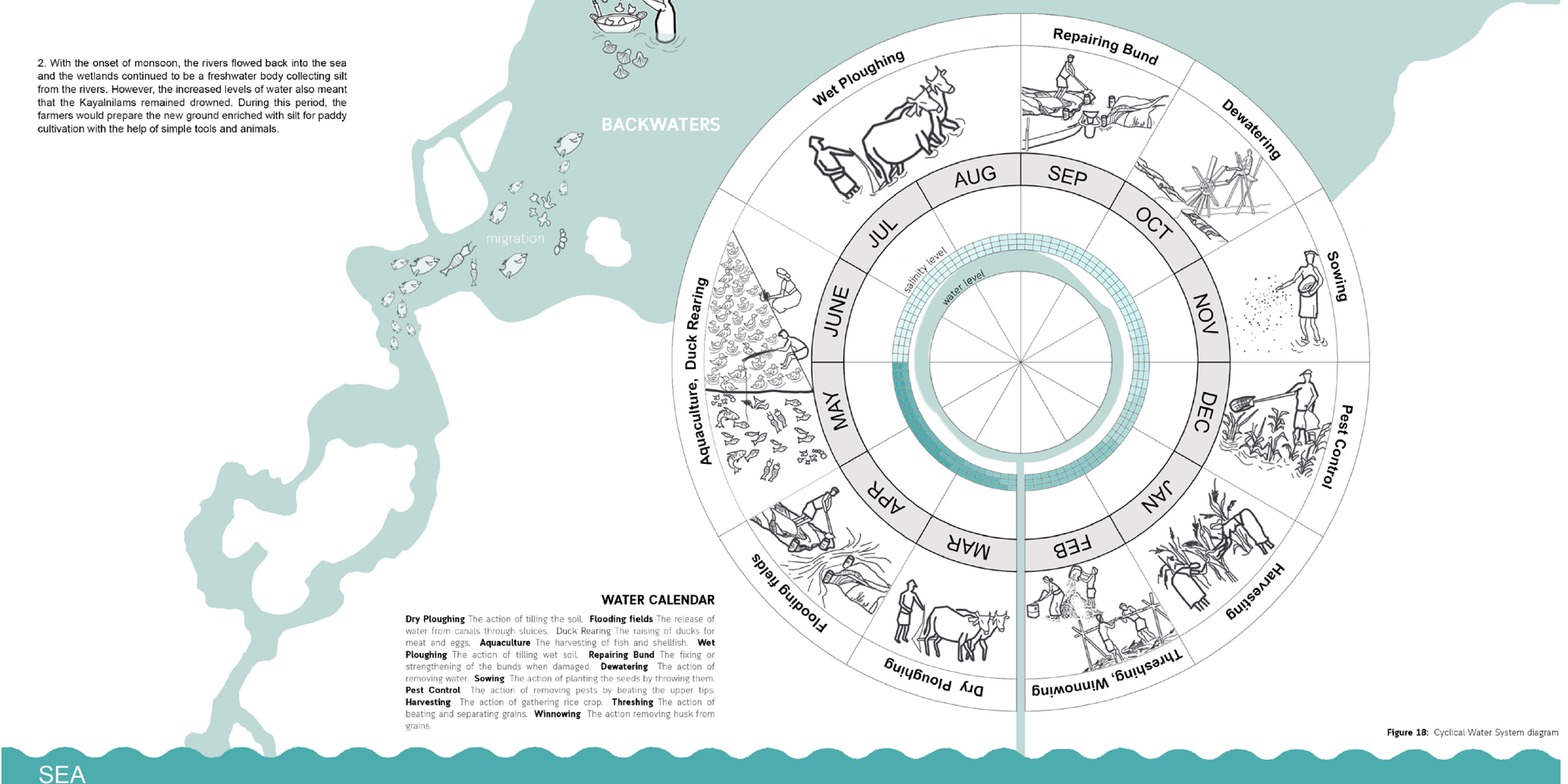
The salt which came across as a curse sealing the fate of the farmers however was a blessing for the fishermen due to fish migration from the sea. Hence, the circle of life in Kuttanad was explicitly linked to this cycle of blessing and curse intermingling with the cycle of water and salt. Likewise, Kayalnilams also operated to optimize their performance within this spatio-temporal context specific to Kuttanad.

1. When the salinity level rose, the Kayalnilams being unsuitable for paddy cultivation were flooded deliberately to create a watery landscape barely undistinguishable from the backwaters. The Kayalnilams then became a source of a wide variety of fishes and made more room for ducks.



3. When the water levels recede post monsoon, the remaining water was dewatered and the agricultural activities would prevail. The crops were harvested in time to welcome salt from the sea d and marking the completion of a cycle of water and salt.

2. 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.



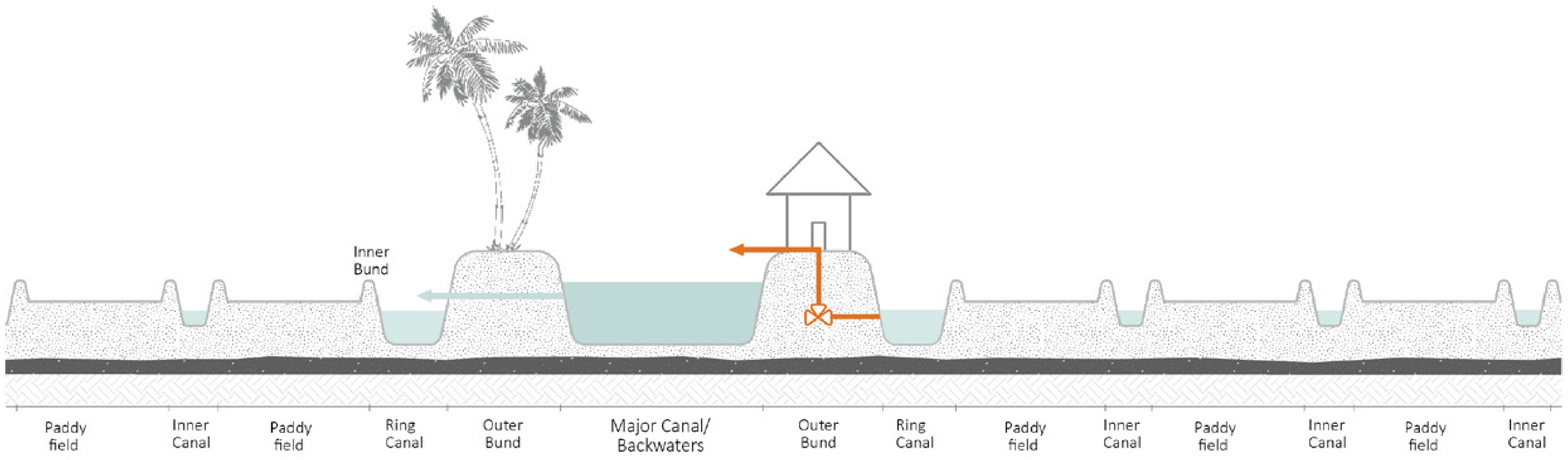
WATER CALENDAR

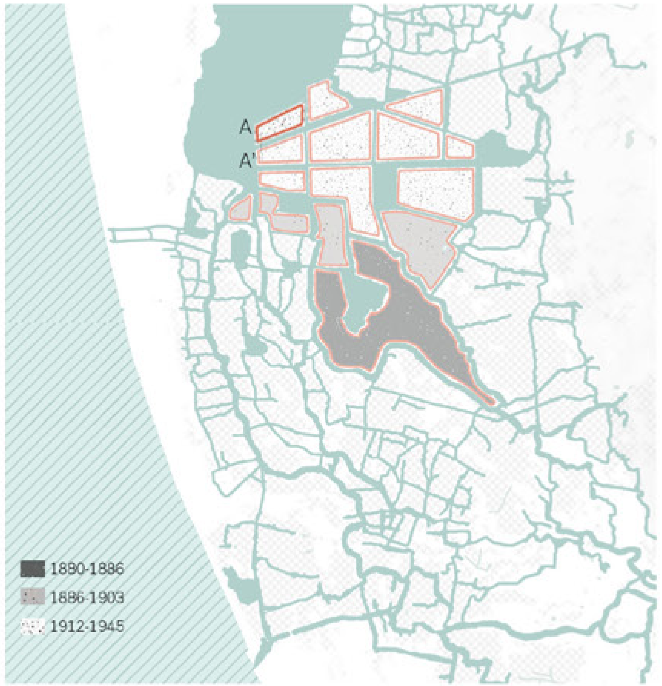
Dry Ploughing The action of tilling the soil. **Flooding fields** The release of water from canals through sluices. Duck Rearing The raising of ducks for meat and eggs. **Aquaculture** The harvesting of fish and shellfish. **Wet Ploughing** The action of tilling wet soil. **Repairing Bund** The fixing or strengthening of the bunds when damaged. **Dewatering** The action of removing water. **Sowing** The action of planting the seeds by throwing them. **Pest Control** The action of removing pests by beating the upper tips. **Harvesting** The action of gathering rice crop. **Threshing** The action of beating and separating grains. **Winnowing** The action removing husk from grains.

Figure 18: Cyclical Water System diagram

Water System.

A total of 4400 hectares of land were reclaimed from the backwaters between 1880 and 1945 in three phases. Rani is one such Kayalnilam which is the closest to the Vembanad backwaters. The reclaimed Kayalnilams were separated by canals or rivers. There was a flexible outlet from the Kayalnilam to these canals or rivers with the help of a dewatering wheel or pump. An intricate network of paddy farm lands with a two- tier water system (major canal- ring canal) were formed which were divided by the earthen bunds yet interlinked by the canals or backwaters.





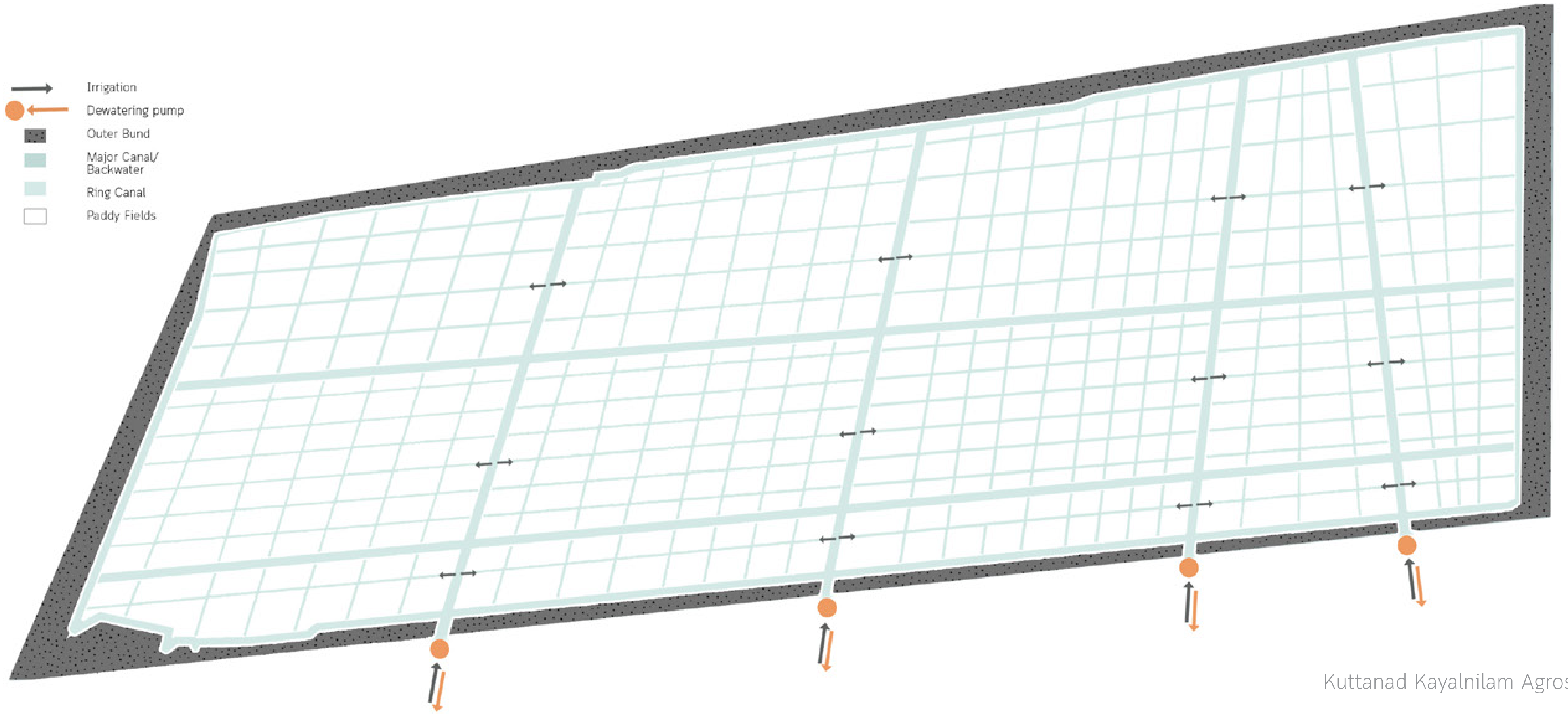
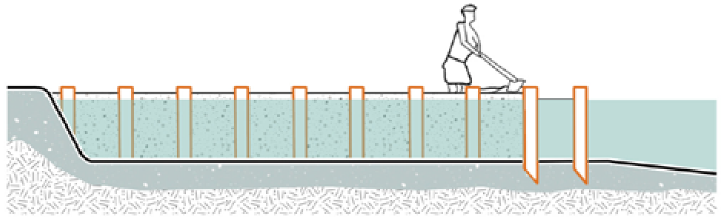


Figure 15: Phases of Reclamation (Bottom left)
Figure 16: Section AA'(Top)
Figure 17: Water Management Plan of Rani (Bottom Right)

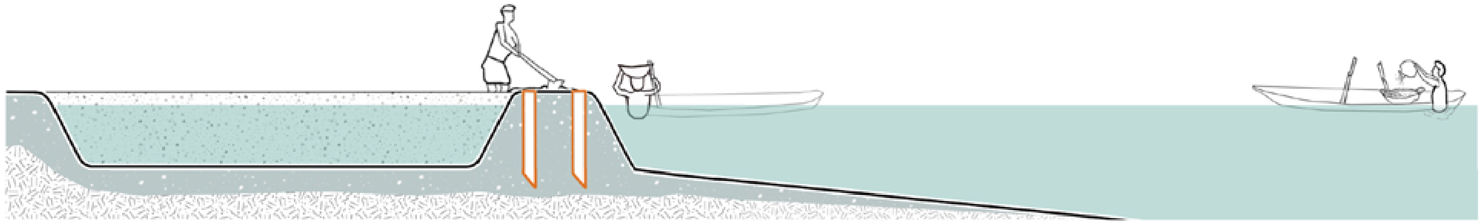
Kayalnilam Construction.

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.

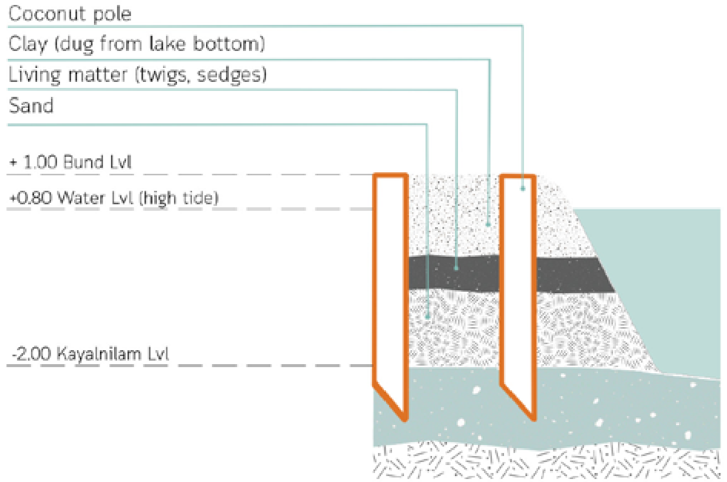
Eventually when the earthen bunds collapse due to heavy rainfall, as the oral history goes by, human sacrifice was seen as a practice to repair this high maintanence structure. A section of these earthen bunds would have dead bodies stacked and buried in an exhilarating depth of mud to stop paddy fields from drowning.

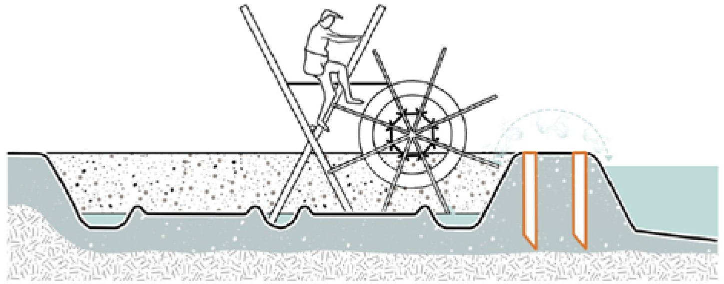


1. Firstly, the boundaries are marked. Then an array of long and stout coconut poles would be hammered deep enough into the lake bed in two rows, normally in 1.5m to 2.5m width, enveloping the entire area. Then they would be fenced with bamboo mats on either side to form a skeleton for the bund



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. Clay digging was called Katta kuth, which involves diving deep in to the lake-bed. In this manner, the earthen bunds are constructed and they are further stabilized or strengthened by planting vegetation cover





3. Dewatering or removing excess water from fields. Traditionally, water wheels of 10-12 feet diameter with blade width of 1-15 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 surrounding lake or canals

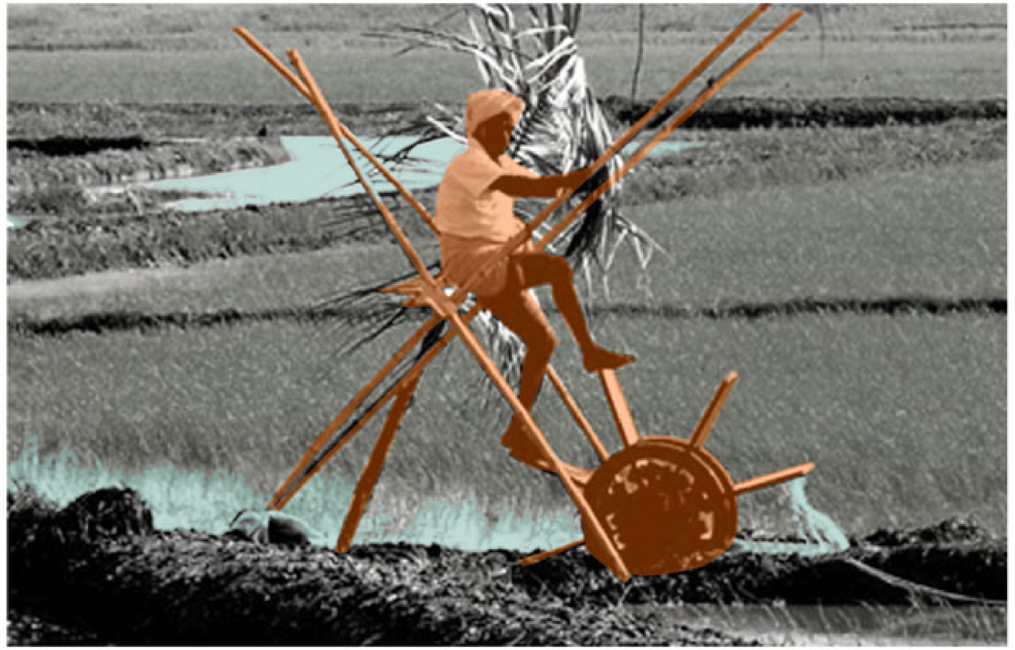
Figure 19: Step 1- Hammering and fencing (Top left)
Figure 20: Step 2- Cutting and filling (Top left)
Figure 21: Construction Section Detail (Bottom left)
Figure 22: Step 3- Dewatering (Bottom right)

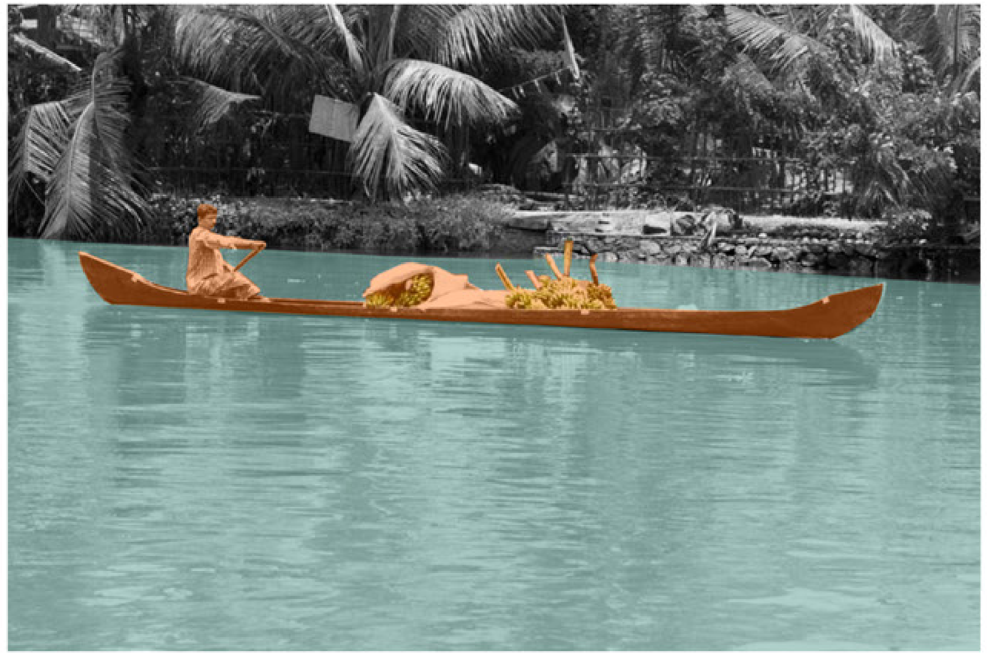
Living with water.

Being water-logged most of the year, these landscapes were geographically isolated and only accessible through a vallam or a local canoe until recently. Alongside paddy cultivation, there was a thriving duck, fishing and clam industry. People were also dependent on allied ecosystem services like coir industry, toddy tapping, fishing net industry etc. Majority of the livelihood strategies were directly linked to the ecosystem services provided by the backwaters and the adjacent low-lying lands. Hence, people also chose to stay here even after facing perpetual flooding issues for the sake of their livelihood.

Not just their livelihoods, but water was the centre of their cultural traditions, social life and daily activities. Because their life was in between land and water, their life can be termed as amphibious in short.

Figure 23: Farmer irrigating the field manually using a water wheel (Top left)
Figure 24: Female labourers harvesting paddy (Bottom left)
Figure 25: Man navigating through waterway in vallam, canoe boat (Top right)
Figure 26: Lady washing utensils by the canal (Bottom right)





Conclusion.

Lessons to be learned- What made this complex water management system 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. A complete set of the 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 system and can be a model for the future direction of flexible and resilient landscapes.

Landscape Values- The bund and canal irrigation system reflect the low-lying nature of the deltaic region composed of clayey soil. This fertility of soil also explains why Kuttanad was considered suitable for farming. The ordered irrigation canals and bunds in grid like patterns also point to the fact that these Kayalnilams were lifted from the backwaters through a man-made process of reclamation. Consequently, this organization of Kayalnilams echo the operational nature of this landscape that maximizes paddy cultivation.

Strategic Values- The water system mainly facilitated two significant processes in paddy cultivation: irrigation and dewatering. This system also acted as a defense mechanism for preventing flooding episodes during the monsoon. Hence, the use of technical devices like sluices for irrigation and dewatering motor for dewatering were critical for this system to function and allow some room for flexibility. Also, this is a two-tier system where the major canals and the backwaters, the main source of water, were at a higher level than the rest of the water system.

Functional Values- These Kayalnilams were organized to maximize paddy cultivation that later gave these landscapes the status of being called a "rice bowl" or the "granary" of the state of Kerala. All the other ecosystem services like aquaculture, duck rearing etc. were in line with the annual agricultural cycle which in turn was dependant on the annual rainfall pattern.

Material and Tangible Values- All the technical devices and infrastructural systems were constructed with locally available materials and using indigenous construction techniques. Some of these materials and devices saw a shift in line with the change in the social conditions and aspirations of the community, i.e. from an ecosystem service-oriented system to an agricultural intensification oriented system.

Values of Sustainability- The Kayalnilams were a circular and cyclical landscape that fluctuated according to hydrological patterns like precipitation and seasonal mixing of brackish and fresh water. There was a cycle of curse and blessing which was linked to the cycle of water and salt within the system. People considered this land as a gift of the backwaters from God and wanted to be in harmony with the ecosystem.

Ethnographic and Identity Values- People were visibly the makers of this landscape as it was lifted from mud, clay and swamps by the collective effort of humans. Both men and women worked closely with these landscapes as farmers, fishermen or labourers involved in the ecosystem services related livelihoods like agriculture and aquaculture. Indeed, their life revolved around the movement of water: from their daily activities and livelihood patterns to their cultural traditions and celebrations. In short, life in this delta can be termed as amphibious.

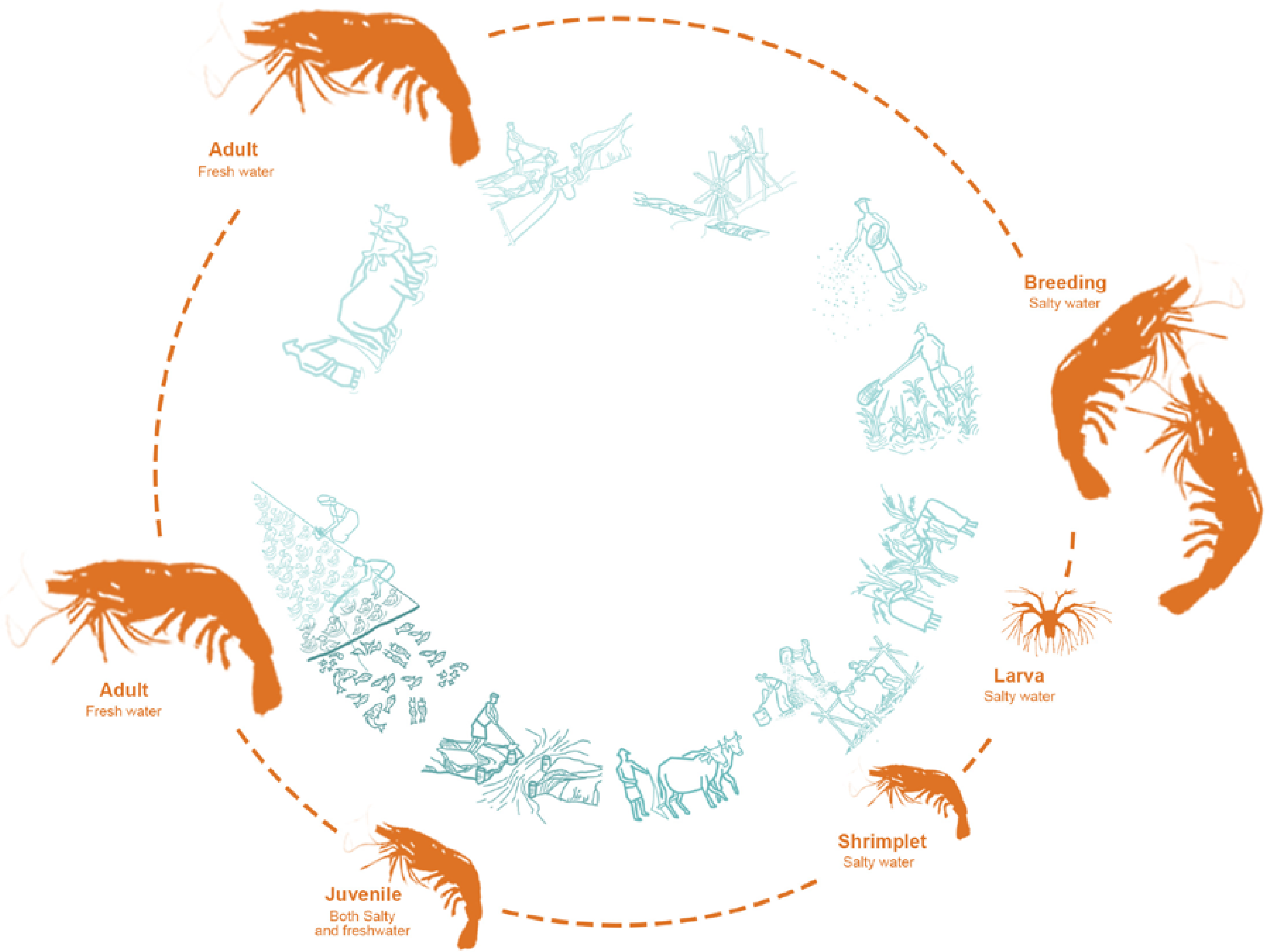


Figure 27: Cyclical operations in harmony with the ecological entities

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