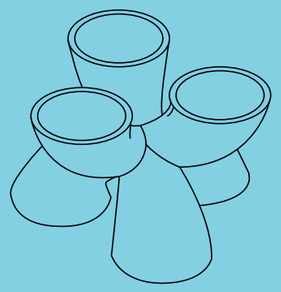

THE JACQUES ROUGERIE FOUNDATION AWARDS 2013

Architecture & Sea Level Rise

CALTROPe – a green lace

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CALTROPe PROJECT DESCRIPTION

Focus on estuaries

The increasing problem of sea level rise represents one of the most flagrant consequences of the global climate change. Even if this multicomponent phenomenon develops so slowly that its symptoms and associated losses do not lame everyday life, it is still a shocking indicator of the human impact on our vulnerable planet on the whole. Humans are unquestionably responsible for these changes. As Intergovernmental Panel on Climate Change (IPCC) reported in September 2013, due to global warming sea level may have increased by 100 centimeters by 2100 which means an exponential growth compared to recent decades. This prediction forecasts the submersion of some five million square kilometers of the lowest lands on Earth, approximately one third of which will be infield. There are also important and densely populated tropical delta regions concerned. These estuary areas are especially endangered because of their low position relative to sea level and their unfavorable economic conditions.

An ordinary big tropical delta on Earth measures tens of thousands of square kilometers. Deltas are incessantly built and evolved by their periodically flooding rivers, tide dynamics and sedimentation pushing always a bit forward the estuaries in the sea. Owing to this sedimentation process deltas conquer substantial areas from the seas every year.

By today human activity transformed significantly the run and hydrodynamics of our planet's huge rivers, including the cycle of river floods thus the quantity of transported alluvium as well. At present times, 24 out of the 33 largest deltas are sinking and losing land, building giving way to erosion, and expansion to decline. Seas have also launched the campaign for the deltas. The increasing sea level rise accelerates the deterioration, entailing a huge loss of valuable and nutrient-rich agricultural land on the long run.

500 million people live in these deltas. The delta means home, life and living for them. In these areas the sea level rise just in itself leads to disastrous consequences but the situation will be hardened by the destruction of more and more intense storms and sweeping hurricanes also ascribable to global warming. Thus vast areas of living spaces and fields may disappear or at least be endangered shortly and, in addition, we have to expect the collapse of the complex estuarine ecosystems.

The main goal is to preserve and, if possible, extend the areas of tillable lands in tropical delta regions through the harmonization of resources, materials and natural processes with the least intervention.

Hence our objective consists in conceiving a complex and constructive project with immediate beneficial effects that meet the needs of the deltas. We intend to design an organic, dynamic and expandable modular system catching up the pace of sea level changes and applicable in diverse circumstances.
After having examined the processes of sedimentation, the hydrodynamic characteristics, and the ecological conditions, we concluded that the intentional retention of water-borne alluvium carried in big quantities by the delta rivers could be the key to compensate land loss caused by sea level rise.

Magnificent mangrove

Mangroves are various types of trees growing in tropical and subtropical foreshore habitats. This type or tree is one of those rare terrestrial plants that are salt tolerant. Mangal occupies vast terrains between latitudes 25° N and 25° S. Its total surface occupies approximately 150.000 square kilometers today. Mangrove swamps are composed by 40-60 species in 20 genera and in a bit more than 10 families. This plant association forms different coastal zones, the composition depending on the degree of salinity and water coverage.

Mangrove trees (Rhizophoraceae) adapted to the waving, tidal fluctuations, and anaerobic circumstances of the littoral swamp by evolving a profuse strong lateral root system for better foothold and special above ground pneumatophores to provide the organism with oxygen. By means of this abundant root system trapping sediment and acting as a natural breakwater these plants prevent neap tide backwash from eroding the coast and contribute highly to soil formation.

Its original coverage reduced by 35 percent, by the millennium, mangal has become one of the most seriously endangered tropical ecosystems on Earth. Consequently, the protection of mangrove forests is now a relevant and urgent issue. In addition to its filtering and debris trapping effects, mangrove also absorbs 75 percent of wave energy so the mangal-entrenched land is highly protected against storms and tornadoes.

Concept

The name comes from the words 'caltrop' (water chestnut) and 'rope', 'caltrop' referring to the shape of the object, and 'rope', to the linear, lace-like installation principles.
Our aim is to synthesize and balance the natural dynamics and forces of the delta regions applying an easy-to-install modular structure. Thus, we conceived a lace-like structure that is able to catch and collect river sediment with the help of mangrove plants, so integrating natural and architectural elements. Working like a catalyst, it will provoke positive changes at the most critical shoreline points.

CALTROPe Lace – how it works:

The hydrodynamic particularities of the given delta taken into account, different structure elements are chosen to be installed. Water depth defines the height of the system, variable from one to three modular levels. The modules serve as containers and incubators for the young mangrove saplings that, getting stronger with time, will become self-supporting and form a natural dam. This structure is thus only a supportive frame of temporary use. The modules can create ideal environment for the plants even in deeper sea-levels. The intricate and intertwined root system of the mangroves integrates little by little in the artificial structure, and the natural dam created collects the sediment and adds it to the shoreline soil.

The lace is constructed by the multidirectional piles of one single element type. That is a caltrop-like node. This module possesses proliferous functions since it is a pot for the young plant, a water filter, and a sediment collector. For filtering, the element is partly perforated for better water straining and for letting the roots spread out. It also keeps distance between saplings to have enough space around for growing, and functions as dykes and piers as well. Shape is kept simple, form follows function. The units are easy to produce using a prefabricated mold set and local human and non-human resources. Local crafting and fabrication skills are also likely to be involved in the process. The elements can be simply batched both horizontally and vertically. Due to their size, the modules are facilely handled, installed, and adapted to the irregularities of the seabed. The building process does not require special conditions and/or tools. The modules' blend is a special mixture of concrete, organic materials and local resources. In 15-20 years, as the plants get stronger, the units start to crumble and the crumbs also become part of the sediment. The remains will be partly recycled by the plants as nutriments.

The shape of the lace-like lines adapts subtly to the curves of the shore. The elements form intertwining sine curves which are slightly undulant and follow the coastline.

The dynamic installation consists of several different steps. Sedimentary processes start immediately, banking up alluvium. 4-5 years after planting the saplings grow strong enough to be self-supporting, to keep soil and strain water. Lower sea level requires fewer levels, one element per meter is needed on average. The higher the sea level gets, the more levels are to be applied. The line of the lace structure follows the shoreline pattern and hydrodynamics for establishing the most effective and firmest structure possible.The prefabricated modules contain hollows. At installation these cavities are blown through with high-pressure air resulting in gaps under the units. These gaps are then filled up with liquid concrete, producing root-like supporting props.

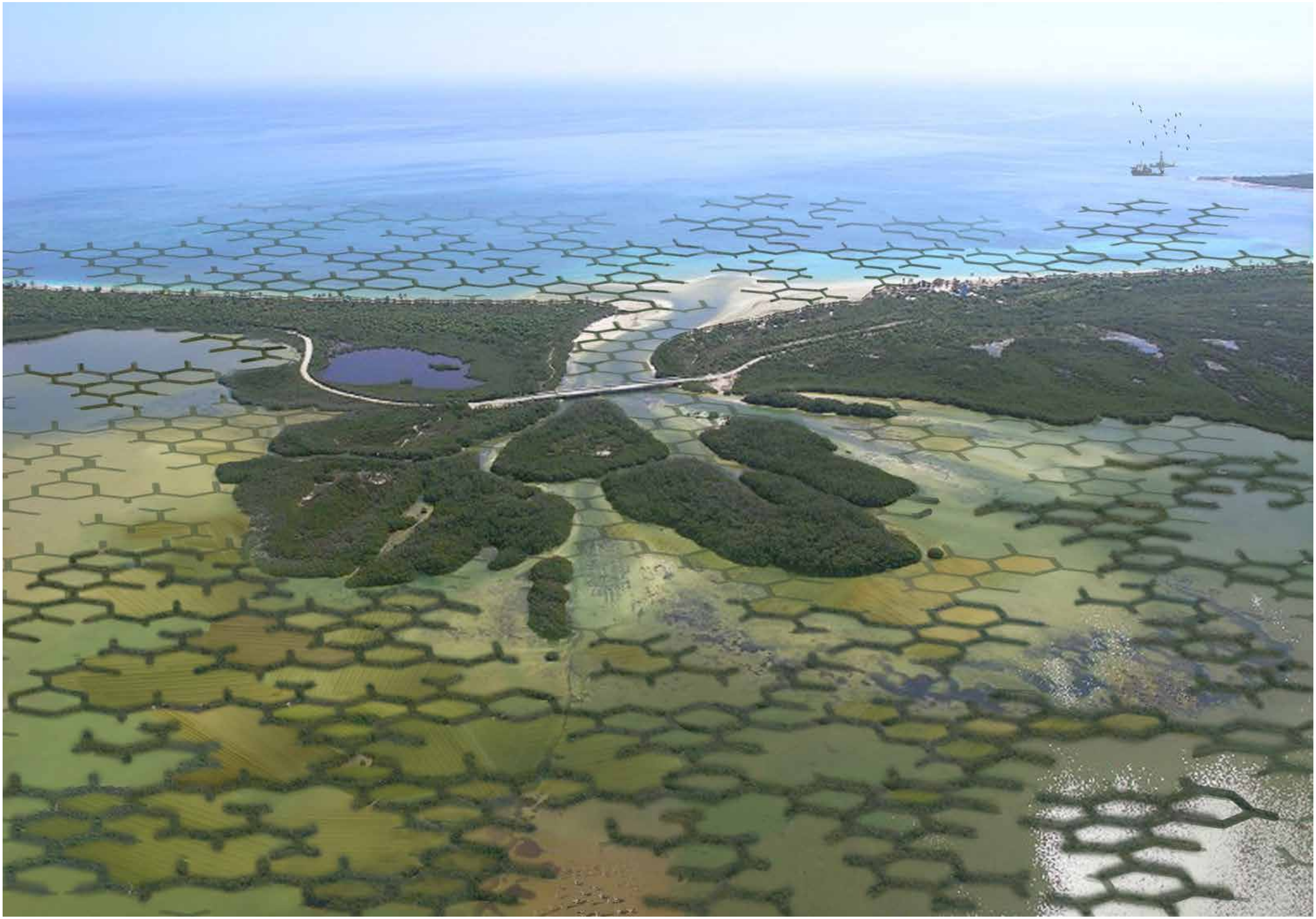
Organic appearance

As CALTROPe lace becomes visible only at low-tides, they hardly disturb the overall landscape. The structure mostly stays underwater and influences only the shape of the tree groups. Over and above, this organic green lace pattern grows out of the modules visualizing hydrodynamics, shoreline, and level rise. CALTROPe is a decent architectural element in the natural landscape. These areas do not only function as a dam, a filter or a pier, these 'watery esplanades' are also a habitat for oysters and prawns. Local communities can earn a sustainable living based on these self-regulating natural resources. People will not only maintain these areas this way but also exploit it protectively. This cooperative, participatory and locally supplied work can also reorganize and socialize the local population in a constructive and self-supporting manner.

Synchronized dynamics

The growth of mangrove trees, the sedimentary processes and the sea level rise are expected to evolve in similar rhythms. In 20-30 years sea level rise is likely to reach the point high enough to result in the blight of the planted mangroves. Then the plantations start to decay naturally and the locals can continuously exploit them for bio fuel and construction material.

Sea level rise is an inevitable fact. Yet the installation of CALTROPe lace can contribute highly to the articulated and effective utilization of delta sediments and/or the rescue of existing estuary infields. The eventual retention of several years' sediments means a lot in itself concerning the protection of the current delta conditions. We believe that, when the sea level will go beyond a critical point, the quantity of sediment trapped will form sufficiently high dams to save the current lands. The protected areas can also be used agriculturally or can be populated because their soil is rich in nutriments and they are solid enough.

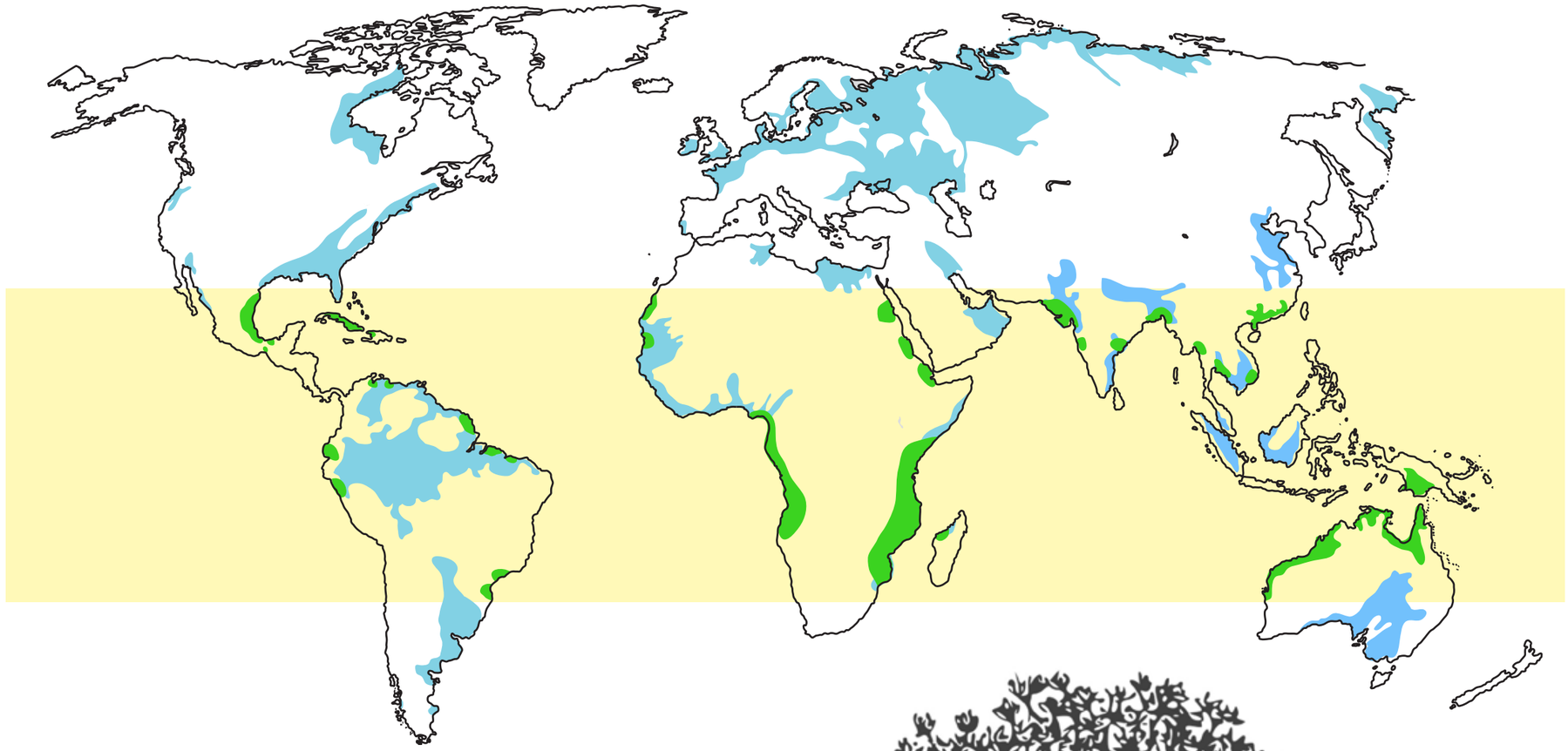


EFFECT OF SEA LEVEL RISE

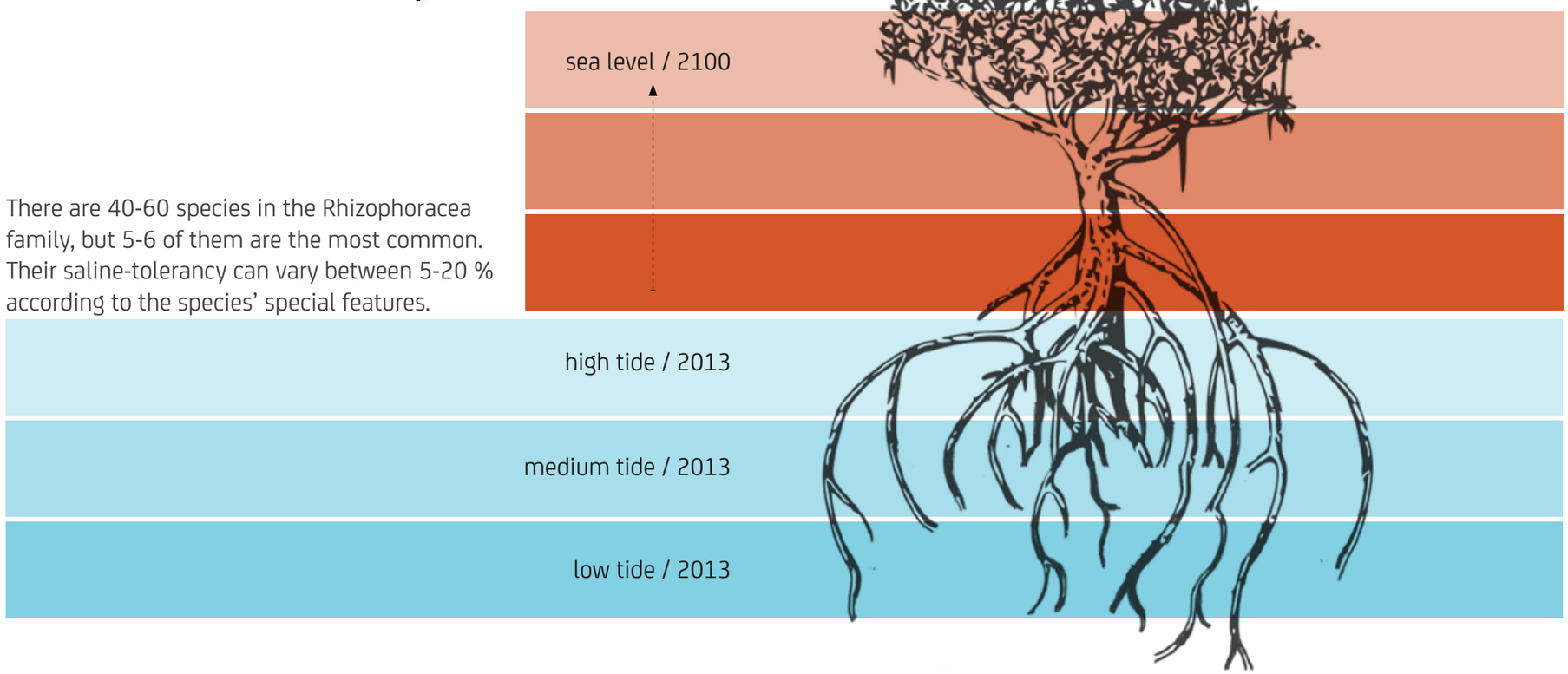
tropical and subtropical zones

current mangrove forests

estimation of flooded areas until 2100



There are 40-60 species in the Rhizophoracea family, but 5-6 of them are the most common. Their saline-tolerancy can vary between 5-20 % according to the species' special features.



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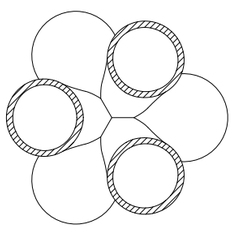
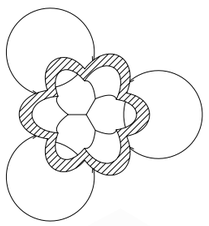
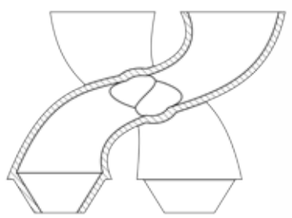
The modules serve as containers and incubators for the young mangrove saplings that, getting stronger with time, will become self-supporting and form a natural dam, dyke and wave-breaker. This structure is thus only a supportive frame of temporary use. The modules can create ideal environment for the plants even in deeper sea-levels. The intricate and intertwined root system of the mangroves integrates little by little in the artificial structure, and the natural dam created collects the sediment and adds it to the shoreline soil.







horizontal and vertical sections

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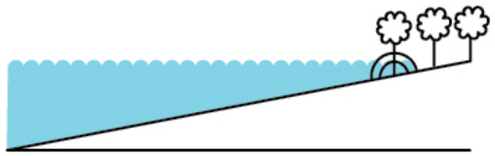
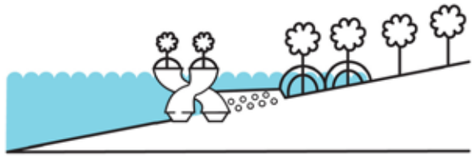
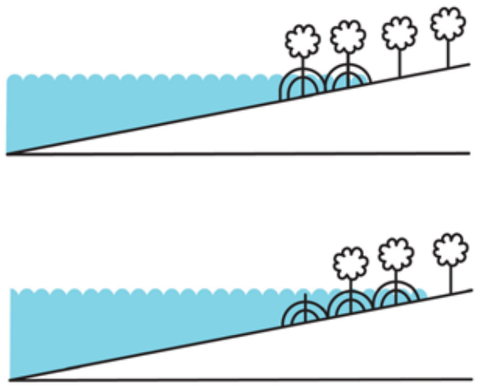
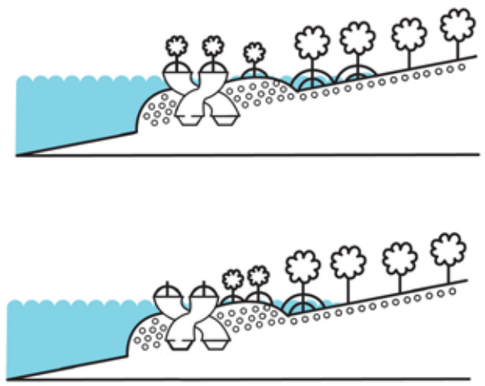
sedimentary processes
in the nature

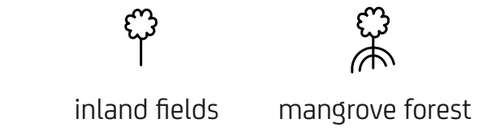


sedimentary processes
with the CALTROPe









The location of mangrove swamps is defined by the water levels of the tidal cycles. While their seaward expansion is limited by the mean sea level, they can spread on land as far as the high tide covers it.

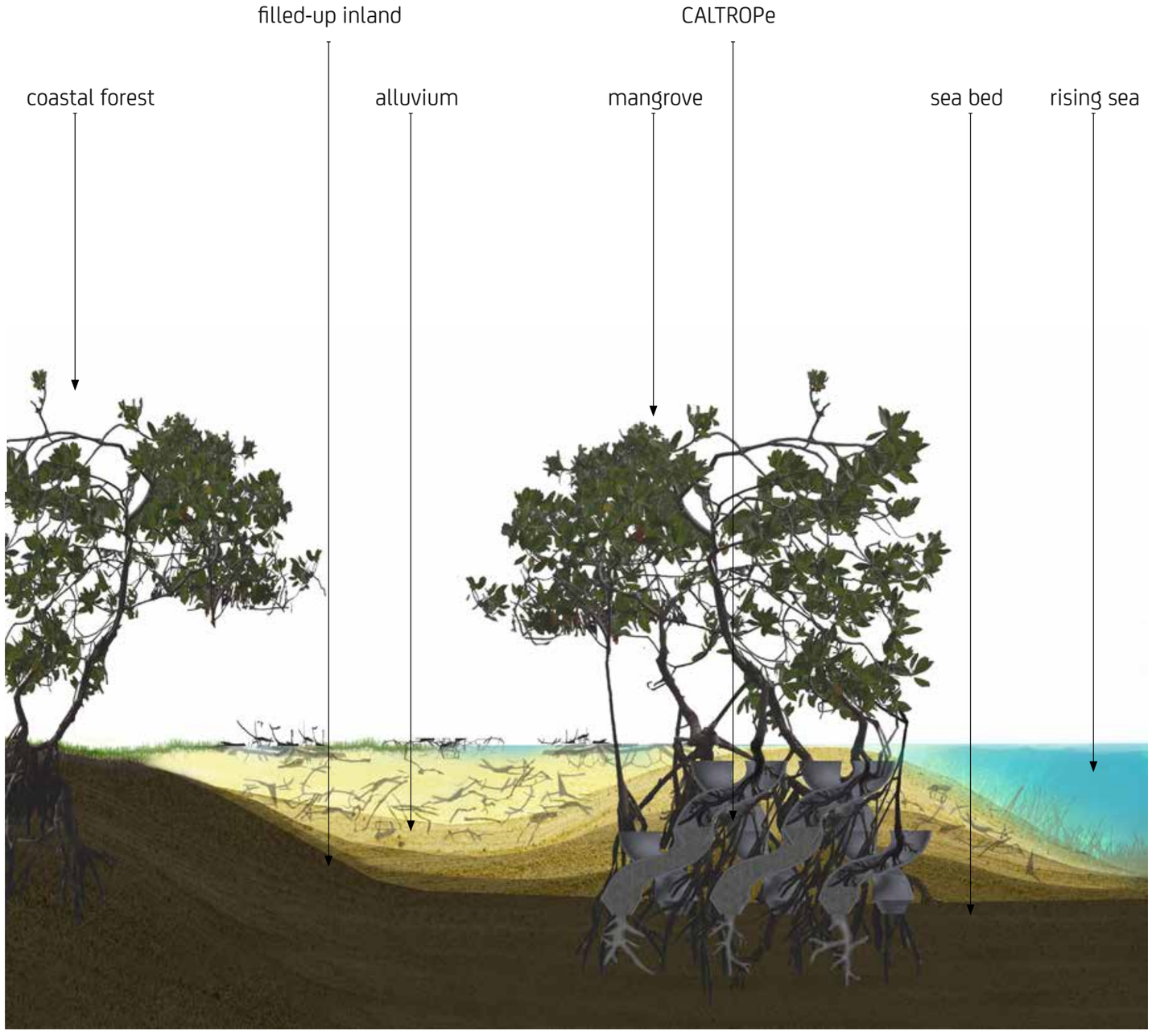
Mangal is shrinking due to sea level rise and the decreasing amount of alluvium. Seaside its boundary is moving back to the new average level, meaning land loss. While mangrove is climbing with high tide on land which phenomenon is accompanied with the blight of land plant associations.

CALTROPe lace is placed in the sea in front of mangrove zone and its height is defined
by the mean sea level.

By dint of the structure and the raised mangrove saplings planted in it, the course slows down putting down alluvium and starting sedimentation processes which enables new mangrove seedlings to turn up.

Due to the structure, shore is building up little by little keeping pace with sea level rise thus the lace hinders withdrawal.

The dynamic installation consists of several different steps. Sedimentary processes start immediately, banking up alluvium. 4-5 years after planting the saplings grow strong enough to be self-supporting, to keep soil and strain water. Lower sea level requires fewer levels, one element per meter is needed on average. The higher the sea level gets, the more levels are to be applied. The line of the lace structure follows the shoreline pattern and hydrodynamics for establishing the most effective and firmest structure possible.



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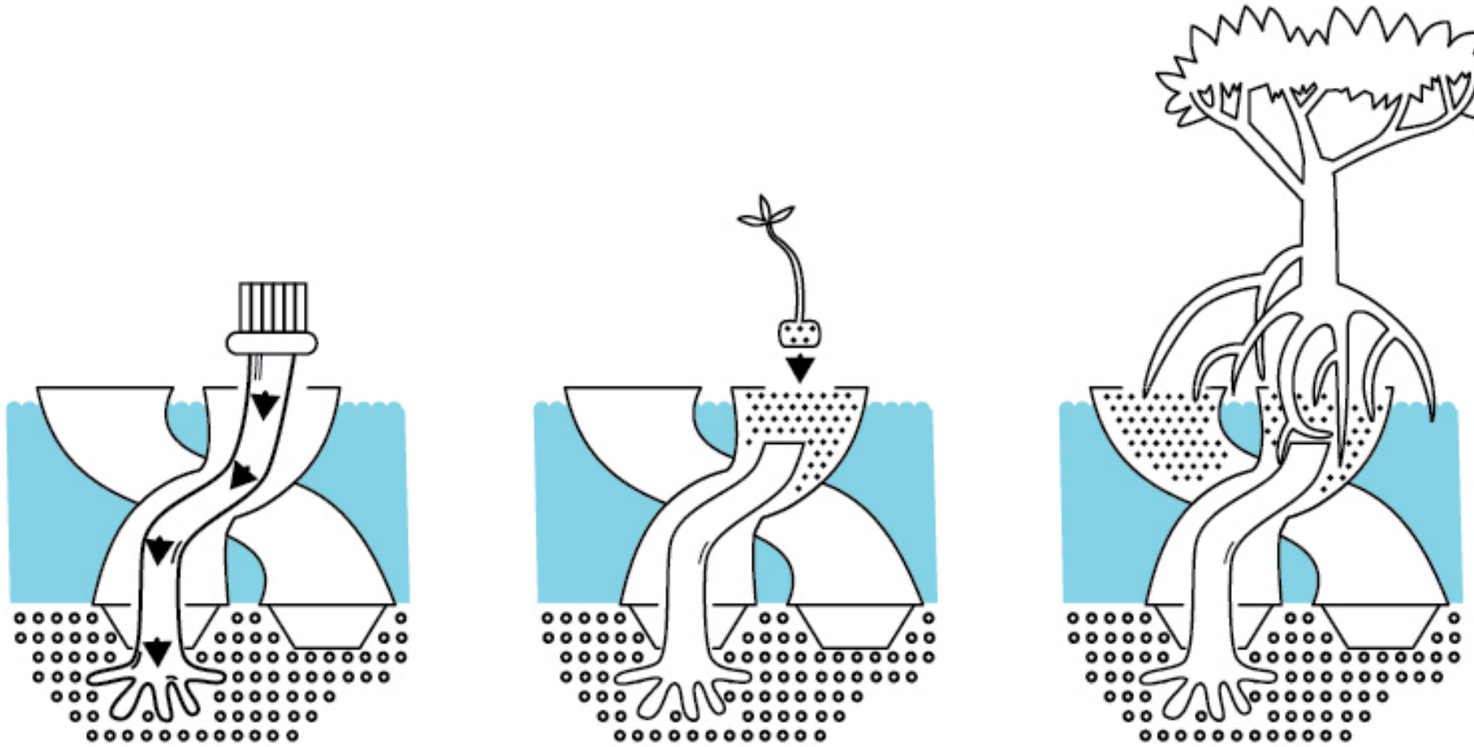
after placing the modules,
concrete is poured inside

pre-grown saplings are placed into
the holes together with nutriments

in 4-5 years, the tree grows strong
enough to be self-supportive



The units are easy to produce using a prefabricated mold set and local human and non-human resources. Local crafting and fabrication skills are also likely to be involved in the process. The prefabricated modules contain hollows. At installation these cavities are blown through with high-pressure air resulting in gaps under the units. These gaps are then filled up with liquid concrete, producing root-like supporting props. The modules' blend is a special mixture of concrete, organic materials and local resources. In 15-20 years, as the plants get stronger, the units start to crumble and the crumbs also become part of the sediment. The remains will be partly recycled by the plants as nutriments.

concrete
as construction material

use of local resources

method of installation

community planting

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CALTROPe STRUCTURE

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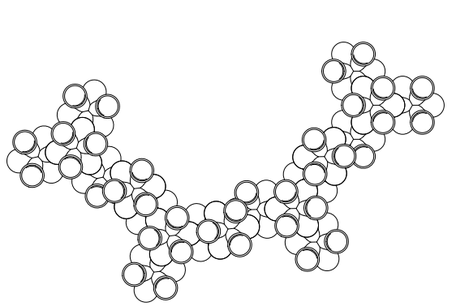

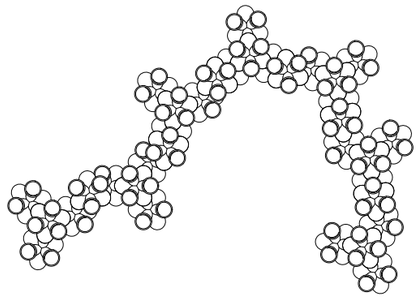

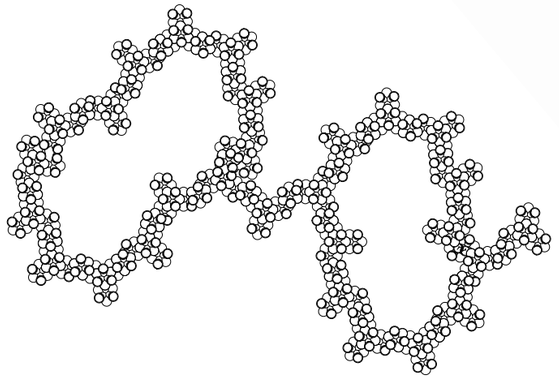

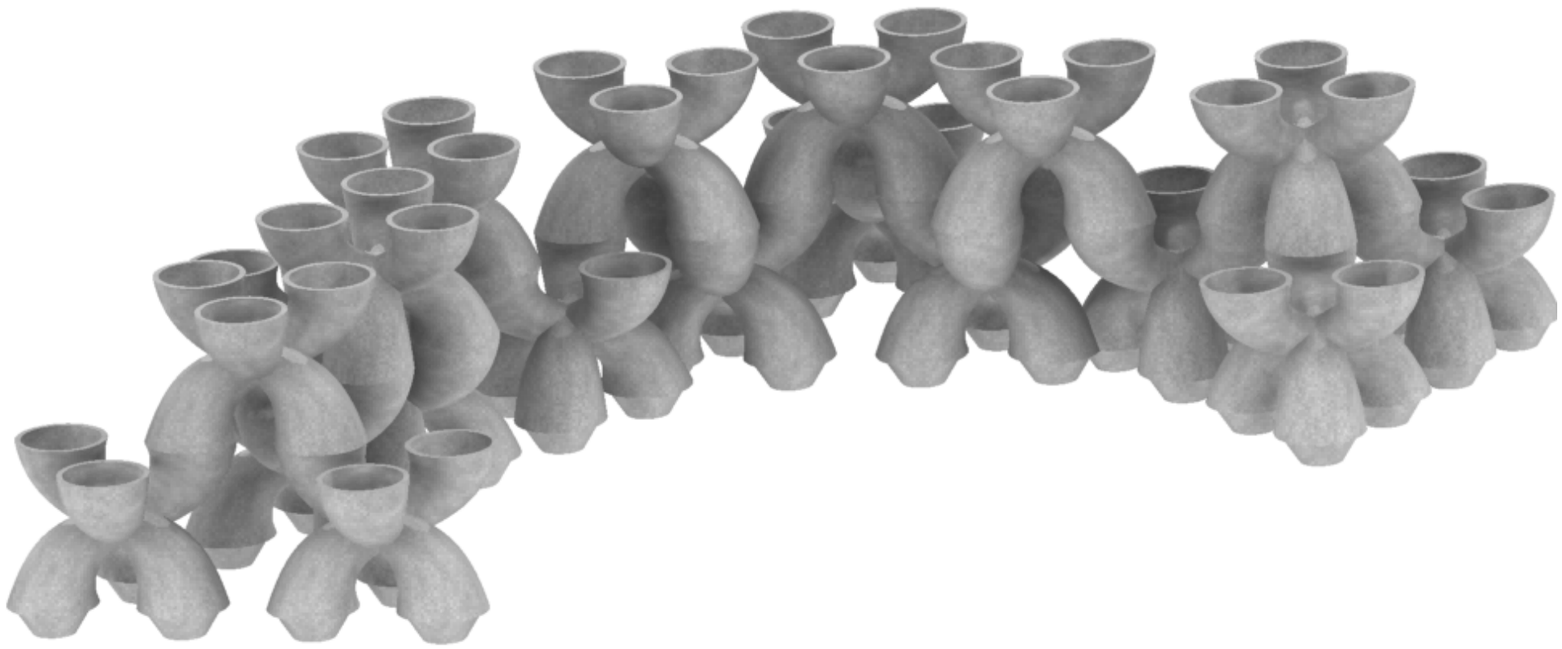

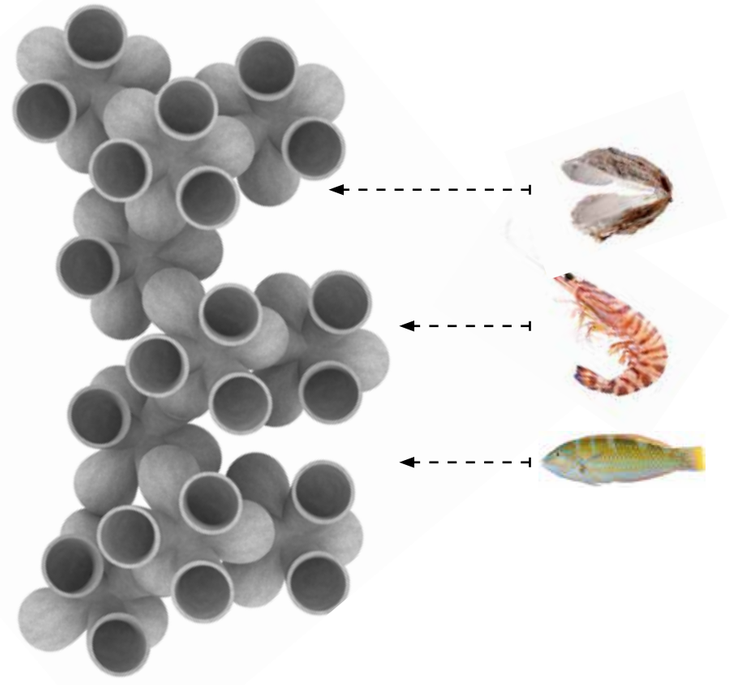

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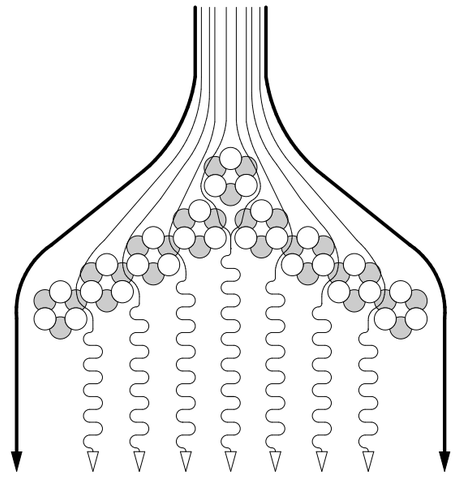
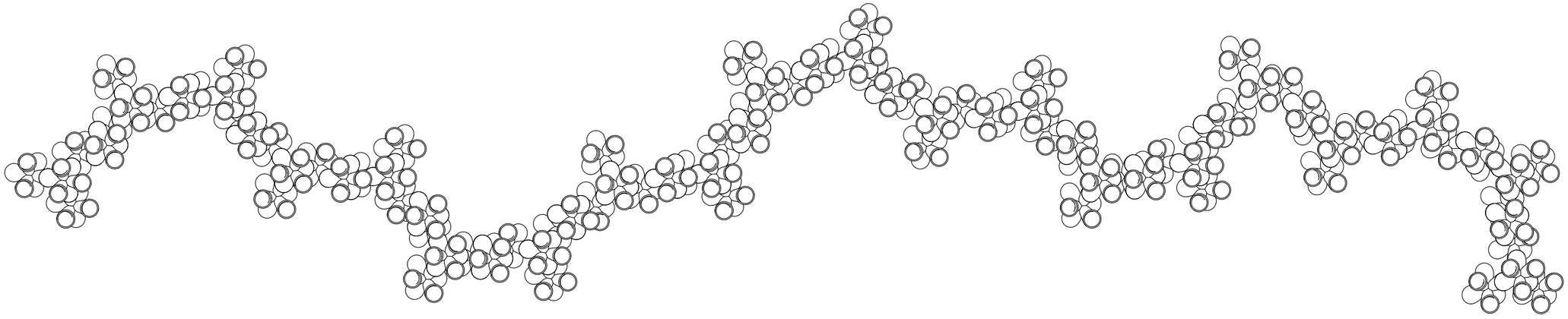


river’s currents are followed
by the structure’s placement



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