THE OPERATING VENETIAN LAGOON: THE AGENCY OF *BARENE*.

A RESILIENT LANDSCAPE INFRASTRUCTURE TOWARDS ECOLOGICAL, CULTURAL, AND PRODUCTIVE HERITAGE PRESERVATION.

Colophon

Author
Amina Chouairi

First mentor
Denise Piccinini
Chair of Landscape Architecture, Delft University of Technology

Second mentor
Taneha Kuzniecow Bacchin
Chair of Urbanism, Delft University of Technology

Examination committee
Marietta Haffner

Department of Urbanism,
Chair of Landscape Architecture
Flowscapes Studio - Circular Water Stories Lab
MSc Landscape Architecture
Faculty of Architecture and Built Environment
Delft University of Technology
Delft, The Netherlands

Studio coordinator: dr. ir. Inge Bobbink

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For further inquiries about the present Landscape Architecture master thesis, please contact:
Amina Chouairi
chouairi.amina@gmail.com

All the pictures present in this graduation report, unless stated otherwise, have been taken by the author during the field trip conducted in the Venetian lagoon in October 2019.

TU Delft STICHTING N·H·BOS
ter bevordering van de landschapsarchitectuur

Se vogliamo che tutto rimanga com’è, bisogna che tutto cambi.

If we want things to remain the same, things will have to change.

Il Gattopardo, Giuseppe Tomasi di Lampedusa, 1958

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Water is everywhere before it is somewhere.

It is rain before it is rivers, it soaks before it flows, it spreads before it gathers, it blurs before it clarifies.

Water at these moments in the hydrological cycle is not easy to picture in maps or contain within lines. It is however to these waters that people are increasingly turning to find innovative solutions to the myriad water-related crises that catalyse politics, dynamics, and fear.

Is it not time to re-invent our relationship with water- see water as not within, adjoining, serving or threatening our settlement, but the ground of settlement?

Could this be the basis of a new vocabulary of place, history, and ecology?

And can the field of design, by virtue of its ability to articulate and re-visualize, lead in constructing this new vocabulary?

Anuradha Mathur, Dilip da Cunha, Design in the Terrain of Water

Abstract

Key words: Venetian lagoon, Building-with-Nature, Landscape Infrastructure, resilience, brackish marshlands.

Transitional territories such as lagoons are among the most impacted and delicate environments, threatened by the combined effects of climate change and human action. This Master thesis in Landscape Architecture examines the Venetian Lagoon in North of Italy as one of the most endangered and critical cases, as the last extreme flooding event of November 2019 demonstrates.

The thesis aims to address the Venetian Lagoon hydromorphological sufferance, the state of neglection of its secondary islands, and the over-engineered flood defence design as crucial issues. From the research conducted, emerges clearly the need for redefining the role of the entire Venetian Lagoon in the next future, shifting its role from passive, being exploited and consequently damaged, to active, able to sustain resiliently the rest of the territory. In order to do so, the main strategy to be pursued is to reinforce the "barene" landscape, the brackish marshlands, fundamental for the hydromorphological and ecological survival of the lagoon. These brackish marshlands are able to limit tidal and wind impact, favour water exchange and act as an expansion vessel, but, from 20th century onwards, 70% of their surface have been lost due to anthropic actions.

Therefore, the goal of the thesis is to employ the agency of "barene" to mitigate the impact of anthropic and natural threats, acting as a nature-based flood defence (function), to recover hydromorphological sufferance (flow), and to support the cultural, ecological and productive heritage (form), making the Venetian Lagoon function as a sustaining landscape infrastructure. The "barene" act as pivotal means to achieve a comprehensive vision for the Venetian Lagoon where functions, flows, and forms are implemented and designed as part of a unique co-operating system.

The central area of the Venetian Lagoon is chosen as project site, being the most damaged hydromorphologically. Having researched on how natural forces (tides, winds, etc.) influence this portion of lagoon, different combinations of under-water and above-water concave structures are designed in harmony with these forces, to capture suspended sediments and promote accretion. In the most compromised cases, the structures are partially supported by initial dredges. The islands of the central lagoon become the perceptive points from which experience the transformation and the growth of this new landscape. In the end, the intertwined system of "barene" and islands, once grown sufficiently and matured, will produce a beneficial effect over the hydromorphological, ecological and biodiversity, and cultural surrounding environment.

Through the process of research by landscape design, the project seeks to mitigate the threats of climate change and relative sea level rise in the Venetian Lagoon; provide a nature-based flood defence; create brackish marshland's habitat for ecosystem restoration; invest on alternative forms of slow-tourism and foster different duration of stay in Venetian lagoon; enrich local community livelihood and economical vibrancy. Moreover, the project wants to consolidate and enhance the cultural image of the Venetian Lagoon, consisting of the diffuse sense of horizontality, reflection and visibility conveyed by the diffuse and unceasing water surface.

LAGOON

n. f.

lat. lăcūna, der. di lăcŭs “lagoon, lake”; fig. “gap, lack, loss”

A shallow body of water (*Venetian lagoon*) that is connected to a larger body of water, typically the ocean or sea (*Adriatic Sea*), by a narrow passage (or multiple narrow passages). Most lagoons are elongate, parallel to the coastline, and separated from the main ocean or sea by a narrow elongate barrier island or reef complex (*Cavallino-Treporti peninsula, Lido island, Pellestrina island*). Many lagoons have shallow stagnant water, and the salinity of lagoon waters is highly variable, depending on the amount of runoff, mixing with sea water and evaporation rates. Lagoons are broadly similar to estuaries, tipically perpendicular to the shoreline and fed by mainland river systems; river input to lagoons is generally negligible.

Most lagoons are fed and flushed by tidal inlets (*Lido, Malamocco and Chioggia inlets*), with waters exchanged with the change of tides (*every six hours*). Winds (*Bora from north-east and Sirocco from south-west*) and wave formation may strongly affect the turbidity of waters in shallow lagoons, but in deeper lagoons the turbidity is controlled by the strength of tidal currents.

Lagoons commonly form on coastlines that are subsiding or where sea level is rising (*during the past century, Venetian lagoon has sunk of 12 cm circa, 3 cm of natural subsidence and 9 cm of anthropogenic subsidence, and sea level has risen of 11 cm*, Carbognin 2005). The sedimentary evolution of the lagoon depends on the relative rates of migration of the landward and seaward coastline, which may migrate at different rates, widening or shortening the lagoon (Kusky, 2005). The rate at which the lagoon fills depend on the amount of sediment flux from the mainland, the amount of material that moves in through the tidal inlets, the amount of overwash from barrier or reef, and the amount of organic and muddy sediment produced within the lagoon (*every year, on average, 2.100.000 m³ of sediment is brought into suspension from the lagoon bed and settle again on the lagoon bottom. Around 30.000 m³ of sediment are discharged in the lagoon by the rivers and 70.000 m³ erodes from the salt marshes, 580.000 m³ of sediment is lost in the Adriatic Sea via tidal currents and 400.000 m³ is dredged from the lagoon channels*, Bernstein and Montobbio, 2011).

BARÉNA pl. baréne

n. f.

lit. “brackish marshland”

From the Venetian dialect “*baro*”, which means “bush, clump of grass”.

Piece of land emerging from the waters of the lagoon, submerged only during high tides, slightly higher than the medium sea level; generated by river floods, it has a flat surface and a clayey constitution, with sandy intercalations. The term is used specifically along the Veneto- Romagna Adriatic coast.

ACQUA ALTA

n. f.

lit. “high water”

Typical phenomenon in the Venetian lagoon – with woodpeckers of tide very pronounced that provoke flood in the insular urban area.

BRICCOLA or BRICOŁA

n. f.

It is a nautical structure used to indicate waterways (canals) in Venice, Marano and Grado lagoons.

It is formed by one, three, or five massive wooden trunks, generally *Larix decidua*, tied together. The function is signalling boats the limit of the deepest part of the lagoon, navigable without risks, guiding them and avoiding being stranded in shallow waters.

CALLE or CAŁE

n. f.

From Latin “*callis*”, literally means “path, route”. The *calle* is the typical Venetian paved street, limited on the sides by two continuous lines of buildings.

FONDA-MENTA

pl. fondamente

n. f.

The *fondamenta* it is the stretch of road that runs alongside a canal or a *rìo*, a stream. It typically presents landing places with Istrian stone steps that descend into the water, to facilitate the docking of boats, the loading and unloading of goods and passengers.

GHÈBO

n. f.

The minor naturally formed canal that cross the brackish marshlands (*barene*) and the mudflats (*velme*) of the Venetian lagoon, connecting the inner areas of the lagoon with the main waterways.

The *ghebi* have a remarkable role in the Venetian lagoon ecosystem, regulating the water supply both during high tides, with drainage functions, and during low tides, allowing the passage of water even in the innermost areas. They also help to mitigate the erosive effect of incoming tides.

LINEA DI CONTER-MINA-ZIONE

n. f.

lit. “Lagoon Boundary”

Linea di Conterminazione Lagunare delimits the boundary of the lagoon basin, or the area of management and administrative competence of the former Magistrato alle Acque di Venezia.

Interestingly, it has been evolving since early XVII century, to better define the territorial boundaries inside which apply regulations and dispositions to preserve the Venetian lagoon. Between 1791 and 1792, 99 *cippi*, boundary markers, have been erected, defining a route of 157 km, to delimit the lagoon territory by separating what was brackish water from the rest.

VALLE DA PESCA

n. f.

lit. “fishing valley”

Valli da pesca are embanked spaces along the border of the Venetian lagoon (Conterminazione Lagunare) where the aquaculture activity takes place. Today the active fishing valleys are 15.

VÈLMA

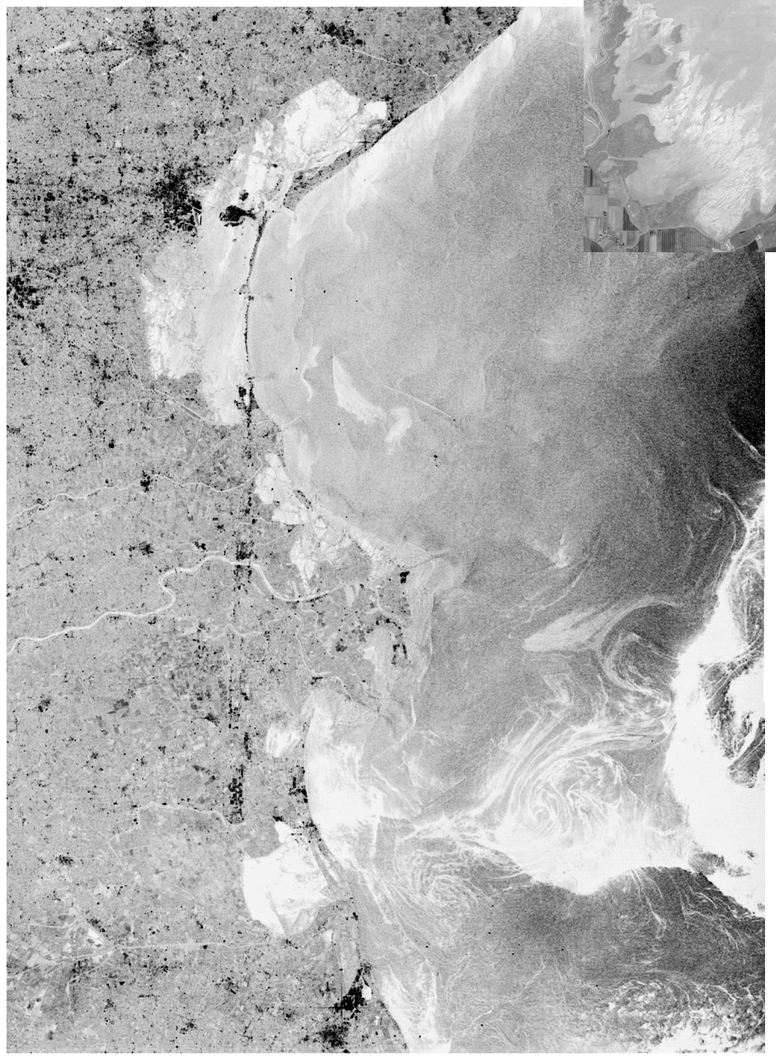
pl. vèlme

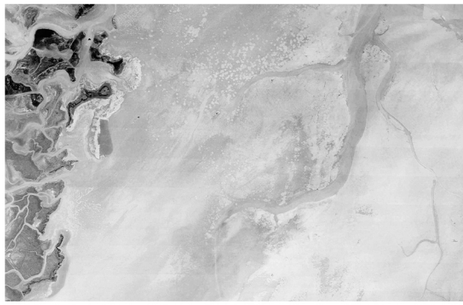
n. f.

lit. “subtidal mudflat, hump”

Areas categorized as underwater tidal mudflat.

They are populated mainly by underwater vegetation (as maritime phanerogams) and normally submerged, only emerging at very particular conditions of low tide. *Velme* are particularly interesting ecologically, in fact the strong variations in salinity and oxygenation create an environment even more selective than the one defining the *barene*.





Previous and current page. Satellite images of the Venetian Lagoon.
Source: EOSNAP and Google Earth.

First prelude: November 4th 1966

Friday November 4th 1966, at 6:00 PM occurred the highest *acqua alta* ever recorded since the beginning of the systematic surveys. At the tidal gauge located in Punta della Salute (or Punta della Dogana) +194 cm were recorded. This completely unexpected *acqua alta* arose due to the concomitance of a series of anomalous events, consisting of: astronomic high tide, rivers swollen by abundant rains (the Piave river itself, which since centuries has been diverted away from the lagoon, poured its waters back into it), a strong wind of Sirocco (which prevented the outflow of the tide from the lagoon to the sea), and the drop of atmospheric pressure of 30 hPa in 48 hours.

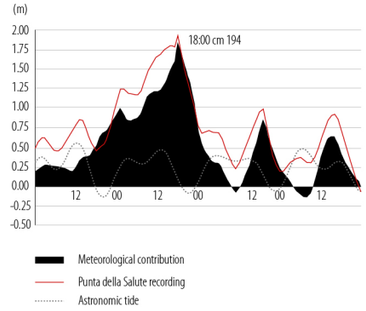
Furthermore, "*the flood has been extremely long in time: unlike other cases, hypothetically reduced inlets would not have deprived the sea of the time required to fill the lagoon. Indeed, the level remained over 110 cm for 22 hours, and the residual was over one meter for more than 10 hours and for about 40 hours over 50 cm*" (Canestrelli et al., 2001). The scenario of devastation included not only the historical centre, but the islands of Sant'Erasmo, Burano and Murano, Lido, Pellestrina and Cavallino Treporti. For more than 40 hours consecutively, every single piece of land in the territory of the lagoon has been submerged by salt water.

"In the general paralysis, which had also involved telephones since the morning, the amazement or, better, the despair was reinforced by a fearful unknown factor: towards evening, everyone felt that a centuries-old balance had broken, that the city and the lagoon had lost a ring, who knows which, of their delicate gear. Nobody, except few people and public institutes (which in those hours seemed to have diluted in the tide), still knew that there, on the coasts, the sea had made a disaster that not even the war had managed to sow: the coastal defences, including the murazzi, had burst." (Obici, 1967)

As reported by Sandro Meccoli in *Storia di Venezia (1797-1997)* by Distefano and Paladini, all the embankments were seriously damaged, not to mention the entire artistic and architectonical heritage. The hydraulic equilibrium of the lagoon, which has been safeguarded by the Venetians for centuries with uncompromising laws, as the most valuable asset, it had been broken by excavations and landfills imposed indiscriminately by the industrial development at all costs.

After 25 hours, the Sirocco unpredictably stopped. The water stopped from rising, but did not move at all for at least fifteen minutes, as if it did not know where to direct itself without the guidance of the wind.

"As it was risen, the tide left the city, suddenly and with a violence equal to that of its access. It had reached the unprecedented height of +194 cm above the average sea level, devastated all the shops in the city, invaded all the houses on the ground floor, damaged almost all the craft businesses, plucked the naphtha from hundreds of boilers, drenched and deteriorated an incalculable number of books in libraries, destroyed goods stored in warehouses, furniture in houses, public acts in many offices. In twenty-four hours of absolute domination, the waters had given their terrible demonstration and now they could recede, giving back to the Venetians - being able to pour themselves into the streets accessible once again - another Venice, of which everyone felt the need to regain possession. November 4th ended with a hyperbolic image, yet lucidly accurate. In the deep, moonless darkness in which the city was immersed, rather than being able to see, people could just glimpse: there, the silhouette of a boat in a calle, the walls mourned by a black sign of naphtha, mattresses, furniture, chairs, garbage scattered everywhere, doves and dead rats at every corner, the desolation in the houses on the ground floor. On this uniform and immobile backdrop, hundreds of little flames, which passed through it without illuminating it. The Venetians, by the candlelight, patrolled the places of devastation: yet it seemed that they were celebrating a collective, poignant funeral rite on their dying city." (Obici, 1967).



Tidal graph from the 4th of November 1966. The highest tidal peak ever recorded of 194 cm was reached at 18:00 in Punta della Salute tidal station.

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Pictures from "Anche questa fu Acqua Granda", metropolitano.it
01/ Ca' Roman embankments.
02/ Riva degli Schiavoni.
03/ Piazza San Marco.
04/ Giudecca, Calle Michelangelo.
05/ Giudecca, Cantiere Magnanini.

Second prelude: November 12th 2019

Tuesday November 12th 2019, at 22:50 occurred the second highest acqua alta ever recorded since the beginning of the systematic surveys. At the tidal gauge located in Punta della Salute (or Punta della Dogana) 187 cm were recorded.

The maximum scheduled for 22:00 was 140 cm, but still at 22:30 the tide continued inexorably to rise. It was not retreating, held and constrained inside the city by Bora wind gusts at 100 km/hour. The boats were torn apart from their moorings, lifted like twigs, hurled on the fondamente, or pushed into the calli, for the occasion transformed into rivers. The waves were crashing on bridges and banks, demolishing railings and parapets, dragging newsstands and balustrades away, overcoming barriers, flooding hallways, shops and all kind of buildings. The shopkeepers were fighting a fight against time, continuing to lift up goods, refrigerators, machineries, in a frantic race against water that did not seem to stop from raising and raising. Everything was piled up until that everything was about to touch the ceiling, when the action had to stop, among powerlessness and resignation. Nothing could escape from the disruptive power of waters. At that point, yieldingly, the water took everything.

The Venetians all looked horrified and full of concern as the black water was mounting. It is known that the tragedies all arrive during the evening, in the dark, as if they were ashamed, and wanted to be seen by as few people as possible. Who knows how many had the tragedy of 1966 in their eyes: the displaced people, mud everywhere, or *Murazzi* destroyed by the power of water. In that moment, water was gushing up from the toilets, was filtering from the hinges of the doors and windows like a waterfall, was sweeping away window-shops. The water was flowing again into the crypt of San Marco.

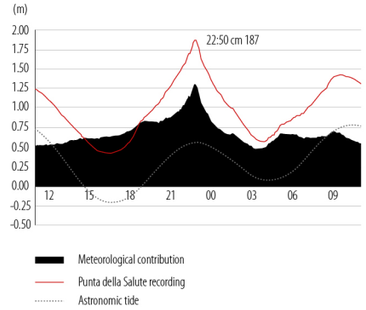
On the ground floors, those slim and manageable gates, ready to be located in front of the entrance doors, that normally protect, once the water has entered, they were holding it inside, increasing the damage and the despair. Not even the siren was calibrated to warn a sea wave above 140 cm. In fact, 140 cm was established by Venice Municipality as the maximum threshold that could be reported. A part of the city remained without light for the whole night.

At 23:30, websites and social networks broadcasted live images of critical situations, almost overflowing, as the water was doing all around: half-sunk motorboats, demolished walls, devastated piers, ferryboats and *gondole* hovering on the Riva degli Schiavoni. Television channels began to broadcast special editions, waiting for the tragic headlines of the following day's newspapers. As in 1966, unpredictably and without giving any kind of warning, after 23:30 the dark noise of the gusts stopped, the wind went down letting the tide receding placidly into the Adriatic Sea, back to the source again.

The tide was retreating.

Many institutions, lately interviewed, have addressed the impossibility of making correct suppositions about the future, stressing the unpredictability and the uncertainty of this kind of events.

In 1992, *La Stampa*, an Italian newspaper, titled loudly: "Here it is MO.S.E.: it will save Venice. Everything will be ready by 1995". After twenty-eight years, MO.S.E., a system of underwater closable gates installed at the three inlets of Treporti, Malamocco and Chioggia, started in 2003, cost 5.5 € billion, it is still incomplete. The night of November 12th, it has not been activated during that incredible high tide. The following day, in the throes of emotion, many institutional representatives said they wanted absolutely to complete the MO.S.E. as soon as possible, not considering it for what it has already become: old, obsolete and with rusty hinges, because of the constant submersion. Mo.S.E. is a project, which, so far, has not been tested in a case of real emergency.



Tidal graph from the 12th of November 2019. The second highest peak ever recorded of 187 cm was reached at 22:50 in Punta della Salute tidal station.

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Pictures from
01/ Series of three pictures, retrieved from "Era Mare", a photographic project by Matteo de Mayda.
02/ +187 cm of November 12th 2019 *versus* +194 cm of November 4th 1966.
03/ Palazzo Gritti, Marco Bertorello.
04/ Fondazione Querini Stampalia on November 12th 2019, Internazionale.

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01/ INTRODUCTION.

Venice is Lagoon: it was written on many windows of our houses, printed in white over green bedsheets, the colour of the water. Some people still show them periodically, few years later, because nothing has changed and that green and white bedsheets are always actual. Other people have never removed them and the green has gradually become less green, and the white more gray; but its stentorian, the indisputable meaning is not less clear for this reason.

A slogan to be shown to strollers, to politicians, to tourists, because it is not easy to explain it around, that Venice is a lagoon, since it is full of unsuspected people who keeps telling you that Venice is "a city by the sea", and for them now, here at the bar, I am writing by the sea.

No my dear ones. Venice is a lagoon. How many times have I repeated it in this book? Will I manage to convey how atrocious the anomaly of big ships in these delicate waters is?

For this reason, it was inevitable to borrow it also in this book, to tell it to the whole world, that Venice is a city of its lagoon, not of the sea.

Roberto Ferrucci, Venezia è Laguna

01/01 The origin of this research

I have always been fascinated by lagoon and riverine landscapes, especially the ones along the coast of Veneto region, in north-eastern Italy. There, between the coastal lagoons of Caorle and Bibione I have spent most of my childhood vacations .

As a child, frequenting those places mainly in summer, *water* was the element I came in contact with more often. It was shallow and often turbid; at that time, I still did not know why. I only remember that when, back to school, seeing my friends' holiday pictures, I was jealous of their crystal clear waters. In those lagoons, currents and tides were almost non-existent. However, there were different water temperatures, warm above and cold below. Once, as all children do, I drank the water of one of these lagoons by mistake and I still remember the amazement in my mouth. It was not completely salty, but *brackish*, sweet and salty at the same time. I can assert that the lagoons of Caorle and Bibione has not been only settings, banal backgrounds, of my childhood fairy adventures, but are those first natural landscapes with which I have established a direct and intimate connection without an immediate adult mediation: they have been for me primary stimulators and promotors.

During those summers in Veneto, I used to take a connecting regional train in Venezia-Mestre station, towards my final destination of Portogruaro-Caorle. Venezia Santa Lucia, Venice city train station, was immediately there, just a few minutes away by train, beyond Ponte della Libertà; however, it was not planned to pass by, *there*. For years, I have thought so many times about staying seated on that train for just another stop, leaving Mestre behind, getting off in Venice and finally *see*. As time passed by, I have developed a morbid attraction for that unknown and undiscovered city on a lagoon.

The recondite and, for some aspects, *romantic* passion for a place of my childhood, the relevance of the Venetian Lagoon landscape and the city of Venice within the Italian artistic, cultural and naturalistic panorama, the emergency that this territory is experiencing nowadays, the necessity for a landscape design integrating holistically forms, functions, and flows, the desire to stitch solidly together the complex identity of Venice and its precious lagoon; all this important load of research, awareness and personal experience has contributed to the production of the present master thesis in Landscape Architecture.

fig. 01/01 The lagoon waters by Fulvio Roiter (1926 - 2016), Italian photographer.

fig. 01/02 Salvador Dalí picturing San Marco from inside the lagoon waters. To grasp the complexity of this territory it becomes important to shift the point of perspective from land to water.

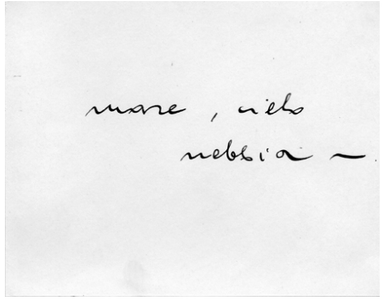

fig. 01/03 "Mare, Cielo, Nebbia": notes about the Venetian Lagoon by Paolo Monti. What else is the lagoon, if not simply and just *"sea, sky, fog"*.

fig. 01/04 Next page, pictures by Paolo Monti (1908 - 1982), Italian photographer.
01/ Laguna di Chioggia.
02/ Laguna di Torcello.
03/ Alberoni Arabesco.
04/ Laguna di Pellestrina.
05/ La Gondola, 1940.
06/ Spiaggia degli Alberoni, l'ultimo bagnante.

01/02 The image of the Venetian Lagoon or the *sense of place*

The sense of place of the Venetian Lagoon is indissolubly embedded in the existing dichotomy between what is fixed, anchored, permanent and what is in movement, oscillating, transitory. As Turri (1995) states, taking sides against an entrenched historiographical interpretation, the Venetian the Lagoon cannot be seen as a given, stable, immutable construction, which nature has prepared for men, as an ideal refuge for the fugitives from the mainland, but continuously exuding a *sense of periturus*.

The city, Venice, and the islands, both Lido, Treporti, Pellestrina and the secondary scattered around, represent the first system. The waters, riverine, lagoon, maritime, ebb and flood tides, wind bursts, waves, mist, represent the second system. This almost oxymoric juxtaposition is farcically derided by the reflective feature of water: undulating gently and rippling, water seems to be able to move even the most solid houses, churches, belfries and walls.

This relationship, between what varies only with the passage of long temporal laxes (tens or hundreds of years) and what varies in short hourly laxes, has been taken up in the design phase, giving prominence to this interesting dichotomy characterizing the Venetian Lagoon. The history, the slow progressions, made of waiting and uncertainty, and the sudden, cheerful variations have been integrated, trying to reflect the times and spaces of both the city and the lagoon. To achieve this, the point of view has been shifted: as Salvador Dalí does, depicting the beauty of San Marco and its *campanile* immersed in the turbid waters of the lagoon, I have tried to conclude this research with a coherent and respectful design proposal, approaching the pure understanding of the extremely delicate and complex territory that is the Venetian Lagoon.

However, above all, is present the awareness that the lagoon is destined to return continuously to what it has always been and always will be: a temporary condition, the moment of chaos before order, a transitory state towards new equilibriums.

THE OPERATING VENETIAN LAGOON: THE AGENCY OF *BARENE*
A resilient landscape infrastructure

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fig. 01/05 Opponesi elemento ad elemento, translated literally with "opposing element to element". This allegoric engraving, realized by Alessandro Zucchi for Bernardo Trevisan treatise on the Venetian Lagoon, clearly represents the continuous tension between water and land in the lagoon. As Caniato reports, commenting this specific image in *La laguna di Venezia* (Turri et al., 1995), "the search for the unstable balance between water and land has always been an indispensable prerequisite for survival of the *Dominante*, whose delicate profile recalls all its fragility in front of the opposing forces of nature, which embrace but at the same time repel each other."

01/03 Both the Venetian Lagoon and Venice or how the survival of the city depends on the lagoon and how the survival of the lagoon depends on the city

Having understood the duplicity and dichotomy represented by those components that define the sense of the Venetian Lagoon, it is important to trace and understand the consolidated history, the present tendency and the desirable future of this relationship.

The lagoon, which needs to be considered as an anthropic territory, is in fact a construction of the Venetians. This people has built and defended the lagoon space and have challenged the open sea, enriching themselves through seafaring and mercantilistic adventures and, thanks to these enrichments, have been able to pour the experiences and the money accumulated in the construction of the city and in the defence of the lagoon, considered inseparably. The lagoon, through the centuries, has been proposed as the territory that every city needs as an essential space, to put down roots, as well as a defence space. The Venetian Lagoon became the *liquid fortress* of Venice and the islands.

But the lagoon is not an ordinary territory or, at least, cannot be treated as a mere physical support. It does not divide or even unite, it is "*a common place*", as Zanetto and Calzavara report, both physical, natural, and linguistic, shared by the entire settlement, a space of signification. Venice is not a simple hydraulic case; water is the limit, shape and image of the city itself (see fig. 03/01, p. 41).

In XIX century, after the fall of the maritime republic of Venice, the *Serenissima*, while during the past the Venetians carefully controlled the lagoon's assets in order to safeguard, with the lagoon, their city, once Venice had lost its centrality and became part of an Italy united with its rules, its bureaucracy, its distant power, man's control over the lagoon was no longer as direct, solicitous, and concerned as it once was.

The XX century, the century of industrialization at all costs, has seen as protagonist the environmental degradation of the Venetian Lagoon. Land reclamations, groundwater extractions, big canal excavations marked the decades immediately following the opening of Porto Marghera in 1917. This exploitation tendency has come to an end only in the late 60s, when inevitably the greatest damage had already been done.

In these recent times and as a warning for the future, it has become extremely urgent to reintroduce the a "both-and", and exclude a "either-or" approach, in regards to the city and the lagoon. If the city will invest on the correct functioning of the lagoon, and implement its infrastructure, and protect its precious environment and mechanisms, and safeguard (again) its waters, the lagoon will be able to fulfil its ancient task of defence, flanked by a beneficial ecosystemic functioning. If the city will continue to unreasonably exploit its lagoon and will not take its side, the lagoon, with its deterioration, will make survival almost impossible for the city itself.

Finally, as Turri (1995) present, out of literature and metaphor, Venice and the Venetian Lagoon live together, they are the result of a progressive and heroic adaptation of men to the difficulties of a difficult, poorly defined environment: wet, muddy, repulsive on one side, sandy, treacherous, threatened by the sea on the other.

fig. 01/06 Aerial photograph pictured by Fulvio Roiter. The island in the centre is Torcello, located in the northern Venetian Lagoon.

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02/ FASCINATIONS.

[...] But to understand the profound meaning of this show, bringing it back to history, you have to look behind the scenes, and forget Venice, forget the city shining with its marbles, lights, colors.

You must forget the aspects that make a day spent in the lagoon happy and unforgettable and let yourself be grasped by the sense of place and the sense of time, by the mortuary smells, by the heaviness of the horizontal landscapes, by the filiform lands, above the water, which contribute to the perception of the lagoon landscape.

Eugenio Turri, La valva di Venezia

02/01 Horizontality, visibility, reflection: *giochi d'acqua*

Through the centuries, the Venetian Lagoon has weaved an extreme and profound relation with its horizon. In that precise moment the observer finds herself surrounded by its waters, its wideness and its diffuseness seems to have no end. Each element, from the water surface, the tidal marshlands and the nurseries and woods along the lagoon contermination, the marble and concrete environment of the city, is extremely dilated, camouflaging its very end with the beginning line of something else, not identified. Therefore, every single vertical element is even more enhanced by this uniform condition spread until the eyes can reach. The *briccole*, the wooden poles stuck in the bottom of the lagoon, the mussels' cultivation trilithon structures, the metallic poles signifying the passage underwater of electric cables or pipes, or even broken tree trunks displaced by tides become those unique vertical elements populating the lagoon.

Closely related to the diffuse sense of horizontality just described is the radius of visibility, although surprisingly subject on light and atmospheric conditions. Being the lagoon landscape defined majorly by the linear distribution of its elements, the radius of visibility drastically changes as the elevation gently changes. By boat, exploring this territory on the sea level, everything is immediate, almost graspable. By walking over the embankments protecting the fishing valleys along the borders of the lagoon, not more than +1.50 metres high, the horizon moves away of several hundred meters, unveiling the constant repetition of waters, slightly emerged pieces of land, islands and, again, waters. By climbing up the spiral staircase inside Spignon lighthouse, right in front Malamocco inlet, the narrow embrasures on its brick walls reveal, while turning, the lagoon. At the end, a minuscule circular terrace at a height of 15 metres dominates the totality of this immense mass of waters.

The reflective characteristic of water plays mysterious tricks, amplifying and exaggerating even more the objects reflected. *Briccole*, wooden and metallic poles seem longer because their juncture point with the water is unexpectedly hidden, the islands, where vegetation has grown savagely, seem surrounded by floating gardens, and the sunrays seem to create highways of light.

Sense of horizontality is enhanced and strengthened by the continuous extension of water.
Radius of visibility increases or decreases depending on the distance between the observer and the surface of water.
Reflection, water's most distinctive feature, diffuses the elements populating the lagoon.

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fig. 02/01 Pictures of:
01/ The Venetian central lagoon, and Venice in the distance, seen from the entrance of Spignon lighthouse.
02/ Mussels cultivation in the central lagoon.
03/ Sunrays and briccole with a resting bird on their top.

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C’est un phénomène de perception. On perçoit d’abord l’horizon. On perçoit à l’horizon.

It is a phenomenon of perception. We first see the horizon. We can see on the horizon.

Gilles Deleuze, 1988

fig. 02/02 Set of clear horizons of the Venetian Lagoon:
01/ Northern sub-basin of Treporti.
02/ Lagoon in front of Pellestrina island.
03/ Lagoon in front of Pellestrina island.
04/ Concrete electricity pilons near Sant’Angelo della Polvere and San Giorgio in Alga islands, northern sub-basin of Lido.
05/ Barene in front of Lio Piccolo, northern sub-basin of Treporti.
06/ View over mussels cultivation from Spignon Lighthouse, central sub-basin of Malamocco.

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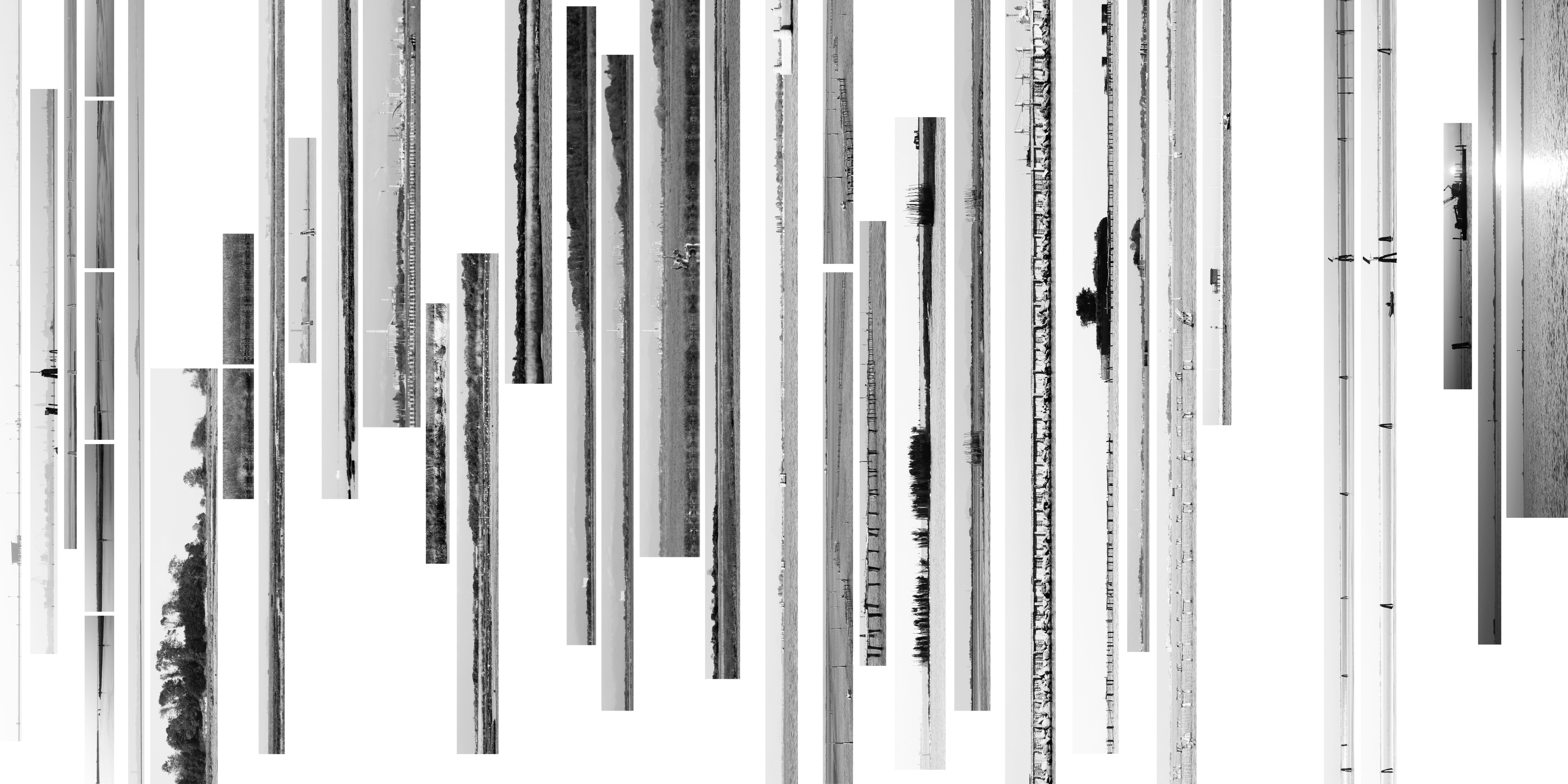
fig. 02/03 In the following page: collage with a series of horizons captured during the site visit. All the pictures have been taken from the boat towards the waters of the lagoon.



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03/ PROBLEM FIELDS.

The three problem fields investigated throughout this graduation thesis, i.e. the Venetian Lagoon current hydromorphological sufferance, the over-engineered flood defence Mo.S.E. project, and the abandoned cultural heritage of the secondary islands, refer to the landscape functioning of the Venetian Lagoon and its consideration as a unique system. In fact, the elements considered and the analysis conducted led to the understanding of a precarious relation between water and sediments fluxes and a diffuse tendency to exclude the areas in between and along the boundaries of the lagoon, those same satellite islands and lands that have been crucial for the affirmation of Venice historical centre.

The lowest common denominator, i.e. what crosses the limits among these crucial problem fields, is the lack of a systemic, inclusive and comprehensive landscape approach regarding the foreseeable future of the Venetian lagoon and the proposition of a possible vision considering a desirable amelioration from a spatial and functional perspective.

Nowadays, *forms, functions, and flows* are not at all being implemented as a unique co-operating system, through a unitary vision, from a landscape architectonic perspective. The Venetian Lagoon functions, or better, serves goals that are distant, and sometimes boycott, its own survival. The complexity of this territory has been defined by centuries of anthropic interventions over the natural landscape, taming it to ensure Venetian people survival in the waters of the lagoon. With the technological progress, especially in the last century, the approximate balanced interrelationship between men and nature systems has switched from control-driven to exploitation-driven. The performance, aesthetics, and operating of this delicate ecosystem are being seriously compromised by the contemporary tendency that sees the city of Venice as the gold mine for mass tourism and necessarily at the centre of any preservation measure, especially by whom blindly do not grasp that the protection of the lagoon implies without any further effort the safeguard of the city itself.

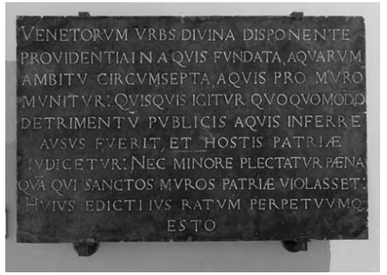

fig. 03/01 Editto di Egnazio, Museo Correr, once Palazzo dei Dieci Savi in Rialto, headquarter of *Ministry of Waters* (Magistrato alle Acque). The translation from Latin to English is provided on the bottom of this page.

The city of the Venetians at the behest of the divine providence founded on the waters, and surrounded by the waters, is protected by waters instead of walls: therefore anyone who dares to harm public waters in any way is condemned as an enemy of the country and is no less seriously punished of the one who violated the holy walls of the homeland.
The right of this edict is immutable and perpetual.
Giovanbattista Cipelli L'Egnazio

03/01 Venetian lagoon hydromorphological sufferance

03/01/01 River diversions or The Era of Diversions

Since the early settlements started to grow around V century A.D., mainly to escape barbarian invasions, the Venetian lagoon started to be shyly manipulated by men. Starting from XII century though, strong processes of land-filling deriving from the sediments brought inside the lagoon by the main rivers (Piave, Brenta and Sile) were in act.

On one hand, the southern lagoon was strongly threatened by the river Brenta, discharging its water in Fusina, right in front of Venice. Between XIV and XIX centuries, major (and minor) severe modifications to its course has been conducted by the Venetians: multiple diversions executed inside the lagoon itself (1330-1457), the diversion of Marzenego, the excavation Osellino canal (1507), and the final and most important infrastructure work of Taglio Novissimo del Brenta (New Cut of Brenta, cut here specifically means when a river gets diverted in order to reduce its carrying capacity) as a collector of the lowest waters (1560-1613). In the end, the river Brenta has been completely ousted outside the lagoon and canalized to let it discharge in the south of Chioggia.

On the other hand, the northern lagoon was indirectly influenced by Piave river which, even though not directly discharging in it, with its floods and amount of sediments transported, was slowly land-filling the upper parts of the lagoon until Burano and Torcello islands and the inlet of San Nicolò (today Lido inlet). Therefore, from XVI century on the Republic of Venice started promoting engineering solutions not just to move away Piave river threatening the functioning of northern inlet and its part of lagoon, but also to transport another river, Sile, into Piave former riverbed for hygienic and defensive reasons. "*[. . .] the exclusion of the Sile closed what by analogy could be called the "Era of Diversions", which lasted for almost two hundred years, during which the Serenissima developed its utmost commitment to counteract the phenomena of interruption of the lagoon without ever losing sight of the final objective, despite the many difficulties encountered and the costs incurred.*" (D'Alpaos, 2010, p. 54)

For more than five centuries, watercourses have been diverted to exclude the sediments they brought from the Venetian lagoon and reduce the amount of freshwater discharged. The Venetians have been doing it in order to preserve the lagoon as such, implementing it as a liquid fortress for Venice, maintaining a necessary water depth to sail, and fighting against the generation of swamps for hygienic reasons However, "*the interventions carried out by the ancient Venetians on the large hydrographic systems falling in the controlled territories and interfering directly or indirectly with their lagoon, cannot be described as "a good general governance of the waters and an illuminated and overall vision" of hydraulic problems, which official historiography and many commonplaces continue to attribute to the Serenissima Republic.*" (D'Alpaos, 2010, p. 54)

Without any doubt, the rivers diversion and the consequent reduction in terms of freshwater and sediments discharge can define the starting point of a trend reversal in the hydromorphological behaviour of the lagoon, whose effects have been contained for a long time. In fact, "*land-filling phenomena, which prevailed before the rivers diversion and generated a shallow waters lagoon in which it was difficult to navigate, were replaced, following the rivers diversion,*

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fig. 03/02 Venetian lagoon inlets of Lido, Malamocco, and Chioggia transformation between 1763 and 2019. To be noticed is the progressive deepening of the navigable canals and the construction of concrete sea jetties to funnel water currents. This funnel effect determines the self-deepening of the inlets.

with widespread but slow erosion processes. These processes, initially acting with moderate effects and mainly in a horizontal direction [. . .], only during the last century they have developed with greater intensity also in the vertical direction, increasing the depths of the water areas [. . .]." (D'Alpaos, 2010, p. 56)

03/01/02 The piers construction at the Venetian lagoon inlets

The second crucial challenge encountered by the Venetians is represented by the maintenance of the lagoon inlets (Lido, Malamocco and Chioggia), the three strategic points establishing the communication between the Venetian lagoon and Adriatic Sea waters.

As already mentioned, the most delicate issue has always been represented Lido-San Nicolò inlet in the northern lagoon, very difficult to manage mainly due to Piave river sediments transported by anti-clockwise coastal currents. Consequently, the Serenissima Republic, until its fall in 1797, has always given more incentives to use the Malamocco inlet, in the central lagoon, for commercial traffic, until the Napoleonic government decided to intervene more drastically on the mouths, in order to increase the depths of their seabed. In XIX century, the inlets of the lagoon presented themselves with the typical characteristics of natural mouths overlooking shallow sandy coasts, slowly degrading towards the sea. These conditions naturally favour the formation of enlarged mouths with reduced depths, whose morphological structure is governed by the interaction between the tidal currents that run through them and the coastal currents. The first engineered arrangement of Malamocco inlet took place in 1806 through the establishment of the Prony Commission on behalf of Napoleon Bonaparte, with its final configuration reached only in 1872. Following the annexation of Veneto region, the Italian government decided to apply the same measures also at the mouths of Lido and Chioggia, until then excluded from any kind of changes.

As Professor Luigi D'Alpaos eminently reports, "*the construction of the piers at inlets of Lido, Malamocco and Chioggia [...] if on one hand led to the restoration of the navigability of the lagoon and its strengthening [...], on the other triggered important morphological processes, which were in no way considered or foreseen at the time of the execution of the works nor observed and analysed with the necessary attention in subsequent years. These processes, of a purely hydrodynamic and morphodynamic nature, overlapping with the consequences caused by almost total cancellation of the external contribution of sediments due to the diversion of the major rivers from the lagoon and the natural submergence phenomena, are at the origin of the morphological degradation that is observed today in the lagoon.*" (D'Alpaos, 2010, p. 83) Furthermore, "*the construction on the piers at the three inlets has generated an effective solution just for a specific problem, locally, without investigating, nor understanding what effects (mainly negative) these measures could have more generally entailed for the entire lagoon [. . .].*" (D'Alpaos, 2010, p. 84)

In the end, the new constructions have increased the seabed depths, have changed the configuration of the wave fields around the inlets, and have increased the volumes of water exchanged between the lagoon and the sea. All this has determined strong symmetries between the ebb and flow phases in the distribution of the tidal currents and the modalities of transport of the suspended sediments through the new excavated channels, with negative effects on the lagoon morphology.

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fig. 03/03 Venetian lagoon transformation

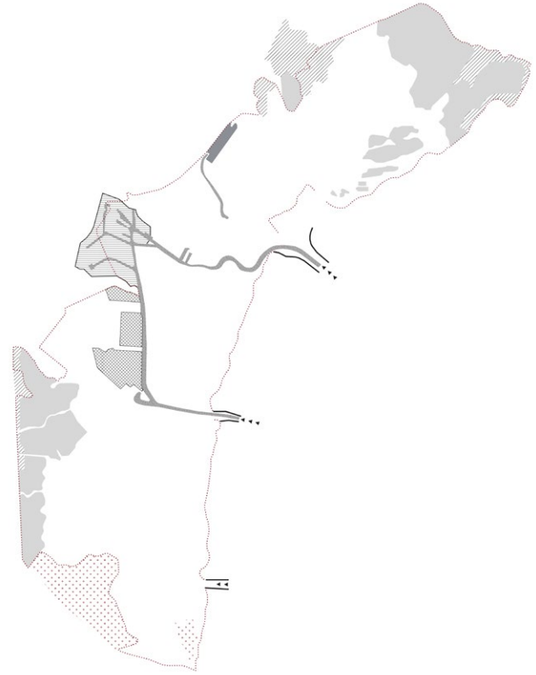

fig. 03/04 Venetian lagoon transformation

03/01/03 The excavation of large navigable canals or The Era of Navigation

Already since XVII century, the issue regarding the lagoon inlets (especially in the Lido-San Nicolò case) became arduous and, therefore, the need to implement intra-lagoon connections was growing. Hence the decision to create an internal connection between the port of Malamocco and the basin of S. Marco, to allow ships to dock in front of Venice passing by the best performing Malamocco inlet. This determined an implementation of the network of navigable canals in the portion of the lagoon in front of the Lido Island. The spearhead of this improvement plan was the Santo Spirito canal, built in 1726, which, despite communicating the partisan area between the central basin of Malamocco and the northern basin of S. Nicolò, "*did not substantially disturb the pre-existing regime of the tidal currents and did not appreciably alter their general structure or local characteristics*" (D'Alpaos, 2010, p. 87). This was not the case for the

fig. 03/05 Satellite images taken February 8th 2020 (above) and March 19th 2020 (below), during Italy's lockdown due to COVID-19 pandemic. The interesting aspect to be noticed is the incredibly reduced water traffic. Consequently, the turbidity of the water is extremely reduced, since the wave motion produced by the vessels is the main cause of the resuspension of surface sediments in lagoon waters. Source: European Union, Copernicus Sentinel data 2020, processed with EO Browser.

Vittorio Emanuele canal, dug between 1920 and 1925, and Malamocco-Marghera canal, excavated between 1964 and 1968. The latter can be defined as the infrastructural work that most negatively influenced the hydromorphodynamic processes of the Venetian lagoon since the early human modifications to this territory started to take place.

Malamocco-Marghera canal, known as the Oil Canal, put directly in communication the Adriatic Sea with Marghera harbour without the necessity of passing by Canal Grande in Venice. It is 15 kilometres long, averagely 200 meters wide, 17 metres deep until the curve, and afterwards around 12.5 metres deep. It has induced extremely negative effects regards the regime and circulation of the tidal currents, the increase in high water events in terms of number and intensity in the historical city of Venice, Lido Island, and of course in the whole central basin.

Its excavation "*was supported by a project that was not very commendable from a technical point of view and lacked from a scientific acquaintance, even though the knowledge in the field of lagoon hydraulics allowed a less indecorous framing of problems that the insertion of the new route water could have led to the delicate lagoon environment*." (D'Alpaos, 2010, p. 90) The serious and dangerous consequences of this water infrastructure are evidently noticeable: the central basin of Malamocco is now characterized by flat and poorly articulated seabed depths, in which the natural channels have been buried due to the sediment dispersed by the enormous displacement of water masses, and a considerable drop in the average depth has been documented during the last forty years.

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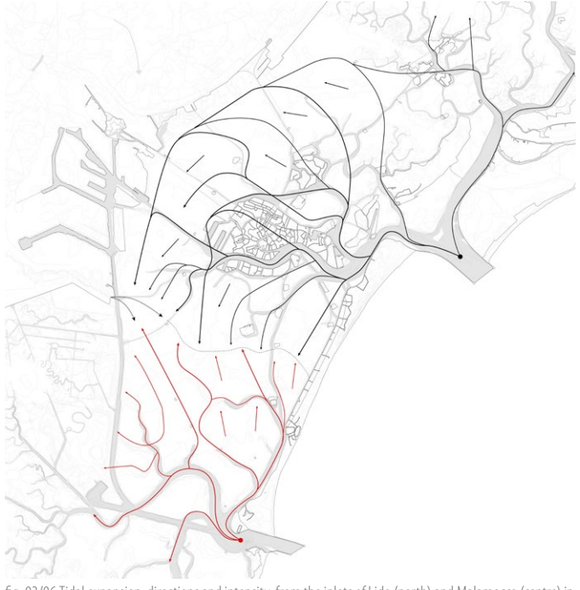

fig. 03/06 Tidal expansion, directions and intensity, from the inlets of Lido (north) and Malamocco (centre) in 1969, before the excavation of Canale Malamocco-Marghera.

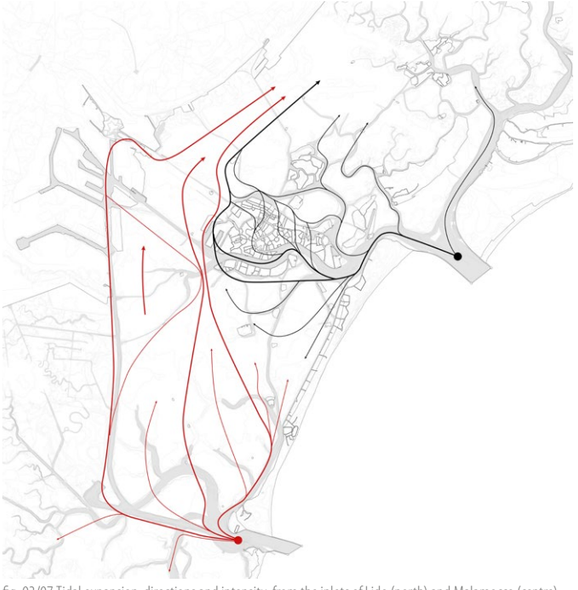

fig. 03/07 Tidal expansion, directions and intensity, from the inlets of Lido (north) and Malamocco (centre) in 2009, after the excavation of Canale Malamocco-Marghera. Visibly, due to the funnel effect characterizing the central inlet of Malamocco, after the excavation of the canal and the construction of concrete jetties in the Adriatic sea, the incoming currents (red arrows) are channelled powerfully in the Canale Malamocco-Marghera. This causes the constraint of the incoming currents from Lido inlet (black arrows) inside Venice's canals. The instability between the red and black arrows have caused the increase of *acqua alta* events within the last 70 years.

fig. 03/08 Mosè, Michelangelo Buonarroti, San Pietro in Vincoli, Rome.

fig. 03/09 Mo.S.E. movable sluices during a test in Lido inlet. Source: mosevenezia.eu

fig. 03/10 Mo.S.E. bird-eye view, Lido inlet. Source: metropolitano.it/speciale-mose

03/02 Over-engineered flood defence infrastructure: Mo.S.E.

After the previously mentioned flood that devastated the entire Venetian L agoon the 4th of November 1966, in 1973 the first "special law" for Venice declared that the city and the whole territory required a particular interest by the central government. This declaration led to a legislative process that lasted for more than thirty years.

In 1975, the Ministry of Public Works (now called Ministry of Infrastructure and Transport) demanded for tenders but any among the projects presented have been selected to be realized. Seven years after, the final products submitted to the competition were entrusted to a group of experts in order to develop a unique synthetic project for the conservation of the hydraulic balance of the lagoon and the defence of Venice from high waters, the so-called "Big Project" of 1981. In 1984, a second "special law" declared the necessity of tackling the safeguard interventions to be proposed in a cohesive and unitary way, through the institution of the "Consorzio Venezia Nuova", the so-called "Big Committee". Between 1988 and 1992, the whole Consorzio worked towards the definition of the prototype of sluice gates (the Electromechanical Experimental Model, Mo.S.E.). Eventually, in 2002, the definitive (but not the executive) project was presented and the constructions started April 3rd 2003, with the opening of the building sites at the three lagoon inlets of Lido, Malamocco and Chioggia simultaneously.

On one hand, following a pure positivistic approach, where everything that exists can be verified scientifically through experiments and observations, therefore understood and controlled, Mo.S.E. flood defence system has been conceived in order to protect the historical city of Venice (and the rest of the Venetian Lagoon?) from high water events, opposing its closable sluices to the threatening tides, in order "*to execute the necessary works for the purpose of preserving the hydrogeological balance of the Venice lagoon and the reduction of high waters in historic centres*" (D'Alpaos, 2010, p. 194). In addition, this hubristic approach is already embedded in the name itself. In fact, "Mo.S.E." (acronym of *Modello Sperimentale Elettromeccanico*, electromechanical experimental model) loudly recalls the biblical figure of Moses who, on divine indication, has divided the waters of the Red Sea to set free the people of Israel.

On the other hand, the project proposed in 2002 has been developed considering the prediction regarding the relative sea level rise by 2100 of 22 cm, the probable value, and not 31.4 cm, the pessimistic value (developed in 2001 by Co.Ri.La. Consorzio di Ricerche Lagunari, consortium for Venetian lagoon researches). The same year, IPCC (Intergovernmental Panel on Climate Change) predictions for relative sea level rise by 2100 presented 50 cm as probable value, 9 cm as minimum value, and 88 cm as pessimistic value.

The controversial decision of not considering the worst-case scenario, the exorbitant costs (in 2014 the work was 90% completed for a corresponding expenditure of 5,493 billion euros), and the eternal building procedure (to date the Mo.S.E. it is still unfinished and not working) undoubtedly address the case of the Mo.S.E. as the key fact in the understanding of recent anthropic modifications in the Venetian lagoon. Imposing the will at all costs of preserving the Venetian Lagoon with a strong engineered and infrastructured opposition to its natural fluxes and processes has seriously damaged the ecological, social and environmental settings of the entire system. Without any doubt, the project proposed for the safeguard of Venice and the entire Venetian lagoon, representing the deep contradiction of forcing an electromechanical solution to deal with natural fluxes without being able to sustain, prove, and justify it scientifically, failed completely to grasp the complexity of this delicate territory balance.

Calculations and models, however sophisticated and well structured, are still a schematic representation of reality, especially as a complex and multifaceted reality such as that of the Venice Lagoon.
Luigi D'Alpaos, 2010, p. 197

fig. 03/11 European territories below 5 metres above sea level. The entire Venetian Lagoon is included in this enumeration.

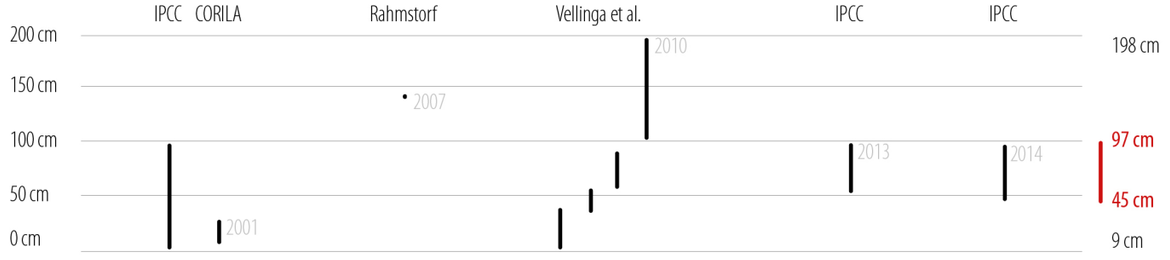

fig. 03/12 Mean Sea Level Rise by 2100 predictions from 2001 to 2014.

03/03 Abandoned cultural heritage of the secondary islands of the Venetian Lagoon

The whole Venetian Lagoon is dispersed with secondary islands. Despite their elevate amount and the incredible historical evidence they carry, during the last century of gradual abandonment, the lagoon has witnessed social detachment and unawareness regarding the cultural, architectonic and traditional heritage of its islands.

Through the centuries, the city of Venice and the surrounding centres have built the connective tissue that gives unity to the lagoon, which "*creates a territory*", in a way that is not so different from what happens in continental cities (Turri, 1995). All the islands together form a cohesive system, almost neighbourhoods of the same city, the Lagoon, of which Venice has eternally held the office of mayor. During the XVIII century, at the decline of the power of the Republic of Venice, this delicate and intricate structure of interdependencies has been gradually fading away, until the current situation.

"A study carried out with the students clearly shows that the majority of tourists and Venetians do not known the lagoon islands. Mind maps record just a few of the most important islands on the page, but ignore the more than 100 islands in that lagoon which was once city. Abandonment is not just a historical-cultural process, but above all abandonment of the collective imagination" (Cipriani, 2017).

Sailing closer to these abandoned ruins, they seem almost to warn Venice, revealing to her eyes her upcoming future. Nevertheless, despite their state of neglection, these islands do not perform too differently from those urban elements, on land, called *campi*, "squares". The similarity emerges clearly, since these islands are the only dry elements among the lagoon waters, further away from Venice. Teenagers, just out of school, reach these islands with their small boats, sailing fast through the lagoon canals-*roads*, and spend their afternoons there with friends. Anglers use them as storage for their gear; nets and fishing rods abound. Tourists often request personalized tours that include visits to these islands: unreachable, mysterious, secret, romantic ruins populated by absurd myths.

Undoubtedly, this heritage attracts passers-by and curious locals, perhaps because of its state of abandonment and mystery. The most interesting value these islands have is exactly their ability of performing as open and accessible public spaces, while not being designed to act as such.

fig. 03/13 Pictures taken around the central lagoon abandoned islands.
01/ Poveglia and Ottagono Poveglia.
02/ Santo Spirito.
03/ Sant'Angelo della Polvere.
04/ Faro Spignon.
05/ Santo Spirito.
06/ Santo Spirito

In 1468 a decree of the Senate of the Serenissima established on the island a Lazzaretto with the task of preventing contagion, called "Novo" to distinguish it from the other one already existing near the Lido (called "Vecchio"), where instead were hospitalized the manifest cases of plague. The island became a place of "contumacy" (here the "quarantine" was invented) for ships arriving from various Mediterranean ports, suspected of carrying the disease.

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01


02


03

04


05


06

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04/ RESEARCH STATEMENT.

04/01 Research objectives

The graduation thesis objective seeks to research the possible outcomes of the Venetian lagoon analysed, synthesized, developed, and eventually implemented as a sustaining landscape infrastructure through a resilient and strategic planning for the whole system. In this perspective, the functioning landscape has to be intended as the means through which the cultural, productive and ecological heritage preservation is achieved, being able to tackle directly anthropic and natural threats and implementing its resilience to future stress events. The complex hydro-morphological challenges in the Venetian lagoon will be studied in the specific, in order to design with them as the major strategy to achieve the aforementioned goals. Developing this research through a landscape architectonic lens plays a focal role in both implementing the resilient characteristics of this fragile and overexploited territory (*functions*, i.e. *processes*) by improving the balance between human and nature systems, and preserve and enhance its spatial qualities, characterized by horizontality, visibility, and reflection (*forms*).

_Mitigate, adapt, and restore the correct functionalism of the lagoon through the implementation of *barene*, the brackish marshland landscape. This rehabilitation will prolong life in Venice and in its Lagoon, preserve their activities, and consolidate their images.

_Design-with-Nature in the Venetian Lagoon.

_Deal with uncertainty. When it comes to design with natural fluxes, creating the conditions for certain processes induces certain re-actions (more or less predicted) of the system. This continuous adaptation and evolution cannot be entirely foreseen in advance, but only promoted. The final ambition is to create a spatial framework for the entire Venetian Lagoon addressing its hydromorphological evolution in order to define a "*preventive landscape design*", able to incorporate possible unexpected mutations, the so-called "*inevitable indeterminacy*" (Fontanari, 2010). As addressed previously in the problem statement, in the Venetian Lagoon the traditional territorial planning approach has encountered many relevant difficulties in trying to govern complex processes of transformation.

_Establish an inclusive "*both-and*" approach rather than an exclusive "*either-or*". The lagoon needs to operate and function correctly to allow the survival of the city. The city needs to be wealthy and florid to invest on the preservation of the lagoon. If the lagoon lives, Venice lives, and if Venice lives, the lagoon lives.

_Design with the "*sense of lagoon*" (Turri, 1995 p.3). Its logics, rhythms, processes, time and spatial dimensions need to be included in the proposed framework.

_Re-balance the relation between nature and human systems in the Venetian Lagoon.

_Re-consider the interaction between project and time, to be articulated through wait and patience for natural processes to happen and pre-vision, to see beforehand, to predict possible changes or tendencies (Marini, 2010).

04/02 Research questions

The brackish marshland landscape is identified as the core protagonist to achieve the aforementioned research objectives. From this acknowledgement, the research questions arise:

_How can the brackish marshlands (*barene*) be used as the nodal means to achieve a systemic, inclusive and comprehensive vision for the Venetian Lagoon where functions, flows, and forms of the territory are implemented and designed as part of a unique co-operating system?

_How can the agency of barene be employed to mitigate the impact of anthropic and natural threats acting as a nature-based flood defence (*function*), to recover the hydromorphological sufferance (*flow*) and support the cultural, ecological and productive heritage (*form*), making the Venetian Lagoon function as a sustaining landscape infrastructure?

_What role should play the Venetian Lagoon cultural image, intended as the diffuse sense of horizontality, reflection and visibility?

_Which values, part of the Venetian Lagoon ecological, cultural and productive heritage, are to keep in consideration to define the design strategies?

_How will the centennial relationship between man and water in the specific context of the Venetian Lagoon evolve in the next future?

SPATIAL QUALITIES

visible / invisible
appearing / disappearing
wet / dry
horizontal / vertical
expanded / confined
crystalline / turbid
wind / fog

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PROBLEM FIELDS	RESEARCH QUESTIONS	RESEARCH OBJECTIVES
LACK OF SYSTEMIC, INCLUSIVE AND COMPREHENSIVE LANDSCAPE APPROACH	**How can the brackish marshlands (*barene*) be used as the nodal means to achieve a systemic, inclusive and comprehensive vision for the Venetian Lagoon where *flows, functions, and forms* of the territory are implemented and designed as part of a unique co-operating system?** What role should play the Venetian Lagoon cultural image, intended as the diffuse sense of horizontality, reflection and visibility? How will the centennial relationship between man and water in the specific context of the Venetian Lagoon evolve in the next future? Which values, part of the Venetian Lagoon ecological, cultural and productive heritage, are to keep in consideration to define the design strategies?	_Venice and the Venetian Lagoon: "both-and" inclusive approach _Design with the sense of lagoon (logics, rhythms, processes, times and spatial dimensions)
VENETIAN LAGOON HYDROMORPHOLOGICAL SUFFERANCE	How can the agency of barene be employed to mitigate the impact of anthropic and natural threats acting as a nature-based flood defence (*function*)...	_Recovery of hydromorphological processes through the agency of barene landscape
OVER-ENGINEERED FLOOD DEFENCE INFRASTRUCTURE	...to recover the hydromorphological sufferance (*flow*)...	_Design-with-nature based flood defence for the preservation of cultural, ecological and productive landscape _Design with uncertainty _Relation between project and time: wait and prevision
NEGLECTED CULTURAL HERITAGE OF THE SECONDARY ISLANDS, ECOLOGICAL HERITAGE OF *BARENE* AND PRODUCTIVE HERITAGE OF FISHING ACTIVITIES	...and support the cultural, ecological and productive heritage (*form*), making the Venetian Lagoon function as a sustaining landscape infrastructure?	_Restoration and enrichment of ecology and biodiversity _Inclusion of secondary abandoned architectonically relevant islands, _Implementation of fishing facilities and production

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05/ THE VENETIAN LAGOON: AN ANALYSIS.

05/01 Mapping the landscape composition

05/01/01 Gradient of wetness

The Venetian Lagoon has been read as a continuous succession of dry, semi-dry, semi-wet and wet environments. This alternation relies on daily and seasonal tide oscillations: every six hours, high tide and low tide alternate, reaching different heights during the year. The average tidal excursion considered in this research at 60 cm.

The dry environment corresponds to Venice historical centre and the secondary islands (in total 30 km^2), Porto Marghera, the embankments separating the fishing valleys from the lagoon, and the lagoon from the surrounding municipalities. Dry elements are defined by a solid and tangible perimeter, are elevated and detached from the water surface.

The semi-dry and the semi-wet environments correspond mutually to *barene*, brackish marshlands, and *velme*, subtidal mudflats. *Barene* and *velme*, in the following page represented through different shades of grey, occupy in-between spaces. Sometimes they emerge and appear from the water surface, sometimes they are submerged and hidden. This alternation, of appearance and disappearance, based on tidal recurrence, is the most peculiar trait of these elements.

Velme, as briefly explained in the Glossary at the beginning of the research, indicate a shallow but normally submerged portion of the lagoon seabed, which nevertheless emerges at extremely low tide. For this reason they are generally devoid of vegetation but associations of *Zostera noltii* can be found, since their are able to tolerate prolonged period emerged. They occupy more or less 150 km^2 of the whole open lagoon surface. Their muddy soils allow the proliferation of different *benthos* communities (ecological category comprising aquatic organisms living in close contact with the bottom or attached to a solid substrate).

An extensive explanation of what *barene* are, of their fundamental functioning for the lagoon ecosystem, and of their evolution through time will be addressed in chapter 05/03/01.

Furthermore, while completely separated from the lagoon waters, the fishing valleys can be enumerated as a combination between wet and dry environments: the breeding ponds for the fishes and the embankments separating them from the open waters represent both categories.

The wet environment corresponds to the waters of the lagoon. Canals and open stretches of water, in the following page represented in black, constitute those elements occupying the largest portion of the Venetian Lagoon.

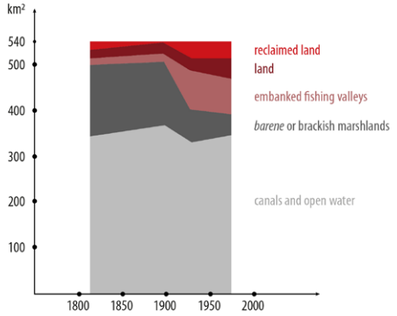


fig. 05/01 Surface evolution of landscape components: from XIX century to mid XX century. To be noticed is the reduction in surface of *barene*, which will be further addressed in chapter 05/03/01.

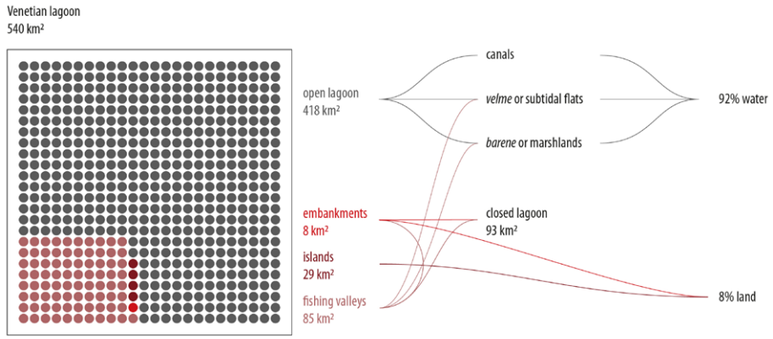
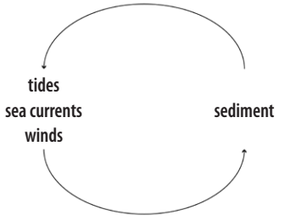
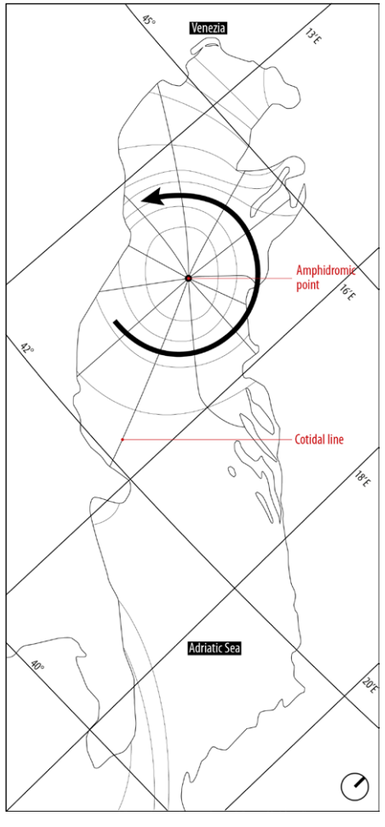


fig. 05/02 Landscape composition of the Venetian Lagoon: open lagoon, closed lagoon; water and land.

fig. 05/03 Landscape composition of the Venetian Lagoon, in space: the transition from white to black represent environments from a higher to a lower degree of wetness.





05/01/02 Landscape components interaction: hydromorphology

These in-between environments, semi-dry and semi-wet, are the ones that establish the most a direct and open dialogue with daily water oscillations. In fact, *velme* and *barene* are composed mainly by fine sediments (silt and clay), which are more prone to be recollocated by water currents. This peculiar feature makes them constantly evolving, almost metamorphic, unsettled environments. Therefore, it has resulted fundamental to understand how this relationship evolves and what forces and matters are directly involved in this millennial dialogue.

First of all, the Venetian Lagoon, presenting three inlets connecting her to the Adriatic Sea (Lido, Malamocco, and Chioggia), has to be considered as a "system of lagoons" (Molinaroli, 2008) rather than a single lagoon. *This trait increases the degree of complexity of the hydraulic system.*

Through these three inlets, sea currents and tides expand inside the lagoon. These currents, thanks to their different expansion speeds and an intricate network of lagoon canals, are able to reach the borders of the lagoon. This combination of canals and currents define together four hydraulic sub-basins: Treporti, Lido, Malamocco and Chioggia.

The tidal currents expanding within the Venetian Lagoon borders are generated in the Adriatic Sea, which peculiarly is characterized by anti-clock wise curves of tidal propagation. *This trait increases the degree of complexity of the hydraulic system.*

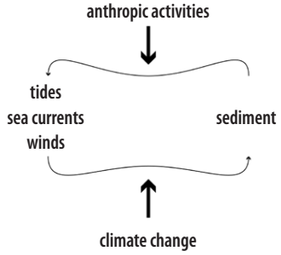
The astronomical tides of the Adriatic Sea are also under the influence of two winds, Scirocco from South-East and Bora, from North-East.

Scirocco originates when low pressure forms on the high and medium Tyrrhenian Sea, and the Balkans are in an area of high pressure. It is a hot dry wind and raises the temperature by several degrees even in winter. It does not blow in gusts like all warm winds but constantly, especially in spring and autumn. It is a very common wind in the Venetian Lagoon because it directly contributes to the phenomenon of high water, not letting the tides retiring into the sea.

Bora is a wind that blows down from a topographical inclination and has its origin in Dalmatia, Croatia. Its main characteristic is to be a discontinuous wind, i.e. manifests itself with stronger gusts, interspersed with less intense gusts. It tends to accumulate water into the lagoon but in a less incisive way than Scirocco, although it contributes to the creation of powerful waves. Blowing more vigorously than Scirocco, the waves created by its gusts displace a discrete amount of sediment in the shallow waters. These waves directly contribute to the horizontal erosion that the Venetian Lagoon is experiencing (05/02/02).

fig. 05/04 On the left: characteristic curves of the propagation of the tide relating to two elementary components of the astronomical tide recorded in the Adriatic Sea. The arrow indicates the direction of rotation of the cotidal lines. Source: Polli, S. (1960) *La propagazione delle maree nell'Adriatico*. Trieste: Istituto Sperimentale Talassografico.

fig. 05/05 On the right: the image represent the combination of the different water flows inside and outside the Venetian Lagoon: sea current, tidal flood from the three inlets of Lido, Malamocco and Chioggia, and its expansion through the lagoon canals. The flood tide considered (speed and expansion directions) has occurred March 17th 2019.



05/02 Threats

Proceeding through the hydromorphological understanding, many are the perils threatening the correct functioning of the Venetian Lagoon. Through a careful analysis and study six degradation trends have been identified:

_Deepening of shallow water seabed
_General flattening and horizontal erosion
_Negative sediment balance
_Higher astronomic tides and faster tidal propagation
_More powerful tidal currents
_More frequent high water events

While researching, the main causes determining these issues have been investigated. The lowest common denominator, exerting the most significant pressure, has been the excavation of big canals, in particular Malamocco-Marghera canal, during XX century, to support Porto Marghera industrialization. Still nowadays the effects of this excavations are perceivable when analysing the major issues the Venetian Lagoon is coping with.

Alongside with canals excavation and Porto Marghera activities, anthropically generated subsidence, resulting from excessive groundwater exploitation, cruises and cargo ships passage through the lagoon, the construction of concrete jetties at the inlets, rivers diversion, and natural eustatism and subsidence are the eight variables influencing directly the aforementioned threats. As visible from the scheme on the left, all the effects and the causes result to be almost inextricably intertwined, feeding on each other, making the comprehension even more complex.

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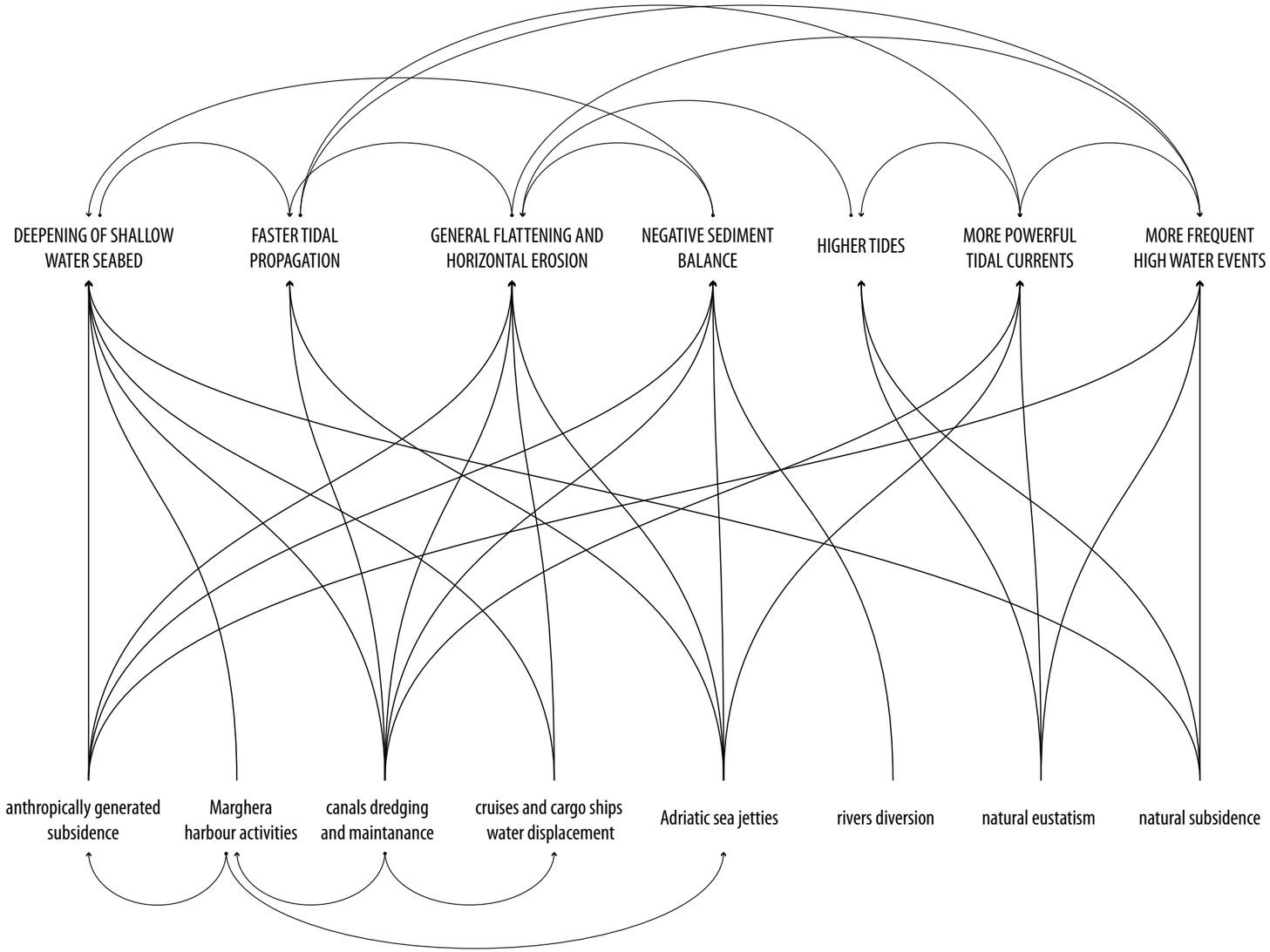


fig. 05/06 On the left: comparison between three bathymetry surveys, taken in 1970, 1990, and 2000. This comparison has been widely addressed by Emanuela Molinaroli, who is considered here as the main source of knowledge regarding this threat.

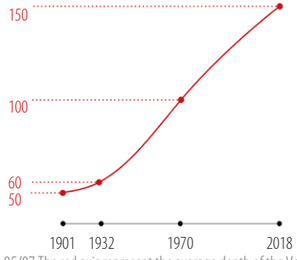


fig. 05/07 The red axis represent the average depth of the Venetian Lagoon (expressed in centimetres) and the black axis the time frame when that depth was recorded.

05/02/01 Deepening of shallow water seabed

The significant deepening of the shallow water seabed of the Venetian Lagoon has occurred after 1960, and it has been caused mainly by extreme dredges (due to the necessity of opening the harbour to bigger and bigger cruises and cargo ships) and only partially by eustatism.

As concluded by Molinaroli (2008), in the Venetian Lagoon:

_There has been a general reduction in the frequency of depths of —0.60/—0.80 m, combined with a general increase in frequency of elevations of —1.00/—1.20 m in Lido and Chioggia sub-basins, and up to —1.80 m in Malamocco sub-basin

_This reduction has directly caused a flattening of the lagoonal morphology with a transition from intertidal flats, *barene*, to subtidal flats, *velme*, (circa 30 km^2) and from subtidal flats to open lagoon conditions (circa 60 km^2);

_The recorded deepening of tidal flats (by approximately 20 cm) is to be ascribed more to decreased sediment supply, disappearance of seagrass and clam fishing than to the relative sea level rise of almost 5 cm;

_More than 50% of the lagoon experienced erosion in the 30-year period.

05/02/02 General flattening and horizontal erosion

Due to he displacement of the sediments solicited by waves (mainly generated by boats and cargo ships, but also by strong winds as Bora); the water currents' speed of expansion; and the consequential loss of sediment through the three lagoon inlets, the shallow waters seabed has been suffering not only of an increase in terms of depth but also of a

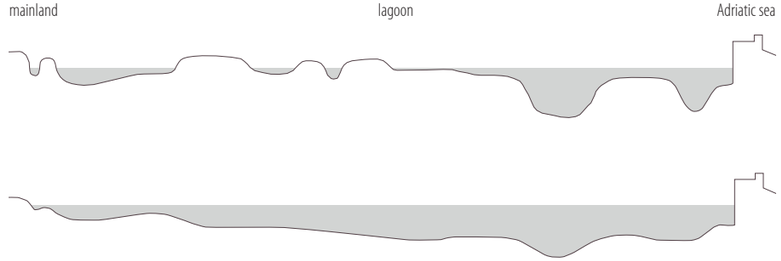
fig. 05/08 On the left: the abstract section depicts the described change in terms of horizontal underwater morphology due to flattening and erosive processes. The image above represents the situation at the end of XIX century, and the one below at the end of XX century.

general flattening and erasure of its underwater diverse morphology. This can be attributed also to invasive methods of clam fishing, through tools that mechanically excavate and enliven the seabed, and the disappearance of vast phanerogams prairies (seagrasses as *Zostera noltii* and *Zostera maritima*) populating the sub-basins of the lagoon (Molinaroli, 2018). This tendency has gotten worse around half of XX century.

05/02/03 Negative sediment balance

Every year, on average 2.2 million m^3 of sediment is brought into suspension from the lagoon bed and settle again on the lagoon bottom. Around 30.000 m^3 of sediment are discharged in the lagoon by the rivers and 70.000 m^3 erodes from the saltmarshes. 580.000 m^3 of sediment is lost in the Adriatic Sea via tidal currents and 400.000 m^3 is dredged from lagoon channels (Bernstein and Montobbio, 2015).

Compared to the information referring to the time frame 1970-1990, where the sediment lost in the Adriatic Sea was 1.1 million m^3, the amount of sediment lost today is undoubtedly decreased. However, the trend is indeed in deficit, being completely negligible the amount of sediment entering the Venetian Lagoon as river discharges. This unbalance, added to the aforementioned issues regarding the deepening and flattening of the seabed, is contributing even more to this vicious cycle: the deeper the lagoon gets means that too many sediment are lost, and the more eroded the lagoon gets means, similarly, that too many sediment are lost.



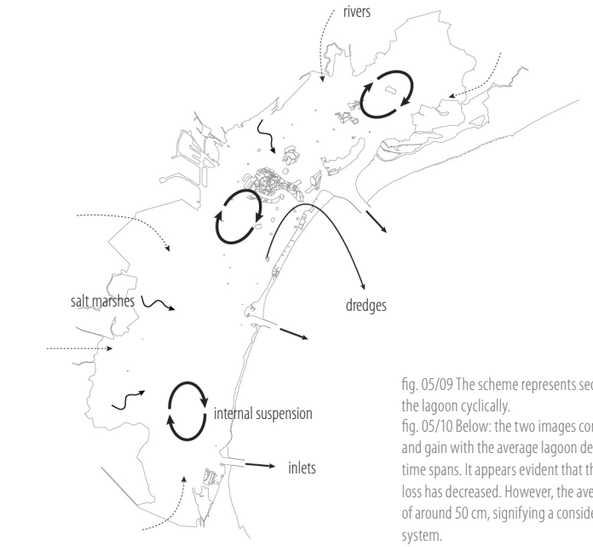
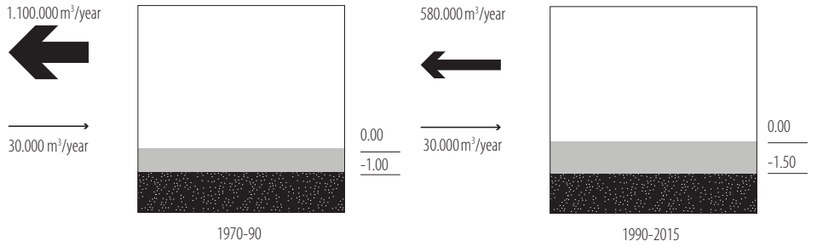


fig. 05/09 The scheme represents sediment movement happening in the lagoon cyclically.
fig. 05/10 Below: the two images compare the average sediment loss and gain with the average lagoon depth in the 1970-90 and 1990-2015 time spans. It appears evident that the average amount of sediment loss has decreased. However, the average lagoon depth has increased of around 50 cm, signifying a considerable damage underwent by the system.



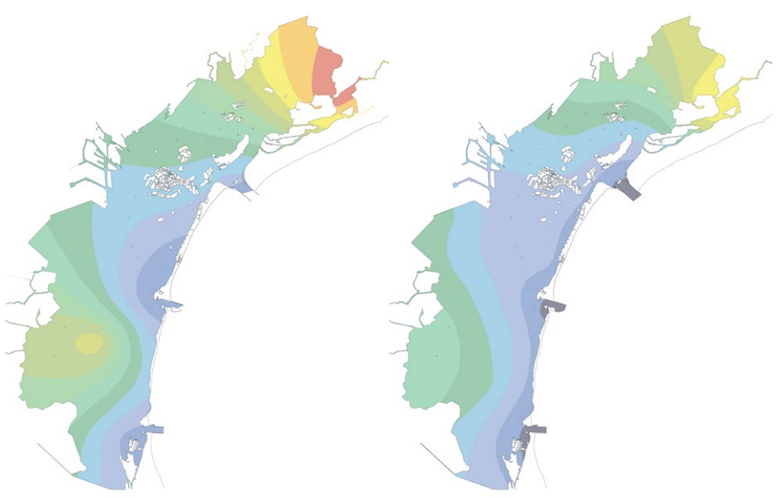


fig. 05/11 The two images compare the tidal minutes of delay at the beginning of XX century (left) and at the end of XX century (right). More minutes the tide has of delay, the lower is the speed of expansion, and the more the tide is thwarted during its expansion. The legenda represent the minutes of delay.

fig. 05/12 The two images compare the centimetres of height at the beginning of XX century (left) and at the end of XX century (right). The higher the tide is, the more has space to expand and to occupy. The legenda represents the contimetres of height.

05/02/04 Faster tidal propagation and higher astronomic tides

The two pairs of images, reporting the minutes of delay and heights that tide could reach at the beginning and at the end of XX century, appear as the logical effect of what stated above. Seabeds have been eroding, deepening, and flattening and sediment have been continuously lost therefore tides have become faster in expanding and higher.

05/02/05 Increase of high water events

In the end, it appears evident how the previous degrading processes have determined an increase in terms of amount of high water events during the last century. The definition of high water (*acqua alta*) is every time the tide rises abnormally over +110 cm, causing a progressive flooding as the tide rises. The phenomenon was historically limited to the months of early and late winter, especially November and February, but with the advent of modernity there has been a progressive exasperation and increasing frequency and unpredictability of high water event. Between the 1940s and the years 2010 to 2018 the frequency increased almost 14 times: from 5 only between 1940 and 1949, to 69 between 2010 and 2019 (data by Centro Previsioni e Segnalazioni Maree - Municipality of Venice).

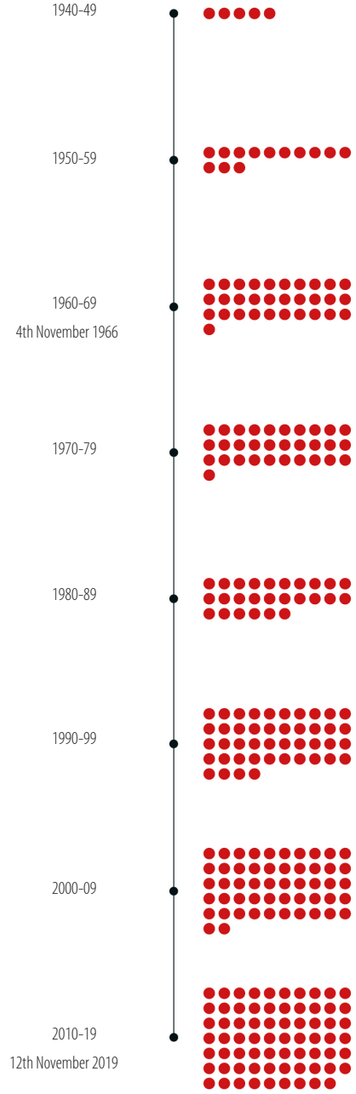


fig. 05/13 The visualization represent the amount of high water events per decade from 1940 to 2019. On November 4th 1966 and November 12th 2019 occurred the highest and the second highest high water events ever recorded.

05/02/06 Conclusions

Having traced the evolution of the threats the Venetian Lagoon is facing nowadays has been crucial in pointing out, spatially, those areas more prone and subjected to these worsenings. This line of reasoning has diverted the attention on the central sub-basin of Malamocco and its contemporary status, identifying it as fertile testing ground. The research-by-design, based on its damaged current functioning, will investigate a possible proposal able to address its restoration.

fig. 05/01 The image on the following page displays erosion and accretion patterns in the Venetian Lagoon between 1970 and 2000. The white represents where accretion has occurred, the red represents where erosion has occurred. The central sub-basin of Malamocco is the one that has experienced the most erosive tendencies among the four sub-basins.

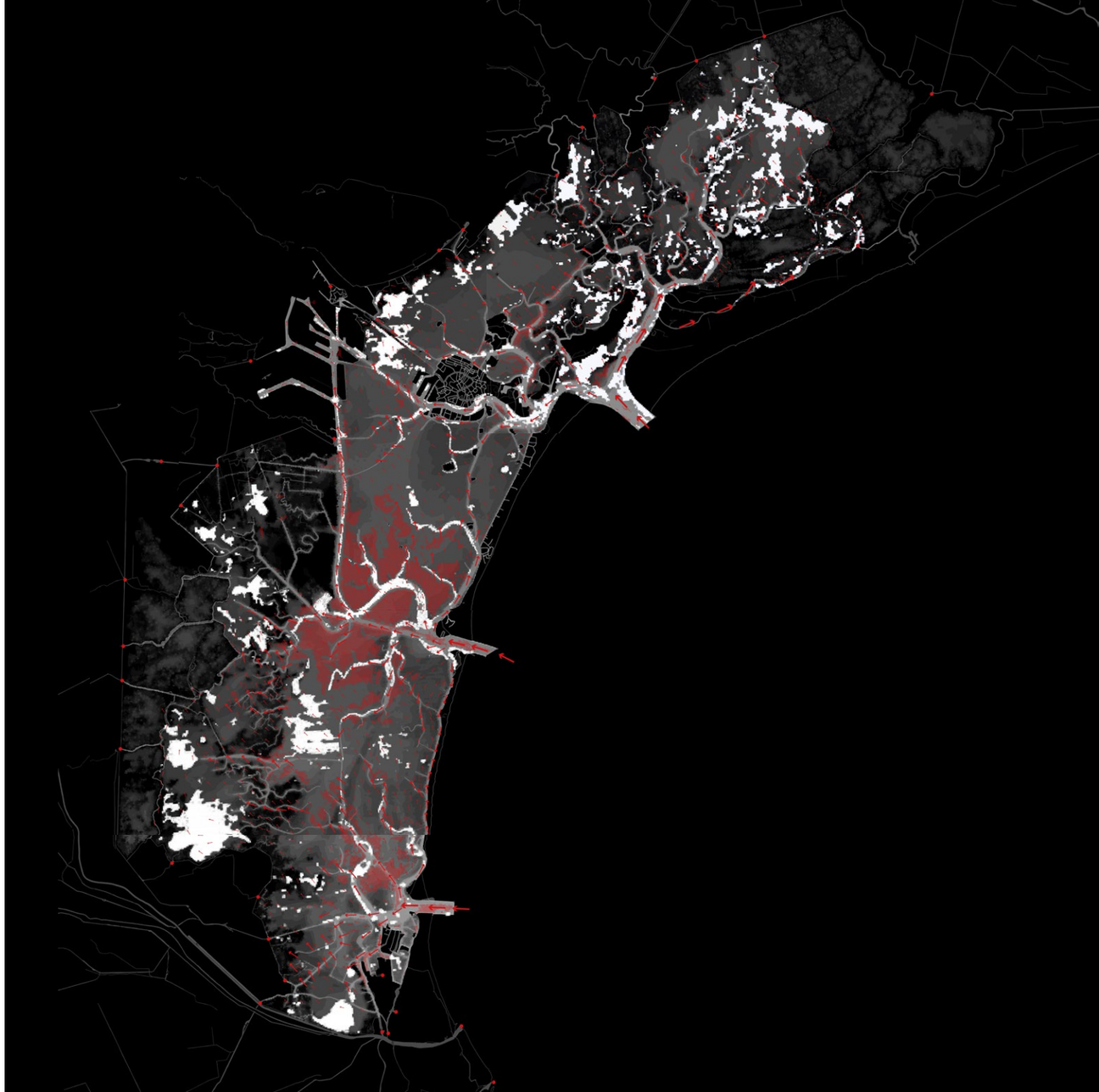


fig. 05/02 Current surface occupied by *barene* in the Venetian Lagoon, around 10% of the totality.

05/03 Values

Despite the threatening processes in act nowadays, the true character of the Venetian Lagoon is still embedded in those elements, which in the research have been addressed as values. These are recurrent figures in the collective imagery and memory of the lagoon, pivots, fixed points eternally changing. These elements are the Ecological System of *barene*, the Cultural System of secondary islands, and the Productive System of fishing activities and production.

05/03/01 Ecological System of brackish marshlands: *barene*

In the Venetian Lagoon, areas with different biological and morphological significance alternate. These can be subdivided into land that is always emerged and land that is submerged during high tides. The former are the islands, where the major urban settlements are located (see chapter 05/03/02); the latter are known as *barene*, brackish marshlands, and form the most particular amphibious environment which, as such, is constantly poised between land and water. Their tabular surface is covered by a thick bushy vegetal mantle, know as *baro* (from which *barena*), and it is often crossed by erosion furrows which form tortuous meandering little channels, called *ghebi*.

Barene form the most characteristic environment of the Venetian Lagoon and are home to halophytic flora, i.e. species particularly suited to living on salty soils, physiologically arid and inhospitable for the vast majority of plants.

The tides, which in the northern gulf of the Adriatic Sea reach the largest amplitudes in the Mediterranean (see figure 05/04), in addition to influencing the water exchange in the lagoon, create numerous micro-environments on the *barene*, characterized by soils with different levels of salinity over which the aforementioned halophytic vegetation develops.

The Ecological System of brackish marshlands produce incredible hydromorphological and hydraulics benefits for the lagoon ecosystem. In fact,

_*Barene* has a very high rate of CO_2 sequestration, if related to their actual surface (see fig.);

_*Barene* favour water exchange acting as expansion vessels, limiting tidal impact, reducing wave power and speed, mitigating strong winds;

_*Barene* provide the Venetian Lagoon with protection against coastal flooding and erosion.

In fact, the function of vegetated coastal habitats for coastal protection involves, among other benefits, the attenuation of wave transmission onshore. As

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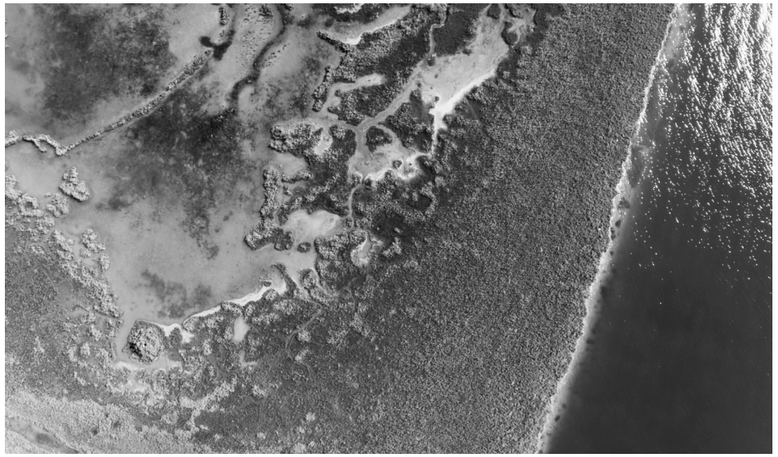

fig. 05/03 Aerial photos of barene in the Venetian Lagoon. *Source*: juzaphoto.com

Duarte (2013) reports, "*seagrasses have a particularly high capacity to dissipate wave energy, whereas salt marshes and mangroves have a high capacity to protect from surges. Moreover, these ecosystems often occur in juxtaposition with seagrass in subtidal areas and salt marshes or mangroves (depending on latitude) in the intertidal zone, thereby increasing their combined effectiveness in protecting from waves and surges*". In the specific case of the Venetian Lagoon, this co-operation between intertidal and subtidal environments is represented by *barene* and *vèlme*.

05/03/01/01 Flora and fauna

Barene have an average height comprised between +0.20 and +0.60 cm above sea level. According to this rage of elevation, and salinity concentrations, vegetal population evolve hosting different species. Above the *barena*, which undoubtedly constitutes the most striking aspect of the lagoon landscape, the dense vegetation seems to form a rather uniform cover. In reality, very

fig. 05/04 Barena montage

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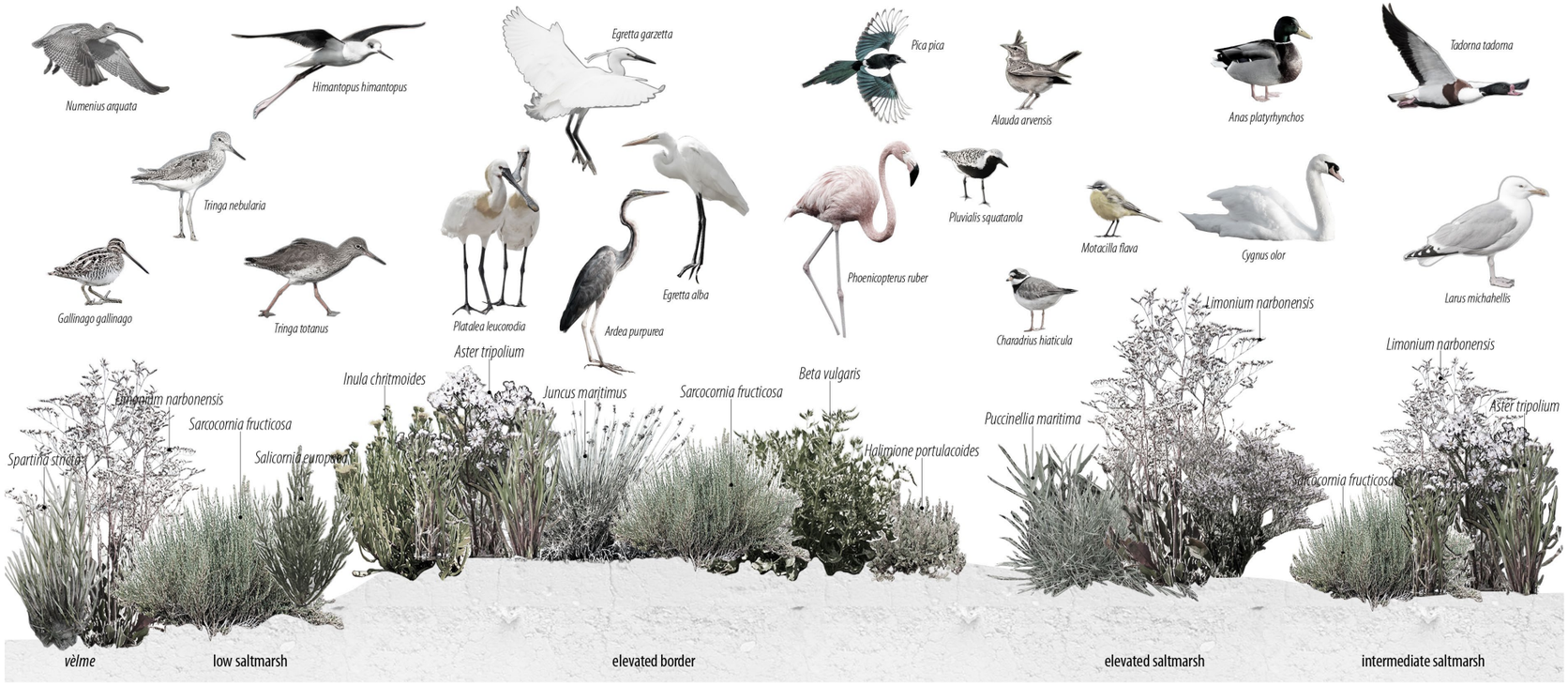
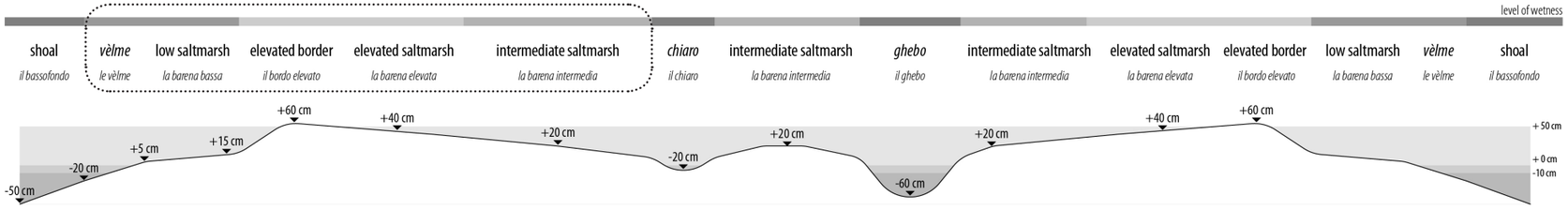




subtle, delicate and almost imperceptible elevation differences in the soil surface lead to the development of a mosaic of akin plant populations. These are perennial halophyte associations consisting mostly of *Puccinellia palustris, Arthrocnemum fruticoso, Halimione portulacoides, Limonium serotinum, Aster tripolium* and other species. Barene, according to their elevations, are subdivided into four groups: *barena bassa* (low saltmarsh and edges), *barena intermedia* (intermediate saltmarsh), *barena elevata* (elevated saltmarsh), *bordi elevati* (elevated borders).

Barena bassa (low saltmarsh and edges)

Spanning between +5-10/+15-20 cm. Characterized by predominance of *Spartinetum strictae* on inconsistent soil, rich in organic matter and soaked in water. In direct communication with the surrounding shoals and *vèlme*. Salinity rate around 25-35 ‰.

Barena intermedia (intermediate saltmarsh)

Tabular internal surfaces, spanning between +20/25 cm- Characterized by the predominance of *Limonietum venetum* on clayey soil, very wet or soggy, poorly ventilated, high salinity rates, periodically submerged during high tides. 90% of the barene are covered by this vegetal association. The thick and dense vegetation presence act as ground consolidator.

Barena alta e bordi elevati (elevated saltmarsh and borders)

Spanning between +40-45 cm up to +60 cm. Mainly characterized by *Puccinellietum palustris*. It gets flooded only by the highest tides.

The *fauna* community of the *barene* apparatus is composed almost exclusively by birds. This composition appears rich and mixed, given the wide and differentiated food resource. Still, the waters and the seabed, submerged and emerged, are those elements that almost uniquely provide food, while the herbaceous expanses constitute a precious breeding habitat. *Ardeidae*, *caradrides*, *laridae* and *anatidae* are the most represented avifauna groups.

Ardeidae: white egret (*Egretta garzetta*) present in all seasons; red heron (*Ardea purpurea*) in summer; greater white heron (*Egretta alba*) in winter.

Caradrides: black-winged stilt (*Himantopus himantopus*) and common redshank (*Tringa totanus*) nest in small colonies, with eurasian curlew (*Numenius arquata*), common snipe (*Gallinago gallinago*), Common greenshank (*Tringa nebularia*).

Laridae: yellow-legged gull (*Larus michahellis*).

Anatidae: mute swan (*Cygnus olor*) in this environment it nests with a limited number of pairs, common shelduck (*Tadorna tadorna*), nesting in the cavities of the soil on the most elevated bumps, and mallard (*Anas platyrhynchos*) are species of particular aesthetic and ecological interest.

Sporadic and irregular presences of *Phoenicopterus ruber* and *Platalea leucorodi*a confirm the considerable potential of the environment.

The salinity of water is an important element of selection for living organisms. in fact, while the majority of plant species require the presence of fresh water in a more or less drained soil, few are those that adapt or prefer brackish soils.

Giovanni Caniglia, 1995, p. 81

fig. 05/05 Below: schematic and general section of a *barena*, highlighting the peculiarities of its different elevations. Interesting to be noticed is the relation with daily tides: more than 80% of a *barena* gets submerged twice a day, when high tides occur.
fig. 05/06 Above: close up on flora and fauna species populating more frequently the different elevations of a *barena*.

fig. 05/07 Historical evolution of the surface occupied by *barene*, from 1811 to 2013. Based on data retrieved from D'Alpaos, 2010 and D'Alpaos, 2010.

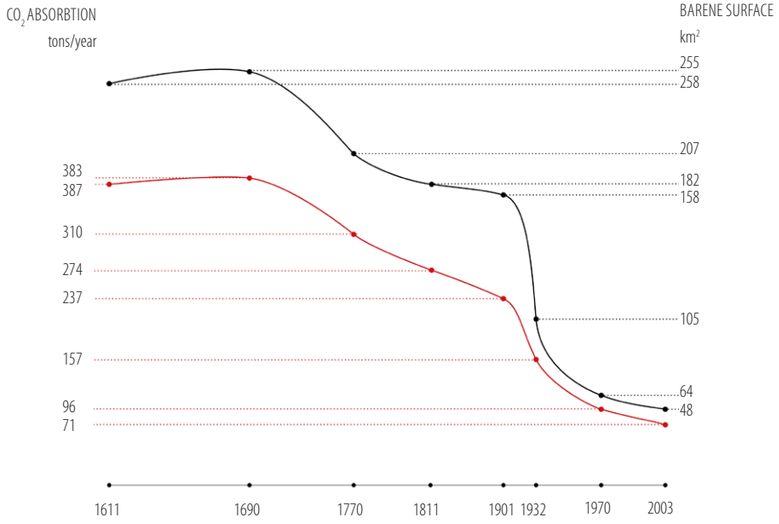


fig. 05/08 The graph on the left represent the historical development of the relationship between *barene* surface and their carbon burial capacity.

05/03/01/02 Evolution through time

Unfortunately, the barene ecosystem has suffered a significant reduction in surface (D'Alpaos, 2010). The information presented by figures 05/17 and 05/18 indicate the dramatic reduction in surface area suffered by the *barene* from the early twentieth century to today, with a very strong acceleration of the phenomenon in the last period. This erosive process identifies an erosion rate suffered by the barene landscape of the Venetian Lagoon of more than 300% between XVII and XX century.

Extensive surfaces once subject to flooding only during high tide have progressively changed, assuming for the most part the condition of shallow waters, constantly submerged by water. At the same time an uncountable volume of sediments, but certainly considerable, has moved from the *barene* to areas of lower altitude (shallow waters and canals) or is no longer resident in the lagoon, having been expelled into the sea (D'Alpaos, 2010).

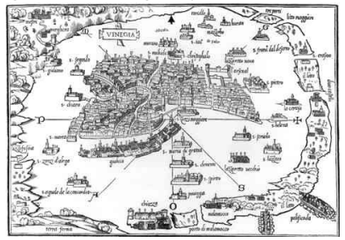
The reduction in surface of the barene landscape can be included in those factors which have concurred in amplifying the hydromorphological deterioration (caused by the aforementioned threats in chapter 05/02) of the Venetian Lagoon during the last century.

540 km² Venetian Lagoon
48 km² barene surface (2003)
37 km² SIC surface in the Venetian Lagoon (Sito Interesse Comunitario) community interest site for natural and semi-natural habitat conservation
36 km² ZPS surface in the Venetian Lagoon (Zone di Protezione Speciale) special protection areas along bird migrating routes.

The Venetian Lagoon is at the same time:
SIC area
ZPS area
UNESCO World Heritage Site since 1987 (Venice and its Lagoon)
Ramsar Site (The Lagoon of Venice)

fig. 05/09 Photographic project by Giorgio de Vecchi "Venezia e la cucina di Barena." *Source*: https://bycartography.com/storie/venezia-e-la-cucina-di-barena/

fig. 05/10 Above. The secondary islands of the Venetian Lagoon.
fig. 05/11 Below. *Isolario lagunare* by Benedetto Bordone, 1528.



Sono intorno a Venezia e le fanno corteggio, quasi ancelle a regina, da forse venticinque isolette.
direbbesi che la meravigliosa città, caduta dal cielo e scheggiatasi in qualche parte, spargesse a sé intorno questi frammenti di sua bellezza.

L. Carrer in Lodi (2017)

All around Venice and paying court to her, almost like handmaidens to a queen are perhaps twenty-five small islands.
You might suppose that the marvellous city, falling from the sky and shattering into pieces, had scattered all around herself these fragments of her beauty.

05/03/02 Cultural System of secondary islands

The Venetian Lagoon system is extremely dynamic, in continuous change: daily, for tides, but also decennially, centennially and even millennially, for natural and anthropic phenomena. The islands of the lagoon environment are uncertain lands that appear, disappear, transform, vary in size and number, change the vegetation that characterizes them. For this intrinsic character of indeterminacy, it is difficult to define a unique number. The stable islands vary from a minimum of 75 to more than a hundred considering many barene, *motte* (small outcrops, hillocks, humps) that, due to the phenomenon of subsidence, occasionally appear and disappear. If we consider Venice the islands reach 130 units (Cipriani, 2017).

Between the northern and central lagoon, 35 secondary islands are located: 23 results in an abandonment state. Out of 35, 17 are state property and the rest are privately owned.

_4 octagons (Orragono Alberoni, Ottagono San Pietro, Ottagono Ca' Roman, Ottagono Abbandonato o Campana)

_10 military batteries (Isola Fisolo or Forte di Sotto, Ex batteria Poveglia or Forte di Mezzo, Batteria Podo or Forte di Sopra, Isola delle Tresse, Isola di San Secondo, Isola Campalto, Isola di Tessera, Isola Carbonera, Buel del Lovo)

_5 powder kegs (Sant'Angelo della Polvere, San Giacomo in Paludo, Madonna del Monte, Santo Spirito, San Giorgio in Alga)

_9 built islands (Poveglia, Sacca Sessola, San Clemente, La Grazia, San Servolo, San Lazzaro degli Armeni, Lazzaretto Vecchio, Lazzaretto Nuovo, San Francesco del Deserto,)

_7 un-built islands (San Giuliano, Monte dell'Oro, Isola dei Laghi, Sant'Ariano, La Cura, Santa Cristina, La Salina).

The decline of the lagoon satellite islands began with the fall of the *Serenissima* Venetian Republic in 1797, and inexorably continued first with the Austrian domination and then with Napoleon Bonaparte. With the Napoleonic edict of suppression of religious orders and guilds from 1810, the monastic seats on the islands were transformed into military headquarters. The plundering of religious buildings was accompanied by their transformation into military installations, hospitals, warehouses that have been used until the First and Second World War. On the surface, this military function was maintained until the 1970s when the Italian State decided to abandon the islands, concluding that process of degradation and oblivion still evident today (Cipriani, 2017).

05/03/02/01 Venice, the islands, the lagoon

The secondary islands have been founded, defended and occupied as entities in symbiosis with Venice historical centre: satellites fluctuating in the common universe of the lagoon. After the fall in 1797, they have shifted their role, turning from sentinels to relicts: former technological implants, landfills, cemeteries and ossuaries, museums, residences, churches, monasteries and cloisters, military forts and powder kegs, agricultural farms, fishing valleys, hotels and resorts, populate nowadays the lagoon, apparently abandoned leftovers deprived of a common ground.

The overall structure of the lagoon settlement appears sufficiently clear: the islands are not simple "*spatial proximity*" typical of urban growth by parts (Zanetto and Calzavara, 1995), traditionally theorized for cities, but they are not even mutually exclusive entities. The lagoon represents a real territory, not

The secondary islands: from sentinels to relicts.
145.235 m2 unused state property islands
59.093 m2 unused private property islands
36 islands in use in 1797
15 islands in use in 2007
Sara Marini, 2010, p. 95

just a mere physical support (as already addressed in chapter 01/03) within which a sort of specialised polycentrism has been achieved. It is in this context that the role of the secondary islands should be re-evaluated, in which, considered as a whole, the survival of a rationality of the Venice-island-lagoon system is to be grasped. A rationality for which the Venetian Lagoon has not yet been transformed into a mere scenario, i.e. into an image, but continues to be both a form and function. The landscape analysis and architecture, in the specific case of the Venetian Lagoon, proves to be particularly effective, not only because the landscape represents both the sensitive form of the territory (as a space of representation) and of the environment (as a space of functionalization), but also because the relation Venezia-Laguna respects by definition the binomial-dichotomy city-landscape and landscape-city.

These dry outposts, immersed in the lagoon waters, look at each other and in turn are looked at: being faithful to their last military task, they master visually the panorama surrounding them. Paraphrasing Steenbergen and Reh, describing the concept of *integrazione scenica* in Villa Medici (Florence) between the villa itself, its surrounding garden, and the view (Steenbergen and Reh, 2003), the panorama is of the new spatial type which has to be integrated into the *islands* architecture.

Moving, *sailing*, through the lagoon the islands appear as a continuous succession: the observer (a sailor, a tourist, an angler, etc.) looks for these landmarks or, better, *water*marks to orientate himself/herself. This connection established between the observer and the observed through the architectonic components (walls, buildings, shape of the island, etc.) allows to experience the slow, healing flow of time. Enables us to *see* and, therefore, to *understand* the passing of history, and to participate in time cycles that surpass individual life. (Pallasmaa, 2005)

fig. 05/13 In the following page. 35 islands populating the northern and central lagoon, catalogued by property, use, and potential relevance.

fig. 05/12 Below. 10 island of the central sub-basin of Malamocco included in the design framework.

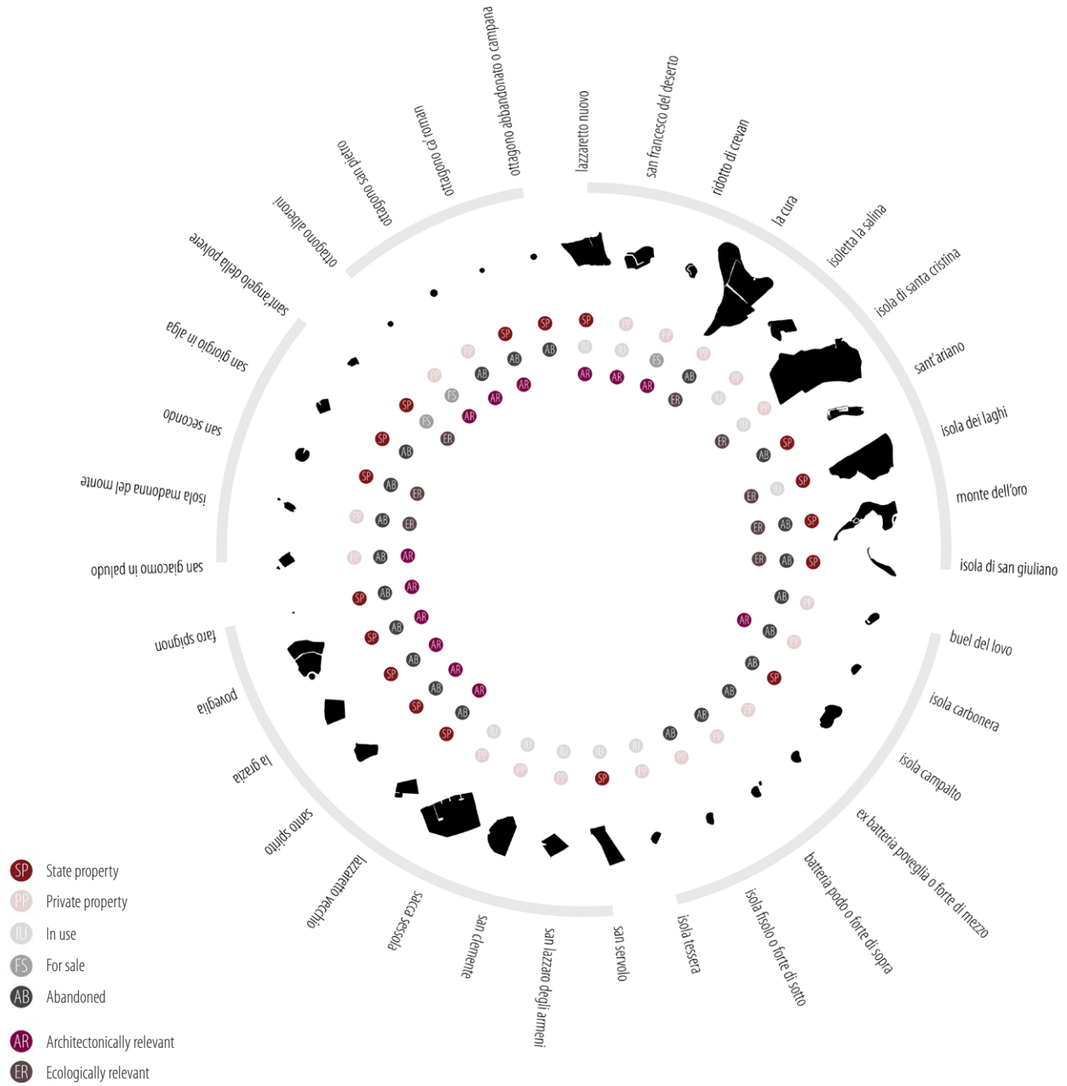


fig. 05/14 Fishing valleys (black), mussel cultivation (dark red), clam cultivation (red), and itinerant fishing activities with temporary nets (light pink).

05/03/03 Productive System of fishing activities and traditions

The Productive System of fishing activities is spread on the whole surface of the Venetian Lagoon, and it is mainly dedicated to mussels and clam cultivation, itinerant fishing, and embanked aquaculture valleys along the borders.

The peculiar environmental morphology, dominated by wide lagoon extensions, favoured a specific anthropization, effectively adapted to the natural surroundings, and the first stable settlements were certainly connected to the exploitation of the abundant availability of fish and game. Since then, until around the end of the Second World War, life in the lagoon has partly maintained its original economic vocation, so actively that the productive vitality of fishing has proved capable of sustaining an ever-increasing demographic weight, thanks also to the refinement of peculiar techniques for the respectful exploitation of the environmental potential such as, for example, the breeding of valuable fish species (eels and oysters in particular).

Venetian Lagoon fishing activities, as in other limited river, lake and coastal areas, is opposed to the modern instrumental homogeneity of open sea fishing through a still alive technological multiplicity, whose character, strongly conservative, expresses the strength of a tradition nourished by a fruitful relationship between man and territory. This type of fishing was mostly linked to the direct sustenance of the fisherman, allocating surpluses to the market only during certain periods of the year.

Currently the protagonists of lagoon and coastal fishing are largely located in the lagoon centres of Burano, Treporti, San Pietro in Volta, Pellestrina and Chioggia. Even if the percentage weight of these activities compared to other economic categories is clearly in decline, it is still possible to perceive among the ancient settlements, as well as along the mooring docks, the visible, but also olfactory and sound elements that make up the still solid formal and, perhaps, above all informal organization of the fishing landscape.

Spatially, this system is defined by interesting elements, all characterized by a sense of temporality, as visible in the following page in figure 05/20. Temporary and informal cabins, nets, poles, and stilts are spread especially on *barene*, used by anglers as depots and bases. In fact, when the equipment characterizing itinerant fishing is pulled dry on the higher *barene*, to clean them from algae or to repair them, their thin and vertical profiles supported by poles contribute to highlight even more the flat lagoon horizons.

Despite a marked decline in lagoon fishing techniques and activities, the dense meshes of cultural homogenisation sometimes allow the survival of archaic, mostly marginal technical choices, whose economic function has now become far from negligible. Today the interest in these almost anachronistic practices, while enhancing the iconic possibilities to be destined to the tourist imagination, is supported by the more mature awareness that these technical-cultural relicts have an irreplaceable social function capable of enhancing the historical consciousness of the community (Vallerani, 1995). Strongly connected to the concept expressed clearly by Vallerani, there exist both the design will and socio-economical necessity to integrate and extend the participation also to those lagoon workers that live and work with this complex environment, for a simple and basic matter of fact: no one better than them knows the Venetian Lagoon intimate behaviours.

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fig. 05/15 V. Carpaccio, *Caccia in Laguna*, 1490-95

fig. 05/16 G. Ciardi, *Pescatore in barena*, 1870

fig. 05/17 G. Ciardi, *La Laguna di Venezia con Pescatore*, 1880-85

fig. 05/18 P. Longhi, *La posta in botte*, 1765-1770

fig. 05/19 P. Longhi, *La Caccia in Laguna*, 1760

fig. 05/20 Temporary and informal fishing traces in the central sub-basin of Malamocco.

informal fishing base

informal fishing base

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bilancere

mussels cultivation

casone

temporary nets and traps

casone

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06/ METHODOLOGY.

06/01 Research methods: events analysis, extra-disciplinarity, landscape in time

"[...] Representation through the mapping of complex levels of information is instrumental to the design of infrastructure and ecology." (Bélanger, 2012, p. 291)

Considered the thorough amount of maps and data, scientific papers, theoretical publications, and literature edited about the Venetian Lagoon, the early beginning of the research needed to be framed and limited. In order to tackle this initial complexity, three major events, occurred in the last century in the Venetian Lagoon, have been analysed: the opening of Marghera Harbour in 1917, the strongest flood and highest level of *acqua alta* recorded (194cm) between November 3rd and 4th 1966, and the introduction of *Tapes philippinarum* (Philippines clam) cultivation in 1983. From here, the interrelationships between water and human systems, and between water and sediment flows (hydromorphological processes) have been acknowledged as key actors to understand *the functioning of the Venetian Lagoon territory*. Furthermore, the site visit conducted in October 2019 and the interest in how the lagoon has been represented and portrayed (through movies and documentaries, novels, paintings, photographs, etc.) contributed to the definition of *the cultural image of the Venetian Lagoon landscape*.

Having set the boundaries of the research (water-man interaction and hydromorphological processes) and considered the delicacy and complexity of the Venetian Lagoon, extra-disciplinary interviews have been organized to deepen and consolidate the knowledge about how water and sediment interact in a lagoon system. Professor Andrea D'Alpaos (University of Padua, dept. Geosciences, expert in barene and Venetian Lagoon sediment and water dynamics), Erik Mosselman (Deltares and TU Delft, Faculty of Civil Engineering and Geosciences, dept. Hydraulic Engineering, sect. River, Ports, Waterways and Dredging Engineering), Ellis Penning (Deltares, expert in Nature Based Flood Defence Solutions and Ecohydraulic), Luca Sittoni (Deltares, expert in Ecosystem and Sediment Dynamics), and Ir. Tjerk Zitman (TU Delft, Faculty of Civil Engineering and Geosciences, dept. Hydraulic Engineering, sect. Coastal Engineering) have been contacted for feedback sessions concerning the conducted research. In parallel, the investigation proceeded further between literature study (hydromorphological tendencies in the past and future projections, sedimentation patterns and behaviours, tidal expansions, freshwater discharge, salt-water exchange between Venetian Lagoon and Adriatic Sea, landscape composition, etc.), and analytical mapping.

From the feedback sessions and the continuous research process has emerged the necessity of elaborate comparisons, to understand trends and behaviours of the lagoon through time. Mapping how, historically and contemporaneously, the water-man, and the water-sediment relations have changed has brought to surface important clarifications, essential to speculate on future predictions.

"A management approach based on resilience, on the other hand, would emphasize the need to keep options open, the need to view events in a regional rather than a local context, and the need to emphasize heterogeneity. Flowing from this would be not the presumption of sufficient knowledge, but the recognition of our ignorance; not the assumption that future events are expected, but that they will be unexpected. The resilience framework can accommodate this shift of perspective, for it does not require a precise capacity to predict the future, but only a qualitative capacity to devise systems that can absorb and accommodate future events in whatever unexpected form they may take."

Holling (1973), p. 21

06/02 Theoretical framework

06/01/01 Landscape resilience and principles

Resilience: the ability of a substance to return to its usual shape after being bent, stretched, or pressed; the quality of being able to return quickly to a previous good condition after problems; elasticity; ability to recover readily from illness, depression, adversity, or the like; buoyancy (Cambridge Business English Dictionary, Cambridge University Press).

In 1973, the Canadian ecologist Crawford Holling described in *Resilience and stability of ecological systems* the concept of ecosystem resilience. According to his definition, resilience is the ability of an ecological system to absorb and overcome disturbances, being able to maintain and protect its original structure and functioning (Holling, 1973). More recently, the application of the term resilience has gone far beyond its initial definition and referred more often to social-ecological systems, shifting from its original descriptive meaning to "*a more recent, vague, and malleable notion*" (Brand and Jax, 2007).

Since ecological systems, and therefore their potential ability to be resilient, constitute an integral dimension of the discipline of Landscape Architecture, has emerged the necessity to better define what it means for a landscape system to be resilient and how to direct and promote planning and design towards this implementation.

Therefore, "*landscape resilience*" can be described as "*the ability of a landscape to sustain desired ecological functions, robust native biodiversity, and critical landscape processes over time, under changing conditions, and despite multiple stressors and uncertainties*" (Beller at al., 2015). As reported by Beller (2015), seven principles can be defined both to frame those variables influencing directly landscape resilience and able to support landscape resilience during the planning process. These seven principles are:

_Setting for constraints and opportunities: geophysical, ecological and cultural contexts define how the other six principles can be developed within a certain landscape. At the same time, it is important to understand what has changed and what has persisted through time, in order to predict possible future behaviours.

_Processes for dynamism: system drivers (climate and land use), disturbance events (expected and unpredictable), habitat-sustaining processes (water and sediment fluxes) are the dynamic key elements that sustain landscapes. They allow matter movement, maintain habitats, and organize ecological functions.

_Connectivity for movement: habitat patches, species and habitat range shifts, gradual transitions, habitat connections, and landscape coherence are the elements allowing free movement within and across a landscape.

_Diversity and Complexity of options: richness of landscape features, within-habitat diversity and complexity, diversity in strategy and approach, and genetic and phenotypic variability constitute the core of the fourth principle, where diversity (i.e. the variety of features) and complexity (i.e. spatial configurations and interactions between these features) are considered together because of their interrelating and overlapping nature.

_Redundancy against loss: structural redundancy, population redundancy, and functional redundancy refer to the presence of multiple similar elements or functions within a landscape. The abundance of similar elements reduce drastically loss or extinction's possibility.

_Scale for space and time provision: large spaces, long time scales, and cross-scale interactions allow species, processes and functions to operate.

_People for resilient opportunities: ecological engagement, landscape integration, adaptive management, and stressor management represent those human actions able to effectively create knowledge and manage a certain landscape.

As explained, the seven principles, simultaneously fostered, can participate harmonically in sustaining and enhancing landscape resilience.

In light of what mentioned above, the Venetian Lagoon can be undoubtedly defined as a resilient landscape system, since the disturbances to which it has been subjected have not compromised indefinitely its forms and functions. From the rivers diversion in XV century to the Mo.S.E. infrastructure still to be concluded, the lagoon has always maintained the status of lagoon, neither silting and turning into land, nor sinking and becoming sea. Landscape resilience still characterizes, at least potentially, those environments that have provided space for adaptation (e.g. *barene*). The Venetian Lagoon has preserved its form and functions for more than six thousand years, adapting to sea level fluctuations and conserving its impressive self-preserving capacities. Nevertheless, there is a urgent need for design strategies sustaining the further development of the Venetian Lagoon as a stronger and more resilient landscape, able to tackle and mitigate climate change, and in particular sea level rise. For this reason, the conservation and restoration of peculiar habitats represent the first objective to ensure a consistent functional perspectives to the Venetian Lagoon (Bonometto, 2017).

	KEY ELEMENTS	CONTRIBUTION	EXAMPLE
1. SETTING	_geophysical context _ecological context _historical/cultural context _critical resources	persisting elements native species system trajectories preservation of scarce resources	_tidal fluctuations are vital to maintain lower and intermediate *barene* wet, and limit salinity concentrations (geophysical and ecological contexts)
2. PROCESSES	_physical drivers _disturbance regimes _habitat-sustaining processes	ecological functions and species adaptation redistribution of resources and support of temporal variability	_sediment transport to *barene* allows them to keep pace with sea level rise (habitat-sustaining processes)
3. CONNECTIVITY	_linked habitat patches _habitat connections _landscape coherence _options for habitat range shifts _gradual transitions	escape disturbances, take advantage of resources, recolonize, etc. species can adapt, reorganize acclimation and adaptation opportunities	_habitat patches of any size throughout the lagoon landscape serve as stepping stones and seed sources for colonization (linked habitat patches)
4. DIVERSITY AND COMPLEXITY	_diversity in strategy and approach _genetic and phenotypic variability _richness of landscape features _within-habitat	maintain variability in a heterogeneous and dynamic environment diverse habitats mosaics support more biodiverse niches micro-climates and micro-habitats	_lagoon landscape supports diverse habitats, including sand dunes, Mediterranean pinewood, subtidal mudflats, intertidal brackish marshlands, fluvial reed-bed, etc. (richness of features)
5. REDUNDANCY	_structural redundancy _population redundancy _functional redundancy	discreteness against habitat loss, providing backups	_subtidal mudflats and intertidal marshlands support multiple species of avifauna
6. SCALE	_large spaces _long time scales _cross-scales interactions	sufficient space and time are needed to sustain key processes combine lag times of management actions and ecosystem response	_projections for sea level rise and consequent habitat conversion are incorporated into *barene* restoration design (cross-scales interactions)
7. PEOPLE	_ecological engagement _landscape integration _adaptive management _stressor management	prioritize conservation flexible and coherent management, including stress direct amelioration	_opportunities are available for people to interact with lagoon landscape through close-up paths (ecological engagement) _investment in research, pilot projects and monitoring (adaptive management)

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06/01/02 Landscape as infrastructure

Landscape as infrastructure: a goal-oriented approach, where landscape is treated as an operative field that defines and sustains the urban development, and ecological and economic processes are employed as formative design tools (Nijhuis and Jauslin, 2015).

This approach can be defined as integrated and interdisciplinary where specialisations in engineering and ecology blend with spatial design thinking (Nijhuis and Jauslin, 2015) and where the planner has to always "keep an eye on the whole" (Tjallingi, 2015).

As presented exhaustively and synthetically by Nijhuis and Jauslin (2015), urban landscape infrastructures are about:

_Constructing the landscape itself and not about specific technical constructions in a landscape

_Creating conditions for future development

_Cross-scaling, from regional to local, from general to specific, and maintains overall continuity as well as facilitates local contingency

_Establishing ways of balancing out services and qualities between parts of a territory (Busquets & Correa, 2006)

_Guiding and facilitating flows, movement and exchange (Allen, 1999)

_Creating robust and adaptive systems, which are open to change (Gharajedaghi, 2011)

_Persisting and adapting (Corner, 2004)

_Allowing for the participation of multiple authors

_Creating a directed field for diverse contribution (Allen, 1999)

In light of what mentioned above, the Venetian Lagoon can be undoubtedly defined as a landscape infrastructure. Nevertheless, the impacts of its use as such have become heavier and more spread during the past 70 years. The excavation and maintenance of Malamocco-Marghera Canal (Canale dei Petroli, Oil canal) and other waterways and the use of such waterways by heavy cargo ships and cruises, causing extreme pollution, hydromorphological and ecological sufferance, have intensified the exploitation of the Venetian Lagoon as landscape infrastructure mainly for industrial and economic purposes. It has become urgent to understand how, at the same time, maintain this transportation functioning (with terms), and implement, by planning, its ecological functioning. The research by design presented here wants to investigate the agency of barene landscape as biodiversity attractor, nature based flood defence system, and environmental recover and improver, fostering the Venetian Lagoon as a sustaining landscape infrastructure.

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06/03 Design methods

06/03/01 Scenarios development as design strategy

Scenario: a description of possible actions or events in the future; a description of possible events, or a description of the story of a movie, play, or other performance; one of several possible situations that could exist in the future (definition retrieved from Cambridge Business English Dictionary, Cambridge University Press).

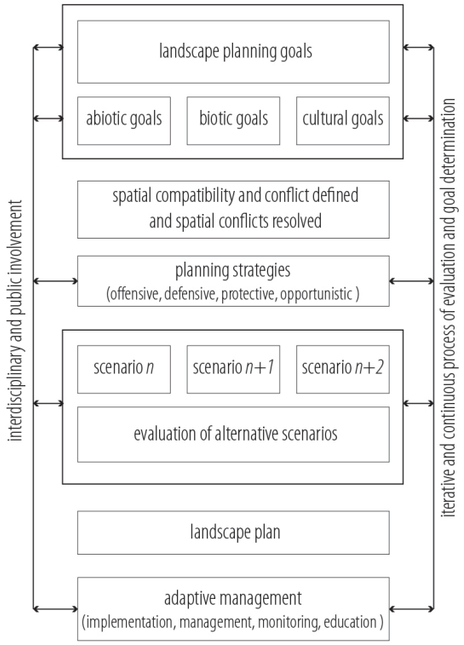
The word "scenario" derives from the Latin scaena, meaning "scene", "show", or "plot". The term was originally used in the context of such performing arts as theatre and film. Van Notten (2005) defines a set of characteristics that identify scenarios as hypothetical, causally coherent, internally consistent, and descriptive. In fact, they are consistent and coherent descriptions of alternative hypothetical futures that reflect different perspectives on past, present, and future developments. Even though there are many variations over the definition of "scenario", on one point there is consensus: it is not a prediction of a probable future, which is something provided by forecasts (van Notten, 2005).

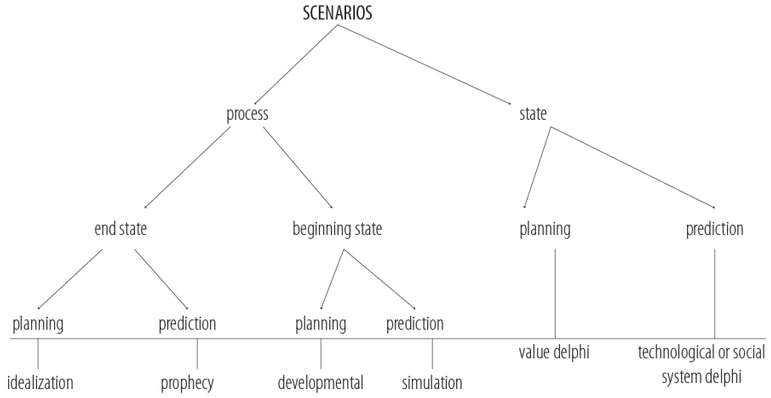
The development of scenarios results to be a very effective tool for the discipline of landscape architecture and planning. In fact, they provide a potential perspective that is not constrained by the present situation and they induce the reflection on spatial consequences. According to Hirschhorn (1980), a complete scenario should include a description of the current situation, a potential future state, and a means of implementation. In many instances, alternative scenarios are intentionally generated with the explicit purpose of demonstrating a range of possibilities, normally very discordant.

In addition, there can be two different types of scenarios: "state scenarios" and "process scenarios". A state scenario simply describes a future situation, without articulating the steps or events needed to reach it. A process scenario provides a "road map" of assumptions, events and steps linking the present with the future. Process scenarios are the most appropriate and most useful for landscape planning. Being process-based, their main goal is to create a link between the present with a possible plausible and surprising future condition. In their turn, process scenarios can be subdivided into "beginning state driven" and "end state driven" scenarios. A "forecasted" or "beginning state driven" scenario projects current trends to produce a trajectory on which a possible future may be conceived. On the contrary, a "backcasted" or "end state driven" scenario, is based on an idealized spatial concept, or vision, of what the future could be. Backcasted scenarios are often designed to articulate and visualize spatial consequences.

As notably discussed further by van Notten, the "state" and "process" scenarios are endowed with two diverse functions: the former promotes "the identification of driving forces and signs of emerging trends, policy development and policy testing"; the latter promotes "learning, communication, improving observational skills". Process-oriented scenarios, the ones more suitable for the discipline of landscape planning, elaborate an educative function towards people's information. They integrate "possible future events and developments into consistent pictures of the future, improve participants' intellectual and creative skills, and might serve as a vehicle to instil a consciousness of the future in society" (van Notten,

But, as societies are not mechanistic entities, the possibility of dramatic changes can never be ignored. Such breaks in trends which seem to be evident occur very often. I think that, 30 or 40 years ago, nobody would have foreseen the shift in the growth of productivity in agriculture in the past few decades, or the spectacular growth in tourism.
Schooenboom (1995), p. 18





Scenarios are not predictions; they are vignettes of possible futures, of what could be given specific assumptions and actions, as opposed to what will be.

Ahern (1999), p. 27

2005).

The main goal of developing scenarios is their exploratory end, consisting in the possibilities the future might unveil. The higher the degree of uncertainty concerning the future the more appropriate is the application of the scenario approach (Ahern, 1999). In addition, the time-spans considered are crucial in the definition of scenarios, especially related to the case of landscape architecture. As suggested by van Notten, Braudel's classification of time (1972) might be at the core of the development of meaningful scenarios, through the consideration of "geographical time" or *longue durée*, "social time", and "individual time" or *histoire événementielle*. This classification, which spans from millennia and centuries, hundreds of years and decades, to several months, weeks and days, needs to be considered in order to elaborate more on the effects at different time scales.

As will be further presented in chapter 07/01, this research-by-design defines four probable scenarios for the Venetian Lagoon by 2100. The variables considered, derived from an extensive historical analysis and previous studies on scenario construction for the Venetian Lagoon by Avella (2019), are the pairs Transformation *versus* Preservation and Resilience *versus* Resistance. According to the existing and presented categorization, four process end state driven scenarios are elaborated according to these four variables, in order to envision four different spatial results for the Venetian Lagoon.

06/03/02 Building-with-Nature, Nature-based flood defences and time

Building-with-Nature, in essence, is a design principle that flexibly integrates land-in-sea and water-in-land in complex ecosystem, taking into account existing and potential landscape values, in harmony with natural materials and forces, in order to reduce the usage of invasive techniques (Waterman, 2007). The materials considered, loose and mobile, are sand and silt of different composition, sizes and structures, while the forces and fluxes integrated in the planning are tidal action (ebb and flood), wave actions, sea currents, river outflow, gravity, wind, rain, solar radiation, dune-vegetation, coastal zone-mangroves, lagoon-brackish marshlands interaction, and marine organisms-sand/silt/coral complex interaction.

According to Deltares, a Dutch Technological Institute, the Building-with-Nature approach is founded on six principles:

_Understand system functioning

_Identify the system's envisaged functions and plan a project or activity accordingly

_Determine how natural processes can be used and stimulated to achieve the project goals and others

_Determine how governance processes can be used and stimulated to achieve the project goals

_Monitor the environment during execution and - if necessary - adapt the monitoring program and/or the project execution

_Monitor the environment after completion, to assess the project's performance, adapt its management, and to learn for the future.

Therefore, as stated by de Vriend (2014), the common denominators that define Building-with-Nature projects are:

_Natural environment inclusion, as a 'stakeholder' and essential contributor to the realization and operation

_Integrated multifunctional approach

_Active stakeholder involvement.

In Building-with-Nature design method, interdisciplinary cooperation and planning becomes essential. Within this framework, every discipline needs to address its own objectives and integrate them with the others, to create the conditions for natural processes to happen and function correctly.

In the specific, regarding the Venetian Lagoon, the Building-with-Nature method and principles applied within the proposed design will contribute to:

_Mitigate the effects of climate change and sea level rise through the definition of a nature-based flood defence

_Increase landscape resilience and efficacy in contrasting powerful waves and currents

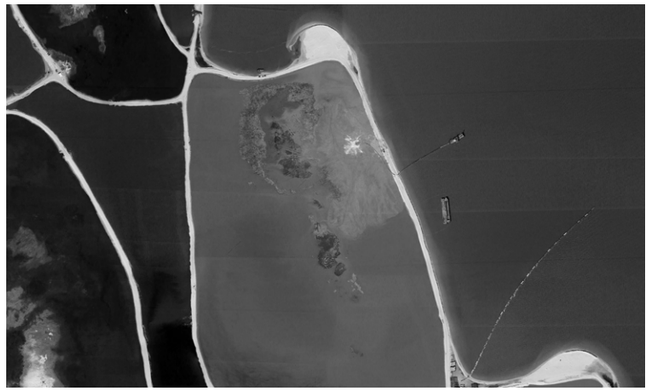
_Restore and create brackish marshlands ecosystem habitat

_Increase differentiation and specificity in relation to the identity and functionality of the places.

06/03/03 Case study: Marker Wadden by VISTA Landscape Architects

The Marker Wadden project by VISTA Landscape Architects has been elaborated following the design principles expressed by the Building-with-Nature design method. The project consists of an artificial archipelago located in the Markermeer Lake, in the municipality of Lelystad, Flevoland Province. The Netherlands. In 2012, this set of islands has been commissioned by the Natuurmonumenten whose main objective was to create a natural reserve in the north-eastern part of the Markermeer.

fig. 06/01 Previous page, top left: Framework method for landscape ecological panning: an iterative, continuous, participatory and interdisciplinary process. Source: Hirschorn, L. 1980. Scenario writing: a developmental approach. APA Journal April: 172–183.
fig. 06/02 Previous page, bottom left: evolution of "process" and "state" scenarios. Source: Hirschorn, L. 1980. Scenario writing: a developmental approach. APA Journal April: 172–183.



The Marker Wadden emerges from the necessity of improving the ecological qualities of the Markermeer. The water quality of the lake and biodiversity rates are extremely poor. The project, directly inspired by the Wadden Islands, is constituted by a stable continuous sandy dune behind which soft and muddy marshlands and wetlands take over. The sandy dune faces the main wind direction, defending the marshes behind from south-westerly winds and north-westerly storms. Creating these dynamic gradients in water depth and land-water transitions (sand dunes, wetlands, reed-beds, marshlands, etc.) contributes to enriching the diversity of habitats and species of the Markermeer. The result will be a marsh landscape with a recognizable spatial structure, with two distinct sides.

To foster the growth of this project, clay is pumped through stages within sand dams, so that it can settle to the lake's bed. Coarser clay drops to the bed closer to the pumping pipes and settle less than the finer clay. This property allow the natural formation of irregular borders and variations in the marshes. Creeks and penetrating water features are both artificially excavated and naturally formed. As the top layer dries out, a crust is formed allowing plants and vegetation to freely grow and birds to search for food. Sand dams are used as foundations for paths and platform, welcoming visitors on the Marker Wadden islands.

From the Marker Wadden case study, three main key points have been deducted, functional to the development of the design project:

_Building with natural processes helps to implement and sustain their intrinsic correct functioning, as well as induce positive effects on the surrounding environment

_Insights on technicalities have been gained (how to orient the groynes according to the main winds and sea currents to implement sedimentation, which initial dredges has to be chosen, how to deposit initial dredges according to the elevation to be obtained, etc.)

_The coexistence of human and natural activities is achievable, in respect to the ecological functioning. The project provides a solid example on how to limit and control human disturbance during specific periods of the year.

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06/04 Scope and relevance of the research

The conducted research and the strategy proposed will engage a significant relevance, at first, for what it concerns the Venetian lagoon itself, with the provisioning of the an unprecedented design strategy built on the complex dynamics of water and sediment flows interaction; furthermore, it will provide insights on decoding and designing in places with similar hydromorphological issues and on considering "building with nature" approach as a catalyst for the coexistence of resilient water protection systems and strong ecological structures; ultimately, it will contribute to the discipline of landscape architecture through the agency of landscape infrastructure in the particular case of its coexistence with an incalculable but seriously threatened historical and cultural heritage, represented here by the city of Venice.

fig. 06/03 In the previous page, clock-wise order: bird-eye view over the Marker Wadden; sand nourishment; detail of wooden walking path over the tidal marshlands. *Sources: VISTA Landscape Architects; Trouw.nl; Natuurmonumenten.nl*

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07/ RESEARCH-BY-DESIGN.

07/01 The concept

The graduation hypothesis relies on the agency of barene, the most distinctive character defining the Venetian lagoon landscape, and their beneficial hydromorphological and ecological functioning to tackle the quantitative disruptive power of water and promote the qualitative amelioration of the surrounding environment. Therefore, fluxes of water and sediments are considered as primary design tools to propose a shift in terms of water protection system in the Venetian lagoon: from a hard infrastructural and engineering-oriented approach to a design-with-nature and processes-oriented approach.

The design will be developed through the implication of lagoon elements characterized by three different levels of dynamism: the most fluid of water (canals for oil ships and containers, cruises, and daily mobility, natural ghebi), barene and velme (appear and disappear according to daily and seasonal tides, grow and erode, in open exchange with the water and winds fluxes), and the islands, the most stable elements, those which has been living places until the moment of abandonment.

The temporal dimension considered by the strategy reaches 2050. The interventions proposed will both consider the immediate necessity, the urgency of achieving significant and functioning defensive infrastructures in a short time period, and the gradual evolution that building with natural processes fosters in a medium and long term period. These three levels of temporality (short, medium and long term) will also dialogue with the cyclical features of the waters in the Venetian lagoon: daily tides with minimum and maximum peaks every 6 hours, weekly tides according to the moon position (syzygy and quadrature), and seasonal tides according to weather components (wind, atmospheric pressure, etc.). These alternations will be considered in the design definition.

The spatial extension considered by the scenario will be the totality of the Venetian lagoon, in order to propose strategical measures able to function among the different systems characterizing the whole landscape. The intermediate scale will refer to the most endangered and threatened area of the lagoon, the juncture surface between the two sub-basins of Lido and Malamocco (central Venetian lagoon). Here, specific locations will be chosen in order to investigate the applications of hydromorphological processes as design tools at the architectonical scale. More in detail, creating the conditions for a specific flora through the recreation of a fresh-brackish-salt water gradient will also be part of the design, determining it as an additional layer supporting ecological amelioration and valuable spatial qualities.

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07/02 Four scenarios for the Venetian Lagoon

As presented in chapter 07, this research-by-design defines four probable scenarios for the Venetian Lagoon by 2100. The variables considered are the pairs Transformation-Preservation and Resilience-Resistance. According to the existing and presented categorization, four process end state driven scenarios (van Notten, 2005) are elaborated according to these four variables, in order to envision four different spatial results for the Venetian Lagoon. In order to better distinguish the possible consequences of these four scenarios, the Venetian Lagoon's transformation from a natural to an anthropic landscape following regulation or exploitation purposes has been studied, analysed and drawn. In fact, to propose a valid range of scenarios is important to have clear in mind the past events in order to understand present times and speculate about possible futures.

The four scenarios resulting from the corners therefore are:

_The Operating Lagoon (preservation-resilience)

_The Engineered Lagoon (preservation-resistance)

_The Archipelago (transformation-resilience)

_The Freshwater Reservoir (transformation-resistance).

The research, to proceed further, has considered the preservation of the lagoon as such as initial entry.

The Engineered Lagoon depicts a moment in future times when the Venetian Lagoon will be defended uniquely through engineering infrastructures, modelled on the Mo.S.E. example. Land opposes the sea; a neat and material definition of surfaces and boundaries is created; it is a divisive and divided landscape, defined by fragmentation,

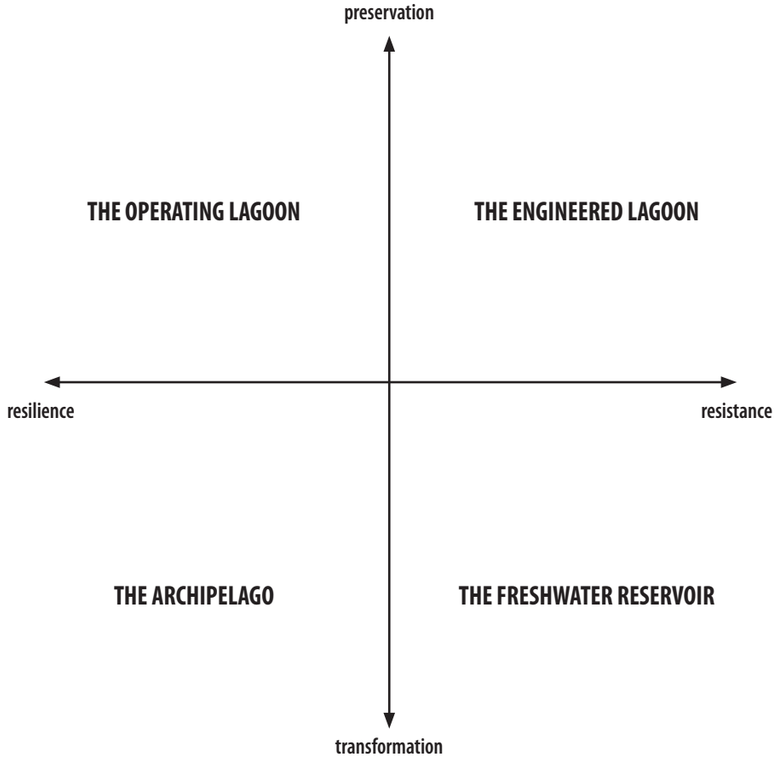


fig. 07/01 AAA

fig. 07/02 Alvise Cornaro plan for the Walled City, 1566.

separation, defence and resistance. As early as the XV century, the emeritus hydraulic engineers of the Serenissima Repubblica di Venezia elaborated functional plans and infrastructures to control and regulate the Venetian Lagoon and better protect the city of Venice. Among all, one explanatory example is represented by the Walled City by Alvise Cornaro (1484-1566), in which high defensive walls are erected in lagoon waters to directly protect Venice islands.

A sub-structure of movable gates protecting uniquely the city of Venice, an increase in height of both Murazzi (between the Venetian Lagoon and Adriatic Sea) and Lagoon Boundary, Conterminazione Lagunare, (between Venetian Lagoon and the agricultural plain behind) embankments, and a system of breakwaters in the Adriatic Sea are thought as possible design strategies.

On the contrary, the Operating Lagoon depicts a moment in future times when the Venetian Lagoon will be functioning correctly, providing independently to its own conservation and preservation. Land integrates sea and sea integrates land, creating sufficient space for coexistence; depth and horizon dimensions characterize the landscape, defined by openness, accumulation and mutation, negotiation and resilience.

According to the theoretical framework previously discussed, the Operating Lagoon scenario, intended as a resilient lagoon and eco-centric landscape infrastructure, will be further investigated through the proposition of 12 design strategies for the achievement of the elaborated scenario.

Short note on "Stop using Malamocco-Marghera canal"

"The great transformations of the 1960s that upset the geography of the Central Lagoon are reasonably non-reversible; but it is still possible to bring the area back to an arrangement that recomposes new functions and identities, restarting a responsible phase in the history of relations between the decision-makers and the Lagoon" (Bonometto, 2017 p. 64).

As explained in detail in chapter 03/01/03, the negative effects that the excavation of Malamocco-Marghera has caused on the hydromorphological processes are manifest and undeniable. Nevertheless, according to Bonometto (2017), a reversal of the disaster caused by the Malamocco Marghera canal is still possible, and can be pursued by responding to these two priority needs:

_Minimize the morphological and hydraulic impacts of the first section of the canal, in order to restore the character and functions of the natural lagoon canals in front of Malamocco inlet (central lagoon);

_Recreate the seabed differentiations, now sunken and flattened, able to channel water flows, in order to reconstruct a network of tidal canals with the relative hydrodynamic layouts.

Regarding the functioning of the aforementioned canal, the goal of this research-by-design is to investigate the transition from the present times, characterized by Marghera harbour as part of the water sphere, relying on cargo shipping and exploiting the Malamocco Marghera waterway as hard infrastructure, to future times which will see Marghera shifting to a green harbour, pertaining the land sphere, depending on logistic traffic, and connected mainly by railway and road infrastructures. This transition will consist on the reasonable and reconsidered coexistence of the harbour and the lagoon, since the limits of tolerance have been widely exceeded.

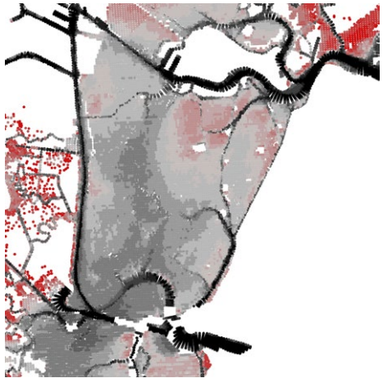
07/03 The Operating Lagoon: 12 design strategies (L)

The Operating Lagoon scenario is developed through the application of twelve synergetic strategies, aiming for the preservation and reconstitution of the Venetian Lagoon. The strategies, derived from the analysis of threats and values elaborated through a cause-effect relation, are:

1. Increase of barene surface (Bonometto, 2017)
2. Implement underwater vegetation (Grechi et al., 2018)
3. Create of water dykes to promote deposition
4. Increase in freshwater discharge (D'Alpaos and Carniello, 2010)
5. Increase in fluvial sediments discharge (D'Alpaos, 2010)
6. Expand fresh-brackish-salt water gradient
7. Reshape and design with lagoon canals (Bonometto, 2017)
8. Open fishing valleys in case of exceptional high water events (D'Alpaos, 2010)
9. Reduce in length concrete jetties of the inlets (D'Alpaos, 2010)
10. Stop using Malamocco-Marghera canal (Bonometto, 2017)
11. Maximum canal's depth set at 5 metres
12. Stop cargo and cruise ships

These measures will produce a mature effect in different time span, from 2020 to 2100, and they will determine a positive response from the whole system of the Venetian lagoon in terms of hydromorphological reconstitution and nature-based flood defence, biodiversity enrichment, cultural heritage rehabilitation and fishing activities support.

fig. 07/03 Scenario strategies visualization: increase of barene surface in the basins of the lagoon; seagrass vegetation implementation (the circles); increase of riverine freshwater discharge and expansion of fresh-brackish-salt water gradient;opening of the fishing valleys in case of exceptional events; length reduction of concrete jetties at the inlets.



-10.00 mt

0.00 mt

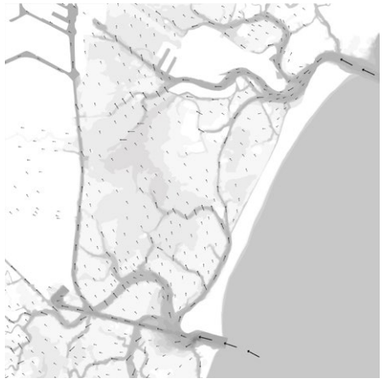
abandoned and private property
abandoned and state property
in use

07/04 Design location and program: between Lido and Malamocco sub-basins (M)

The extension considered for the design proposal is the juncture between Lido and Malamocco sub-basins, between Giudecca Island and Malamocco inlet. First, from the site analysis and scientific literature review, this portion has resulted to be the most degraded area in the entire Venetian lagoon (as explained by the figure about sedimentation and erosion rates between 1970 and 2000); second, it presents the highest concentration of abandoned secondary islands, interestingly relevant from an architectonical and ecological point of view; third, in the proximity of Malamocco inlet, due to the continuous water exchange between the lagoon and the Adriatic Sea, there is a very high concentration in terms of edible fauna: anglers and cultivators habitually frequent these very prosperous waters.

Would it be possible to revolve the tendency of degradation? If yes, how?

Would it be possible to increase the biodiversity rate of the central lagoon, now poor and neglected? If yes, how?



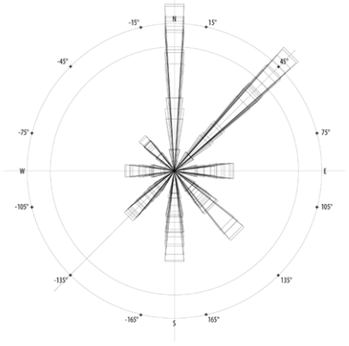


fig. 07/04 Physical boundaries and natural fluxes or those variables present in the central sub-basin of Malamocco that have directly influenced the design proposal. From left to right: bathymetry; islands; canal structure; direction of tidal expansion; sediment plumes; wind yearly average direction.

Would it be possible to design with the neglected heritage of the secondary islands? If yes, how?

Would it be possible to provide functional spaces for workers and anglers? If yes, how?

07/04/01 Flows and environmental functioning

The intervention developed, a system of forty-four barene in the central lagoon, will take advantage of the forces in act, aiming to re-cover the present damaged hydromorphological conditions. The ultimate goal therefore will be to rebalance the power with which the two sub-basins of Lido and Malamocco interact.

The disposition of the system has been influenced by natural flows and physical elements. The flows considered for the design proposal elaboration are the tides (ebb and flood) coming in from Malamocco and Lido inlets, the water currents and their speed of expansion, the sediment plumes (i.e. where sediments are more like to deposit according to water flows) and the winds of Bora and Scirocco. The physical elements considered are the lagoon canal structure, determining as well water transportation routes, the existing bathymetry, and the islands.

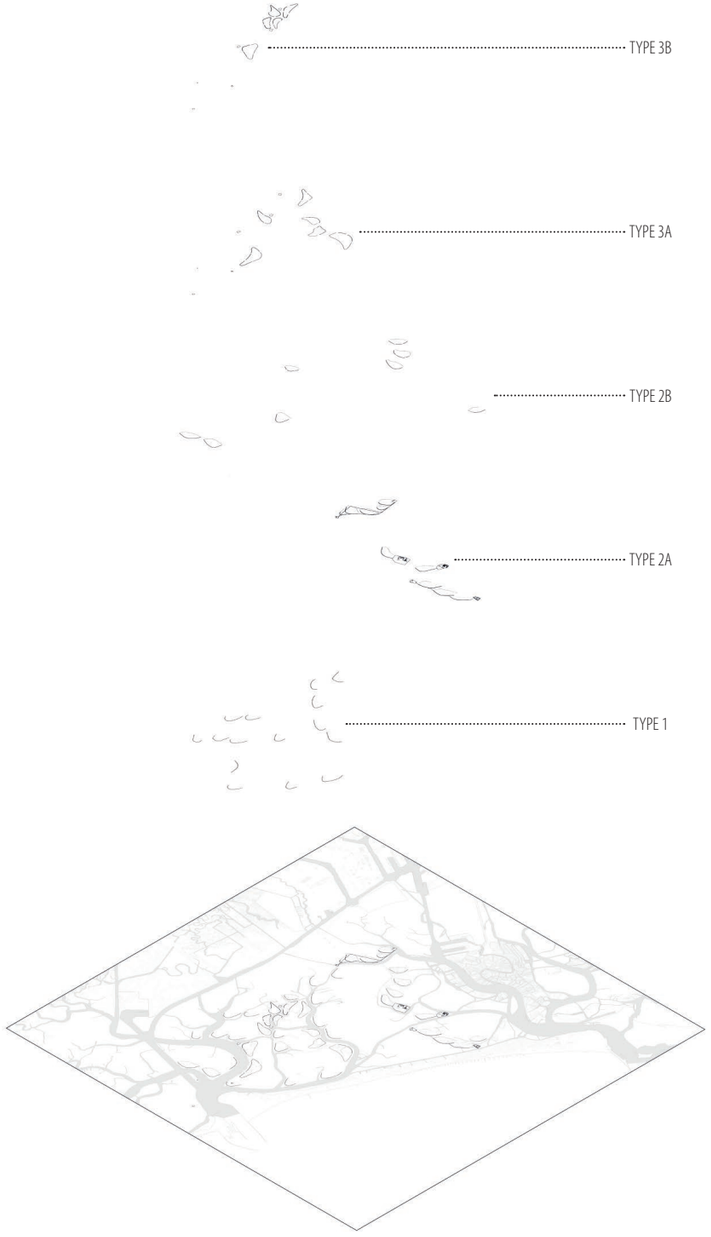
Three different types of structures have been designed, according to initial conditions and goals to be achieved for a certain location.

In the following pages the typological structures will be addressed and explained more in detail.

As concluded by Miazzi (2007), the system of barene positioned as designed will take advantage of natural process and morphological characteristics and will positively contribute to:

_Interrupt wave formation
_Reduce the speed of tidal expansion
_Break wind gusts
_Capture suspended sediments
_Differentiate above water and underwater morphology
_Increment thin sediment (silt and clay) concentration
_Avoid sediment dispersal
_Natural formation of creeks and permanent shallow lakes.

fig. 07/05 Present conditions of the central sub-basin of Malamocco



07/04/02 Technicities: five typologies for 44 structures

07/04/02/01 Type 1

Type 1 structures are composed by a single, open, and continuous underwater dyke (1), arriving at -0.20 mt. below the average sea level. The structure will accumulate sediment underwater up to -0.20 mt., providing fertile ground for seagrasses natural colonization.

The initial conditions required for its application are relatively deep seabed (between -0.75 m and -1.5 m) and presence of powerful waves. In fact, they are placed both there where canals bifurcate (where naturally discrete accretion happens) and where there is great necessity of reducing speed and intensity of natural phenomena.

The main goals achieved will be:

_the interruption of wave formation, caused by winds, ships and boats(1)

_the differentiation of underwater morphology achieved through accretion (1)

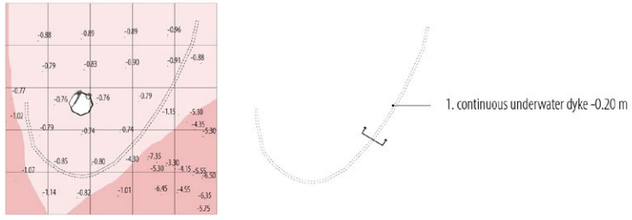
_the reduction of tidal speed of expansion (1)

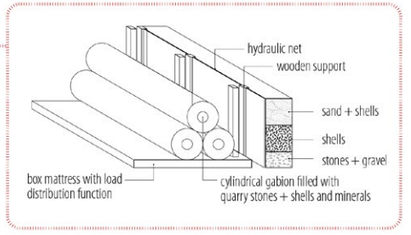
The construction detail (detail A) represents the modular termination of Type 1, consisting of:

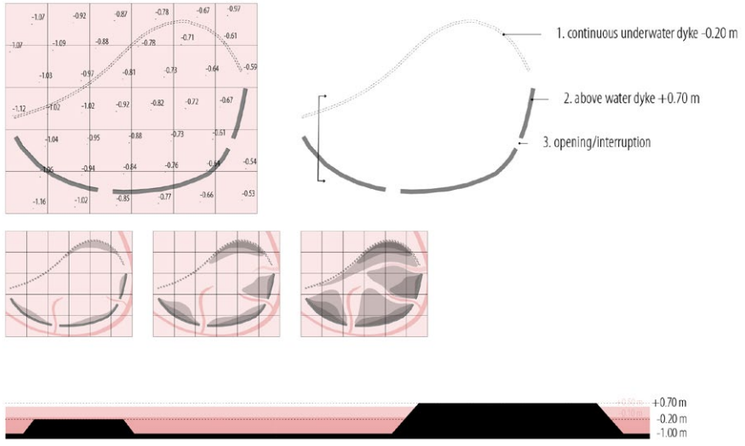
_filtering wall with poles and hydraulic net (placed or spaced according to the intensity of the wave motion);

_cylindrical gabions in high-strength geogrid, or in geogrid in natural fibres with medium/low resistance, installed on several rows;

_load distribution mattress.







07/04/02/02 Type 2A

Type 2A structures are composed by two elements: a continuous underwater dyke -0.20 mt. below the average sea level (1) and above-water dykes +0.70 m high (2). These above-water dykes are interspersed with openings (3) to facilitate the formation of small creeks and natural shallow lakes. The structure will accumulate sediment under and above water, up to +0.60 mt., providing fertile ground both for seagrasses natural colonization and *barene* vegetation.

The initial conditions required for its application are relatively deep seabed (between -0.75 m and -1.5 m) and presence of powerful waves.

The main goals achieved will be:

_the interruption of wave formation, caused by winds, ships and boats (1)

_the differentiation of underwater and above water morphology achieved through accretion (1, 2)

_the reduction of tidal speed of expansion (1, 2)

_avoid sediment dispersal (1)

_the reduction of wind bursts' speed (2)

_the natural formation of creeks and permanent shallow lakes (3)

The construction materials for elements 1 and 2 are the ones made explicit in detail A.

07/04/02/03 Type 2B

Type 2B structures are composed, as Type 2A, by a continuous underwater dyke -0.20 mt. below the average sea level (1) and above-water dykes +0.70 m high (2), and additionally present a continuous internal dyke for saltmarsh development +0.60 m high (4). This element, inside which sand, silt and clay nourishments will be pumped, will avoid the unwanted dispersal of the dredged materials. Openings will facilitate the formation of natural creeks and shallow lakes.

The initial conditions required for its application are relatively deep seabed (between -0.75 m and -1.5 m) and presence of powerful waves.

The main goals achieved will be:

_the interruption of wave formation, caused by winds, ships and boats (1)

_the differentiation of underwater and above water morphology achieved through accretion (1, 2, 4)

_the reduction of tidal speed of expansion (1, 2)

_avoid sediment dispersal (1, 4)

_the reduction of wind bursts' speed (2)

_the natural formation of creeks and permanent shallow lakes (3)

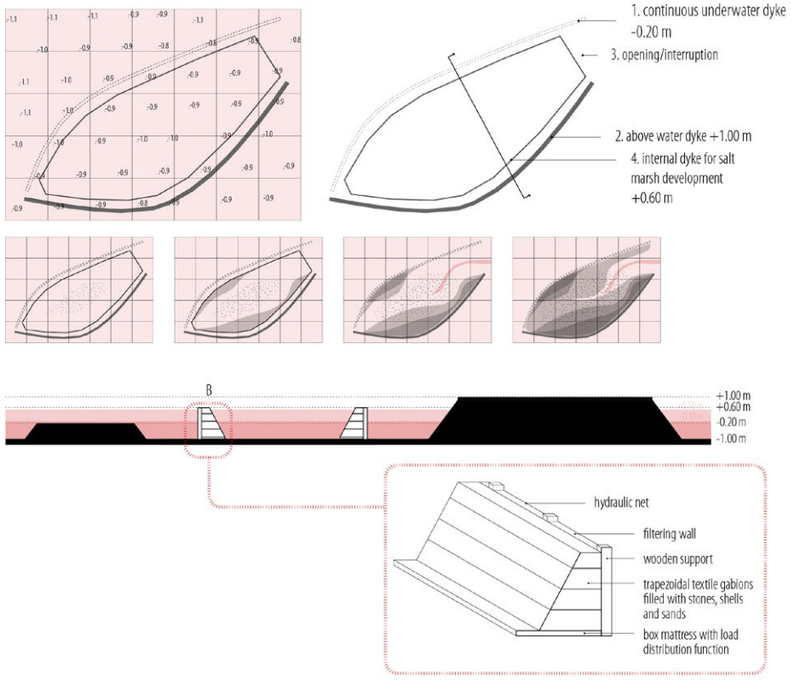
_thin sediment (silt + clay) accretion (4)

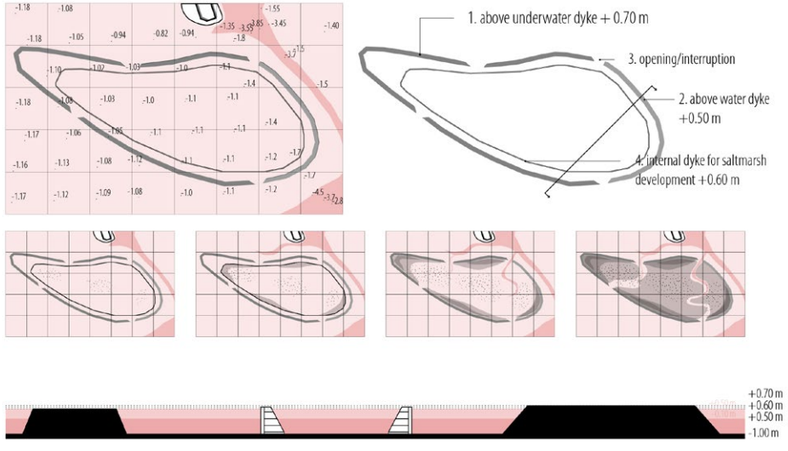
The construction materials for elements 1 and 2 are the ones made explicit in detail A. The construction detail (detail B) represents the modular termination of element 4, consisting of:

_filtering wall with poles and hydraulic net (placed or spaced according to the intensity of the wave motion);

_trapezoidal textile gabions in high-strength geogrid, or in geogrid in natural fibres with medium/low resistance, installed on several rows;

_load distribution mattress.





07/04/02/04 Type 3A

Type 3A structures are completely enclosed and surrounded by above water dykes, +0.70 m (1) and +0.50 m high (2), and a continuous internal dyke for saltmarsh development, +0.60 m high (4). Openings will facilitate the formation of natural creeks and shallow lakes.

The initial conditions required for its application are deep seabed (between -1.5 m and -2.0 m) and presence of powerful waves and currents.

The main goals achieved will be:

_the interruption of wave formation, caused by winds, ships and boats (1, 2)

_the differentiation of underwater and above water morphology achieved through accretion (1, 2, 4)

_the reduction of tidal speed of expansion (1, 2)

_avoid sediment dispersal (1, 2, 4)

_the reduction of wind bursts' speed (1, 2)

_the natural formation of creeks and permanent shallow lakes (3)

_thin sediment (silt + clay) accretion (4)

The construction materials for elements 1 and 2 are the ones made explicit in detail A. The construction material for element 4 is the one made explicit in detail B.

07/04/02/05 Type 3B

Type 3A structures are completely enclosed and surrounded by above water dykes, +1.0 m (1) and +0.50 m high (2), and a continuous internal dyke for saltmarsh development, +0.60 m high (4). Openings will facilitate the formation of natural creeks and shallow lakes.

The initial conditions required for its application are deep seabed (between -1.5 m and -2.0 m) and presence of powerful waves and currents.

The main goals achieved will be:

_the interruption of wave formation, caused by winds, ships and boats (1, 2)

_the differentiation of underwater and above water morphology achieved through accretion (1, 2, 4)

_the reduction of tidal speed of expansion (1, 2)

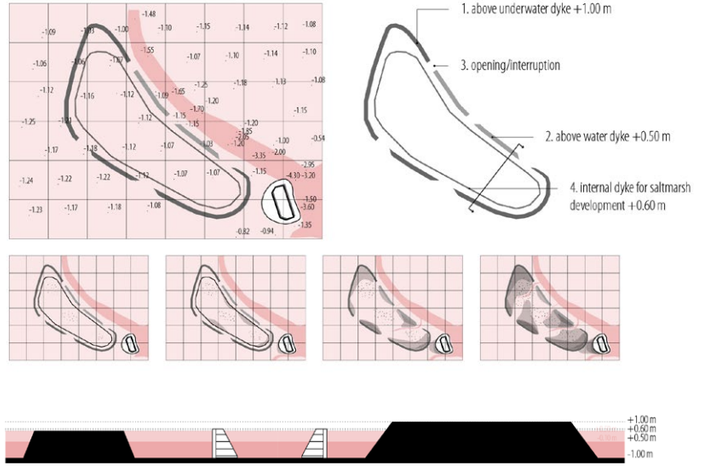
_avoid sediment dispersal (1, 2, 4)

_the reduction of wind bursts' speed (1, 2)

_the natural formation of creeks and permanent shallow lakes (3)

_thin sediment (silt + clay) accretion (4)

The construction materials for elements 1 and 2 are the ones made explicit in detail A. The construction material for element 4 is the one made explicit in detail B.

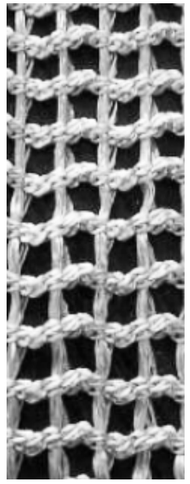


01

02

03

fig. 07/07 From top to bottom. The growth of an artificial barena: after 12 (01), 24 (02), and 36 (03) months. Vegetation and sediment accumulated will incorporate slowly the borders.



01

02

03

04

fig. 07/08 Examples of biodegradable materials to be used for the structures' production.
01/ Geotextile composed of natural fibres (viscose) derived from cellulose.
02/ Geogrid obtained from vegetable fibres from the agave plant.
03/ Geogrid obtained from wood fibres from the outer shell of the coconut.
04/ Natural fibre geotextile composed of yarns from hemp, Yuta, cellulose and wool.

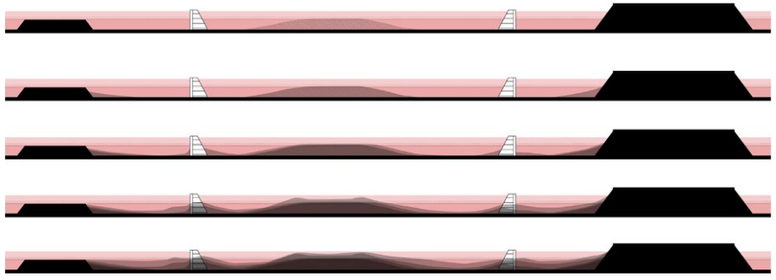


fig. 07/09 Below. Sections in time showing the accretion in a Type 2B structure. 2020, 2025, 2030, 2035, and 2040 are temporal thresholds represented.

As time passes, the sediment accumulated and the vegetation will entirely incorporate the modular termination structures. The materials derive from natural fibres (vegetable, wood, etc.) and their degradation and dispersion will not harm the surrounding environment. Thanks to the wide mesh, thicker sediments and vegetal roots will be able to penetrate into the structures and consolidate permanently.

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07/04/03 Evolution through time

The construction, the growth and the evolution of the different clusters of *barene* will happen through different temporal thresholds, between 2020 and 2050, as explained by figure 07/08 and between figures 07/08/01 to 07/08/20 in the following pages.

As reported in the appendix section, chapter 09/01, the timing and the succession of actions and phases have been derived both from literature study but also from the observation (through time) of different moments in the evolution of a *barena.*

fig. 07/10 Growth of the *barene* system by 2050.

fig. 07/08/01 **2020 - 1st stage: CLUSTER A**
Structure construction of the cluster A, the closest to Malamocco inlet. This cluster has been chosen to be implemented at first because it will directly have a beneficial effect over the high currents expanding from the inlet itself, acting as a set of sequential obstacles.

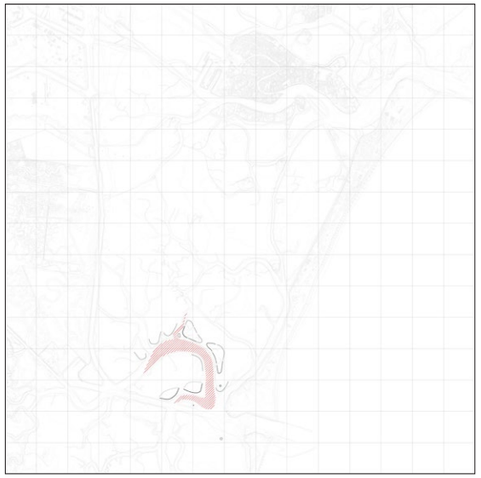

fig. 07/08/02 **2021/22 - 2nd stage: re-opening of Canale Fisolo**
To split the currents, to reduce their speed and power, coming inside the lagoon from Malamocco inlet, Canale Fisolo is cleaned and dug again as it used to be before the excavation of Malamocco-Marghera Canal.

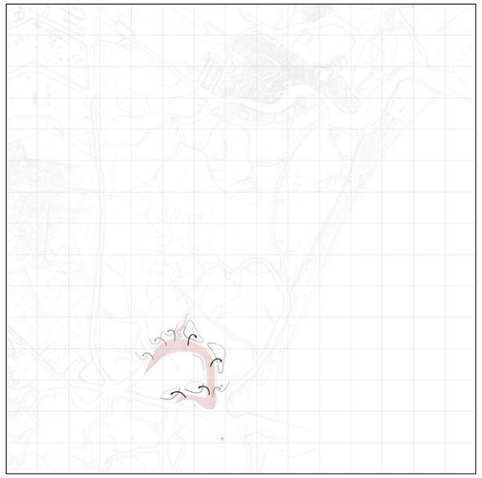

fig. 07/08/03 **2021/22 - 2nd stage: re-opening of Canale Fisolo**
The dredges deriving from Canale Fisolo re-opening will be directly put in place as initiators inside the structures of cluster A.

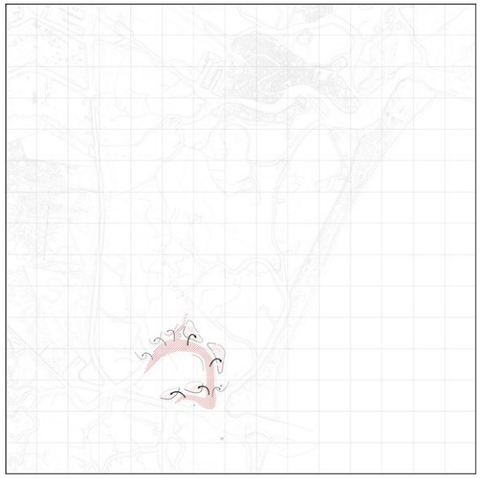

fig. 07/08/04 **2021/22 - 2nd stage: re-opening of Canale Fisolo**
The dredges deriving from Canale Fisolo re-opening will be directly put in place as initiators inside the structures of cluster A. This will help to trap other sediment, naturally circulating in the lagoon.

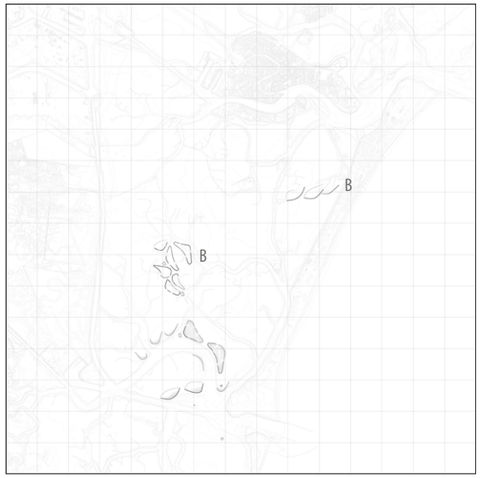

fig. 07/08/05 **2023 - 3rd stage: CLUSTER B**
Secondly, the structures in the centre and between Santo Spirito and Lazzaretto Vecchio islands will be implemented. The structures in the centre because of the damaged situation in which this area is hydromorphologically (function). The structures between Santo Spirito and Lazzaretto Vecchio because of the proximity of the area to the historical centre of Venice and Lido island (image).

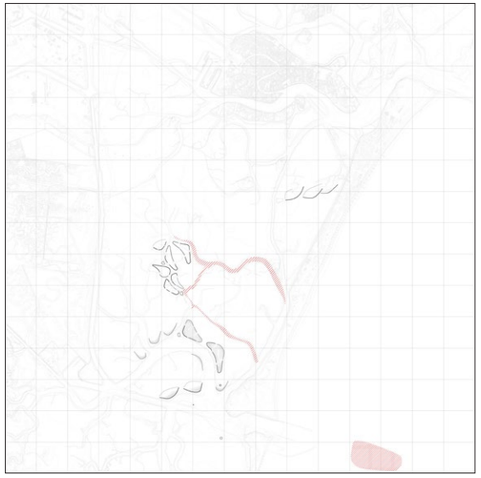

fig. 07/08/06 **2023/24 - 3rd stage: re-opening of Canale Campana, Canale Perarcolo, Canale di Poveglia**
To directly nourish these structures, Canale Campana, Canale Perarcolo, and Canale di Poveglia will be dredged (also to promote better water expansion). In addition, other sediment will be dredged from the area in front of Malamocco inlet.

fig. 07/08/07 **2023/24 - 3rd stage: dredges collocation in cluster B**

fig. 07/08/08 **2023/24 - 3rd stage: dredges collocation in cluster B**
While the dredges are pumped within the cluster B, cluster A continue to accumulate additional sediment, growing in elevation.

fig. 07/08/09 **2025 - 4th stage: CLUSTER C**
The third set of structures to be implement is the one between Sant'Angelo della Polvere and San Giorgio in Alga.

fig. 07/08/10 **2025/26 - 4th stage: cluster C**
To initially help the structures to accumulate sediment dredges from Venice canals' maintenance will be pumped into the system. However, before putting them in place their rate of pollution will be checked. Otherwise, dredges coming from Malamocco inlet will be put in place.

fig. 07/08/11 **2025/26 - 4th stage: cluster C**

fig. 07/08/12 **2025/26 - 4th stage: cluster C**
While the dredges are pumped within the cluster C, cluster A and B continue to accumulate additional sediment, growing in elevation.

fig. 07/08/13 **2027 - 5th stage: CLUSTER D**
With the passing of time, other structures will be added logically. From now on, none of them will be subjected to sand, silt and clay nourishment artificially. Seven structures are added in this phase, of which five underwater will help to diminish water speed in the central basin. In parallel, clusters A, B, and C continue to grow.

fig. 07/08/14 **2029 - 6th stage: CLUSTER E**
In this phase, four structures in proximity of Sacca Sessola island are built. In parallel, clusters A, B, C and D continue to grow.

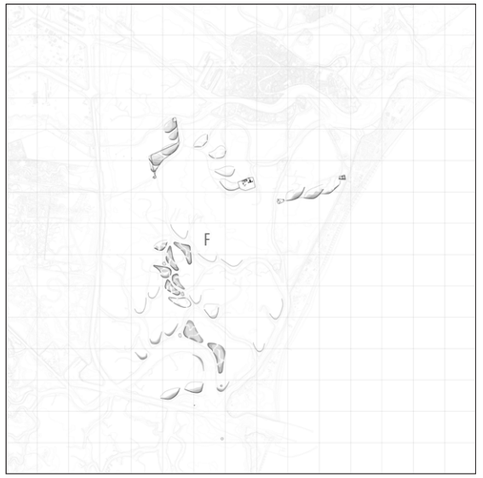

fig. 07/08/15 **2030 - 7th stage: CLUSTER F**
In this phase, three underwater structures are built. In parallel, clusters A, B, C, D and E continue to grow.

fig. 07/08/16 **2031 - 8th stage: CLUSTER G**
Three closed structures are added in this phase. In parallel, clusters A, B, C, D, E and F continue to grow.

fig. 07/08/17 **2032 - 9th stage: CLUSTER H**
The last three underwater structures are built in this stage, in 2032. In parallel, clusters A, B, C, D, E, F, and G continue to grow.

fig. 07/08/18 **2033 - 10th stage**
In 2033, the whole system of artificial structures will be ultimate. The system will continue to grow naturally, taking advantage of natural forces as tides, winds, and waves.

fig. 07/08/19 **2040: 11th stage**

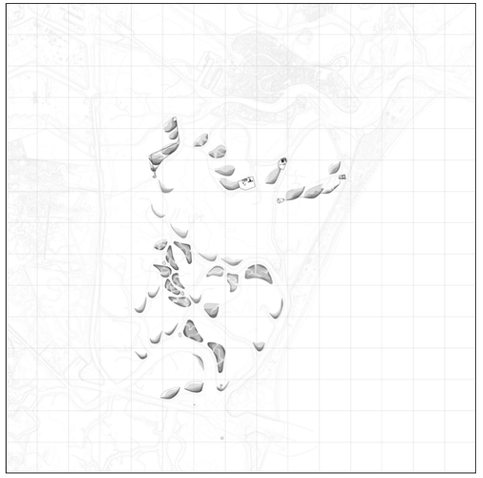

fig. 07/08/20 **2050: mature stage**

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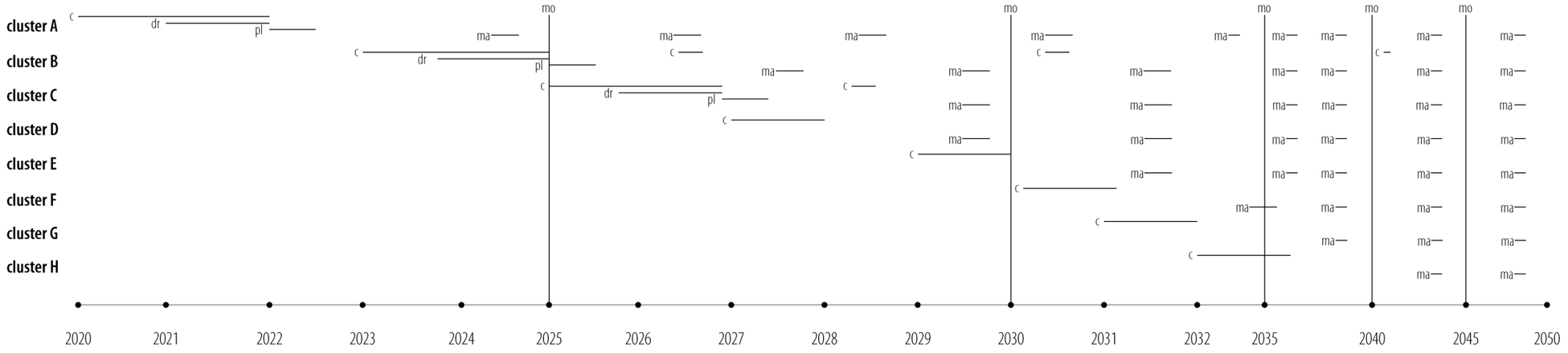

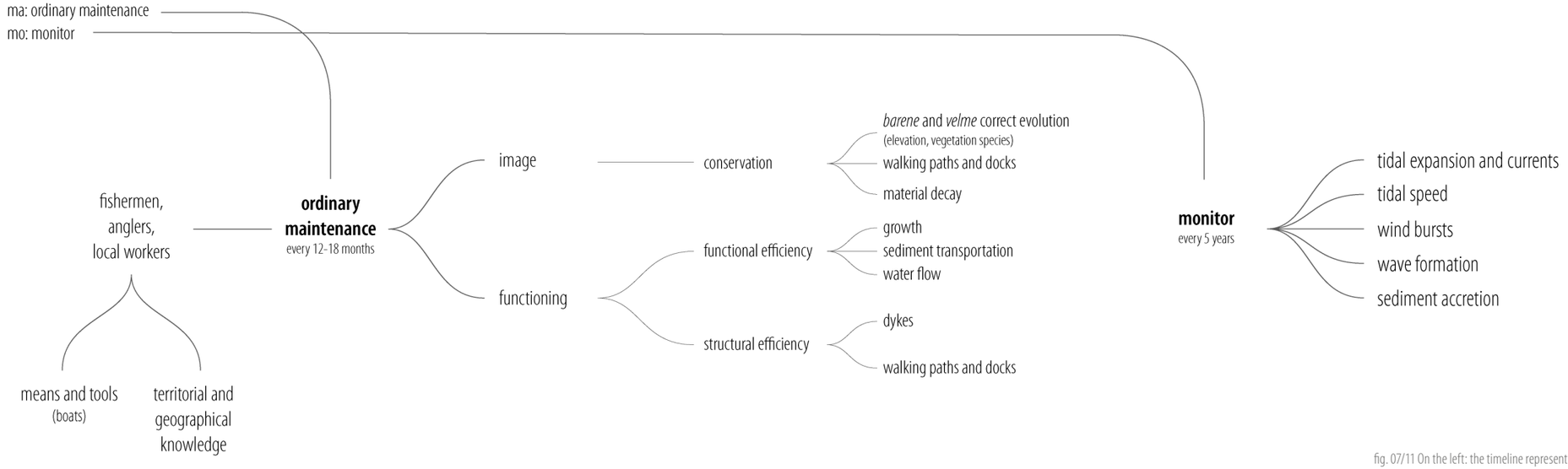

fig. 07/11 On the left: the timeline represents construction periods, maintenance and monitor moments, from 2020 to 2050.

07/04/04 Construction, maintenance and monitor

Construction, maintenance and monitor will play an incisive role regarding the effective performances of the design proposal.

Construction will consist of, at first, building the permanent structures (dykes) that will accumulate sediment. Secondly, the walking paths and boat docks spread all over the system.

Perennial halophyte species as *Sarcocornia fruticosa, Puccinellia palustris, Halimione portulacoides, Limonium narbonense, Juncus maritimus* will be planted, either deriving from the collection of clumps detached from other *barene* or nurseries. Pioneers and annuals halophyte species will spontaneously grow and succeed.

Ordinary maintenance will occur every 12-18 months, and will be carried out by fishermen, anglers, and local workers, equipped with adequate means of transportation and working tools, as well as territorial and geographical knowledge. Ordinary maintenance will concern at the same time both the *image* of the intervention (its conservation) and the *functioning* (its functional and structural efficiencies).

Extra-ordinary maintenance will occur, occasionally, after powerful, unexpected and impacting natural events (heavy swells, thunderstorms, extreme *acqua alta*, etc.) and mainly will consist of checking on the structural efficiency.

Monitoring activities as researches and data collection will be carried out every 5 years about the functional and technical performance of the intervention. Studying the effective physical responses of the central sub-basin to the built structures will provide insightful knowledge regarding potential benefits or potential deteriorations happening in the system.

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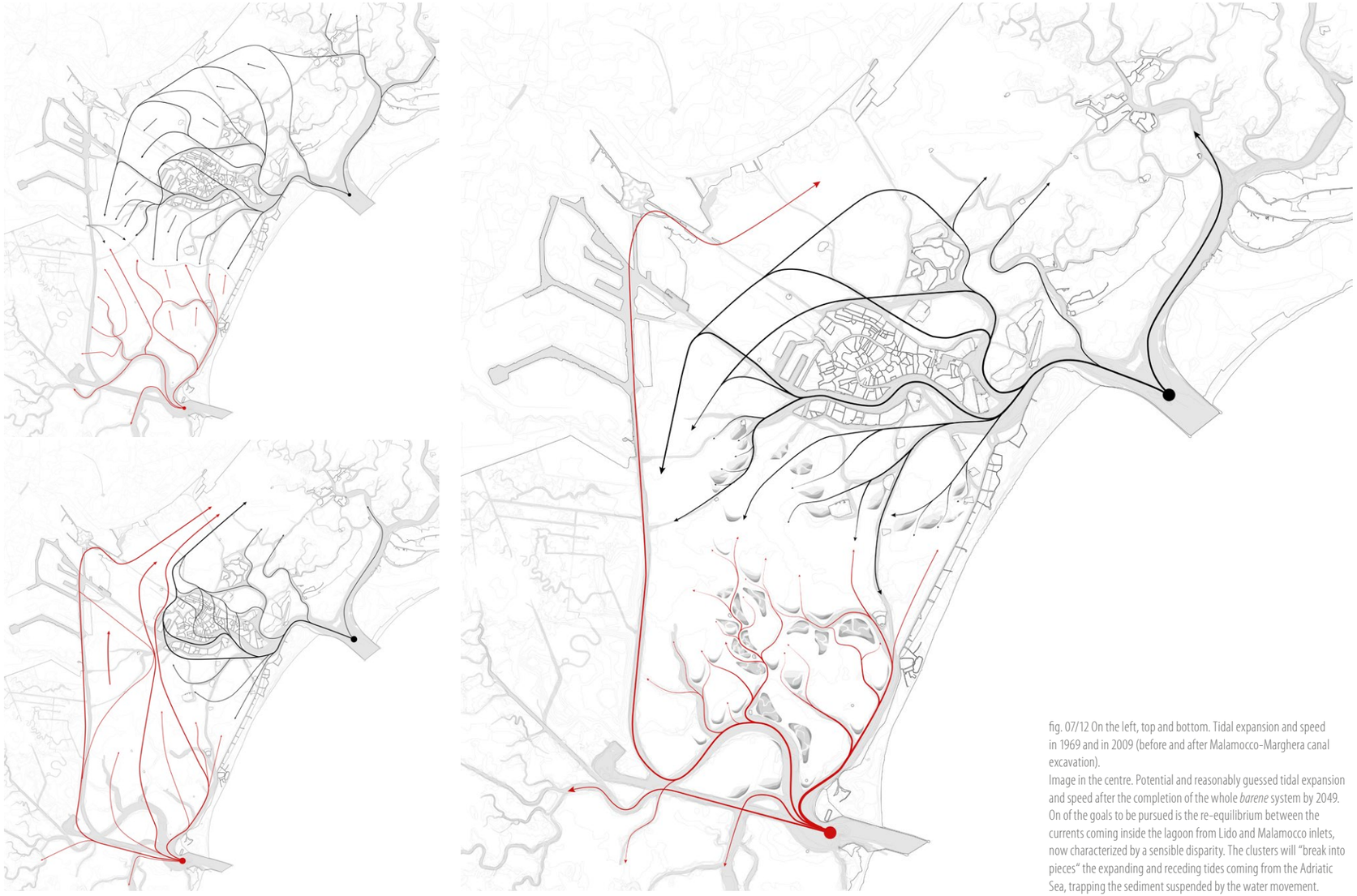


fig. 07/12 On the left, top and bottom. Tidal expansion and speed in 1969 and in 2009 (before and after Malamocco-Marghera canal excavation).
Image in the centre. Potential and reasonably guessed tidal expansion and speed after the completion of the whole *barene* system by 2049. On of the goals to be pursued is the re-equilibrium between the currents coming inside the lagoon from Lido and Malamocco inlets, now characterized by a sensible disparity. The clusters will "break into pieces" the expanding and receding tides coming from the Adriatic Sea, trapping the sediment suspended by the water movement.

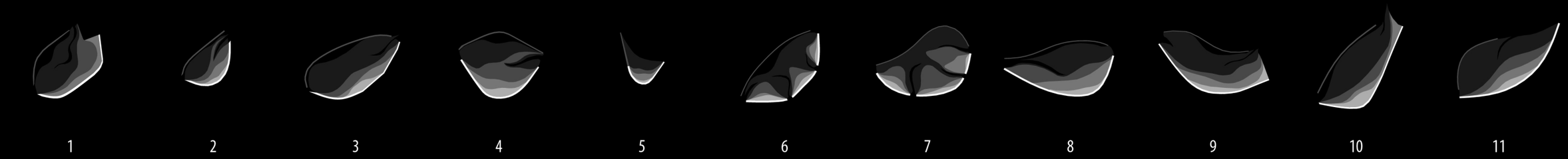
07/04/05 Potential effects on water circulation in the central sub-basin of Malamocco and its resilient performance

The *barene* system, occupying the water surface in the central basin of Malamocco, will determine a (potentially) beneficial effects on its hydraulics and hydrodynamic system. As concluded by Marco Miazzi in 2007 his Master thesis *Analisi degli effetti prodotti dall'inserimento di barene artificiali nella Laguna di Venezia* (Analysis of the effects produced by the insertion of artificial barene in the Venetian Lagoon), the insertion of a number of artificial *barene* in specific locations (corresponding to the designed locations), elevated for +0.50 m over the reference sea level, constitute a significant interruption to the action of the fetch. Through the collocation of these *barene*, winds and wind-generated waves' speed and power are significantly mitigated ("*the shielded areas will be characterized by a lower wave height, which will result in lower tangential forces at the bottom and a decrease in the re-suspension capacity of the sediments*", Miazzi, 2007, p. 79) and the sediment lost in the Adriatic Sea significantly reduced ("*the result of this process will be a reduction in the solid flow rate coming out of the inlet of Malamocco and Lido*", Miazzi, 2007, p. 79).

The design presented in this master thesis addresses these beneficial effects as *potential* because they have not been researched and confirmed through simulating models. Nevertheless, through the comprehensive literature studies carried out, they could be assimilated and described as *probable beneficial effects* to the hydrodynamic system of the central sub-basin of Malamocco.

As underlined in chapter 07/04/03, the gradual growth and evolution of the whole the system will endure and strengthen the resilient response of the Venetian Lagoon. The development of this nature-based flood defence implemented through building-with-nature principles of co-operation will serve, in the short and long terms, the patient reconstitution of those morphological, cultural and productive characters that, over time, have suffered an undeserved state of neglection.

In fact, in the first instance, when the *barene* will be still *young* and not that consolidated, thunderstorms and sea storms will still be affecting almightily the surrounding, but, at the same time, they will be contributing to speed up the accretion processes of the *barene*.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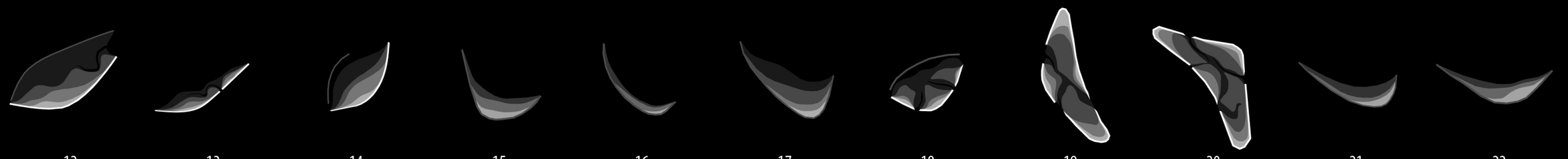
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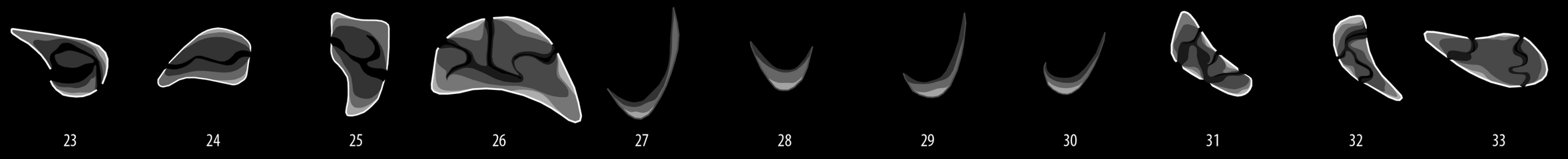
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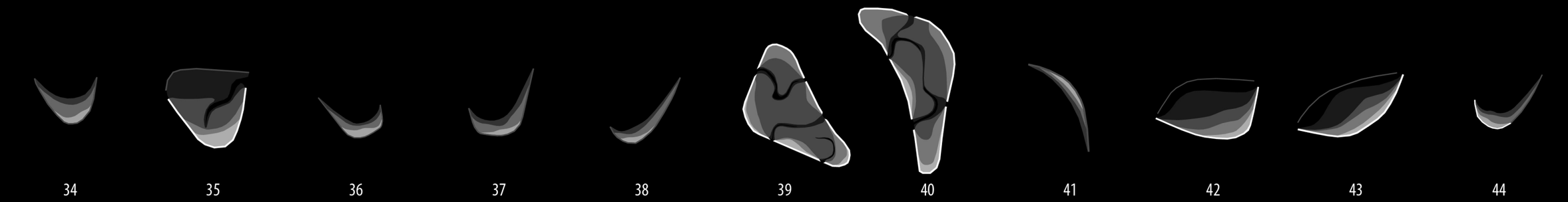
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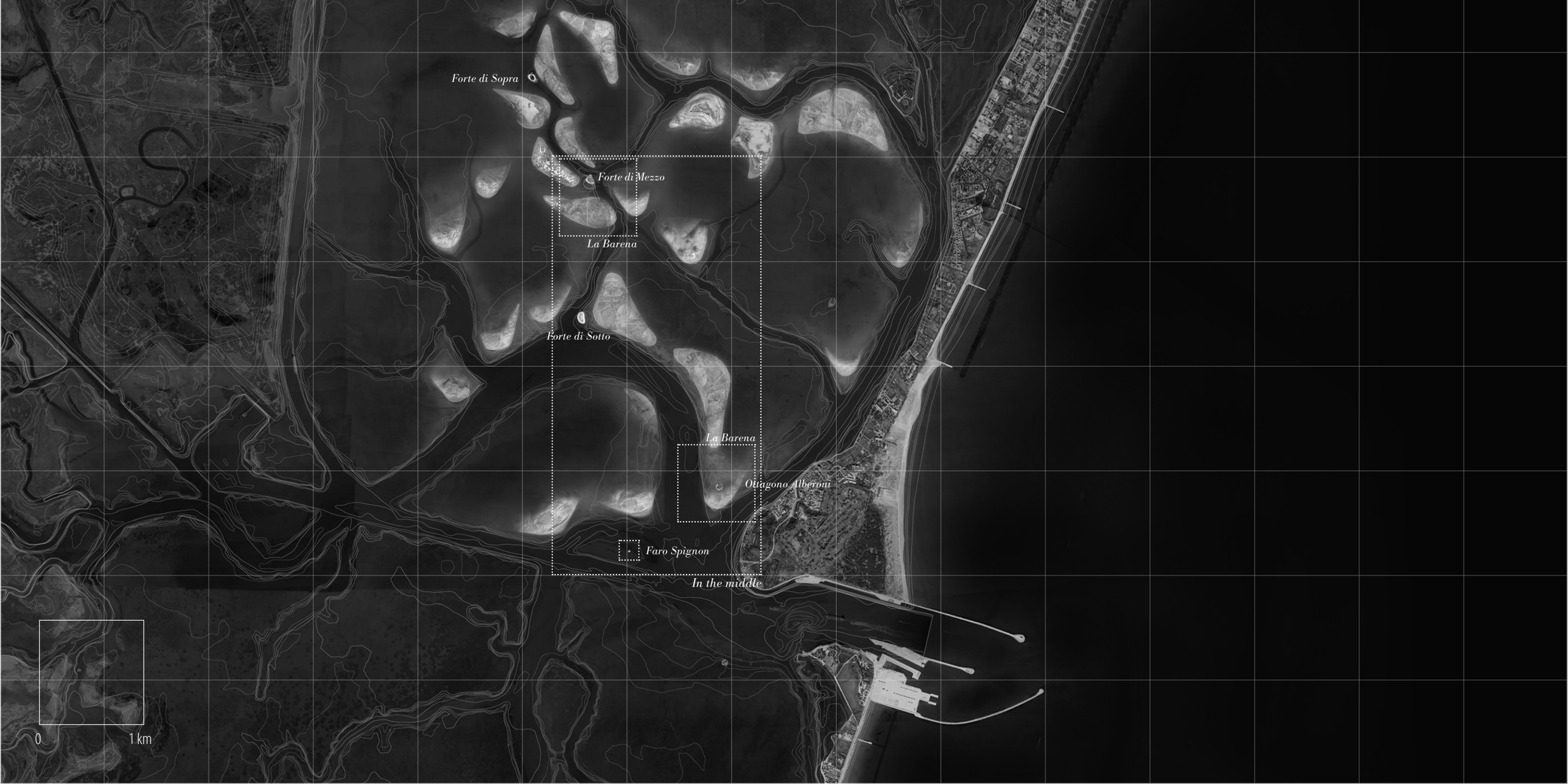
San Giorgio in Alga
Sant'Angelo della Polvere
A walk between Santo Spirito and Lazzaretto Vecchio
Lazzaretto Vecchio
La Barena
Santo Spirito


Forte di Sopra
Forte di Mezzo
La Barena
Forte di Sotto
La Barena
Ottagono Alberoni
Faro Spignon
In the middle
0
1 km

07/04/06 Functional program

The spatial adaptation of abandoned islands is investigated to both reconnect the central lagoon lost architectonical heritage with the local population and foster alternative and slower tourism. In the specific, from north to south, the islands of San Giorgio in Alga and Sant'Angelo della Polvere, Santo Spirito and Lazzaretto Vecchio, Forte di Sopra, Forte di Mezzo and Forte di Sotto, Ottagono Alberoni and Ottagono San Pietro, and Faro Spignon are integrated within the proposed design.

According to the dimensions, the past functions and presence of architectonic artifacts, from north to south, a gradient of activities and experiences has been conceived. The first four (San Giorgio in Alga, Sant'Angelo della Polvere, Santo Spirito and Lazzaretto Vecchio) used to be part of the lagoon life, at first functioning as monasteries. Due to their dimensions, they are more likely to receive a discrete amount of people. The northern barene, closer to the city of Venice, will be more open and oriented towards a lighter kind of tourism; the islands serve as backbone to structure the new barene, as sort of anchoring points.

Vocation: stay and inhabit again, unfold the phenomenon of erosion and sedimentation and tides on an architectonical level, understand the relation between Venice and its lagoon.

The second three (Forte di Sopra, Forte di Mezzo, Forte di Sotto) used to be military forts, having a strategic overview on the central part of the basin and, especially, over Malamocco inlet. The central barene, half way from the city of Venice and Malamocco inlet, are thought to be particularly dedicated to ecological and biodiversity proliferation. They are located in the more degraded area, and the open lagoon here is not at all rich in flora and fauna because of the strong currents that expand during the tides). The islands are included as observation points, detached from the main structures.

Vocation: pass by, observe and understand from the distance.

The third two (Ottagono Alberoni and Ottagono San Pietro), built in XVI century to defend la Serenissima from the Turkish threat, used to be defensive fortifications. The southern barene, closer to the Malamocco inlet, are implemented to support fishing activities (from mussels cultivation to fry and juveniles fishing), being the closest area to the inlet, where freshwater constantly flushes in and salinity is very high. The barene here located will catch the majority of sediments, will become useful breeding area for fauna, and will function as natural environment for fishing activities. The islands will be equipped to sustain anglers with necessary spaces.

Vocation: support production.

Faro Spignon, the final island, as the name already reports, used to be the lighthouse signalling the entrance in the Venetian Lagoon from the central inlet of Malamocco. From its peak 13 metres high, the whole designed system of barene will appear.

07/04/07 Accessibility and transportation

According to the program just outlined, from north to south, a gradient in terms of accessibility and transportation is defined.

The first four islands and the northern barene are thought to be integrated within the already existing system of Venice ferryboats transportation (ACTV), mainly to take advantage of the nautical equipment of the canals already in use. Equipped stops will be provided on the islands: the line 16 will serve San Giorgio in Alga and Sant'Angelo della Polvere, the line 20 will serve Lazzaretto Vecchio, and the line 19 will serve Santo Spirito. A walking path, approximately two kilometres in length, will connect the island of San Giorgio Alga and Sant'Angelo della Polvere, and another the island of Santo Spirito and Lazzaretto Vecchio. These paths will take advantage of the physical structures used to create the barene and they will stand 1.00 metre above the water.

The second three islands and the central barene will be seasonally accessible, from April to October. Organized excursions with flat bottom boats will be provided to visitors to better sail among the shallow canals. Light water transportation means (as canoes, kayaks, and stand up paddles) can freely meander among the barene.

The third two islands and the southern barene will be mainly frequented and used by anglers for productive activities. People and visitors will be welcome especially on Ottagono Alberoni, where a fish market place is thought to be provided by the design.

As already addressed, these islands nowadays are experiencing a discrete amount of informal visits, especially during warmer seasons. During the site survey, this phenomenon has been witnessed in first person, and the design goal is to provide visitors, both locals and tourists, with partially equipped but safe spaces. In order to preserve this free profit observed, the islands are not forced within strict and planned functions.

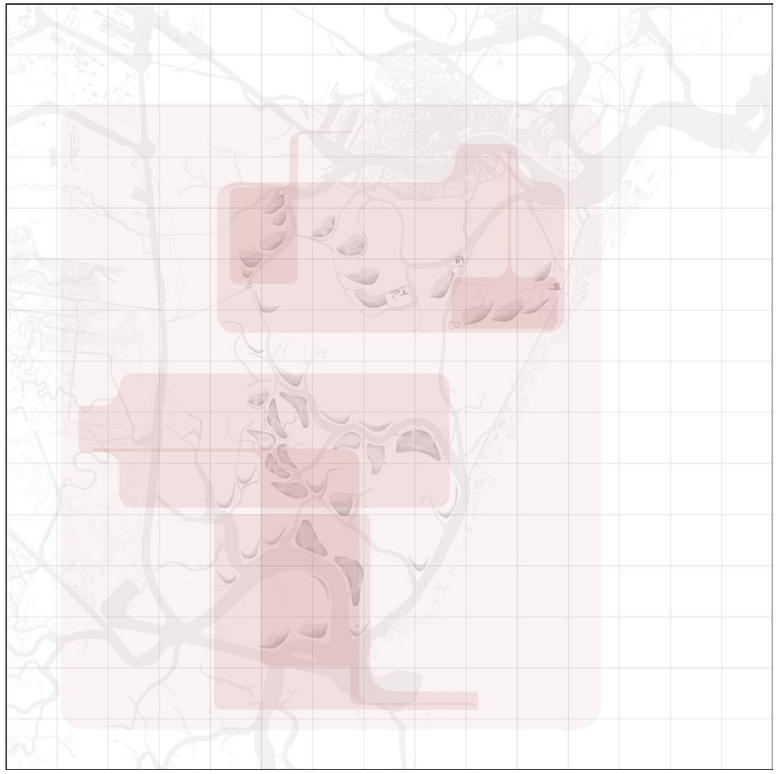


fig. 07/13 Spheres of influences.

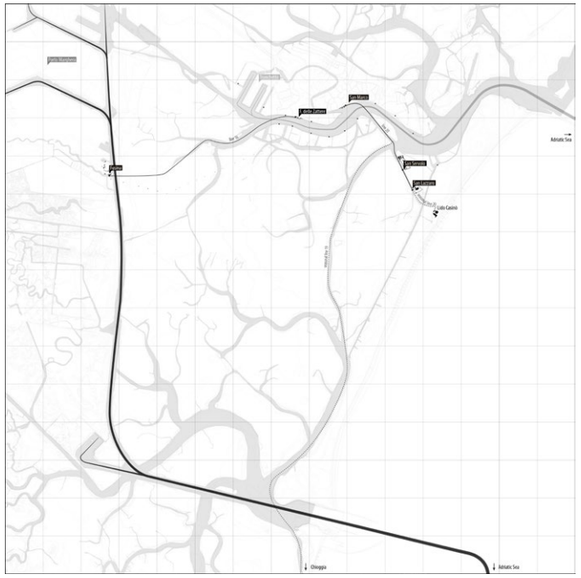


fig. 07/14 Central lagoon navigability as it is nowadays. Heavy cargo ships use Malamocco-Marghera canal to move from the Adriatic Sea towards Marghera harbour, while cruise ships use Canale della Giudecca, crossing the historical centre of Venice, to reach Tronchetto and San Basilio cruise terminal. Only San Servolo and San Lazzaro islands are connected to Venice and, seasonally, to Lido. Fusina can be reached from Zattere all year long.

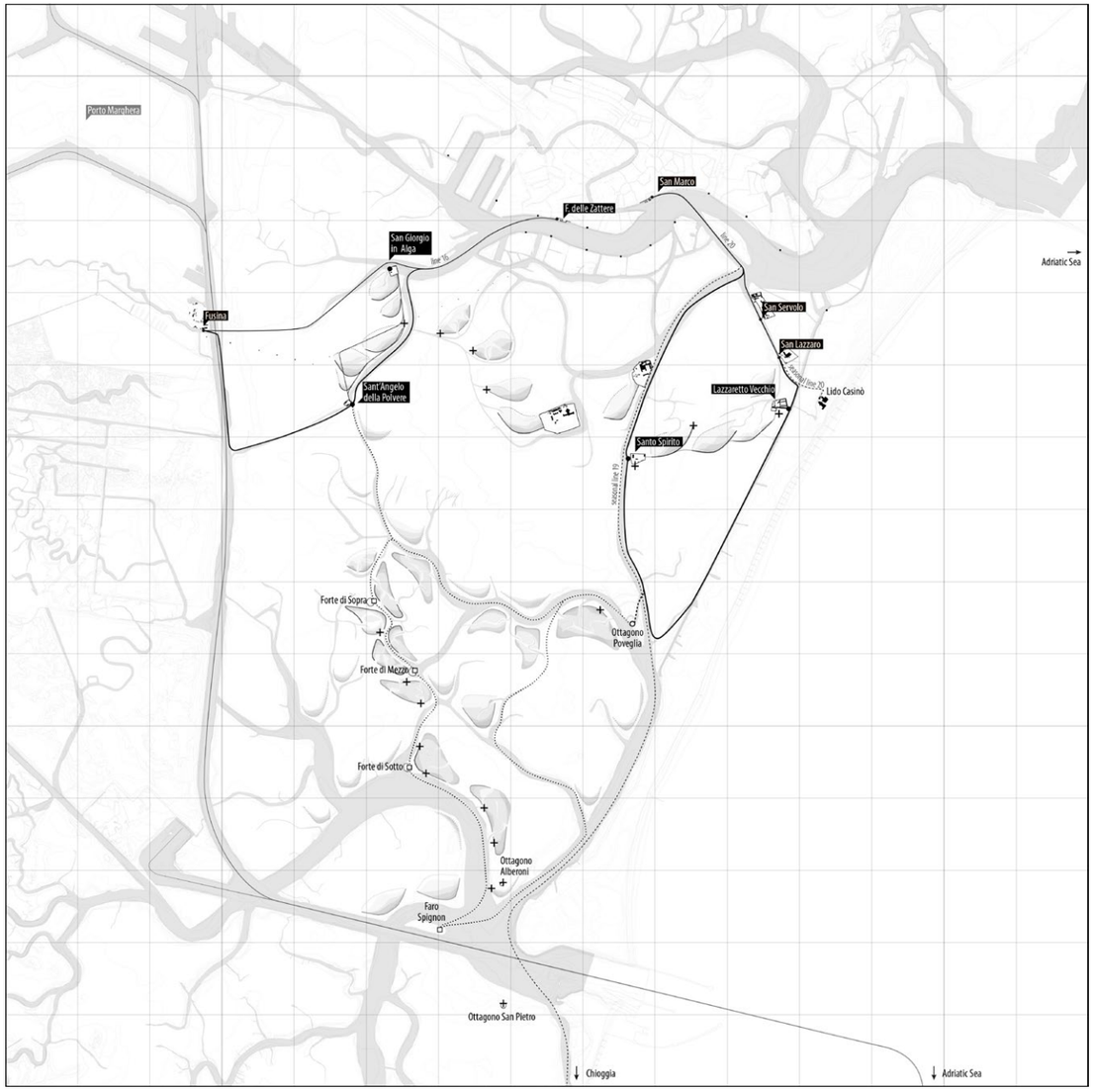


fig. 07/15 Implementation proposed for the central lagoon navigability. San Giorgio in Alga, Sant'Angelo della Polvere, Lazzaretto Vecchio and Santo Spirito become integral part of the public transportation network (ACTV public ferries). Seasonally (from April to October) the central islands of Forte di Sopra, Forte di Mezzo, Forte di Sotto, and Faro Spignon are connected to Sant'Angelo della Polvere and Santo Spirito through a special line. The whole system is equipped with boat docks.

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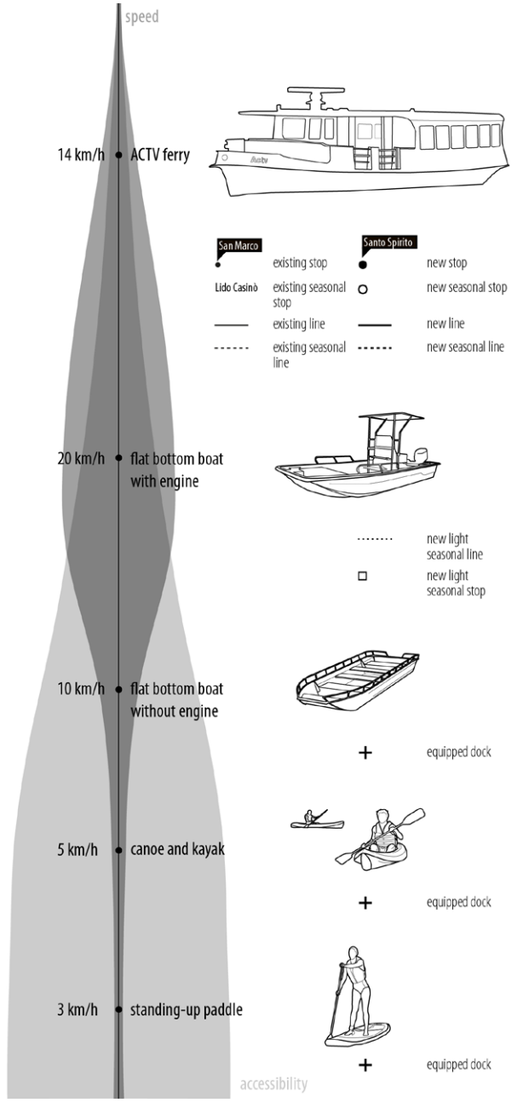


fig. 07/16 The lighter and the slower the transportation means is, the more accessible the project becomes.

07/05 Detailed design (S)

The proposed design is investigated further through the detailing of two selected sites: three *barene* between the two islands of Santo Spirito and Lazzaretto Vecchio; the central core of the system between the islands of Forte di Mezzo and Ottagono Alberoni.

07/05/01 *A walk suspended between land and waters*

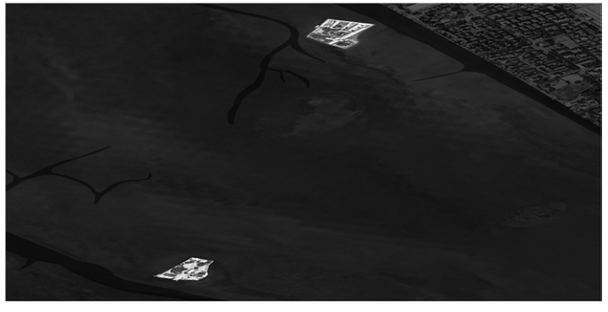
Three barene are proposed to *bridge* the gap between the islands of Santo Spirito and Lazzaretto Vecchio, in the north-eastern part of the central sub-basin of Malamocco. The islands will play the role of anchoring points to which the structures proposed will depart. To be integrated in the design, the islands will be made accessible through partial cleaning of invasive vegetation and securing the present abandoned buildings. The structures will be surmounted with a walking path, circa 2 kilometres long, connecting directly the two extremes.

07/05/01/01 Building process and growth

Being part of the cluster B, the system of three *barene* will be built starting from 2023. First phase, the structures; second phase, sand nourishment; third phase, silt and clay nourishment; fourth phase, seagrasses plating; fifth phase, perennials planting, typical of *barene* ecosystem.

The first five phases, until early 2026, will involve directly anthropic actions (building, dredging, planting, etc.). From 2026 onwards, a part from ordinary maintenance carried out every 12-18 months, natural fluxes (tides, winds, sediment transportation, etc.) will play the most important role.

In the appendix is presented, as a case-study, the evolution of a system of barene built in the northern Venetian Lagoon, in the immediate surroundings of the island of Sant'Erasmo. The timing, derived from the evolution of this system, has been integrated with studies over the evolution of natural *barene*, and therefore here proposed.



2020
Existing situation. The islands of Santo Spirito and Lazzaretto Vecchio are here high-lightened.

2023 - 1st stage: excavation and construction
Based on the former ones occupying the area at the beginning of XX century and later on erased because of accretion, meandering canals are excavated to promote more efficient tidal expansion: they will be fundamental to promote the natural movement of sediment.
The construction of the structures happen in this phase.

2024 - 2nd stage: sand nourishment
Sand, dredged from just outside Malamocco inlet, is used start the process of natural sedimentation. Through a dredge-boat sand is pumped inside the structures until reaching the desired elevation.

2024 - 2nd stage: sand nourishment

2025 - 3rd stage: silt and clay nourishment
Following sand, thinner particles of silt and clay will be pumped in the system. This soil composition is at the base of the typical vegetation proliferation happening on *barene*. Being the sediment extremely thin, they have to be pumped more locally and carefully to avoid unwanted dispersal and loss.

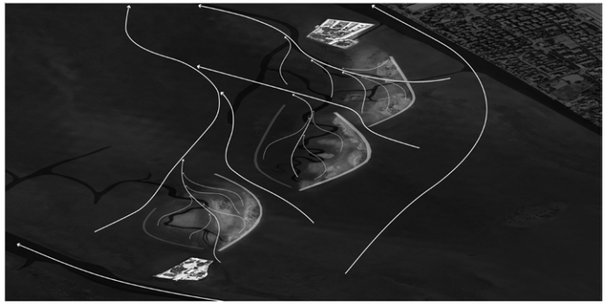
2025 - 3rd stage: silt and clay nourishment

end of 2025 - 4th stage: underwater vegetation prairies
Autoctonous seagrasses of the Venetian Lagoon, *Zostera noltii* and *Zostera marina,* are planted where the structures are the furthest from each other. They will naturally contribute, through their spreading and growing, to consolidate those sediments that will be dispersed by tidal alternation.

early 2026 - 5th stage: perennials halophyte vegetation
Halophyte (salt-tolerant) perennials that populate the elevated borders of barene are planted in this phase: *Juncus maritimus* (sea rush), *Halimione portulacoides* (sea pursplane), and *Sarcocornia fruticosa* (saltworts). Other halophyte pioneer species spread naturally and more quickly, therefore there is no necessity of providing them by planting.

Wind of *Bora*
Wind bursts of *Bora* from north-north east help to consolidate the sediment nourished and naturally accumulated by the system. This happen throughout the life of the *barene*.

Flood tide
Flood tide, occurring every twelve hours, help to redistribute and consolidate the sediment nourished and naturally accumulated by the system. This happen throughout the life of the *barene*.



Ebb tide
Ebb tide, occurring every twelve hours, help to redistribute the sediment nourished and naturally accumulated. This happen throughout the life of the *barene*. Furthermore, underwater dykes and underwater vegetation prairies contribute not to disperse excessively the sediment accumulated by the system.

2026 - 6th stage: accumulation and initial consolidation
Barene start to consolidate of wind, tides and vegetation spread. In this phase, the first part of the walking path (+100 cm and +70 cm of elevation) is built.

2030 - 7th stage: consolidation and continuous accumulation
Barene continue to consolidate thanks to the cooperating actions of wind, tides and vegetation spread. Because of tidal movement, natural creeks and canals form, finding their way through the consolidated sediments. In this phase, following the natural growth of the central *barena*, the second part of the walking path (+50 cm) is built. In addition, sediment start to accumulate on the outer part of the southern dykes, slowly elevating the surrounding bathymetry.

2035 - 8th stage: consolidation, accumulation, and dispersal
Barene continue to consolidate thanks to the cooperating actions of wind, tides and vegetation spread. Natural creeks and canals continue to expand and form. Sediment continue to accumulate on the outer part of the southern dykes. Being part of an open system, the three barene continue to exchange sediment with the lagoon. They gain and lose sediment cyclically.

2040 - 9th stage: consolidation
Barene continue to consolidate thanks to the cooperating actions of wind, tides and vegetation spread. Natural creeks and canals continue to expand and form. Sediment continue to accumulate on the outer part of the southern dykes. In this phase, the third and final part of the walking path (+30 cm) is built.

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07/05/01/02 *La Barena*

The second *barena*, located halfway between the islands of Santo Spirito and Lazzaretto Vecchio, is thought as the device unveiling the dynamics and mechanisms that regulate the functioning of the Venetian lagoon.

Through the help of first sand, and then silt and clay, in twenty years *La Barena* will reach a consolidated form, open to tidal and wind oscillations. To make explicit even more its process of accretion, a walking path is thought to grow alongside with it: as soon, and as long, as La Barena grows, the path will grow with her.

All the attention is focused on the functioning, the image and the solicitations on the five senses: the intervention, making explicit the process of accretion through the gradual addition of the path, brings the observer almost on the same level of the ground. The path gently descends from the structure at +1.0 m, to +0.70 m, to +0.50 m, to +0.30 m, bringing her closer to the internal edge of the *barena*. Here the borders, the limit of what is land and dry and what is wet and water become vague and blurred.

Inevitably, to understand, the visitor wants to overcome the boundary established by the wooden path, and touch finally the soil under her feet.

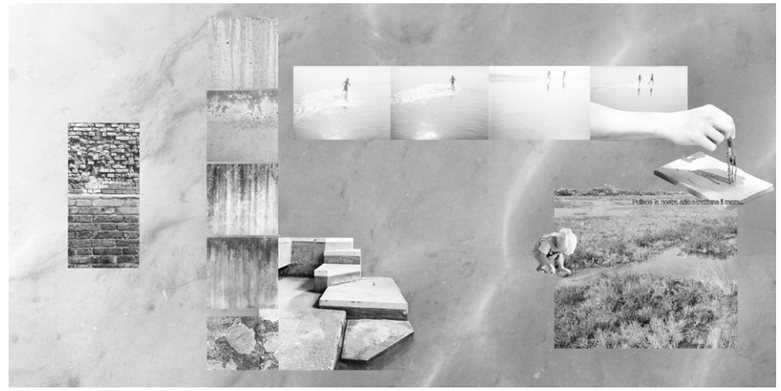

fig. 07/17 to unveil mechanisms and dynamics
to learn about the Venetian lagoon system
to be in contact with nature

fig. 07/18 Positioning of the walking path compared to the surrounding elevations.

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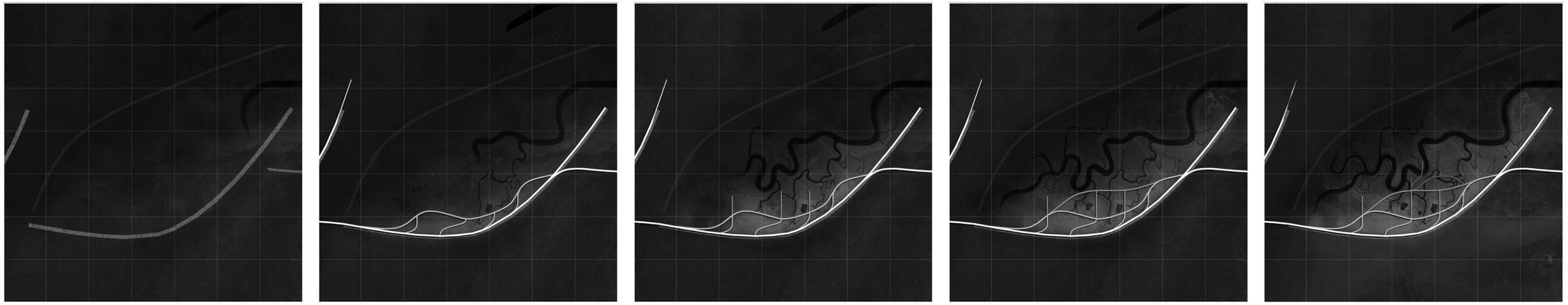
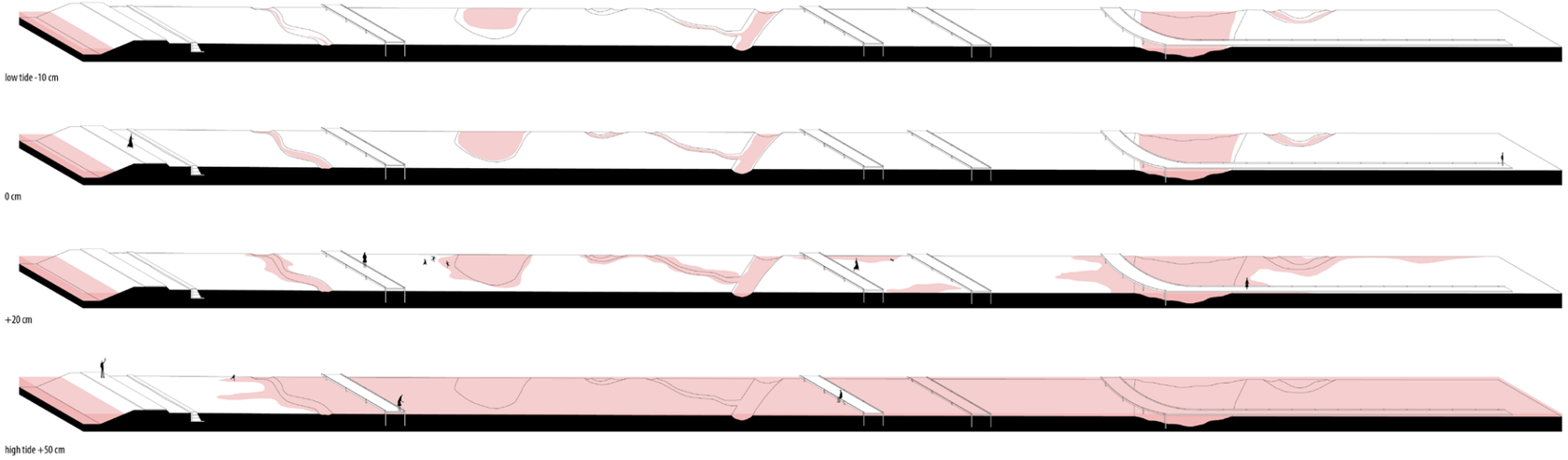
A resilient landscape infrastructure



2023: structures | 2026: +100 cm and +70 cm walking path | 2028: +50 cm walking path, beginning | 2030: +50 cm walking path, completion | 2040: +30 cm walking path

fig. 07/19 Evolution and growth of La Barena between 2023 and 2040.

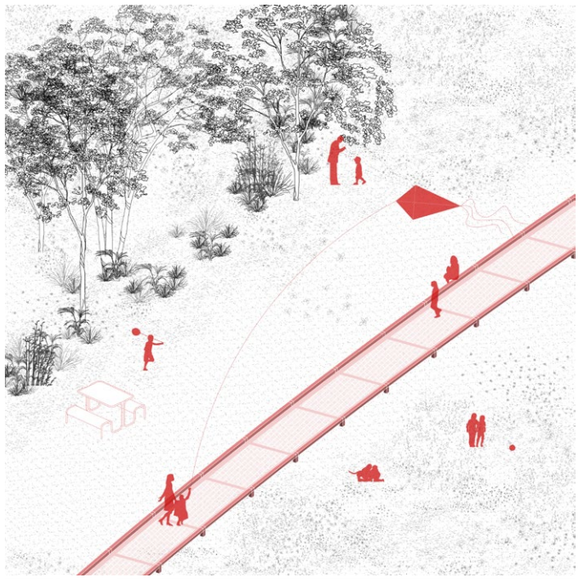


As already addressed in chapter 07/05/01/01, the system will initially benefit of sand, silt and clay nourishment. Parts of the walking path will be then later added as soon as the *barena* will grow.

The channels meandering within the *barena* will contribute to get her flooded during high tides.

fig. 07/20 On the left. Daily tidal oscillation in 2040: average low tide at -0.10 m will make the whole *barena* and the whole path accessible; average high tide at +0.50 m will flood almost entirely the *barena* and will make the path partially accessible (+0.30 m elevation path will be flooded).

fig. 07/21 Axonometry over Santo Spirito island and walking path leading to the *barene*, 2026.

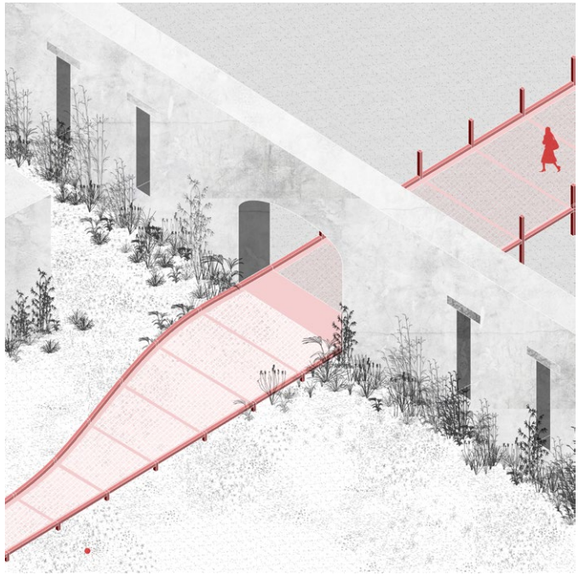


The island of Santo Spirito, after having cleaned up the overgrown vegetation and secured potential loose parts, will serve as gateway to the three barene behind. At the same time, the island will serve as freespace: an open, public, inclusive, creative and imaginary place. No defined function will be addressed on the existing abandoned buildings Santo Spirito, nor on the other islands included in the project: their attractive and mysterious power resides in their freedom.

In the western part of the islands, a small dock will be used as ACTV ferry stop.

The transition point from the island of Santo Spirito to the walking path over the barene structures is underlined by two elements: while the path slightly enlarges, a physical threshold, represented by the walls of Santo Spirito, is being crossed. These two vivid and solid elements communicate directly to the visitor that a passage is happening: the solid, static, dry sphere of an island is being left behind, entering the fluid, dynamic, wet sphere of the lagoon waters.

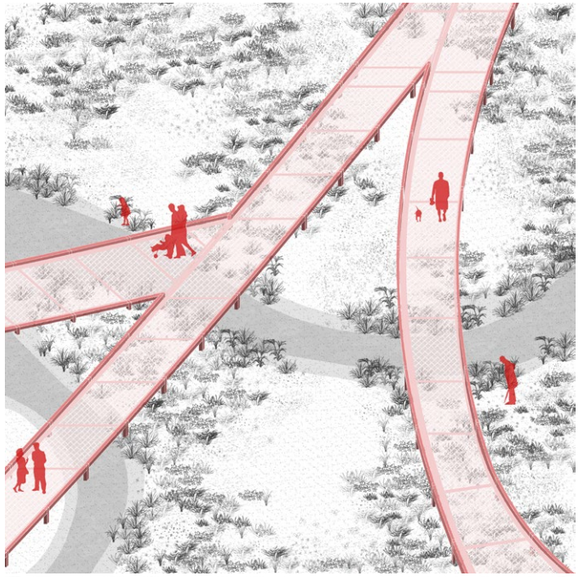
fig. 07/22 Santo Spirito island, central walking path, 2026.



FREESPACE focuses on architecture's ability to provide free and additional spatial gifts to those who use it and on its ability to address the unspoken wishes of strangers. FREESPACE provides the opportunity to emphasise nature's free gifts of light - sunlight and moonlight, air, gravity, materials - natural and man-made resources.
Farrell and McNamara, 2017

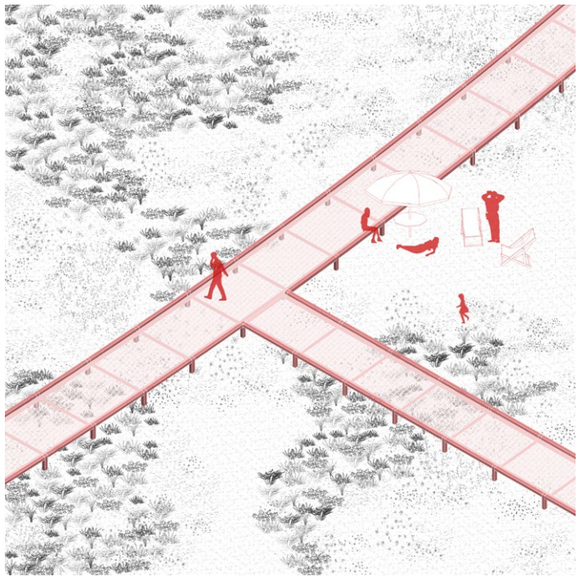
fig. 07/23 Santo Spirito island, the gateway, 2026.

fig. 07/24 Axonometry over *La Barena*, 2036.



The walking paths will run following the different elevations reached by La Barena by 2040. Being slightly elevated (between +0.10 and +0.20 m higher than the actual elevation of the ground), visitors will easily get off the designed pathway to inspect and discover the surrounding environment by themselves.

fig. 07/25 Walking paths +0.70 m, +0.50, +0.30 m high, low tide, 2036.



Some areas, more sandy and therefore where vegetation will not grow, could be used as hangout and resting places. These spots, that will naturally form during the growth and the evolution of La Barena, could also be used to host workshops and field researches over the vegetation species populating it.

fig. 07/26 Walking path +0.50 m, low tide, 2036.

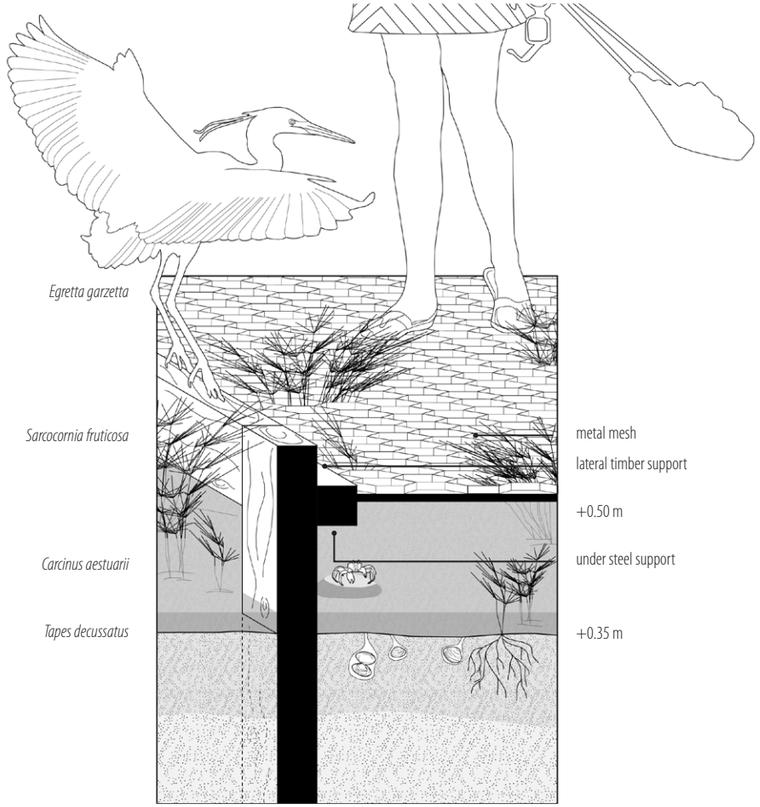
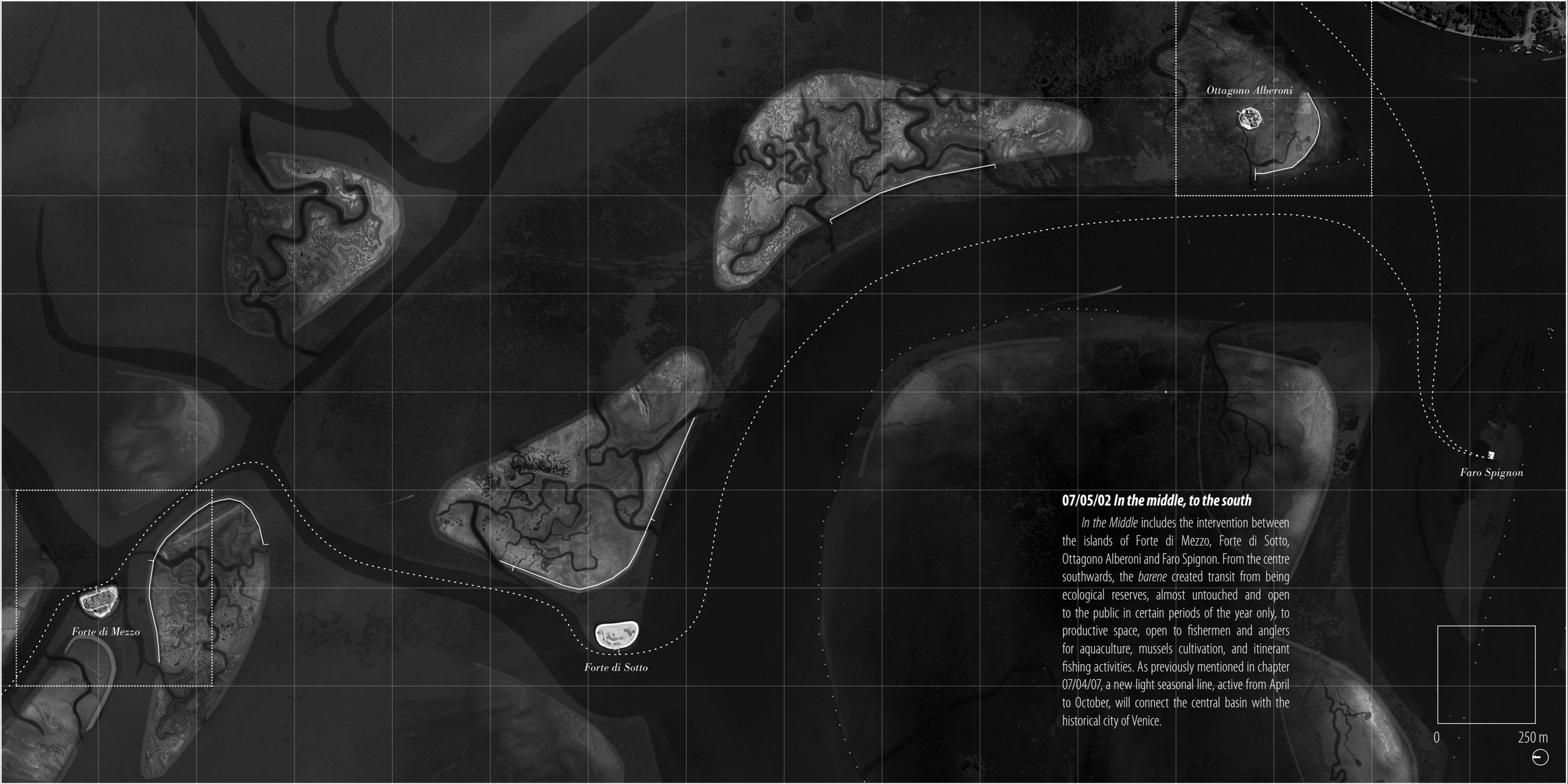


fig. 07/27 Walking path, material detailing.

The walking path, as previously mentioned, is slightly elevated from the actual elevation of the ground. This will allow vegetation to grow underneath and will not harm or interfere with the ecological processes and species populating the barene. Being topped with a wide metal mesh, vegetation may as well grow through it. The lateral timber supports will also act as dry resting spots for the avifauna populating the barene for feeding and breeding.

fig. 07/28 Following page. Atmospheres. Right in front of *La Barena*, just 3.5 km away, the city of Venice stands. From here, the panoramic view opens on the lagoon, first, and on the city, later.
A lady in black is reflecting while looking through the horizon. Someone else is finally enjoying the summertime, schools and offices are closed.
The two images are conceived as looking at each other: they are happening in the same moment. In the second one, the lady in black is standing on the top of structure, lying on the horizon line.



07/05/02 *In the middle, to the south*

In the Middle includes the intervention between the islands of Forte di Mezzo, Forte di Sotto, Ottagono Alberoni and Faro Spignon. From the centre southwards, the *barene* created transit from being ecological reserves, almost untouched and open to the public in certain periods of the year only, to productive space, open to fishermen and anglers for aquaculture, mussels cultivation, and itinerant fishing activities. As previously mentioned in chapter 07/04/07, a new light seasonal line, active from April to October, will connect the central basin with the historical city of Venice.

07/05/02/01 *In the middle*, on Forte di Mezzo

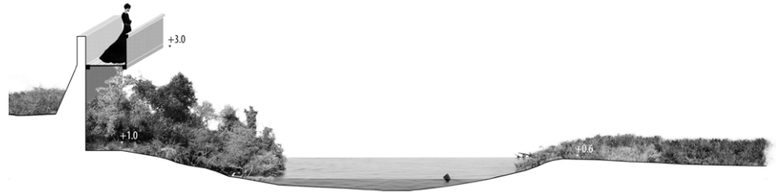
Forte di Mezzo, a military fort and part of the defensive system of the lagoon since *La Serenissima* Republic of Venice, is integrated within the proposed design as pivotal point of observation, respecting its former vocation before the present abandonment.

All around, the *barene* designed for the central part of Malamocco sub-basin want to increment, undisturbed their ecological capacity, controlling visitors fluxes and activities taking place. This is why the island itsef is provided with a 360° elevated walking path at +3.0 m from which the territory all around can be visible from the distance.

From the central point of the central lagoon, as displayed by figure 07/28, is crucial to witness the surrounding from a separated and detached point of view, to experience them seasonally, to respect ecological processes and give them the possibility in space and time to happen smoothly without excessive human disturbance.

fig. 07/29 to observe from distance
to experience seasonally: from time to time
to give time and space to nature to reconstitute

fig. 07/30 Positioning of the walking path (+3.0 m) on Forte di Mezzo island compared to the immediate surroundings' elevations.



Forte di Mezzo

Himantopus himantopus, a flock

Inula chritmoides

Phoenicopterus ruber, a flock

Sarcocornia fruticosa

Himantopus himantopus, a couple

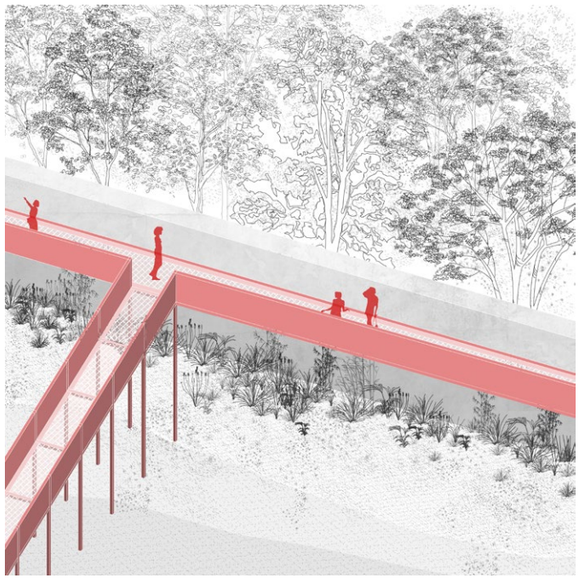
ghèbo, shallow canal

Juncus maritimus

Ardea purpurea

fig. 07/31 Atmosphere. A *barena* close by, with Forte di Mezzo on the left in the background.

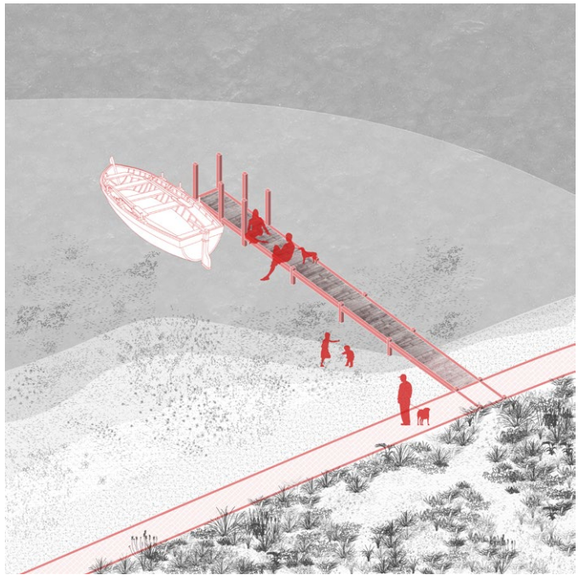
fig. 07/32 Axonometry over Forte di Mezzo island, 2030.



On Forte di Mezzo, two ramps will lead to an elevated walking path (+3.00 m), attached to the existing fort's walls, running all over them and providing a 360 degrees view over the central sub-basin of Malamocco. Within the walls, nothing will be touched: nature will be free to continue to take over, claiming its necessary space.

Two small boat docks will be located on the two opposite sides of the island. On the eastern one, the seasonal line of ACTV ferries will stop.

fig. 07/33 Elevated walking path at +3.0 m on Forte di Mezzo, 2030.



Small wooden docks will be spread all over the barene system, as visible in figure 07/15. This will let private small boats to sail towards and, with high tide, through some barene. The three wooden trunks towards the end of the dock, +1.2 m high, will be used to tie the boat ropes.

fig. 07/34 Dock on the *barena* close to Forte di Mezzo, 2030.

07/05/02/02 *To the south*, on Ottagono Alberoni

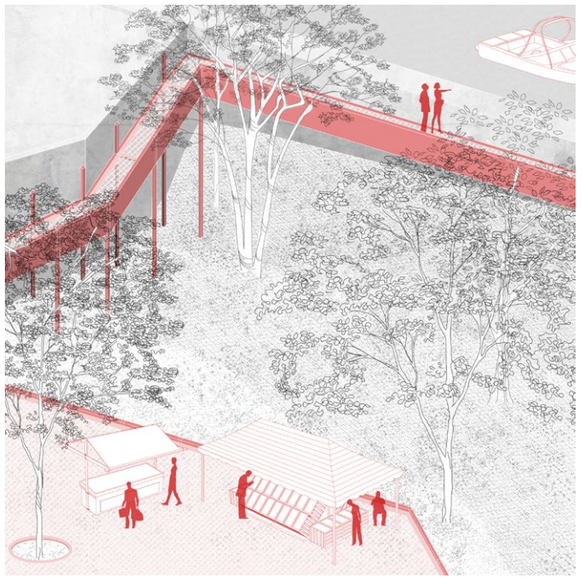
On and around Ottagono Alberoni, the closest island to Malamocco inlet, traditional fishing activities are promoted and fishing facilities (cabins, storages for tools, etc.) are provided. At the same time, the structure positioned in front, will promote accretion towards the island, so that the *barena* emerging could be used as working ground for anglers and fishermen. In fact, aquaculture and mussels cultivation structures are provided near the bifurcation between Canale Fisolo and Canale Rocchetta, exactly there where the water will flow more rapidly and cooler.

On the structure are located four fishing houses, facing both the *barena* on the east and Canale Fisolo on the west. These houses, inspired by the ones that populate the whole Venetian Lagoon, can be rented and used by fishermen using the *barene* of the system.

On Ottagono Alberoni, the present buildings are in good conditions and will be used following the same purpose of the ones located on the structure: spaces serving for fishing tools and activities. A platform, serving as a (fish market) square, will be positioned in the middle of Ottagono Alberoni. This homogeneous ground will connect the two buildings located on the island, with the terrace and the walking path at +5.0 m.

fig. 07/35 to profit sustainably from the barene and their biodiverse environment
to directly involve the community in the landscape conservation

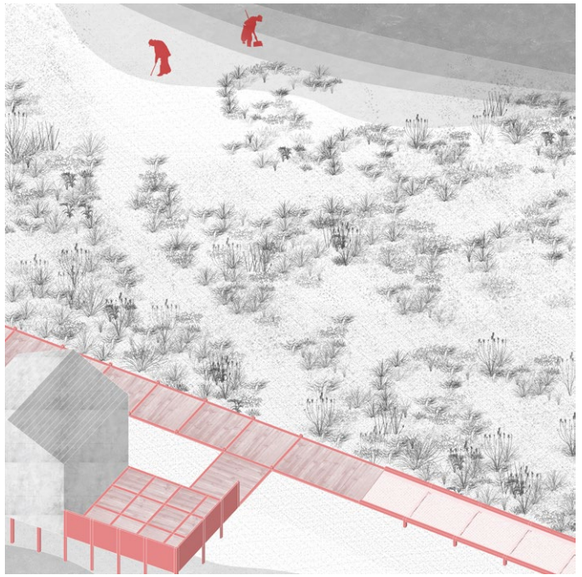
fig. 07/36 Positioning of the walking path on Ottagono Alberoni compared to the immediate surroundings' elevations.



The platform located in the centre of Ottagono Alberoni is thought to be an open ground connecting the fishing sphere and the social sphere. Local people could be welcomed on the island once or twice a week for fish markets, getting in direct touch with the fishermen working in the area.

A ramp connects the platform-square to an elevated walking path (+5.0 m) running on the southern side of the island, over looking the barena growing behind the structure.

fig. 07/37 Ramp leading to the elevated path at +5.0 m and view over the central platform, 2035.



On the structure, a walking path will run over two-thirds of its total length. It is thought to be used majorly as an operative path for anglers fishing on the barena and in Canale Fisolo. Working houses, storages and cabins will be provided to support the fishermen with covered and secured spaces.

fig. 07/38 Walking paths in wood and metallic mesh, fishermen's storage, *barena* and clamsmen, 2035.
fig. 07/39 In the previous page. Axonometry over Ottagono Alberoni, 2035.

fig. 07/40 Atmospheres. *Barena* in front of Ottagono Alberoni, 2035.

fig. 07/41 The archaeologist and mathematician Maria Reiche while on her ladder studying the Nazca lines in Nazca Desert, Peru.

07/06 On Faro Spignon or *the final glimpse at the lagoon*

The last stop of the present research-by-design journey is Faro Spignon, a former lighthouse now in a dilapidated state, one of the most interesting pieces of the secondary islands architectonical heritage. With its 14 meters of height, represents the highest point of the central Venetian Lagoon.

The lighthouse is located at the end of a wider ascensional path, which rises through the chapters just elapsed: starting from *La Barena* (fig. 07/18) where the observer finds herself with her feet slightly raised above ground; then, *In the middle, on Forte di Mezzo* (fig. 07/30), where the observer is at +3. 0 m and the panorama around, calmly, it begins to reveal itself, while the horizon is moving away, but just a little bit; then, *To the south, on Ottagono Alberoni*, where the observer, going up a little more, finds herself able to admire the central basin at +5.0 m (fig. 07/36); and finally, here at the Spignon Lighthouse, where, after having climbed, in the semi-darkness, a spiral staircase for about three minutes, the observer can lastly admire the Venetian Lagoon, illuminated in her entirety.

The lighthouse, which has been in disuse for some decades, seems to be reclaiming loudly its status of *unveiling object*: by nature, a lighthouse indicates the ships the entrance for the safe harbour. In addition to its formal function, the design explicitly adds to this meaning a second shade. As the German mathematician and archaeologist Maria Reiche used to climb on top of her ladder to observe and study the Nazca lines in southern Peru to grasp their complete images and meanings, here, in the Venetian Lagoon, Faro Spignon, can serve the same purpose: to discover, in its totality, the complexity of the lagoon ecosystem, composed by her infinite characters. The City, the Water, the Islands, the Harbour, the Barene, are all pearls of the same necklace, the Lagoon, and contribute all to her gleaming and enchanting beauty.

fig. 07/42 The highest observation point, located on top of Faro Spignon, 14.0 m high.

fig. 07/43 to understand the organic system of the Venetian Lagoon, Venice and the barene and fishing activities and the islands to look for a common ground.

References

Farrell, Y., & McNamara, S. (2017). Freespace manifesto. La Biennale. https://www.labiennale.org/it/architettura/2018/intervento-di-yvonne-farrell-e-shelley-mcnamara

Miazzi, M. (2007). Analisi degli effetti prodotti dall'inserimento di barene artificiali nella Laguna di Venezia. Università degli Studi di Padova.

08/ CONCLUSIONS AND REFLECTIONS

Ripeto: acqua è uguale a tempo, e l'acqua offre alla bellezza il suo doppio. Noi, fatti in parte d'acqua, serviamo la bellezza allo stesso modo. Toccando l'acqua, questa città migliora l'aspetto del tempo, abbellisce il futuro. Ecco la funzione di questa città nell'universo. Perché la città è statica mentre noi (e la laguna, ndr.) siamo in movimento. La lacrima ne è la dimostrazione. Perché noi andiamo e la bellezza resta. Perché noi siamo diretti verso il futuro mentre la bellezza è l'eterno presente. La lacrima è una regressione, un omaggio del futuro al passato. Ovvero è ciò che rimane sottraendo qualcosa di superiore a qualcosa di inferiore: la bellezza all'uomo.

Iosif Brodskij, Fondamenta degli Incurabili

I repeat: water is equal to time, and water offers beauty its double. We, made partly of water, serve beauty in the same way. By touching water, this city improves the appearance of time, it beautifies the future. That is the function of this city in the universe. Because the city is static while we (and the lagoon, ed.) are in motion. The tear is proof of this. Because we go and beauty remains. Because we are heading towards the future while beauty is the eternal present. The tear is a regression, a tribute of the future to the past. In other words, it is what remains by subtracting something superior to something inferior: beauty from man.

08/01 Evaluation of the design proposal

08/01/01 Relation between graduation topic, studio topic, and master track

The project "The Operating Venetian Lagoon: The Agency of Barene" is part of the Circular Water Stories Lab, on its turn part of the Flowscapes studio, the graduation studio of the MSc Landscape Architecture. The Flowscapes studio offers the application of various research methods and design approaches within the discipline of landscape architecture. Among all, landscape as infrastructure, landscape resilience and building-with-nature are the ones that have been integrated within the present research-by-design graduation thesis. At the same time, being part of the Circular Water Stories has played a decisive role in the thesis site and topic choice: the brackish marshland's ecosystem functioning in the Venetian Lagoon.

08/01/02 Relation between research and design.

The fascinations derived from the site visit, the functioning of the Venetian Lagoon and its landscape values (barene, islands, and water-related activities) have played an important role within the completion of the design proposal. Especially the spatial components, translations and implications were crucial to move back and forth coherently from theoretical research to research-by-design proposals.

One of the problem fields identified, the Venetian Lagoon hydromorphological sufferance, even though being extremely interesting and revealing, has required a consistent initial effort, belonging to another field of expertise (hydraulic engineering). Furthermore, the available documentation about the topic is substantial and highly specific, implying an unexpected load of engineering research and understanding. This required technical understanding and the ambition for a feasible and coherent design proposal determined the methodological choice of extra-disciplinary interviews and tutoring sessions with experts.

To generalize, in order to approach complex landscape territories, as the Venetian Lagoon, influenced by a significant multitude of factors, among which natural forces are the most important variables, two different actions can be applied, exemplified here through two different metaphors.

Regarding the understanding of single elements (as layers, events, etc.), the mathematical decomposition of a polynomial into factors can be explanatory. The factorisation of a polynomial, that means expressing a given polynomial as a product of two or more lower order polynomial factors, summarizes efficiently the concept of decomposing complex behaviours into smaller and simpler components that can be analysed and understood.

Regarding the creation of comparisons to understand what are the most important elements to consider, the genetic definition of phenotype and genotype can be explanatory. The phenotype is the set of all the characteristics manifested by a living organism, therefore its morphology, its development, its biochemical and physiological properties. The genotype is the complete genetic constitution of a living organism, only partially expressed by the body (or the phenotype) of this organism. Therefore, the phenotype is what the living being is evidently, while the genotype is the genetic information that is contained in it, which has generated the phenotype. Therefore, the act of comparing it is essential to arrive at the decoding of the genotype, in the specific the genetic identity of the Venetian Lagoon.

08/02 Scope and relevance

08/02/01 Scientific relevance

The conducted research and the strategy proposed will engage a significant relevance for what it concerns the Venetian lagoon itself, with the provisioning of an unprecedented design strategy built on the complex dynamics of water and sediment flows interaction. Furthermore, it will provide insights on decoding and designing in places with similar hydromorphological issues and on considering "building-with-nature" approach as a catalyst for the coexistence of resilient water protection systems and strong ecological structures.

The main four relevant objectives are:

_Functioning: the Venetian Lagoon correct functioning allows the preservation of the whole surrounding territory, including Venice historical centre

_Mitigating: climate change, and in particular sea level rise, is tackled and its effects mitigated

_Building-with-Nature: nature-based design solutions and building-with-nature design principles are holistically applied through the agency of barene

_Innovating: landscape is read as the provider of a resilient structure, intertwining functions, flows, experiences, usages, and atmospheres evoking "the sense of lagoon" (Turri, 1995).

08/02/02 Societal and environmental relevance

Over time, the proposed *barene* system grows and evolves, providing a multi-functional and resilient flood defence structure, achieved through the application of Building-with-Nature design principles. The design contributes to

_Enrich biodiversity and expand the habitat of the brackish marshlands of the Venetian Lagoon

_Integrate the abandoned heritage of the secondary islands, opening them to a lighter and continuous flow of local and external tourism, making them part of the leisure and recreational network

_Provide space and useful means to support local fishing and aquaculture activities.

08/02/03 Ethical issues and dilemmas: a complex system within a complicated reality: the necessity for a Common Ground

Complex: lat. "complexus", p.p. of "complector" *include, embrace*. Composed by "com" = "cum" *with, together* and "plecto" - gr. "plesso" – *intertwine, braid, weave. Made up of several parts connected to each other and dependent on each other.*

Complicate: lat. "complicare" *fold together.* Composed by "com" = "cum" *with, together* and "plicare" = gr. "plekein" *wrap together. Make something less simple, and harder to solve, than what it is.*

Throughout the entire research process, the Venetian Lagoon has more and more emerged as an intricate complex system *per se* while being characterized by complicated and irremediable relationships, governed by economical profit, among those who are deputies for its protection. Here lies the subtle but consistent difference in meaning between "complex" and "complicate". Complexity refers to the amount of interdependences, and the word itself enhances both the acknowledgement of consistency but also the beauty derived from these relations. Complicacy refers to the state of being unable to read these interdependences, tangling them in an unsolvable way, unveiling their chaos. Therefore, in the Venetian Lagoon, exists a deep fracture between what reality presents and how the administrative system interprets it and takes decisions in its regards. As advocated by David Chipperfield in the official press conference of the 13th Venice Biennale Common Ground, becomes crucial "*to react against the prevalent professional and cultural tendencies of our time that place such emphasis on individual and isolated actions; [. . .] to demonstrate he importance of influence and of the continuity of cultural endeavour, to illustrate common and shared ideas that form the basis of an architectural culture*" (Source: https://biennalewiki.org/?encyclopedia=common-ground-2, 2012).

The concept of not thinking individually but harmoniously and holistically can be pursued efficiently within the discipline of Landscape Architecture, where multi and extra-disciplinarity contribute significantly to the mature consistency and coherence of the design assignment.

08/03 What did I learn?

After these nine months, the main accomplishment I have reached is the understanding of flows (and flowscapes) and the practise of designing with them, both as initial conditions and potential builders. As a student with a bachelor degree in Architecture, I was used to conceive the process of design very linearly i.e. responding to problems providing technical solutions. Through the exercise of this research-by-design, I have learnt the possibility to integrate natural processes in an effective way, functionally and aesthetically. Through the application of fixed objects, of obstacles, I have tried to investigate the possible answers deriving from the system of the Venetian Lagoon, but without having the ultimate certainty about how the design will look like. I have learnt to think in four dimensions, through space and time, referring to the growth of the project, its early (and not initial) and mature (and not final) stages, because natural processes do not start nor end, but flow. I have learnt to integrate multiple disciplines (landscape architecture, hydraulic, coastal, ecohydraulic, and environmental engineering, etc.), by getting them to cooperate towards a common goal.

To conclude, as found out through this research and from the past two years of master track in Landscape Architecture at the Faculty of Architecture and Built Environment, I am able to frame more accurately the role of the landscape architect. Her role

09/ APPENDIX

09/01 The growth of a barena: observation through time of artificial barene built near the island of Sant'Erasmo, Venetian Lagoon

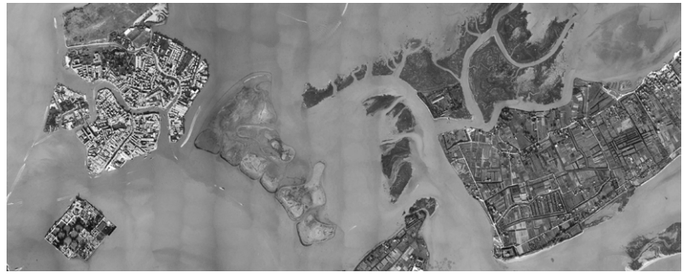
To speculate around the effective formation and growth of barene, I have observed how a set of artificial barene built in the northern lagoon have performed since their construction in 2007 until nowadays. Thanks to the initial pumping of sediment within a confined perimeter, the set of barene analysed have been able to accumulate and trap the suspended sediment in the area. Later on, once the pumped soil have consolidated, pioneer species of brackish marshland vegetation have taken over spreading around according to their preferred elevation.

Based on this and other existing examples within the Venetian Lagoon, I have tried to build the growth sequences presented in the chapters 07/04/03 and 07/05/01/01, in order to provide a reasonable guess on how the lagoon system may react on the design proposal.

2007
Existing situation before the creation of *barene*. The area where the intervention takes place is located in the northern lagoon, between the islands of Sant'Erasmo and Burano.

2010
The white dotted line represents the artificial borders of the *barene*, the built dykes; the white rectangles are the dredgeboats ready to pump sediment inside the created perimeter.

2011
Sand has been pumped inside the structure to accelerate the process of sediment trapping.



2012
The process of pumping dredges has been concluded and the barene starts to actively exchange sediments with the surrounding lagoon.

2014
First pioneer species appear.

2015

2016

2017

2020
The current situation sees the set of built barene still in a relative young phase. Nevertheless, they are successfully performing as an habitat stimulator, attracting many and rare flora and fauna specimens.

09/02 The secondary islands of the Venetian Lagoon: a partial catalogue

Among the 55 secondary islands, here 37 are presented to give a brief insight over the incredible amount of history behind. These islands are scattered all over the lagoon surface, and while being part of the same ecosystem, they differ incredibly in uses, properties, and surfaces.

The groups here presented partially refer to their function, mainly military (octagons, ex powder kegs, and ex military batteries), and partially refer to their geographical collocation (northern lagoon, central lagoon).

	ISLANDS	USE PAST AND PRESENT	PROPERTY	STATE	SURFACE
OCTAGONS	Ottagono Alberoni	Protection of Malamocco.	PP	AB	0,02 km2
	Ottagono San Pietro in Volta	Protection of Malamocco.	PP	AB	0,03 km2
	Ottagono Ca' Roman	Protection Bocca di Porto di Chioggia.	SP	AB	0,02 km2
	Ottagono Abbandonato - Campana	Protection of Malamocco.	SP	AB	0,025 km2
NORTHERN LAGOON	Lazzaretto Nuovo	Museo della Città e della Laguna di Venezia.	SP	IU	0,09 km2
	San Francesco del Deserto	Active monastry.	Congregazione Francescana	IU	0,04 km2
	Crevan	Napoleonic fort, now private residence.	PP	FS	0,004 km2
	La Salina	Remnant area of Ammiana, once a salina, then agricultural production and fishing.	PP	IN	0,03 km2
	La Cura	Fishing valley.	PP	AB	
	Santa Cristina	Agricoltural fields and fishing valley.	PP	IU	0,29 km2
	Sant'Ariano	Former monastry and cemetery.	Comune di Venezia	AB	0,03 km2
	Isola dei Laghi	Agronatural park.	PP	IU	0,085 km2
	Monte dell'Oro	Military fort.	SP	AB	0,0013 km2
EX POWDER KEGS	San Giacomo in Paludo	Former military base.	Murano	AB	0,029 km2
	Madonna del Monte	Monastry and powder keg.	PP	AB	0,0064 km2
	San Secondo	Monastry, then military base.	SP	AB	0,13 km2
	Sant'Angelo della Polvere	In 1060, there was a Benedictin monastry, follower Benedictin nuns, who entitled the church to San Michele Arcangelo. In 1518, Carmelitan monks. Then powder keg since XVI century. Exploded in 1689. Military base until the end of Second World War.	SP	AB	0,005 km2
	San Giorgio in Alga	Benedictin monastry, Congregazione di San Giorgio in Alga, frati paolotti, Carmelitani Scalzi. Political prison, powder keg, military base during Second World War.	Comune di Venezia	AB	0,013 km2
EX MILITARY BATTERY	Buel del Lovo (batteria)	Fishing valley.	PP	AB	0,007 km2
	Carbonera (batteria)	Villa and touristic residence.	PP	AB	0,006 km2
	Tessera (batteria)	Villa.	PP	IU	0,008 km2
	Campalto (batteria)	Landfill for Murano glass wastes.	SP	AB	0,002 km2
	Trezze (batteria)	Methan decomposition.	PP	IU	0,005 km2
	Campana (batteria)	Former military base.	PP	AB	0,004 km2
	Forte di Sotto o Fisolo (batteria)	Former military base, built in 1881. War bunkers, now completely not recognizable.	PP	AB	0,0062 km2
	Forte di mezzo o ex Poveglia (batteria)	Private residence.	PP	AB	0,038 km2
CENTRAL LAGOON	San Giuliano	Former monastry, then military base.	SP	AB	0,01 km2
	Poveglia	Lazzaretto then geriatric hospital.	SP	AB	0,73 km2
	Ottagono Poveglia	Built by the Republic of Venice as an artillery battery station around 1380.	SP	AB	
	San Lazzaro degli Armeni	Monastry and typography.	Congregazione armena Mechitarista	IU	0,03 km2
	San Servolo	Former psychiatric hospital, now Sede Fondazione Europea di formazione degli Artigiani per la Conservazione del Patrimonio Architettonico.	Provincia di Venezia	IU	0,056 km2
	Lazzaretto Vecchio	Hospital and leprosarium. Museo della Città e della Laguna di Venezia.	SP	AB	0,0235 km2
	Santo Spirito	Regular Canons, then Cistercians, then Eremitani, forced to leave the island when Pope Alexander VII suppressed the order in 1656; the Venetian senate sold its goods, obtaining the necessary to meet some war expenses (in that period the war of Candia raged). Then Observant Friars Minor were assigned until 1806. Napoleonic period became a military base.	SP	AB	0,25 km2
	La Grazia	Landfill for Venice's debris, pilgrims' shelter in XIII century, monastry for Confraternita di San Girolamo da Fiesole, suore Cappuccine, polveriera exploded, hospital.	SP	AB	0,03 km2
	San Clemente	Former psychiatric hospital	ULSS	IU	0,067 km2
	Sacca Sessola	Hotel JW Marriott	PP	IU	0,16 km2
	Faro Spignon	Former lighthouse, 15 metres high. It has been built in the second half of XIX century, firstly represented in a map of 1886, used by the ships and boats getting in the lagoon from Malamocco inlet. Now informally used by fishermen as storage.	SP	AB	0,085 km2

Legenda
PP: private property
SP: state property
AB: abandoned
IU: in use
FS: for sale
IN: inhabited

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