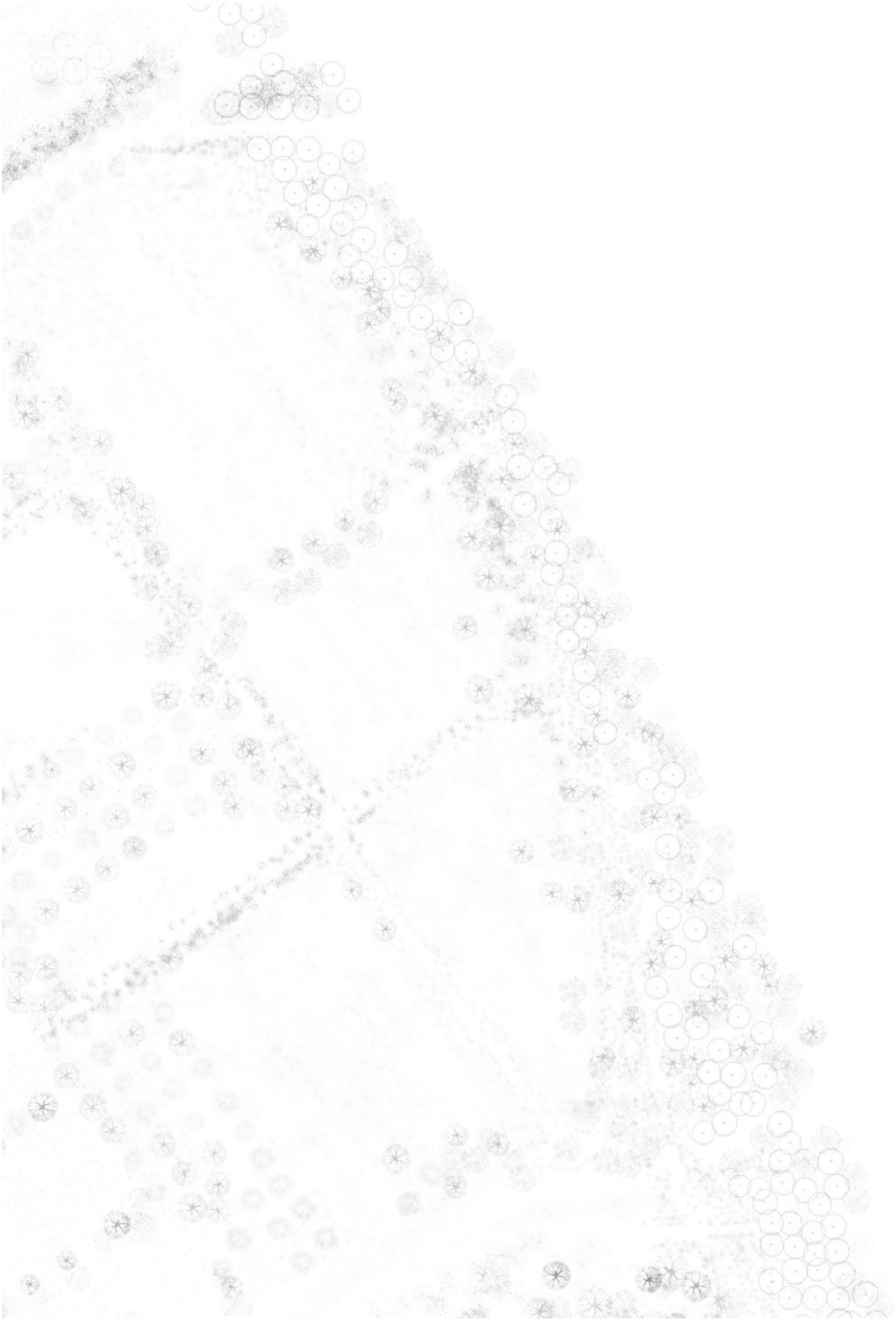

TERRITORIAL SYNERGIES IN THE CAMARGUE:

A Comprehensive Vision for a Resilient Delta

POLITECNICO
MILANO 1863

Territorial Synergies in the Camargue:
A Comprehensive Vision for a Resilient Delta

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POLITECNICO DI MILANO

Creating a vision for Camargue, South France, a predominantly salt-producing region with a unique coastal ecosystem as it faces a future of threats from sea-level rise, mass tourism and economic crises.

TABLE OF CONTENTS

“Tra uomini non è possibile conoscersi reciprocamente prima di aver consumato sale insieme”, così scrive Pliny riguardo al valore del sale, enfatizzando la sua importanza nel mondo civilizzato. Il sale ha un ruolo cruciale a livello biologico nel corpo umano, mantenendolo in vita, così come rappresenta un elemento fondamentale nella gastronomia e nel settore commerciale e industriale. Il motivo per cui il sale è una parte importante del commercio globale è il fatto che può essere prodotto solo in alcune aree specifiche del mondo, chiamate saline, dove tutti gli elementi naturali cooperano a favore di questo processo. “Il sale nasce dai più puri dei genitori…il sole e il mare” è la riflessione di Aristotele in relazione alla particolarità di queste zone produttrici di sale. La presenza delle saline crea un insieme di ecosistemi e cultura in tutto il mondo unico nel suo genere, che oggi sta scomparendo a causa di vari interventi sull’ambiente legati alla globalizzazione e al cambiamento climatico.

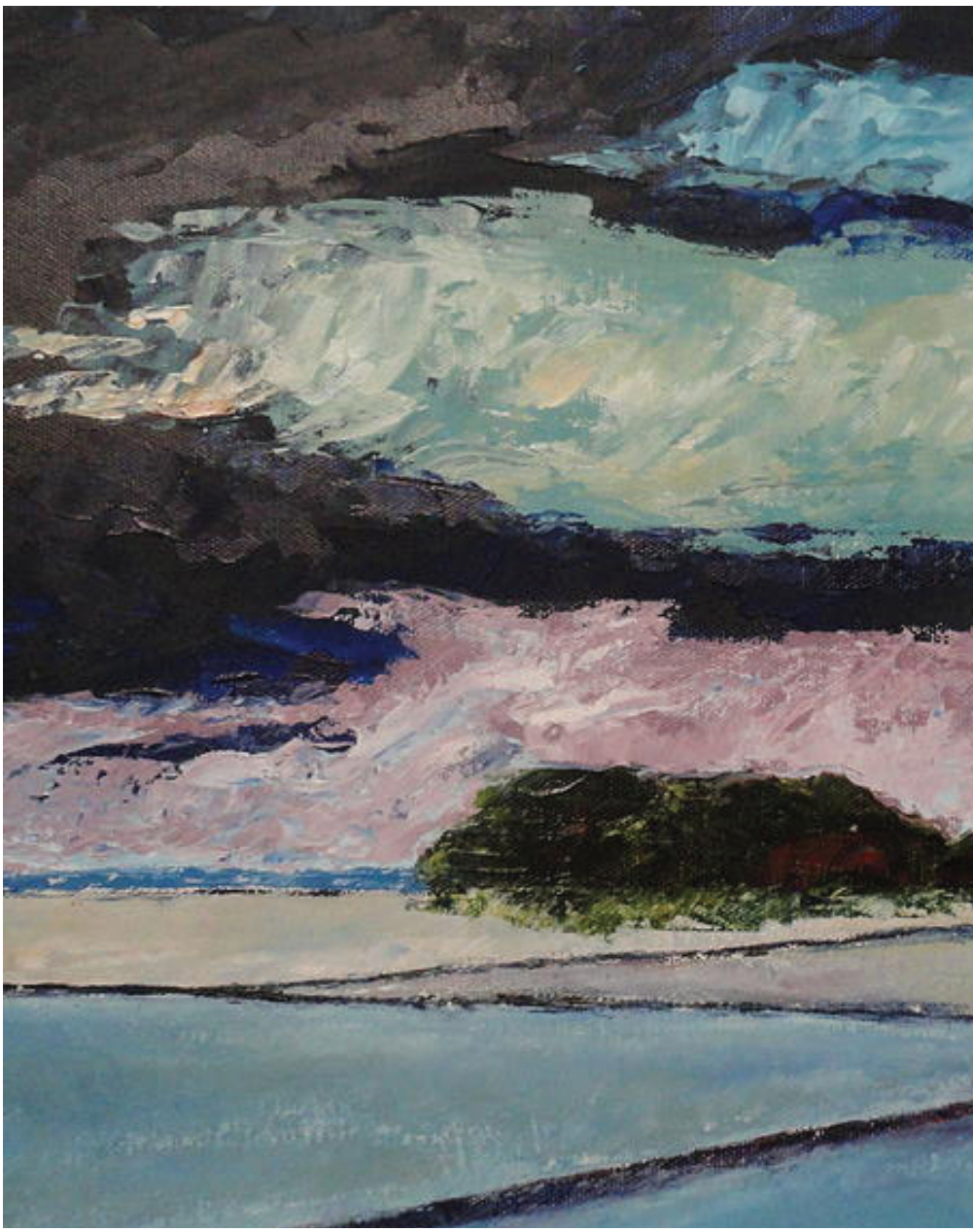
Questo progetto esplora un unico territorio come quello della Camargue, nella Francia meridionale, dove l’estrazione del sale è una pratica che risale ai tempi dei Romani. La Camargue, modellata dal Delta del Rodano, comprende due saline: Salin de Giraud e Aigues Mortes, che insieme formano il sito di produzione di sale più esteso d’Europa. E’ inoltre il più grande terreno europeo fertile per il fenicottero rosa. Lo studio si concentra sulle pressioni subite dalle saline nei pressi di Salin de Giraud, ovvero le sinergie e i conflitti dovuti ad altre attività nella regione, quali la coltivazione di riso e tutela ecologica.

Il progetto si conclude con la proposta di una strategia generale per l’area, basata su una combinazione di infrastrutture verdi e grigie, ragionando su soluzioni basate sulla natura stessa, che possano rendere il territorio adattabile all’incertezza dei fenomeni metereologici del futuro. Inoltre, si propone la creazione di una nuova economia basata sull’acqua marina e la ricerca di miglioramento delle sinergie tra le diverse attività, al fine di creare un territorio sostenibile di coesistenza.

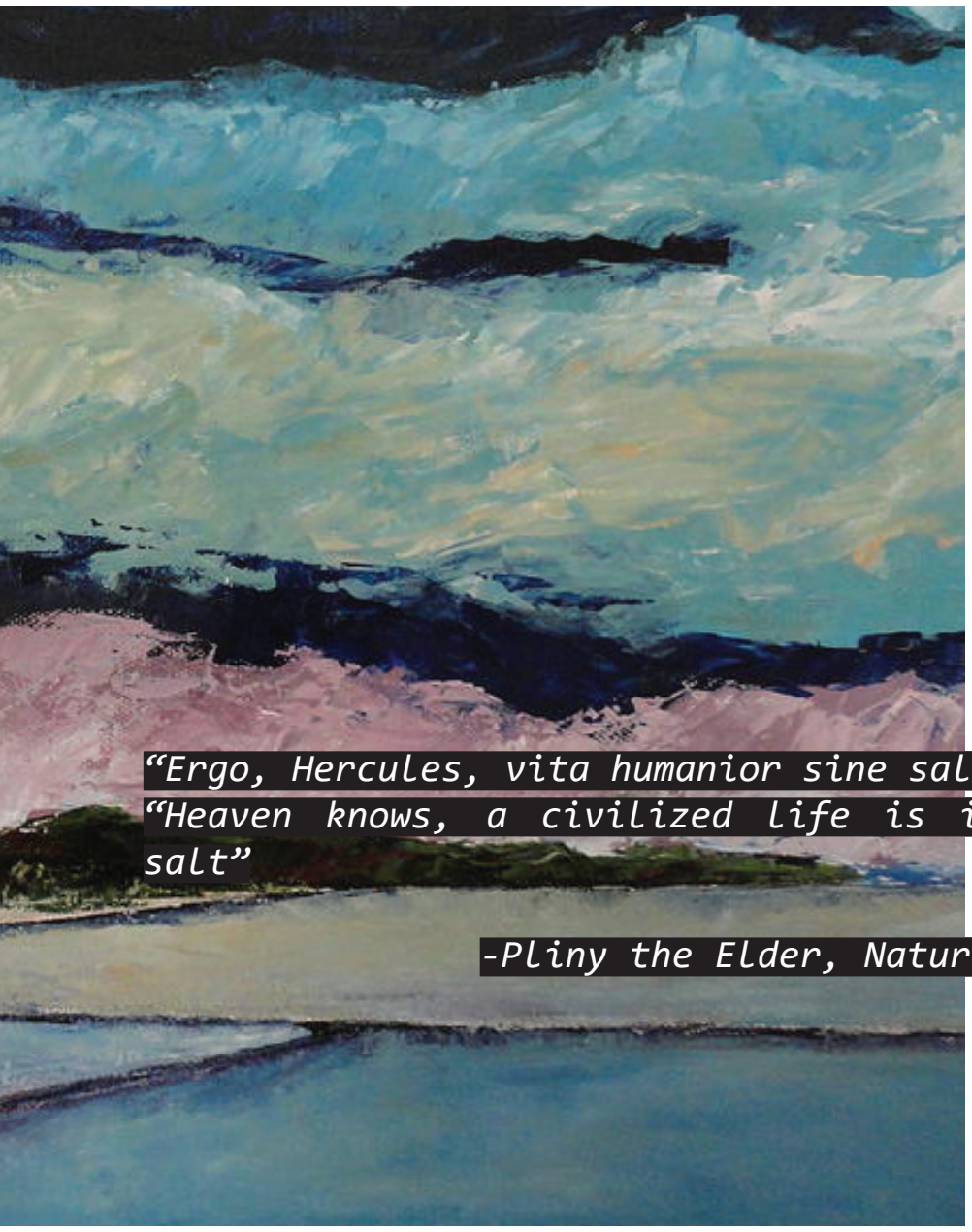
“Men cannot know each other until they have eaten salt together” writes Pliny on the value of salt, echoing its importance in civilization. Salt performs crucial biological functions in the human body sustaining life. It thus forms an indispensable element in gastronomy, trade as well as modern industrial processes. However, what makes salt an important part of global trade is the fact that it can be produced only in specific sites across the world, called salinas, where all elements of nature coincide favorably. “Salt is born to the purest of parents… the sun and the sea”- reflects Aristotle on this site-specificity of salt production. The presence of salinas create unique pockets of ecosystems and culture around the planet that are fast disappearing today due to various threats including those from globalization and climate change.

This project explores a unique territory of the Camargue in southern France where salt extraction has been practiced since the Roman times. The Camargue formed by the Rhone Delta encompasses two salinas- Salin de Giraud and Aigues Mortes, forming the largest salt production site in Europe by area. It is also the largest breeding ground for the pink Flamingo in Europe. The study focuses on the pressures faced by the salinas around Salin de Giraud as well as the synergies and conflicts it shares with the other activities in the region- rice farming and ecological conservation. The salinas have come under threat of abandonment due to recent economic crises fueled by extreme flood events. The city of Salin de Giraud faces depopulation as salt working jobs have decreased.

The project concludes with the proposal of an overall strategy for the area based on a mixture of green and grey infrastructure, looking at nature-based solutions to make the territory adaptable to the uncertain weather events in the future. It also proposes the creation of a new economy based on sea water and seeks to improve synergies among the different activities to create a sustainable territory of co-existence.



01
PROLOGUE



"Ergo, Hercules, vita humanior sine sale non quit degere"
"Heaven knows, a civilized life is impossible without salt"

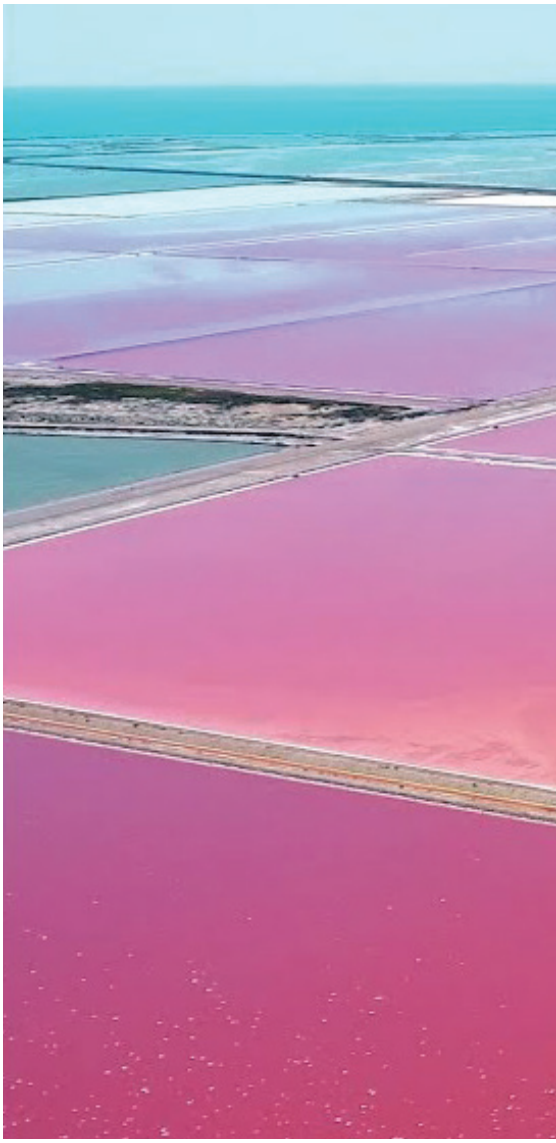
-Pliny the Elder, Natural History XXXI 88

"Las Salinas"
JA Soto Verges, Puerto Rico, 2012

01.1
PROLOGUE- SALT

"Heaven knows, a civilized life is impossible without salt, and so necessary is this basic substance that its name is applied metaphorically even to intense mental pleasures. We call them sales (wit); all the humour of life, its supreme joyousness, and relaxation after toil, are expressed by this word more than by any other. It has a place in magistracies also and on service abroad, from which comes the term "salary" (salt money)" Pliny the Elder's records in Natural History XXXI states the importance of salt in human history.

"Natural History XXXI",
Pliny the Elder



An overview of recent studies on land abandonment in Europe showed that land abandonment primarily occurs in **areas with unfavourable conditions for agriculture**, often being remote and mountainous regions. Secondary drivers of land abandonment include **rural depopulation** and regional specific factors regarding land ownership and tax regime. Lowering of agricultural income also causes rural contraction. Studies that focus on the **perception of land abandonment among different societal** groups are also lacking (Hunziker et al. 2008). This is an important aspect in the case of land

Salinas exploited along the Mediterranean coast.

abandonment, since the users of landscapes are no longer only farmers, but now often also include tourists and other visitors.

The local inhabitants view traditional agriculture as a clear part of their identity and resist changes related to abandonment. This resis-tance can be viewed as a reaction to the changing role of the rural zone, which transformed from a place of agricultural production (productivism) into a leisure and experimenta-tion space with a multifunctional focus (post-productivism).

01.2
SALT SYNERGIES

"Salt is born of the purest parents: the sun and the sea."
— Pythagoras

Salt has been an important commodity throughout history, one that helped shape history, towns, highways and trade routes. It also inspired philosophy and faith in almost all languages, fashioned eating and living habits, and influenced language and vocabulary.

Coastal wetland habitats have been transformed by salt mining, a common activity in the Mediterranean for thousands of years. The hypersaline habitats of Salinas provide an ideal environment for the flora and fauna of many wetland species. In addition, the installations of the salinas typically allow restricted human access, so a variety of species that nest or feed on them are well protected from human threats. Therefore the extraction of artisanal salt is an activity that is mutually beneficial for humans and for nature.

The role of salinas is multifunctional and fundamental when it comes to the conservation and wise use of wetlands: they stimulate biodiversity, serve as a source of inspiration for imagination, are excellent places for educational and cultural activities, attract specialized tourism and are the source of high-quality products used in the gastronomy, health and cosmetic industries,as well as in biotechnological processes.

They contribute to the creation of new jobs, while at the same time meaningfully engaging local stakeholders and build stronger links with wetlands, strengthening the values of the sites.

"Cultural aspects of Mediterranean wetlands", Katia Hueso and Theodora Petanidou.

Salinas exploited along the Mediterranean coast.

01.3
MEDITERRANEAN SALINAS

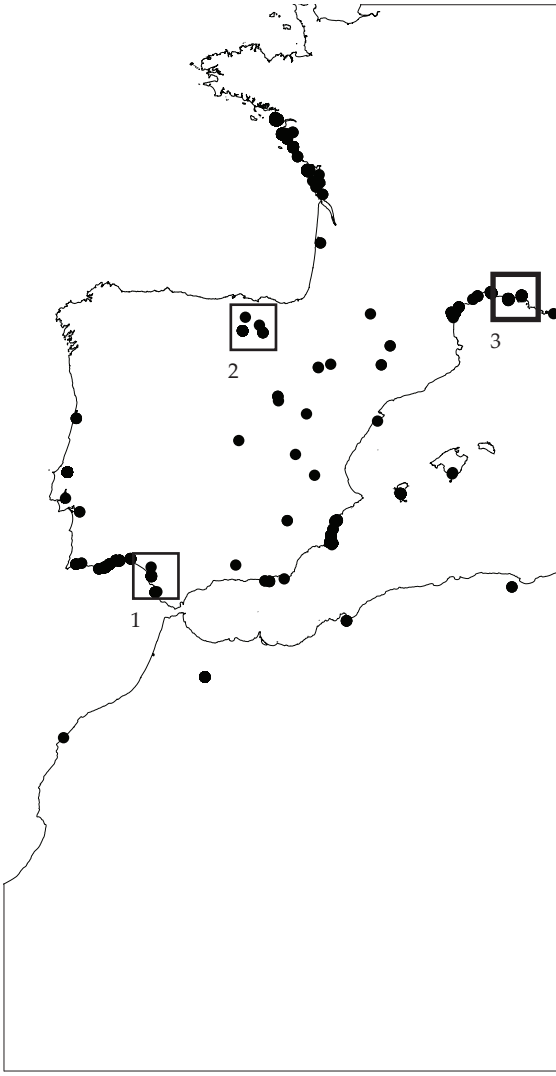
"Guidelines for the environmental management of the Mediterranean and Black sea saltworks (management model) in the Natura 2000 network."
M. Costa, F. Borghesi, L. Casini, Z. Fidlóczky, F. Migani

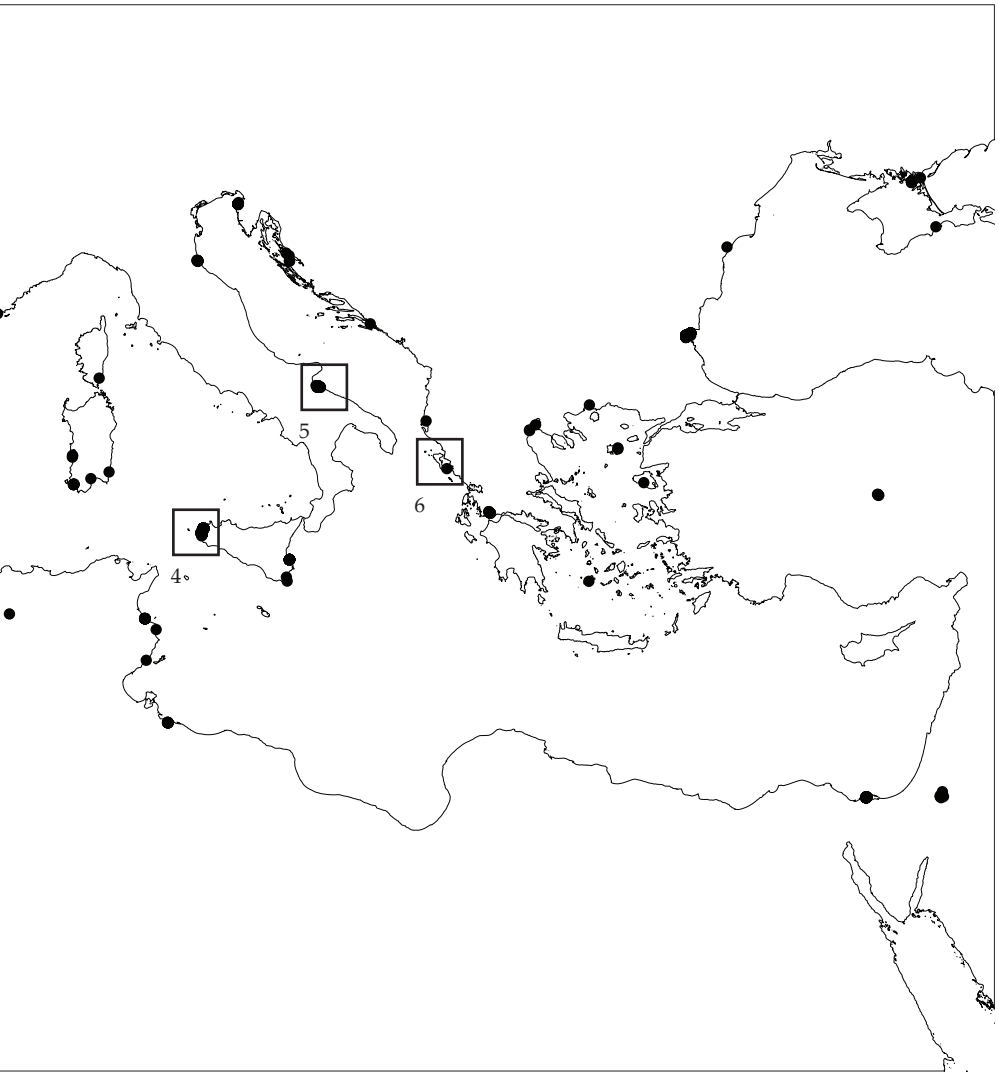
Over 170 saltworks in 18 countries are located in the Mediterranean basin and the Black Sea region. 90 are active saltworks, and 75% are based in the countries of the North and Central Mediterranean: Spain, Greece, Italy, France and Portugal. In the Mediterranean and Black Sea areas, traditional salt pans and small salt pans have been in continuous decline since the 1950s. Their surface area varies from 1 to 12,000 ha, producing approximately 7 million tons of salt annually.

Many of the saltworks that currently operate in the Mediterranean have been improved and turned into large-scale saltworks. Several categories of Mediterranean saltworks can be distinguished, depending on the size, the variety of methods used for production, as well as other features:

-Primitive saltworks, in which salt is produced with little or no human intervention, mainly collected from nature (e.g. rocky coasts). They are made up of a mosaic of bowls cut out by hand in the rock, about 50-75 cm deep.

-Traditional saltworks, linked by canals and dykes, including small pans and crystallizers, can be operated effectively by one or two people. In all





Salinas exploited along the Mediterranean coast.

0 500 1000km

1 Cadiz Ananas 2

3 Camargue Trapani 4

5 Margherita di Savoia Missolonghi 6

stages of salt-making, they are characterized by intense human presence. In the last half century, the introduction of pumps, machines or small-gauge railway network has modernized a few of the largest of these saltworks.

-Modern and industrial saltworks, which include saltworks that are both semi-industrial and fully mechanized. The former consists of relatively large pans and crystallizers and still involves manpower for manual salt harvesting; whereas the latter, with almost no manual operation, is economically extremely large and most profitable.

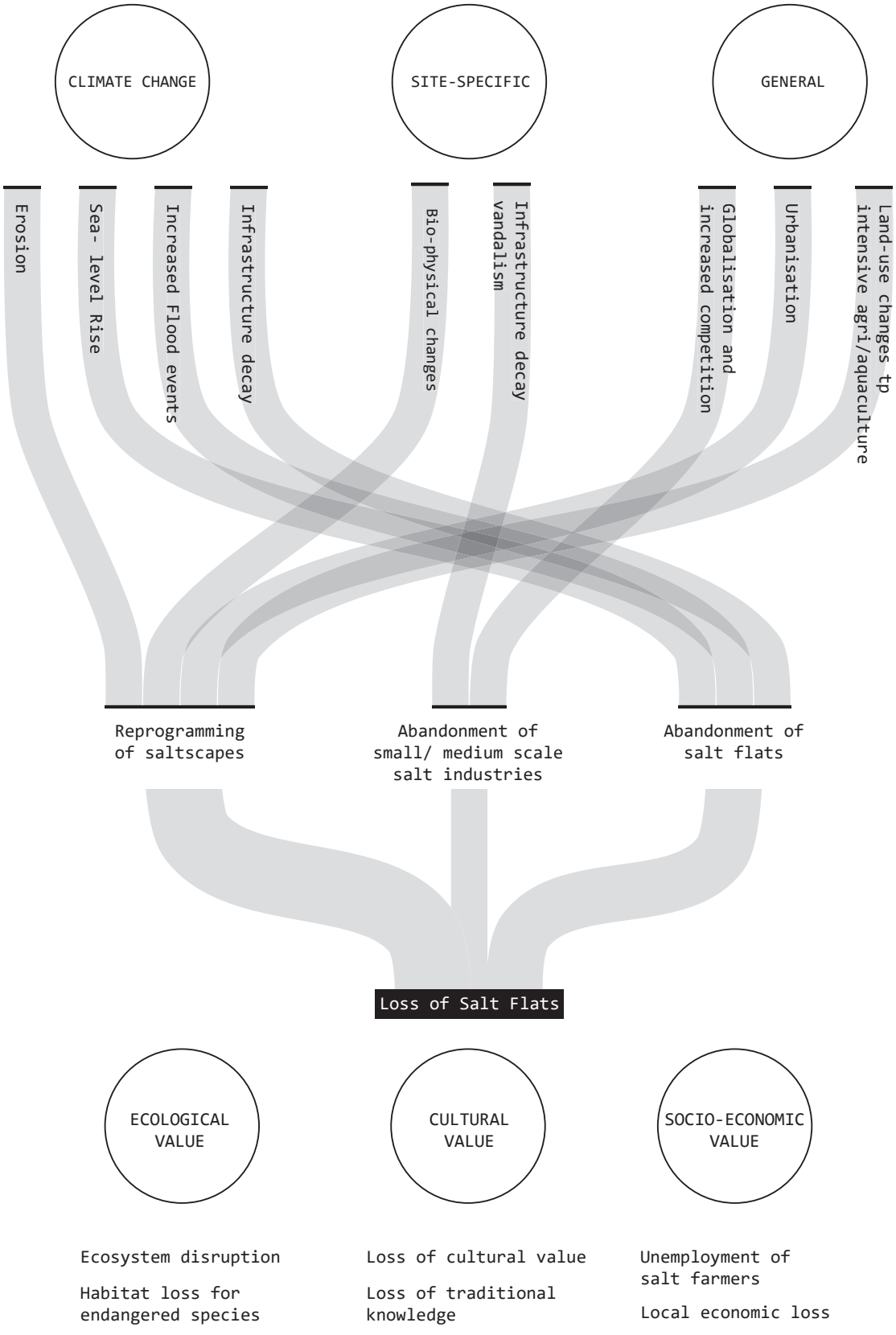
Evaporation ponds in the saltwork of Cervia
Source- Parco Delta del Po Archive

The saltwork of Margherita di Savoia, in Southern Italy
Source- F. Borghesi

Abandoned Salinas in Camargue

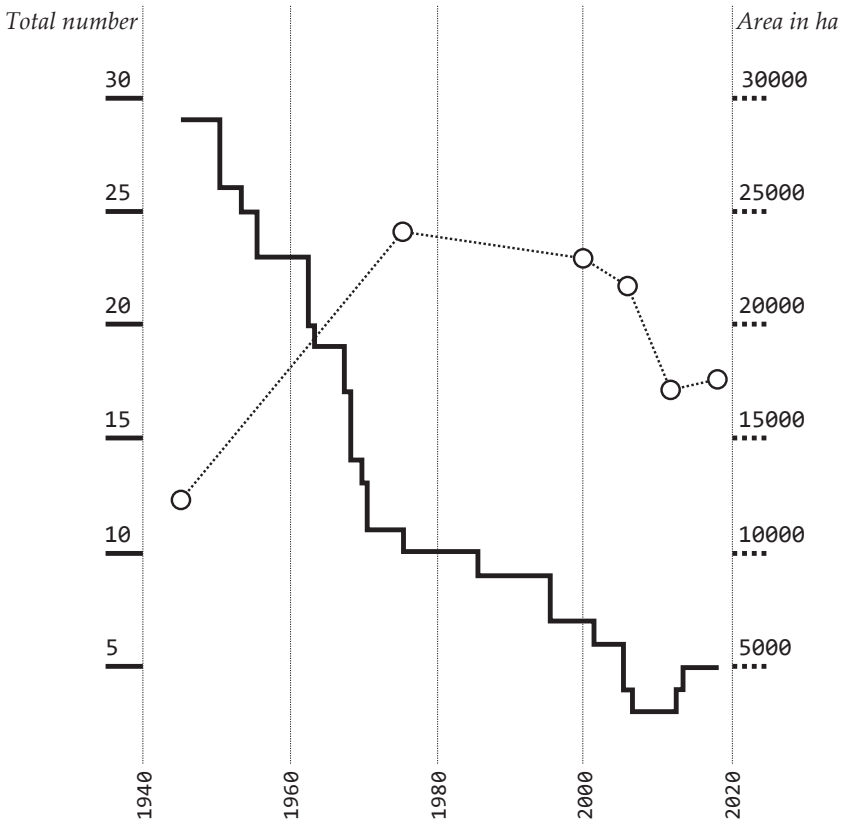
Salinas at Anana valley, Spain

THREATS TO MEDITERRANEAN SALINAS



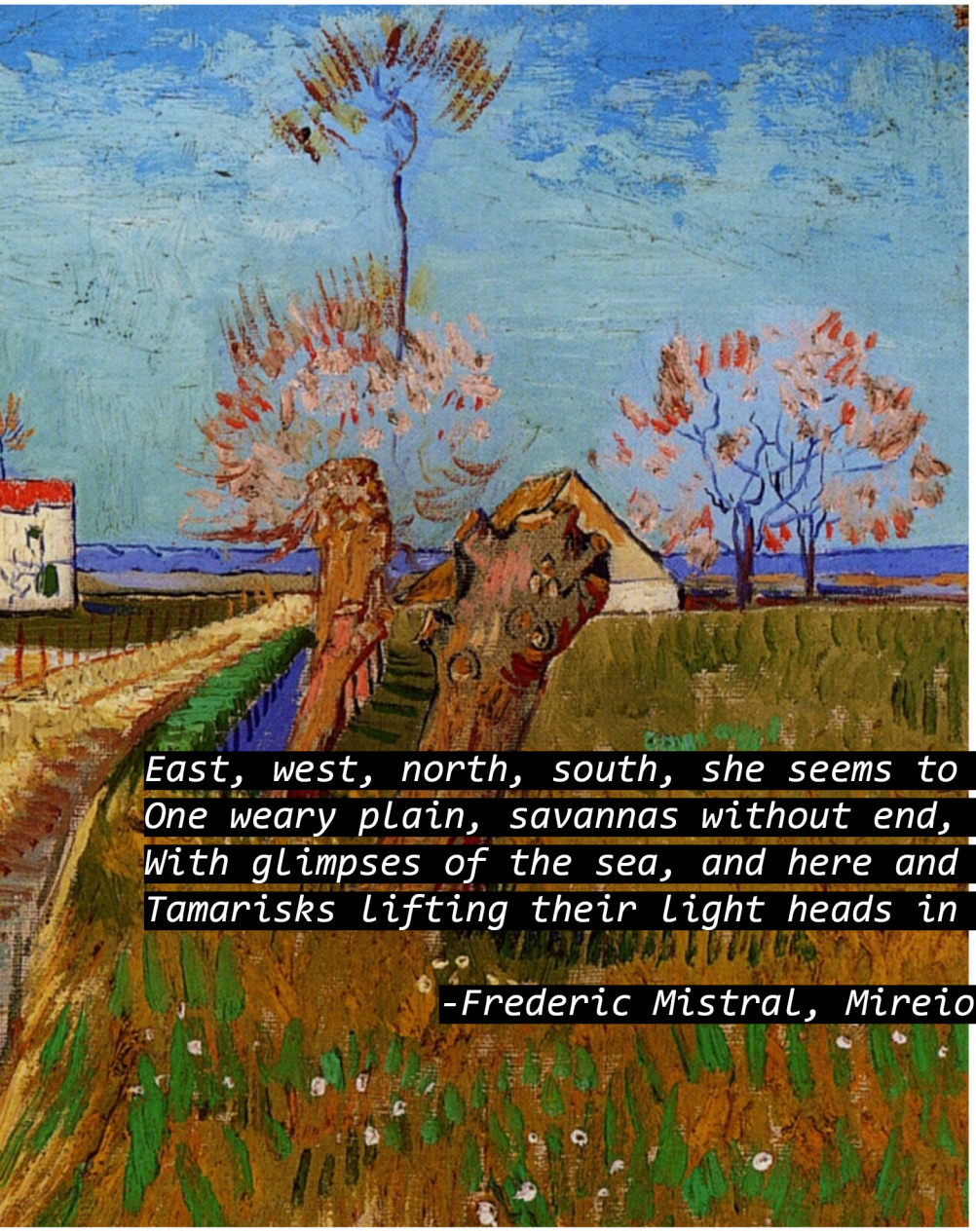
While their salt yield potential has increased over time, there has been a drastic decrease in the number of active salt plants in the Mediterranean, especially in the second half of the 20th century. This abandonment is the result of continuous and profound social and technological changes at various levels, particularly with regard to production systems and means, and globalization during the second half of the 20th century.

Small saltworks have been the first to stop salt production since the 1930's, as an effect of the higher productivity of the larger ones. A large number of saltworks ceased in Europe during the 1950-1990 period, particularly in industrialized countries, while traditional production continued in the southern and eastern Mediterranean.



Exploited Salinas (black line, left scale) and surfaces used in hectares (closed circles, right scale) along the Mediterranean coast in southern France (De Wit et al., 2019)

02
THE CAMARGUE- A PORTRAIT



East, west, north, south, she seems to see extend
One weary plain, savannas without end,
With glimpses of the sea, and here and there
Tamarisks lifting their light heads in air.

-Frederic Mistral, Mireio- A Provencal Poem

"Path through a field with willows"
Vincent Van Gogh, Arles, 1888

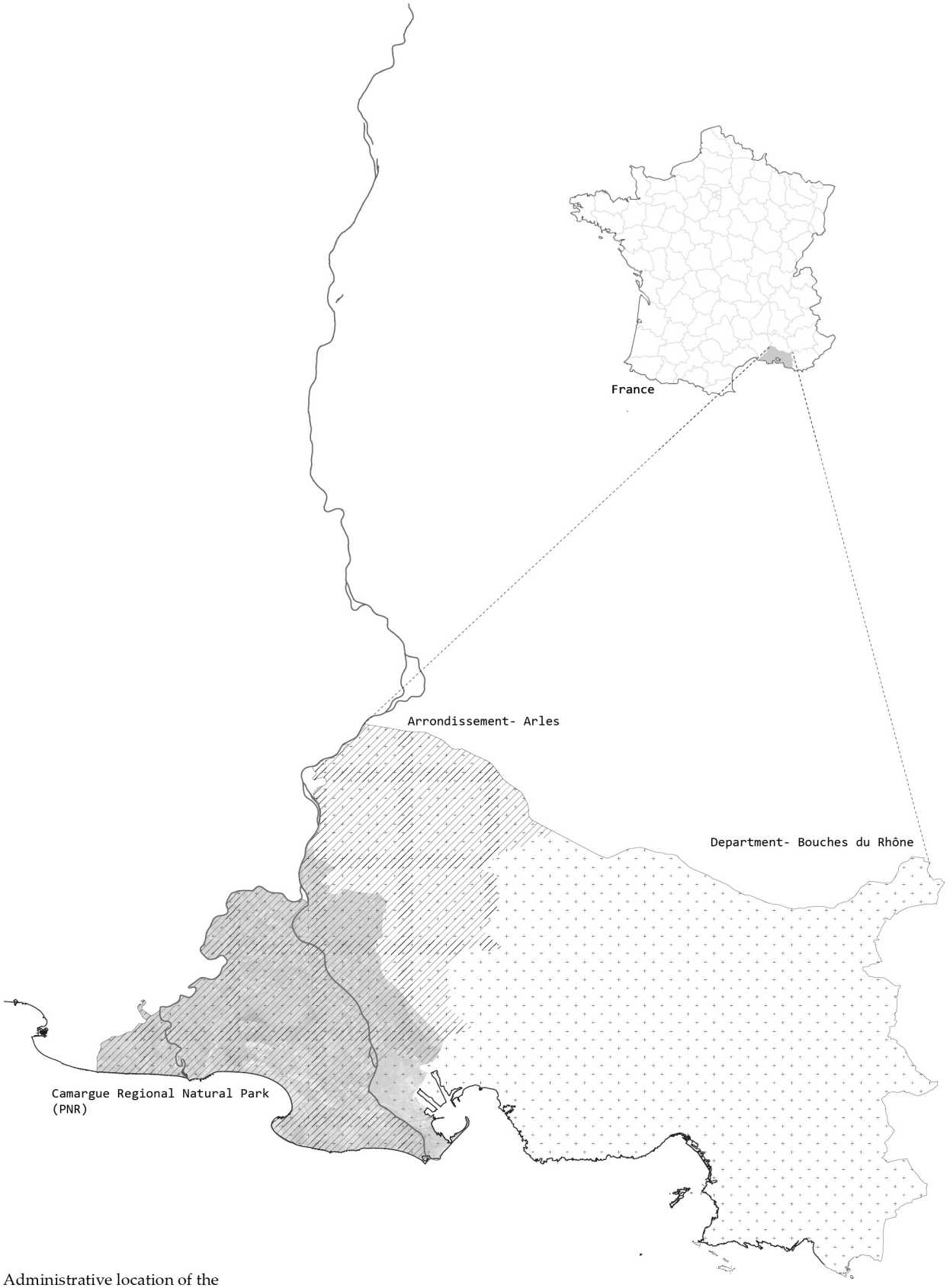
02.1
LOCATION

The Camargue is a protected French natural park in the region Provence-Alpes-Côte d'Azur.
43°30'N 004°30'E.
Area- 85,000 ha;
It forms a part of the Rhône River delta, incorporating vast expanses of permanent and seasonal lagoons, lakes and ponds interspersed with extensive Salicornia flats, freshwater marshes, and a dune complex.

The wetlands are partly supplied by rainfall, but the main source is groundwater pumped to sustain irrigated agriculture. The Camargue is of international importance for nesting, staging and wintering waterbirds. Among the various breeding species are Ardeidae, with Anatidae occurring in winter. Human activities include tourism, hunting, fishing, agriculture and raising livestock.

Ramsar Sites Information Service
https://rsis.ramsar.org/ris/346

" Farmhouse in Provence"
Van Gogh



Administrative location of the Camargue

02.2
GEO-MORPHOLOGY

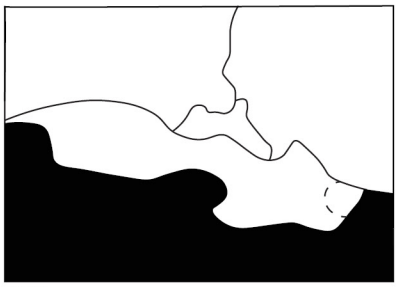
Rhone delta is a triangle of lowlands limited to the east by the plain of Crau, the former alluvial cone of the torrential Durance and to the west by the costière du Gard built by the Cévennes torrents. The course of the Rhône is today separated into two branches from Arles: the Grand Rhône, with 85% of the water, which flows into the sea at Port-Saint-Louis-du-Rhône and the Petit Rhône , with the remaining 15% of the water, which has its mouth near Saintes-Maries-de-la-Mer.

Despite its apparent flat structure (average slope from Arles to the sea of 0.17%), there are corresponding topographic bulges:
- the alluvial ridges of the Rhône, numerous, well marked to the north;
- dune alignments developed by sea currents.

It presents itself as a thick carpet of silty-clayey and sandy alluvium piled up on the stony bedrock accumulated from the Pleistocene (2 million years ago) in the old ria of Avignon. The succession of ice ages up to around 20,000 BC. allowed the establishment of a vast stony plain. Between 10,300 BC and 8300 years BC., various marine transgressions bring lagoon-marine deposits, sometimes exceeding 20 m in thickness. The slowdown in sea level rise from 6000 to 3500 BC. allows the construction of the emerged deltaic plain, extending out to sea.

Sediment input from the river begins to compensate for the rise of the sea and promotes the advance of the delta. The Rhône delta then comprises several arms, that of Saint Ferreol is the most active and brings the highest sediment load. The delta has a pointed shape, surrounded by two large, deep gulfs which will gradually fill in.

These different routes then became dead arms which gradually evolved by clogging in ponds and

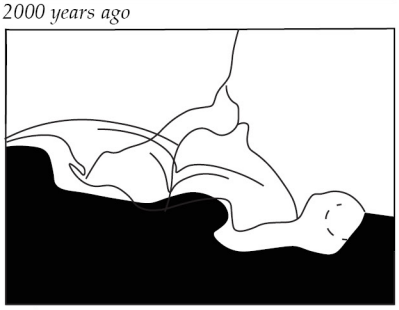


4000 years ago

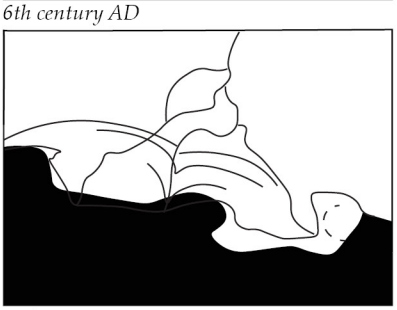
3000 years ago

2000 years ago

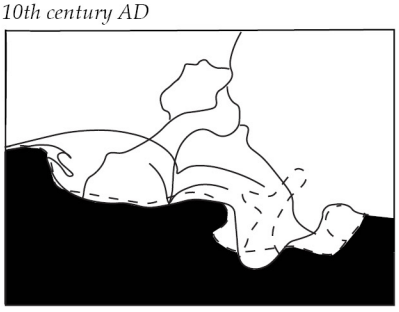
6th century AD



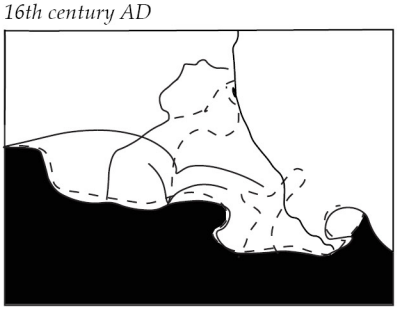
10th century AD



16th century AD



Early 17th century AD



20th century AD

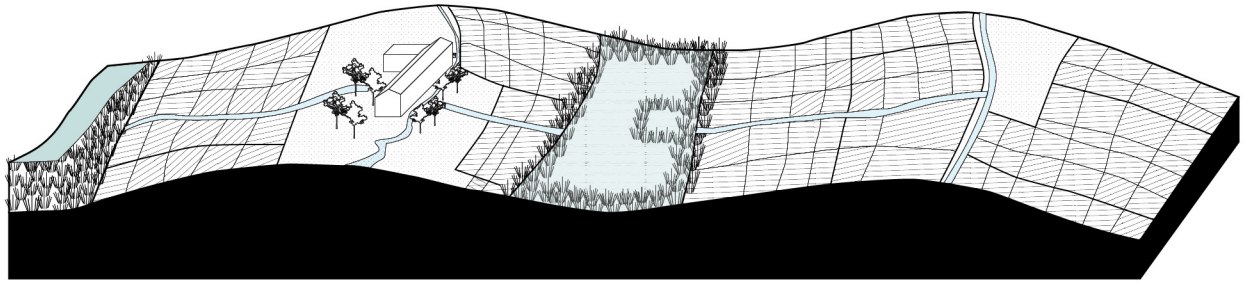
Geomorphological Evolution of the Rhone delta
Source- https://tourduvalat.org/

marshes. The oldest now provide the temporary ponds of Cerisières Nord, Medium and South, the most recent being the large, elongated temporary marshes of Esquineau, Baisse Basse, Baisse du Rendez-Vous, Relongues and Baisse Salée. At the center of these meanders, isolated marshy areas gave rise to the Saint Seren marsh.

On the southern part of the reserve, the sedimentation

is rather marine, still visible today on the sandy hills of Cabane Rouge and Redon, which are located at the site of the old shore line, in the continuity of the one clearly visible on the Camargue National Reserve, at Amphise and the ruins of the Abbey of Ulmet.


Roman Times
Middle Ages

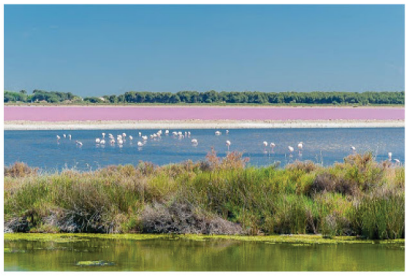


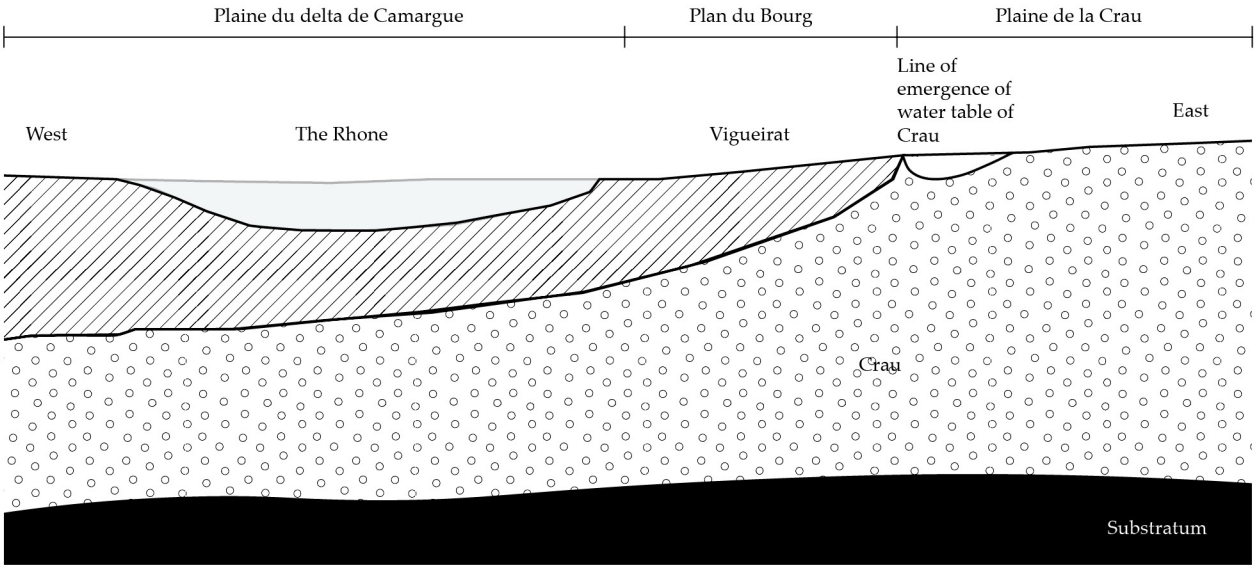
Geo-morphology and Human Occupation
Source- PNR Charter

The territory of the Camargue Regional Nature Park corresponds almost strictly speaking to what historians call the Isle of Camargue, namely the part of the Rhône Delta between the PetitRhône in the west and the Grand-Rhône in the east.

A flat space where the altitudes remain very close to sea level, the soil of the Camargue is mainly made up of more or less sandy alluvium depending on the presence of old beds of the Rhône. Fluvial dunes, marshes, sansouïres or organ swamps offer no stones and few large trees for timber. The sites of the hamlets and isolated farmhouses were dictated by the terrain. They are mainly found on the “heights” of alluvial ridges.

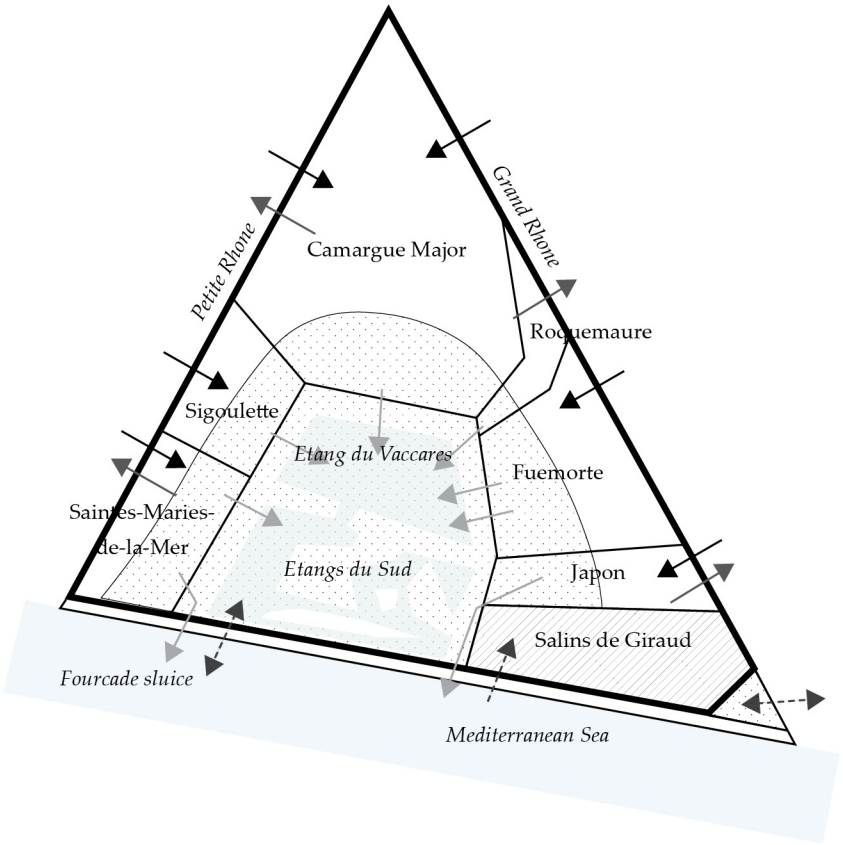
The architecture is strongly linked to the type of operation. Subsequently, the evolution of techniques influenced and shaped the built structures by the need to add buildings adjoining the farmhouse. Thus, the mas of today offer us a reflection of this evolution.





Schematic W-E cross section across Rhone

- Siliceous pebbles
- Marsh Area
- Fluvial Domain
- Silty Colluvium
- Substratum



Hydrological Divisions and Functioning scheme of the Grand Rhone delta

- Siliceous pebbles
- Entry of water
- Discharge of water
- Drainage due to gravity
- Entry of water from sea
- Dike for protection
- Agriculture
- Marshes
- Urban fabric

The main drainage canals, which collect all the drainage water, extend over the alluvial plain of the Camargue dammed (78,700 hectares excluding saline). They cover the fluvio-lacuste Camargue to the north, north-west and north-east as well as the lagoon-marine Camargue to the center and to the south. These Camargue “rivers” are six in number (Japan, Fumemorte, Roquemaure, Rousty, Sigoulette, Pioch-Badet) and determine six farming basins. The boundaries between sub-basins are sometimes very ill-defined.

Fourcade sluice

Canal du Vigueirat

Canal du Midi

02.3
HYDROLOGY

The scope of the diagnosis includes three large distinct hydrographic entities separated by the Petit and the Grand Rhône: La Petite Camargue Saintoise, Ile de Camargue and Plan du Bourg.

1) The Petite Camargue Saintoise is a sub delta bordered to the west by the Rhône Vif and to the east by the Petit Rhône east with the Sylvéréal bridge as its summit.

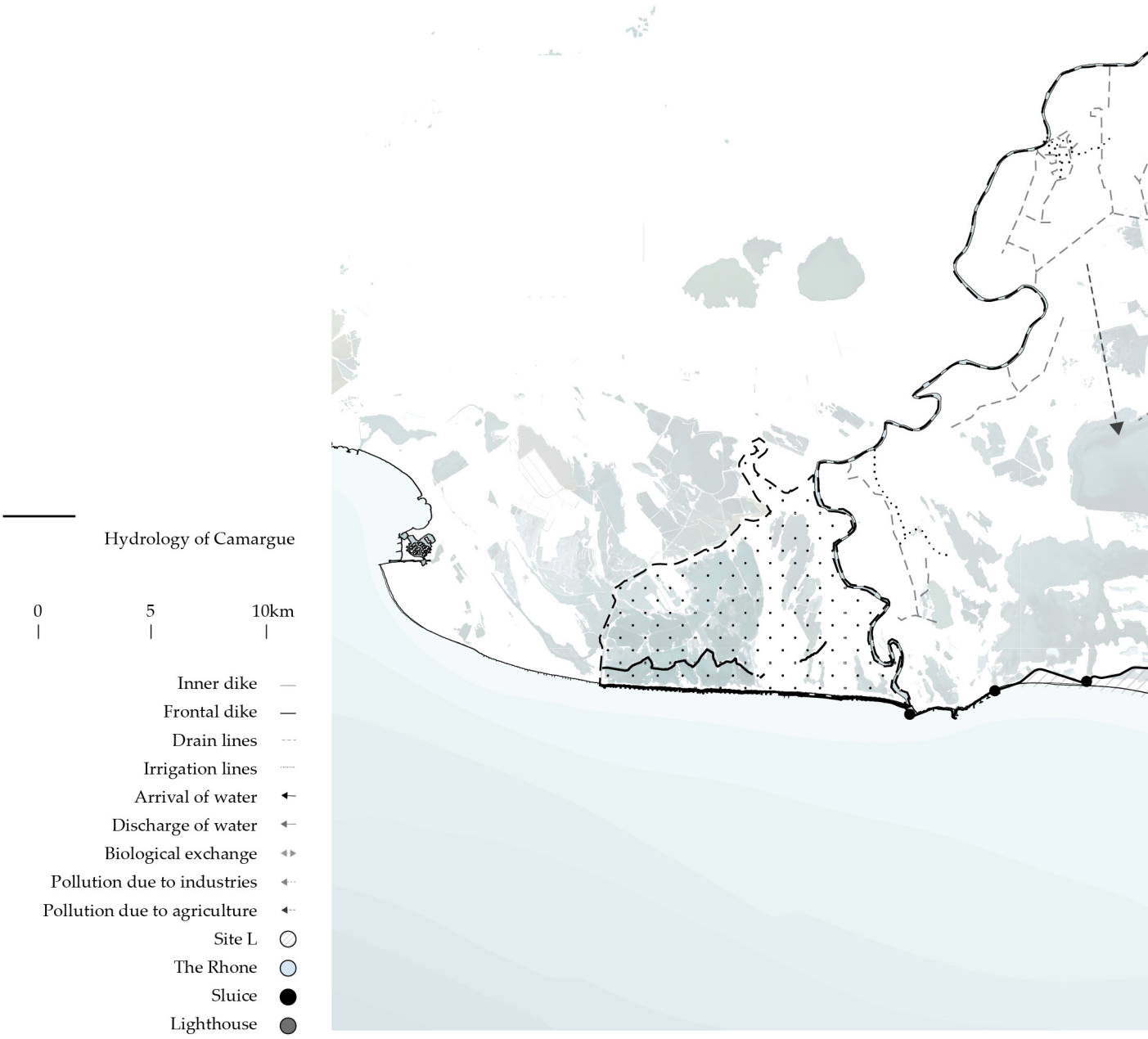
It is divided into two sectors: The western part (between the Canal de Peccais and the Canal de la Pinède) is dedicated to the production of salt from the Aigues Morte salt flats. Along the Petit Rhône, there are agricultural lands which are irrigated by private pumping.

2) The Ile de Camargue or Grande Camargue is bordered to the west by the Petit Rhône and to the east by the Grand Rhône and to the south by the sea. This sector is therefore hydraulically independent from the rest of the territory and therefore justifies its island title. With the exception of Domaine de la Palissade in the extreme south-east of the Grande Camargue, the entire island is dammed to protect itself from both the river and the sea. In order to compensate for the very strong evapotranspiration, the raising of these dikes requires the installation of irrigation works to import fresh water from the river.

Along with this massive introduction of water from the Rhône, a vast drainage system allows water to be evacuated from the delta. Water management is therefore deeply artificial and must meet agricultural, ecological and social objectives that are always interdependent and often contradictory.

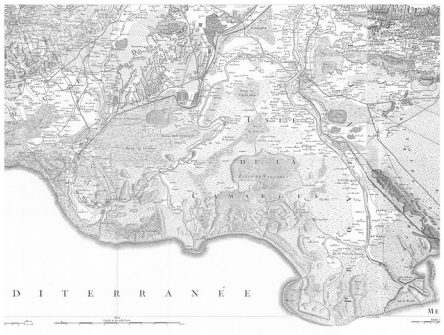
3) The Plan du Bourg east of the Grand Rhône occupies the plain between the river and the Crau costière.

Diagnostic territorial du Parc naturel régional de Camargue



at the site of the old shore line, in the continuity of the one clearly visible on the Camargue National Reserve, at Amphise and the ruins of the Abbey of Ulmet. The Bomborinette pond may be a former “estuary” of an arm of the Rhône d’Ulmet.

02.4 HISTORICAL TIMELINE



Roman Empire

Caesar deputes Roman engineer Peccaius to establish sea-salt pond in estuary of Rhone at present-day Peccaïs, near Aigues-Mortes

•Forest covered major part
•Timber for Arles shipyard
•Exploited by Cistercian and Benedictine monks- Salt was a source of wealth for the Cistercian "salt abbeys" of Ulmet, Franquevaux and Psalmody

Middle Ages

•Wheat cultivation
•Land around the three great abbeys of Psalmody, Ulmet, and Sylvestre, cleared for agriculture

Gallo-Roman

Period of prosperity of salt, Benedictines give a definitive rise to these saltworks after the barbarian invasions.

11th century A.D.

Aigues-Mortes built by Louis IX on land bought from the Abbot of Psalmody in Peccaïs.

1248

Rice cultivation begins.
Vast lands were purchased on which "mas" (large country houses) and "châteaux" were built and paved the way for today's manades, the manadiers (ranch owners), and their ranch hands "gardians".

16th century A.D.

1840, 1841, 1843

Dykes along Rhone built.

Disastrous Rhone floods nearly halts salt production.

mid- 1840's

Salt works aat Salin-de-Giraud built by Henry Merle. Railway line to Arles built.

1855

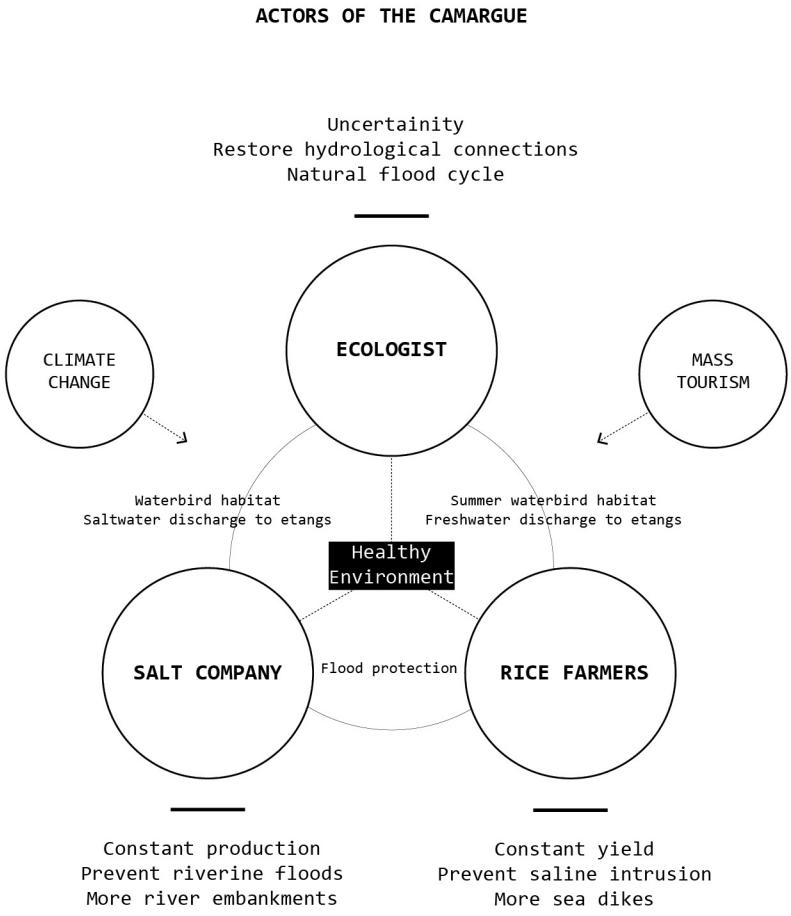
Sea dykes built along the Mediterranean coast.

1858

Salins du Midi, now owner of Giraud saltworks, scales down salt-production at salin-de-Giraud. Sells large area of land to conservation agency CdL.

2007

02.5
ACTORS



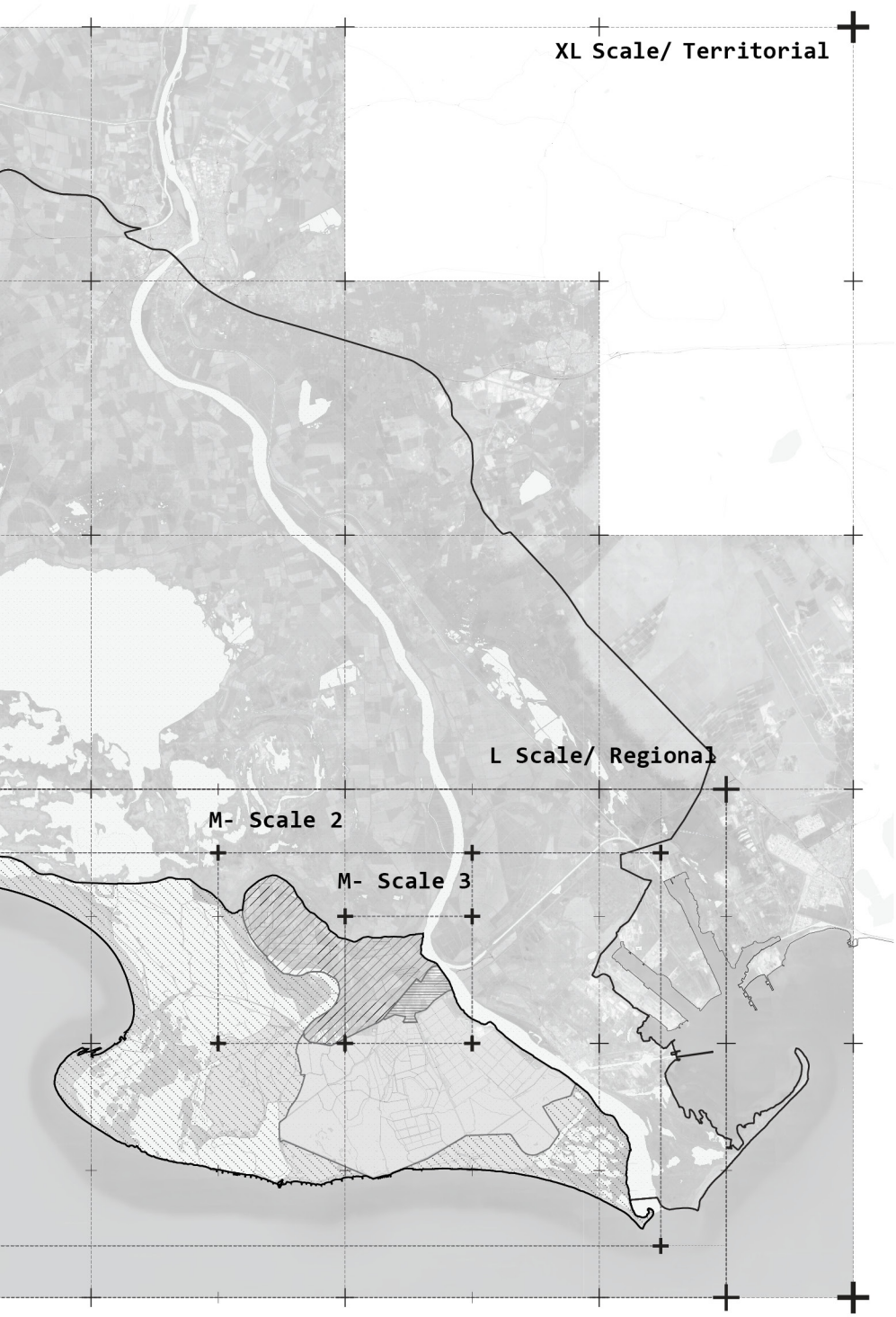
“People come to the Camargue and they see a landscape of biblical simplicity. Fields, lagoons, marshes and sea. Full stop, that's all. They don't understand how complex the history and the economy and the ecology is. They might say good riddance to the rice farming but, if the rice goes, who would pay for the pumping of the water from the Rhône that goes on to fill the Etang de Vaccares?”

- Bernard Picon, L’ Espace et le Temps en Camargue (Actes Sud)

Managers of the Camargue

0 5 10km

03
EXTENTS


XL Scale/ Territorial
L Scale/ Regional
M- Scale 2
M- Scale 3

04
TERRITORIAL STUDY

"Cheval de Camargue"
Hans SIlvester, 1975

04.1
LAND-USE

A territory mainly composed of natural spaces linked to water.
58,000 ha, of which 63% are wetlands and associated environments and 37% open water. Low component in

natural land areas
11,000 ha, of which 77% are natural meadows and woodlands, the rest for beaches and dunes
A cultivated territory dominated by arable crops

24,000 ha, of which 68% is wheat and rice.
Land use map for 2001 and 2016.

04.2
TERRITORIAL INTERFACES

Ramsar Sites Information Service
https://rsis.ramsar.org/ris/346

The Camargue is home to more than 400 species of birds and has been identified as an Important Bird Area (IBA) by BirdLife International. Its brine ponds provide one of the few European habitats for the greater flamingo. The marshes are also a prime habitat for many species of insects, notably (and notoriously) some of the most ferocious mosquitos to be found anywhere in France. Camargue horses (Camarguais) roam the extensive marshlands, along with Camargue cattle (see below).

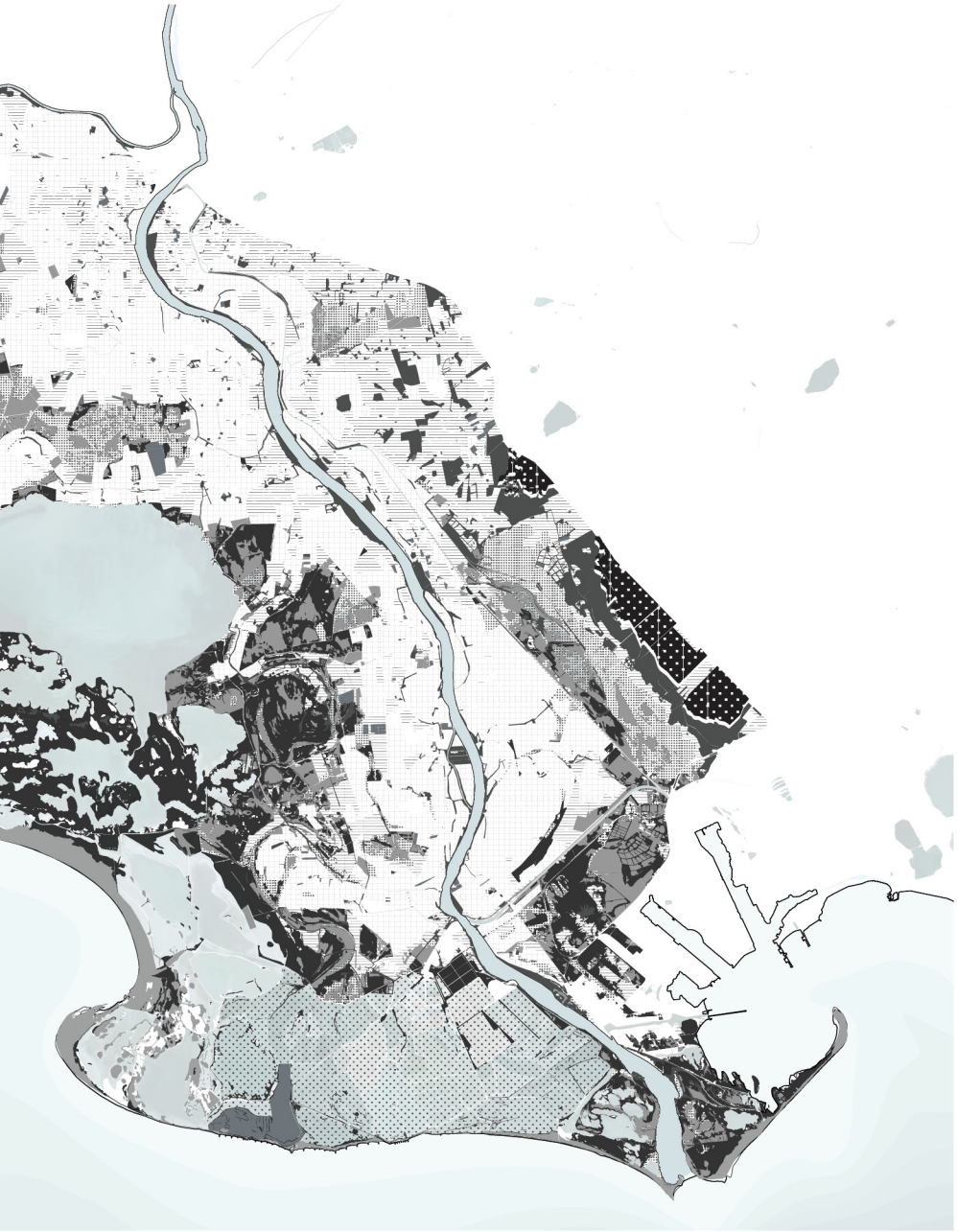
The native flora of the Camargue have adapted to the saline conditions. Sea lavender and glasswort flourish, along with tamarisks and reeds.

White Camargue horses and black bulls roam the wild as herds. More than three hundred predominantly rare bird species have found their refuge in the very shallow brackish water lakes that characterize the typical landscape of the Camargue. Rare water birds such as the pink flamingo and the silvery, matt-shimmering little egret can be observed here in flight or when foraging. The Camargue is home to some of the last breeding grounds for the pink flamingos. The breeding colony is home to up to 45,000 specimens. This makes it the largest breeding ground for the endangered bird species in Europe. Most of the birds nest on the artificially raised island of Etang de Fangassier. From here they start to joint flight formations. They look for food in the Flachsee, which is surrounded by dykes. In the brackish water of the lagoons, the small brine shrimp cavort there and serve as food for the birds. The crustaceans contain the pigments that give the plumage of the pink flamingo its typical color. Part of the population moves to the northern and western regions of the African continent to overwinter in early autumn, while others stay on site.

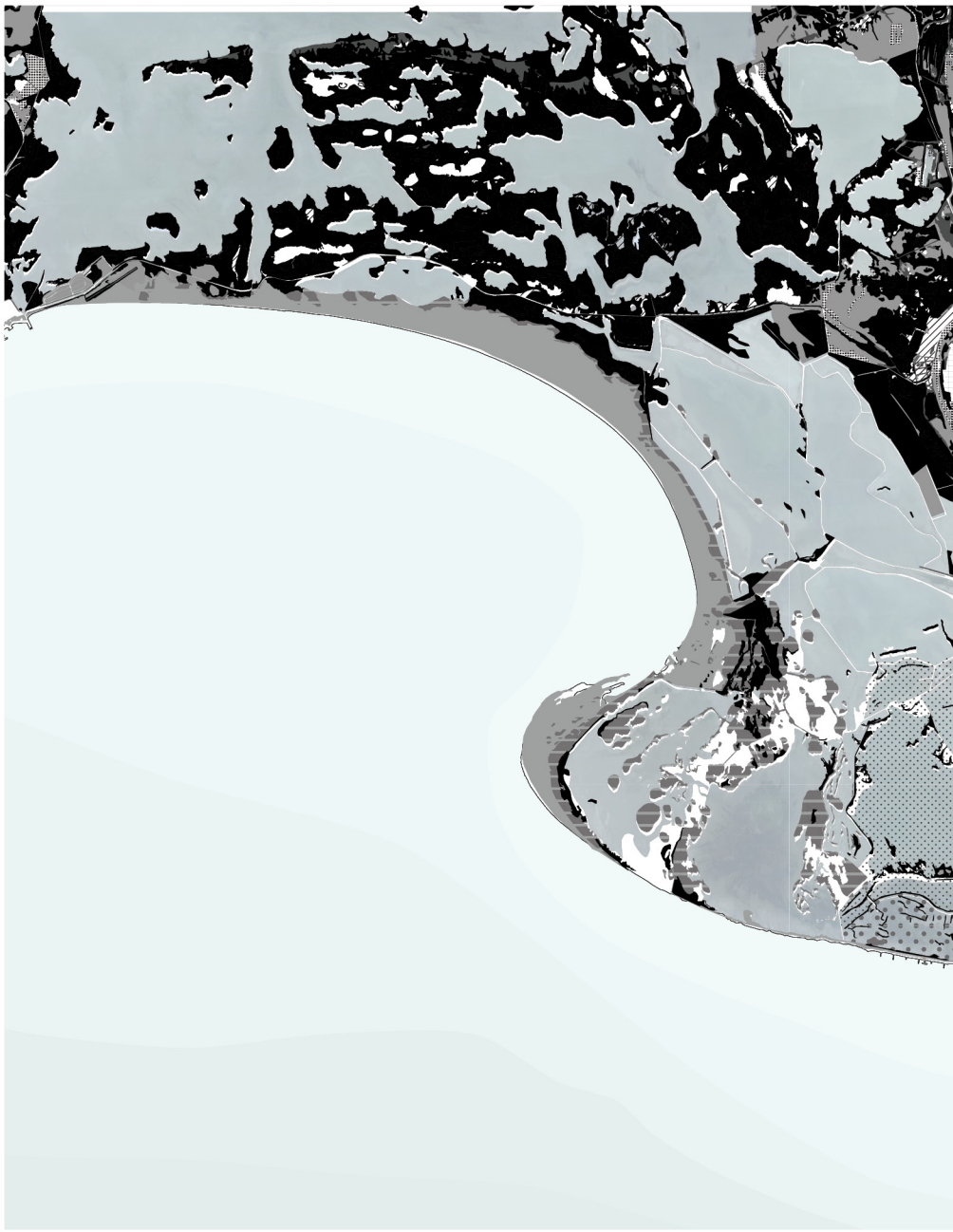
Fauna of the Camargue

The delightful observation of the fauna is thus possible all year round. The white little egret is one of the most common European heron species here. The Camargue is where a special type of rice is grown. The red rice is a product of traditional agriculture. The flat seascapes provide a nutritious and stable base for numerous aquatic plants. There are also many types of reed and tamarisk to be found.

The main types of landscapes of the Rhône delta are a visual combination of the elements of water, sky and the horizontality of grounds with indecisive fringes. Towards the south near the sea, the vision is infinite while towards the north, the Costières and the Alpilles mark the limits. The overall impression felt is that of an immensity, a land without limits.

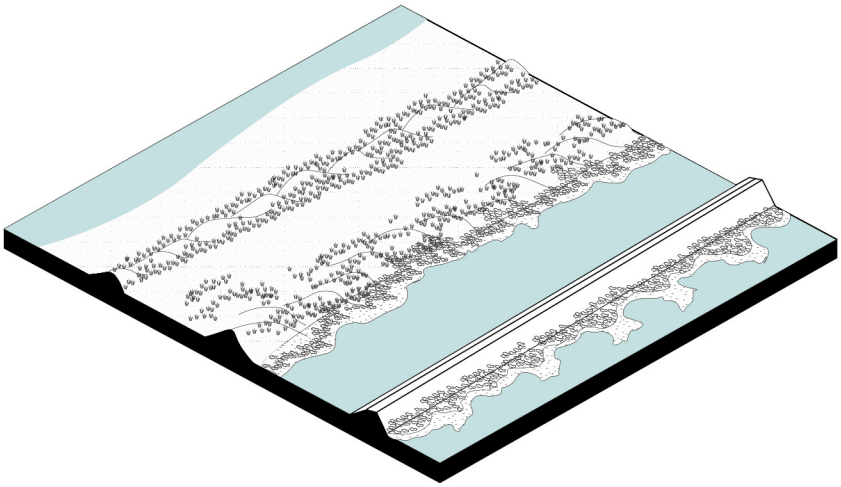


In the large property, the low urbanization further reinforces this feeling. However, despite this almost total absence of relief, the landscapes of the Camargue are varied and follow one another in a nuanced manner. Fluctuating by nature, they are under the double influence of the Rhône and the sea and are closely dependent on human actions.


Territorial Interfaces
L Scale
0
2.5
5 km
Beaches
Dunes
Sansouires
Forests
Cultivated Land
Salt Pans
Markets
Reeds
Pastures
Urban Open Spaces
Lakes
Lagoons
Marshes
Canals

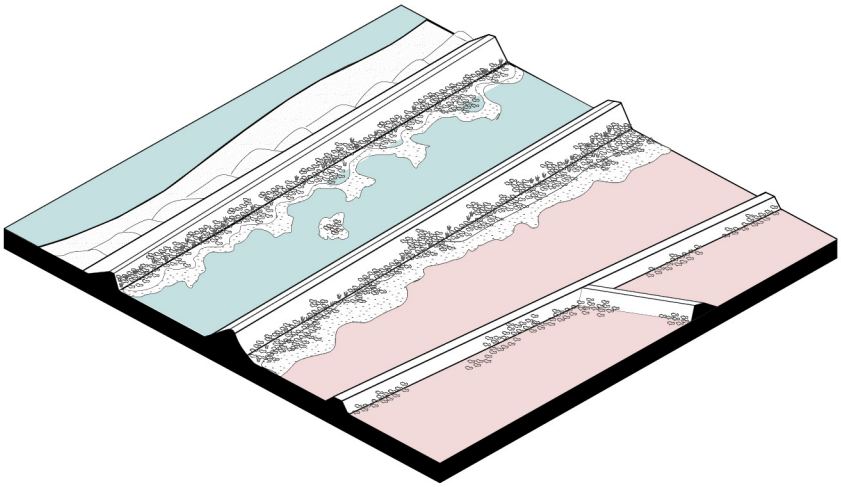
Territorial Interfaces

Source : PNR Charter



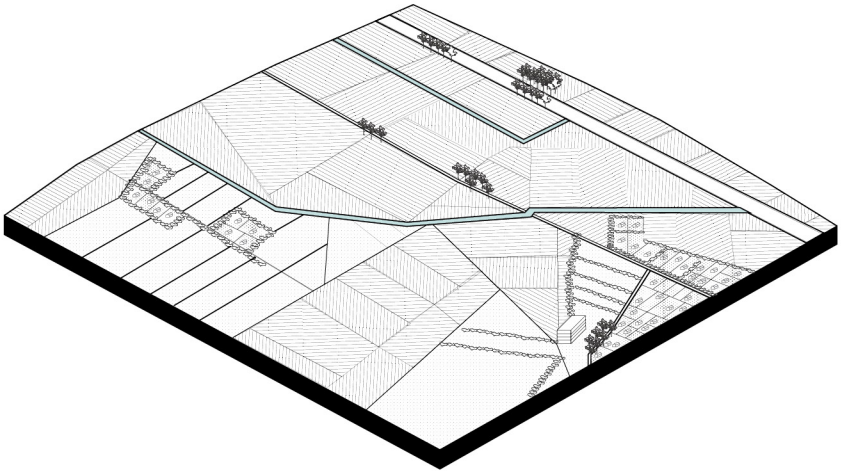
The Maritime Fringe

This area includes the sandy strip from the beach and the foreshore, the dune ridges to the sea wall. Recent coastal developments punctually mark this shoreline. Overall, however, this portion is relatively untouched by urbanization and therefore takes on great value.



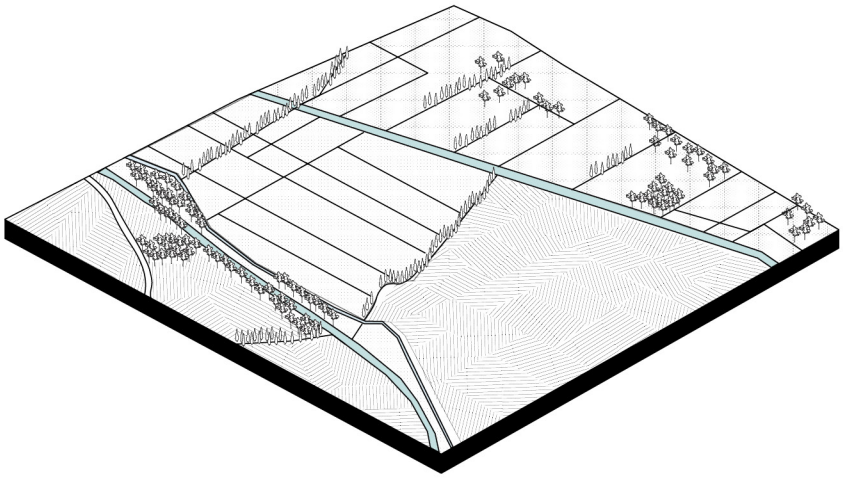
The Salt Imprint

This area covers the basins of concentration in Petite and Grande Camargue. Today, however the cessation of salt production in this sector offers a deserted landscape crushed by the presence of the industrial port complex at the back. Islets of Juniper lend the appearance of rafts



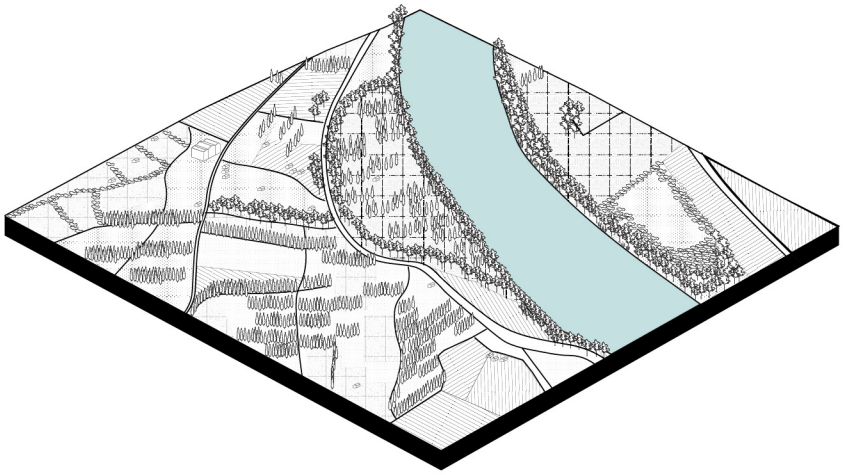
The Cultivated Areas

This unit occupies where rice cultivation is dominant and continues beyond the Grand Rhône on the Grand Plan du Bourg. The salinity is quite low on these lands. In this landscape unit, the vertical elements are more numerous and take on a remarkable importance (riparian forest, landscaped groves, etc).



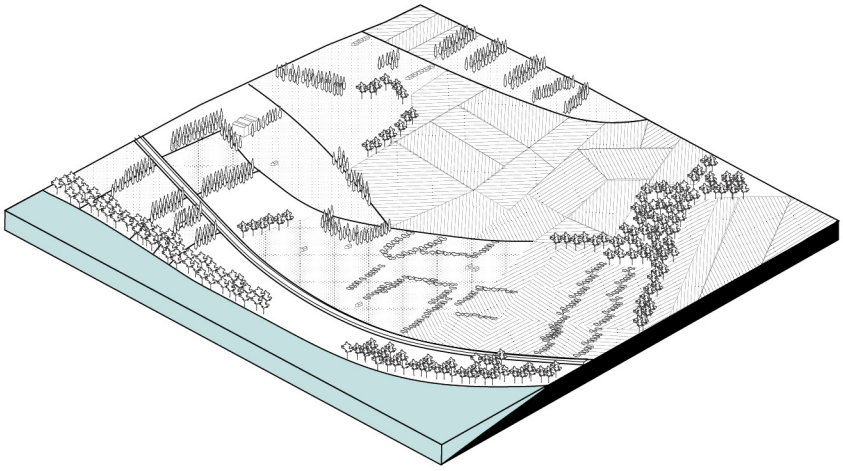
The Cultivated Areas

Irrigation and sanitation have made it possible to extend rice paddies to the old sheep pastures. The dikes delimit the planks, also indicated by a line of reeds and tamarisk along the ditches.
The riverine forests of the Rhône bar the horizon.



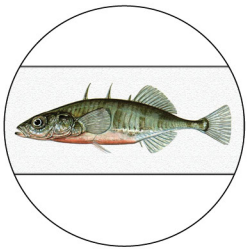
Corridors of the Rhone

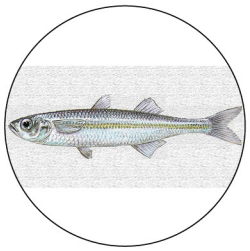
The almost continuous line of the riparian forest closes the horizon. A few forest shreds remain, evidence of ancient alluvial forests. Beyond the riparian forest, the influence of the Rhône is reflected in the mesh of deciduous trees and the network of canals with their vegetal cordon.



The Peri Urban Bocage

This unit is subject to urban pressure: small properties, various crops, a network of windbreaks. The atmosphere is similar to that of the Rhône valley. The two Rhones, their banks, their riparian areas are always close and bar the horizon. Small agricultural properties make up a mixedcrop mosaic.


Gasterosteusaculeatus

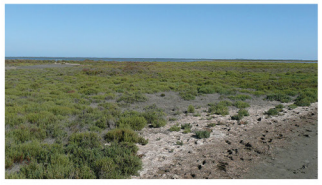

Atherinaboyeri


Gobiidae

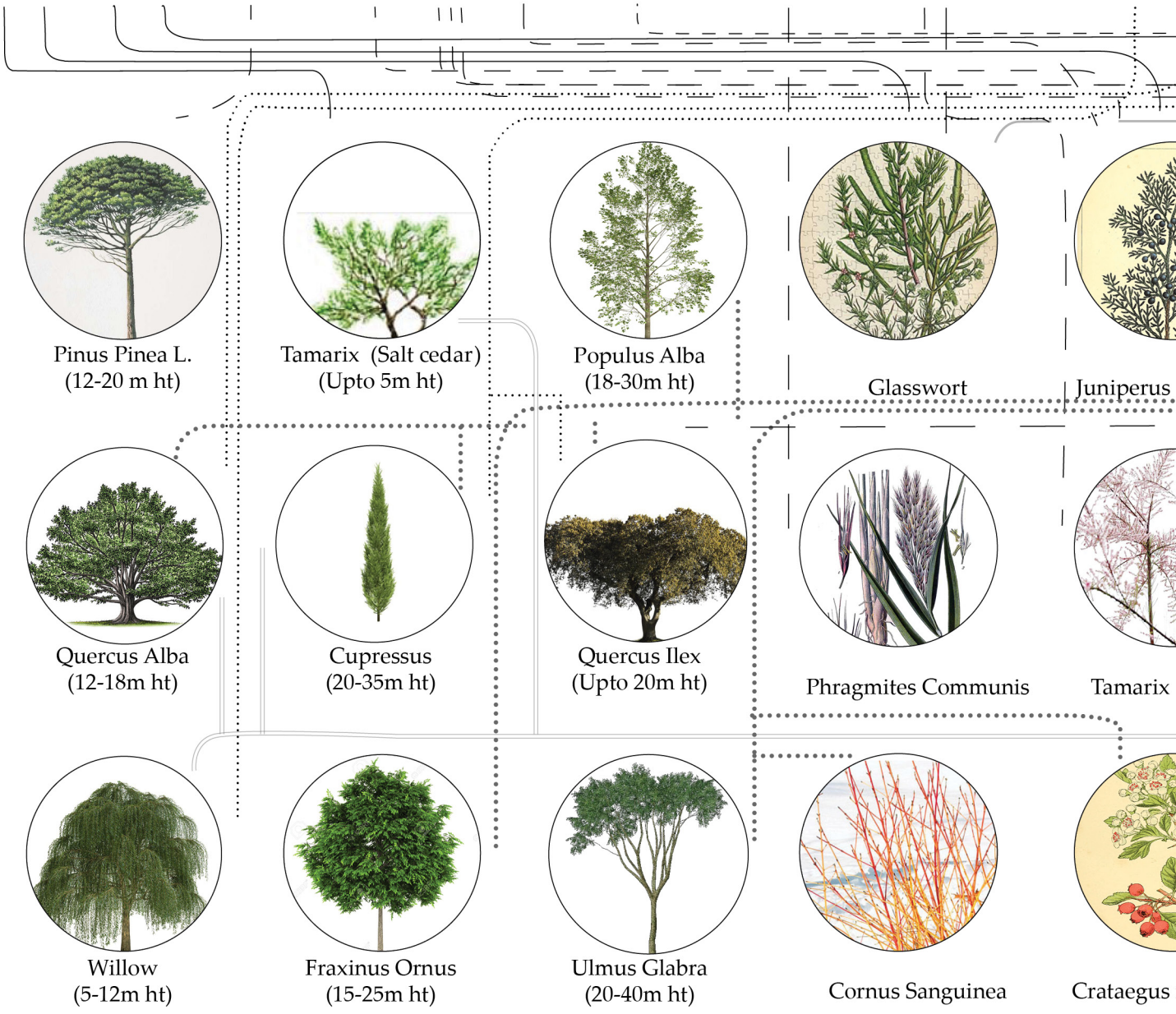

The Maritime Fringe


The Salt Imprint

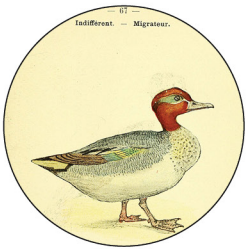

Lakes, Lagoons& Marshes


The Sansouires


Field C



Anas crecca



Anas platyrhynchos

Crops

Corridors of the Rhone

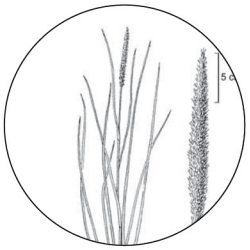
Peri- Urban Bocage

The Crau

The Wastelands

Phoenicea

Salicornia Herbacea



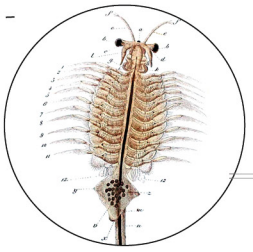
Ammophilia

Wheat

Rice

Galica L.

Bay Laurel

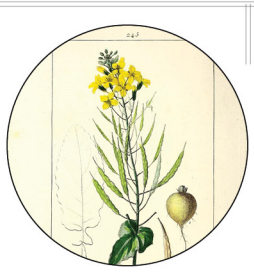


Artemia Salina

Dunalina Salina

Olive

monogyna



Brassica napus

Vines

Corn

Sunflowers

Estimating biodiversity changes in the Camargue wetlands: An expert knowledge approach
Fraixedas, Galewski

Temporary ponds and grasslands reduced 60% in surface area in 1942 to 1984 - converted into farmland or industrial areas

Decline of grasslands and temporary ponds- decline of odonates (dragonflies etc) and orthopterans (grasshoppers etc)

Increase in abundance of vascular plants- construction of irrigation and drainage canals, increasing plant productivity in wetlands and developing woody ecosystems along canals, and the increased nutrient loads in arable lands

Changes in water management regimes- Increase in certain types of water birds

Conservation measures – good for several bird species, but failed to preserve the overall species diversity.

Exotic species like Red crayfish- decline of newts and orthopterans

Mammals and reptiles decline- intensification of agriculture + loss of habitats

RESEARCH QUESTIONS

1. **What can be done to increase habitat for local flora and fauna?**
2. **Measures to protect existing endemic species from invasive species and activities.**
3. **Can we introduce secondary activities that can benefit biodiversity? (hunting, rice-farming)**
4. **Incentives for ecological conservation projects?**

Greater Flamingo

Pied Avocet

Mediterranean Gull

Spatula clypeata

Widgeon grass
(Ruppia cirrhosa)

Dwarf Eelgrass
(Zostera noltei)

Sea Daffodil
(Pancratum maritamum)

Glasswort
(Salicornia) scrubs

Frankenia laevis

Sea Lavender

Salicorna Annua

Erygium Maritimum

Pinus pinea

Pinus pinaster

Flora and Fauna- Key species
Source: PNR Charter

04.3
AGRICULTURE

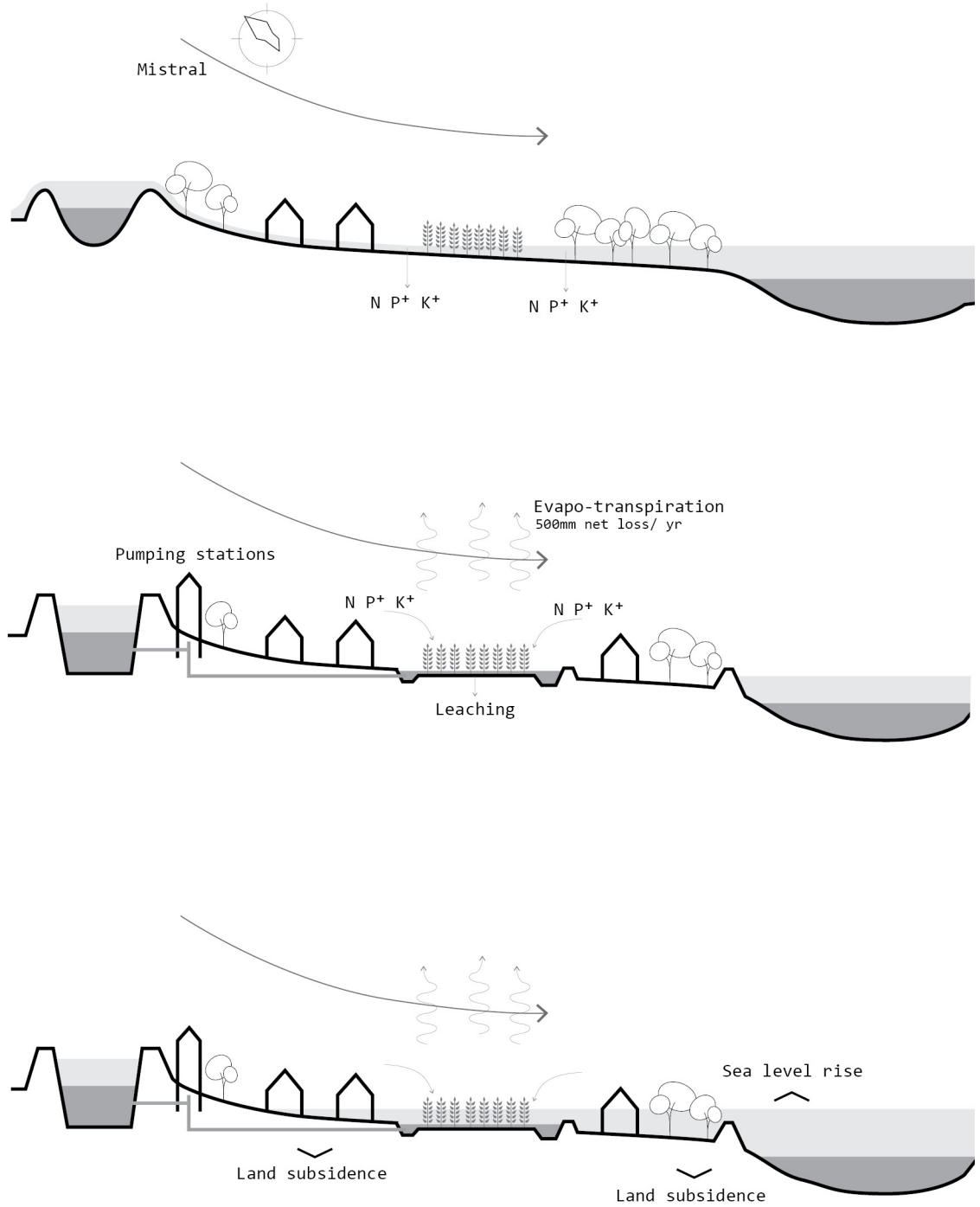
Agriculture is the main economic sector of the Camargue region. However, among agricultural crops rice is the most dominant crop type, having an important impact on the economy and ecology of the region. According to the INRA data of 2011, rice crop in the Camargue comprises 55% of the agricultural crops.

Rice in Camargue is frequently grown in rotation with rain-fed crops, especially wheat, depending on the soil types. For deep soils, rice is frequently replaced by durum wheat and is cultivated for one to five years. For shallow soils, farmers usually prefer continuous rice cultivation.

The crop type classification of 2017 revealed that the agricultural area of the Camargue region is mostly occupied by rice, covering 29.3% of the total agricultural area. The second most important crop observed is winter wheat with 20.5%. Additionally, both lawn and grassland occupy 20% of the total crop area.

Among the observed crop types, wheat is the only winter crop in the region. Additionally, it can be noticed that Camargue has a single cropping season of rice. According to the performed field surveys, the sowing of the rice crop in 2017 occurred in the first 15 days of May and the harvesting occurred from the end of September to the beginning of October.

INRA- [National Institute of Agricultural Research]



Polderisation of land and ecological effects

Agriculture in Camargue

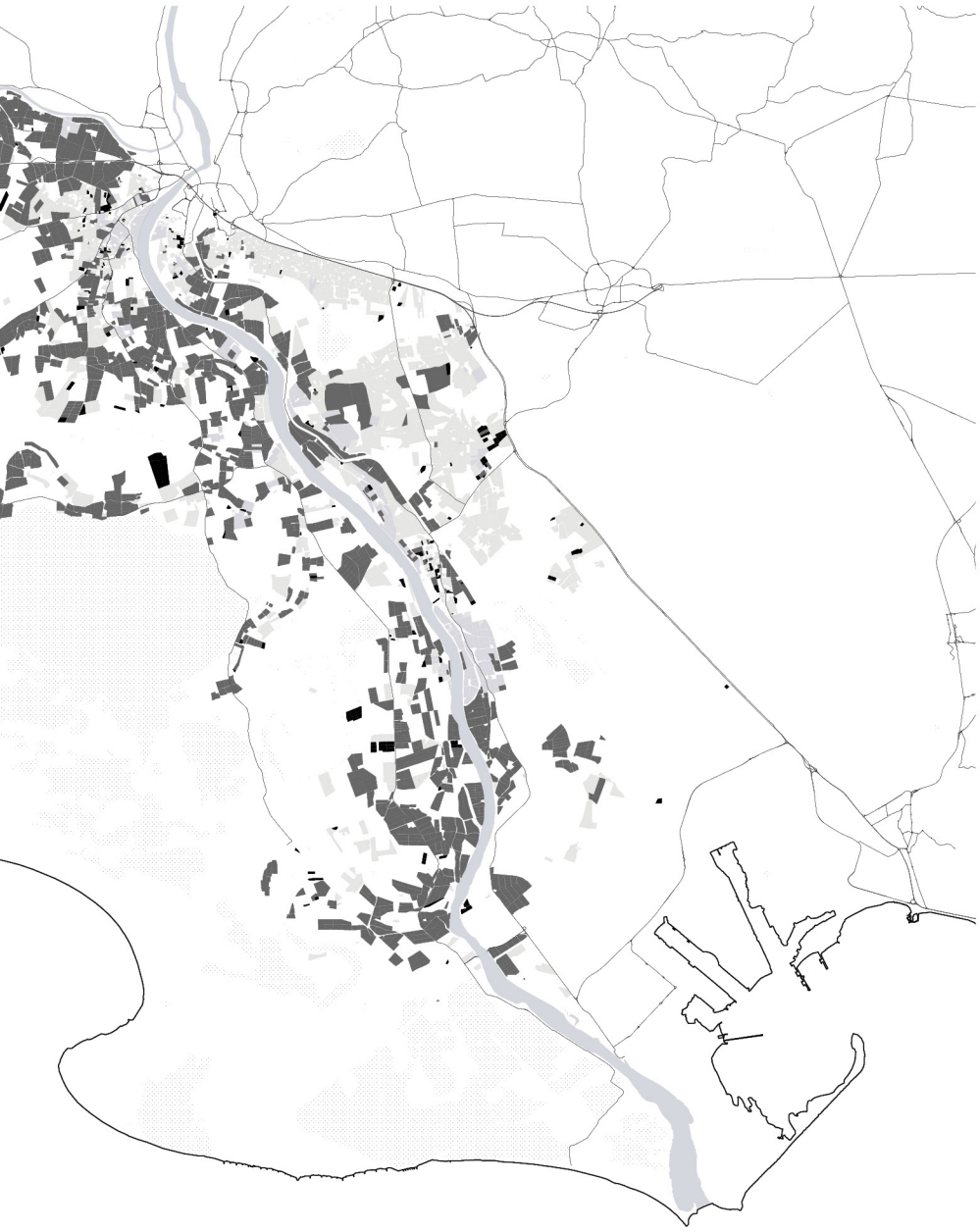
0 5 10km

Rice Fields

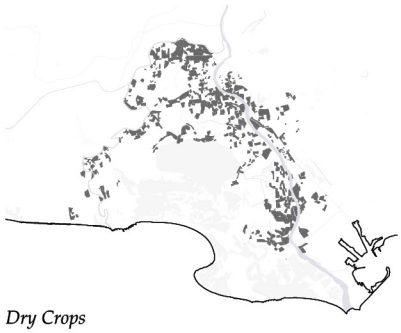
Dry Crops

Abandoned Agriculture

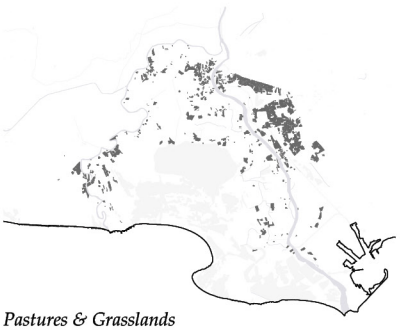
Lakes



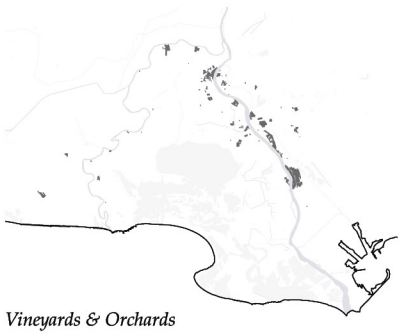
Rice



Dry Crops



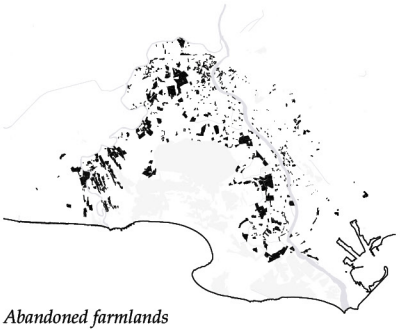
Pastures & Grasslands



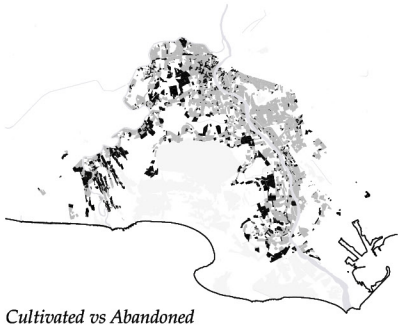
Vineyards & Orchards

Agriculture in Camargue

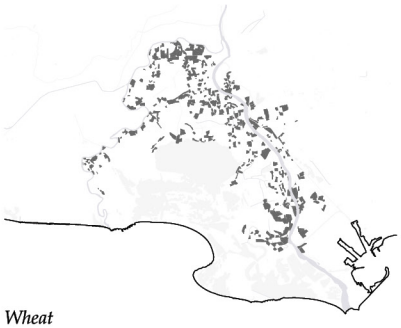
0 15 30km



Abandoned farmlands

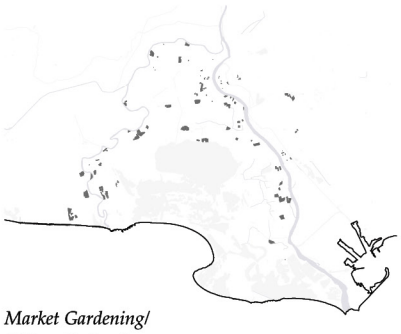


Cultivated vs Abandoned



Wheat

Canola



Market Gardening/ Urban Orchards

Alfalfa

Urban Orchards

Corn

Sunflower

Source: Camargue Natural Park (PNR)

04.4
SALT PRODUCTION

In the Camargue, salt is widely present in the soil. The nature of the ground, flat and clayey, dotted with ponds, lends itself particularly well to its extraction. Known here for a long time, salt exploitation intensified from the end of the 19th century. It took two directions:
- Salin-de-Giraud, production meets industrial needs; further west, around -Aigues Mortes, it is intended for food.

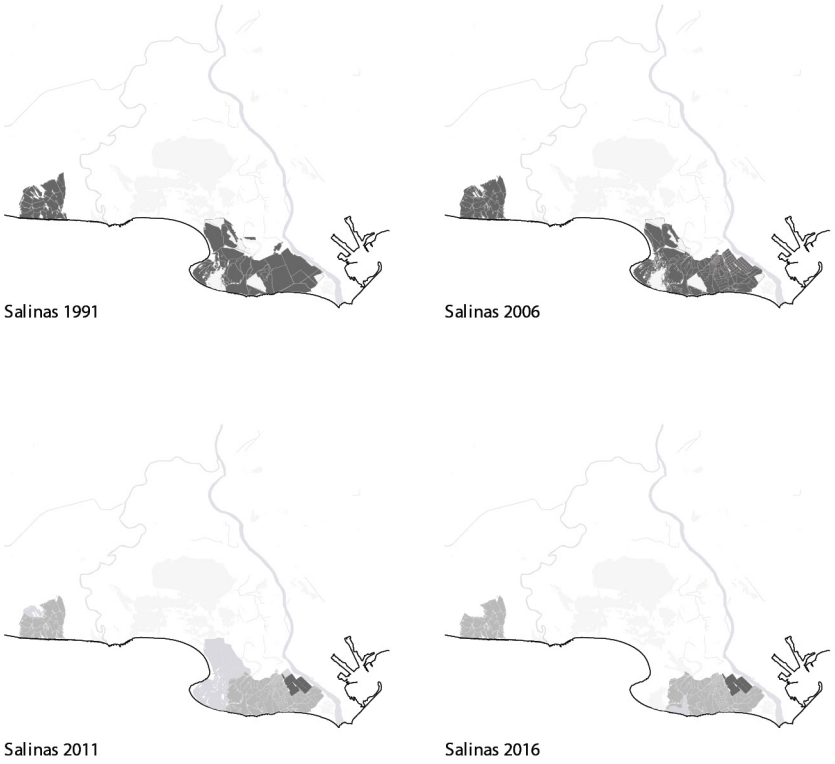
From 30,000 to 40,000 tonnes at the origin, the production of Salin-de-Giraud knew various fluctuations, before reaching an average annual capacity of 800,000 tonnes extracted on a 11,000 hectares.

The salt flats are numerous in the Camargue and most of them have a history which dates back well beyond the Middle Ages. In the east, the salt flats of Peccaïs, close d'Aigues-Mortes, who have the supremacy of salt in Languedoc. The birth certificate of these salins dates back to the time of Charlemagne, but it is very likely that they already existed in the Roman times. The legend attributes the origin of its foundation to a legionnaire of the Roman armies, Peccaius, commissioned by Caesar to establish a saltworks there. It is, however, Benedictines who will give a definite boost to these salt flats after the barbarian invasions.

As we have seen, the Rhône is no stranger to the development of Camargue salt, and, in particular, Salin-de-Giraud is favored. Le Grand Salin ships its salt by sea and by Rhône. The establishment at the end of the last century of the lock at Port-Saint-Louis-du-Rhône was a major asset, as was the arrival in 1892 of the Société Solvay, which, for the needs of its industry, used half of the salt production.

The emerging needs for chlorine prompted salt

Direction du Patrimoine- http://www.patrimoine.ville-arles.fr/document/salin-giraud-arles-boudet.pdf



Crop type and distribution

workers to expand their tool to the point that Salin-de-Giraud quickly became the largest salt works in Europe. In 1954, its production of 400,000 tonnes per year required efficient and reliable installations. The railroad which carries the salt on Arles is abandoned. A questioning of the shipping means gives birth to this wooden silo of 500 tonnes which will belong, from its birth, to the silhouette of the landscape of Salin-de-Giraud.

Direction du Patrimoine- http://www.patrimoine.ville-arles.fr/document/salin-giraud-arles-boudet.pdf

Salt mining process

1. Take seawater. - In the Gulf of Beauduc, from March to September, the waters are directly taken from the sea by three pumps which introduce 80 million Cubic meters.

2. Bring the water to saturation with sodium chloride. - Seawater must pass a content average salt (29 grams per liter) at saturation (260 grams per liter). The salt workers make circulate the waters on partitions (ponds fitted out by dikes and partitions): the water height, which conditions the rate of concentration by evaporation, thus remains constant and as small as possible (on average 35 centimeters).

During a campaign, the volume of water in circulation is around 35 million cubic meters and, before being saturated, these waters traveled approximately 50 kilometers.

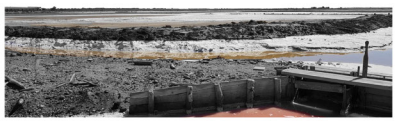
3. Add the salt. - The deposition is carried out by evaporation on “salient” surfaces. On the one area of 770 hectares, their soil, carefully leveled, reduces the water level to 15 centimeters on average. Saturated brines that remain after evaporation take on a pink coloration due to the presence of halophilic microorganisms.

4. Harvest the salt. - The harvest takes place from the end of August to the beginning of October to make the most of evaporation and avoid fall rains. The salt layer is then about 76 thick millimeters, which represents 1,000 tonnes of salt per hectare of surface area, the capacity of extraction being 30 hectares per day.

Water brought in through sluices from the Mediterranean

Canals conduct water to pre-evaporation ponds.

Dykes separate ponds at different stages of evaporation.



The water is then taken to pre-concentration ponds.

Canals run around the system to prevent infiltration.

The salt is crystallised in the crystallisation ponds.

Salt collected using mechanical means and deposited in salt camelles.

Salt is washed and shipped

Salt Production process-
Salin-de-Giraud

Salt camelles of Salin-de-Giraud
Source- pxsphere.com

Mediterranean saltworks are facing both site-specific and general threats. The first include changes in the biophysical features of the wetlands and their natural infrastructure. The most important threats to the cultural values of saltworks are land use changes in favour of intensive agri/ aquacultural developments and urbanisation. Cities development and tourism are fast becoming the dominant economy for coastal regions of the Mediterranean basin.

The competition to find suitable affordable sites for facilities near the shore has pushed developers closer into saltworks. Land change is also driven by industry and shipping. Most damaging is the widespread ignorance of the values of saltworks.

The abandonment of traditional salt-making has had its strongest impact on the human dimensions of the activity, because most of the knowledge about traditional salt-making used to be transmitted orally. When the activity is abandoned, traditions, legends and beliefs related to the salt are slowly disappearing, along with tools, devices and infrastructure. Moreover, both active and abandoned saltworks in the Mediterranean are affected by a variety of point and non-point environmental impacts (not including those related to salt production, but possibly causing detrimental effects to salt production itself), arising mainly from agriculture, industry and tourism.

All these impacts affect the saltworks' role as a cultural heritage and the coexistence of sustainable salt production and biodiversity. grow and multiply.

Environmental Management and Conservation in Mediterranean saltworks and Coastal Lagoons –MC-SALT

RESEARCH QUESTIONS

1. **Provide alternate income to lost salt jobs to counter depopulation**
2. **Promote salt production as part of cultural heritage**
3. **How to deal with abandoned flats?**

(Top) Biking- Salin-di-Giraud
Source- www.visitesalinsdecamargue.com

(Bottom) Wild camping- Piemanson beach
Source- http://avignon-in-photos.blogspot.com/

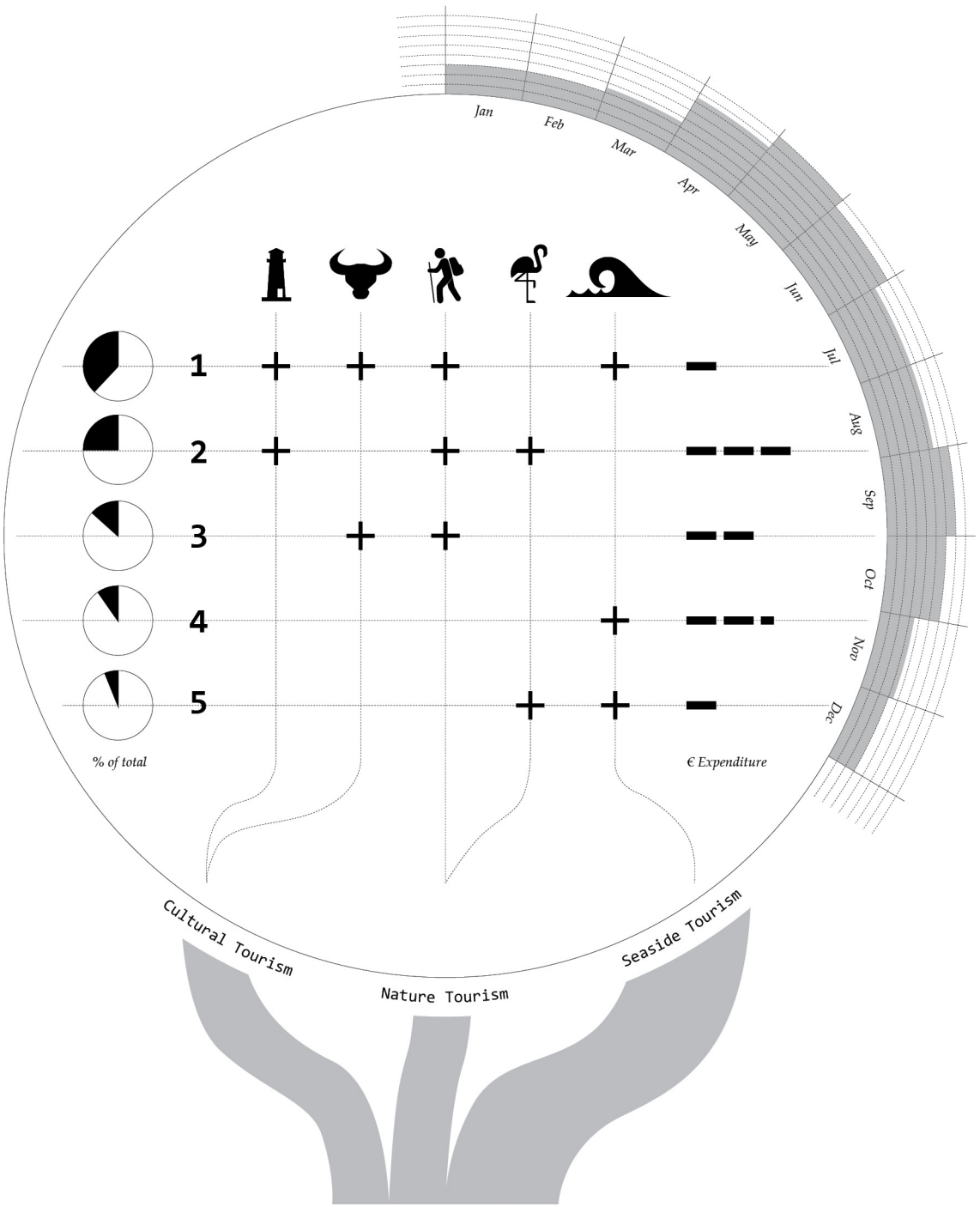
04.5
TOURISM

Camargue land divided into three belts of activities, linked with the ecosystems it contains:

(1) The natural belt, which is the core area, covering 25,000 protected hectares of large lagoons, marshes and reed beds. The main activities there are nature protection, restricted natural tourism, fishing and livestock farming.

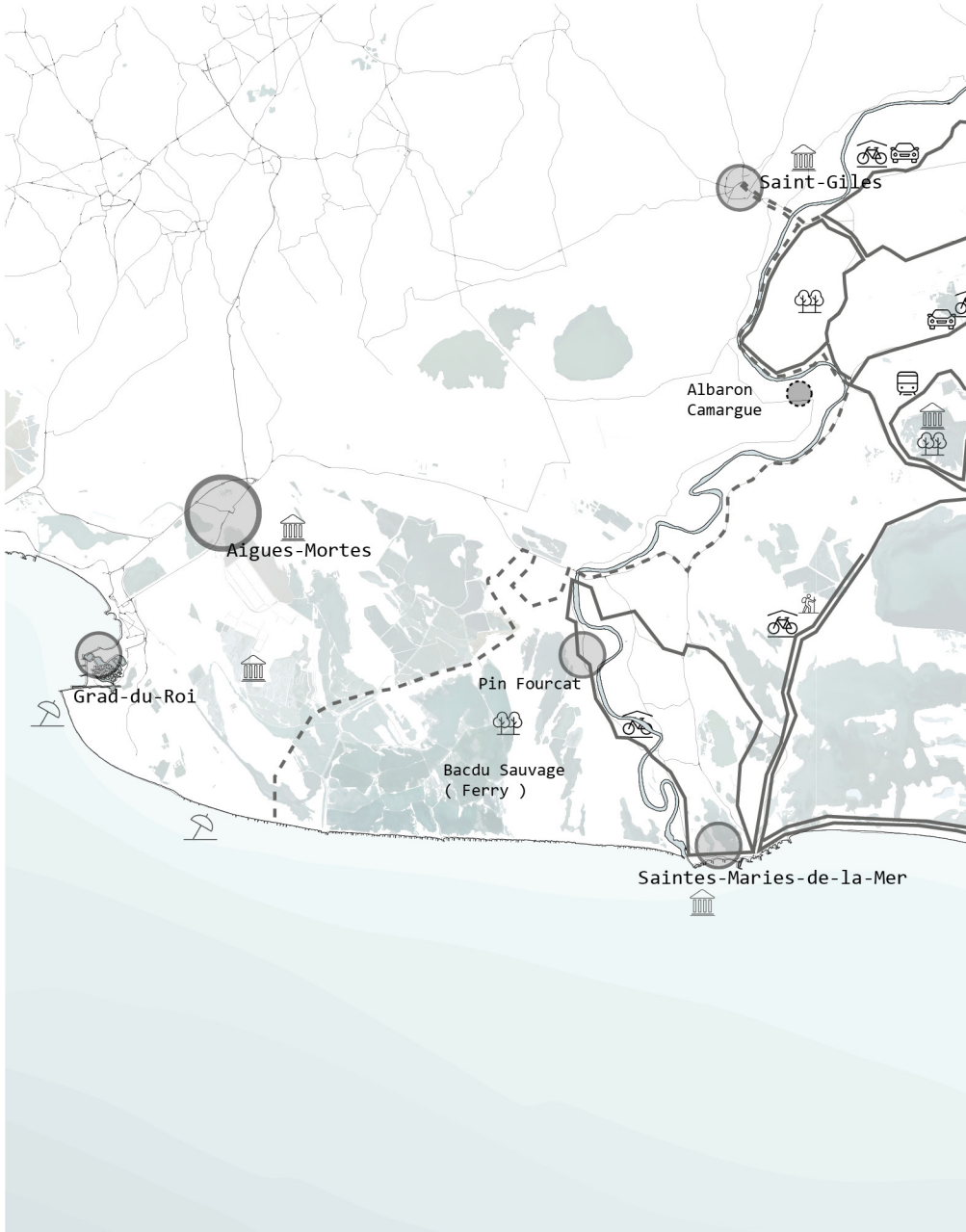
(2) The belt of extensive land uses is characterised by marshes, reed beds, lawns and salt marshes. The activities characterising this belt are tourism, livestock farming, nature protection, hunting, fishing and reed harvesting.

(3) The belt of intensive production covers the periphery of the delta with salt production, beach activities and mass tourism in the south and agriculture elsewhere



1 Million Visitors

Annual Tourism in Camargue



Tourist Network

0 | 5 | 10km

Access

by miniature train

by car

by bike

by foot/ hike trails

Type of Tourism

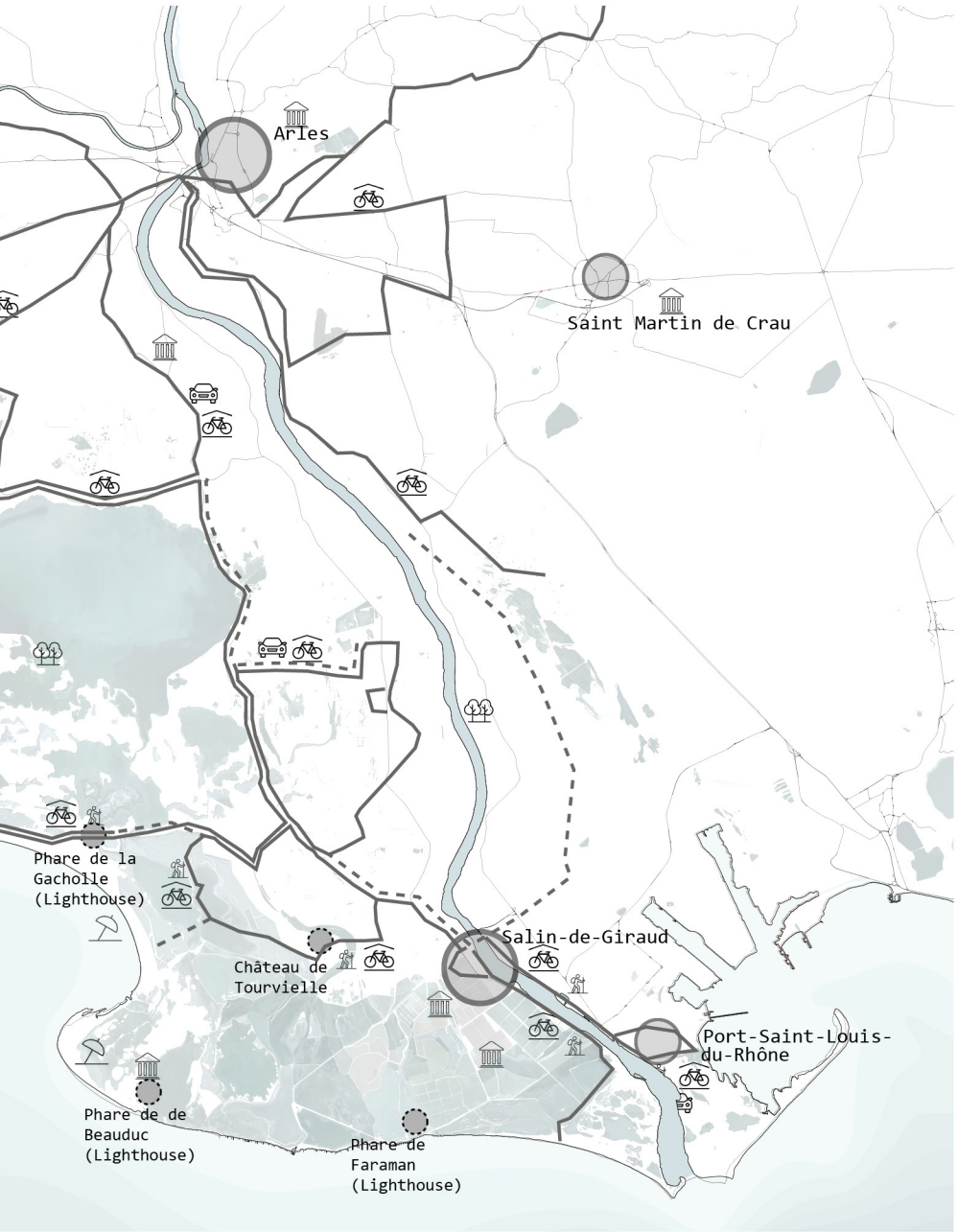
Cultural

Sea side

Nature

Seaside Tourism- Seaside tourism is dominant, with half a million visitors per year. It encompasses (1) authorised beach tourism near seaside resorts (2) forbidden wild camping on remote beaches. *Main stakeholders- public institutions in charge of the coastal ecosystem and of socio-economic development*

Cultural Tourism- The next



most prevalent form of tourism is cultural tourism, which is of two kinds:
- Urban tourism
- Rural tourism

Main stakeholders(rural)- livestock farmers

<u>Nature Tourism</u>- Lastly, nature tourism takes place mostly in the natural belt (protected areas). *Main stakeholders- protected area managers*

04.6
URBANISM & ARCHITECTURE

An evolution of the building linked to the constraints of the territory and uses. The territory of the Camargue Regional Nature Park corresponds almost strictly speaking to what historians call the Isle of Camargue, namely the part of the Rhône Delta between the PetitRhône in the west and the Grand-Rhône in the east. A flat space where the altitudes remain very close to sea level, the soil of the Camargue is mainly made up of more or less sandy alluvium depending on the presence of old beds of the Rhône. Fluvial dunes, marshes, sansouïres or organ swamps offer no stones and few large trees for timber.

The construction of the Roman villas made use of stones from the Alpilles, brought by boats. But the ancient agricultural system was ravaged by invasions and various plunderings, among others Saracen incursions For a long time remained an architecture of shelter and refuge for the outlawed and the marginalized, the vernacular techniques (huts of gardian and shelters of shepherds) used the earth for the walls, the small trunks for the frame and the sagne (reed thatch) for the cover. Sustainable building materials, in particular stone from Fontvieille, had to be imported at great expense by waterway. Their use is historically limited to defensive or religious works.

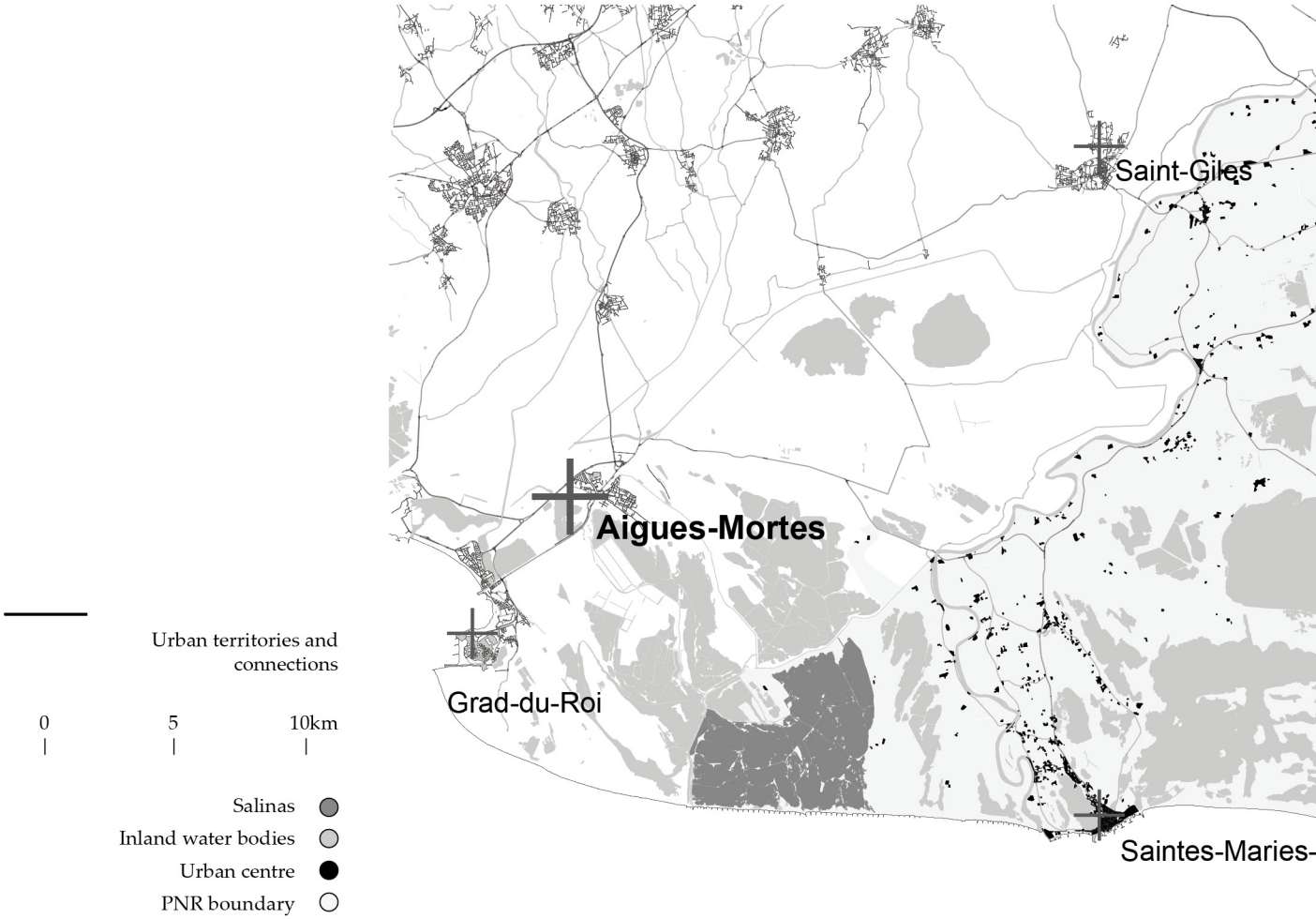
The systematic re-use and recycling of ruined materials (the case of Ulmet Abbey is characteristic) largely explains the absence of large old buildings. It was only with the relative peace and agricultural progress of the 16th, 17th and 18th centuries that the Camargue saw most of the current farmhouses appear.

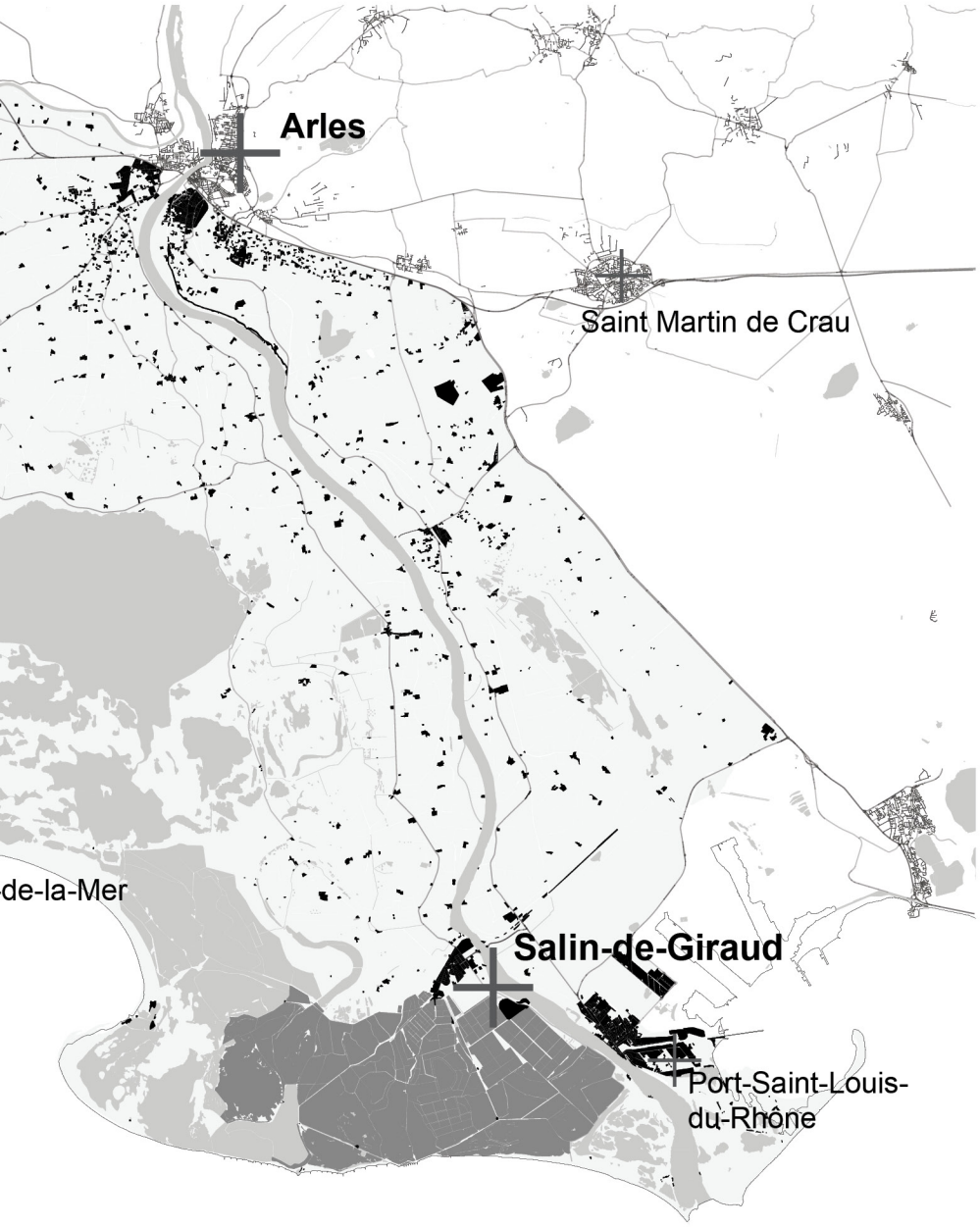
The sites of the hamlets and isolated farmhouses were dictated by the terrain. They are mainly found on the “heights” of alluvial ridges.

Direction du Patrimoine- http://www.patrimoine.ville-arles.fr/document/salin-giraud-arles-boudet.pdf

Vernacular Architecture- Cabana

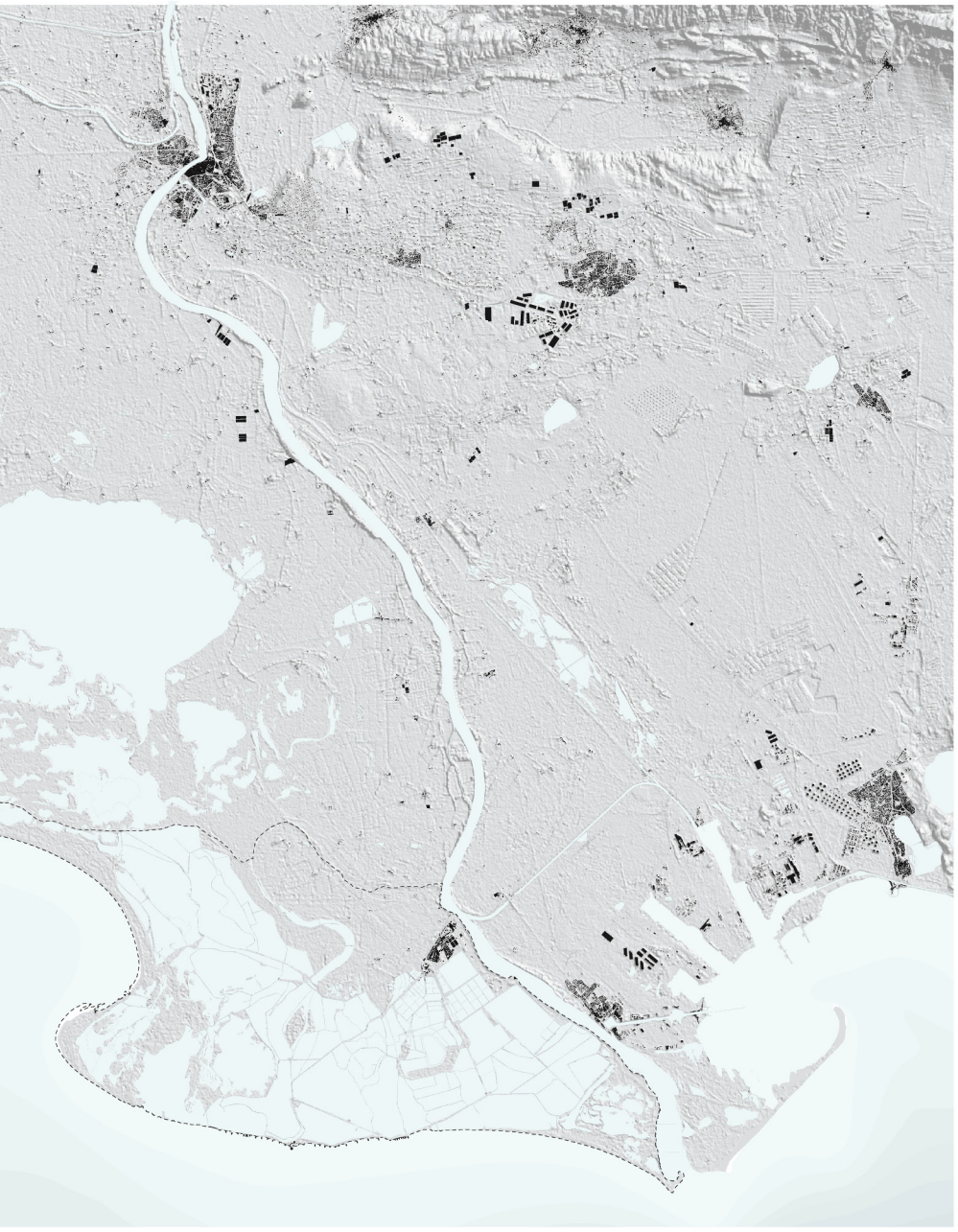
Camargue/ Van Gogh


Saint-Giles
Aigues-Mortes
Grad-du-Roi
Saintes-Maries-
Urban territories and connections
0
5
10km
Salinas
Inland water bodies
Urban centre
PNR boundary

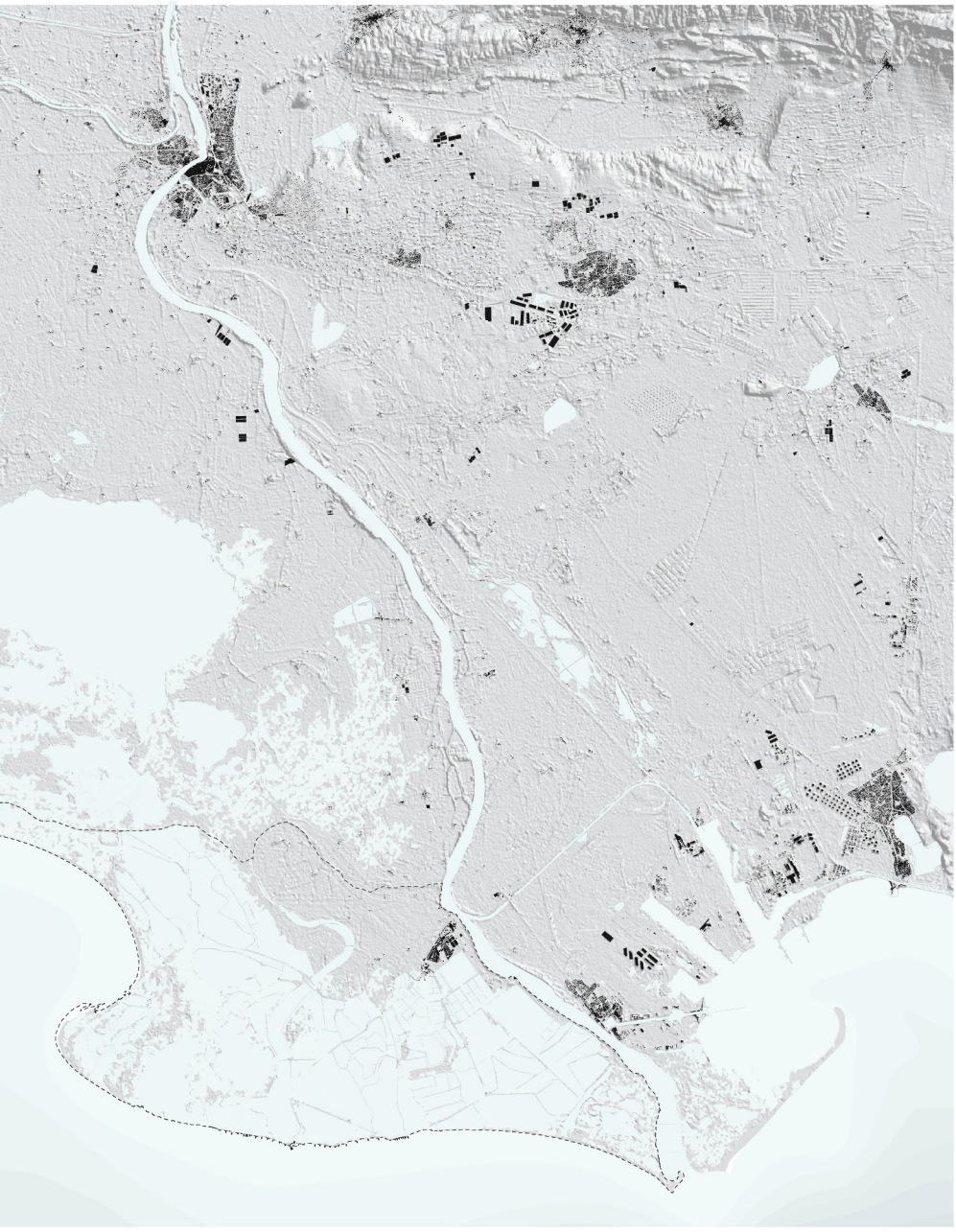

Arles
Saint Martin de Crau
-de-la-Mer
Salin-de-Giraud
Port-Saint-Louis-
du-Rhône

Salin-de-Giraud

05
SCENARIO- CAMARGUE 2100

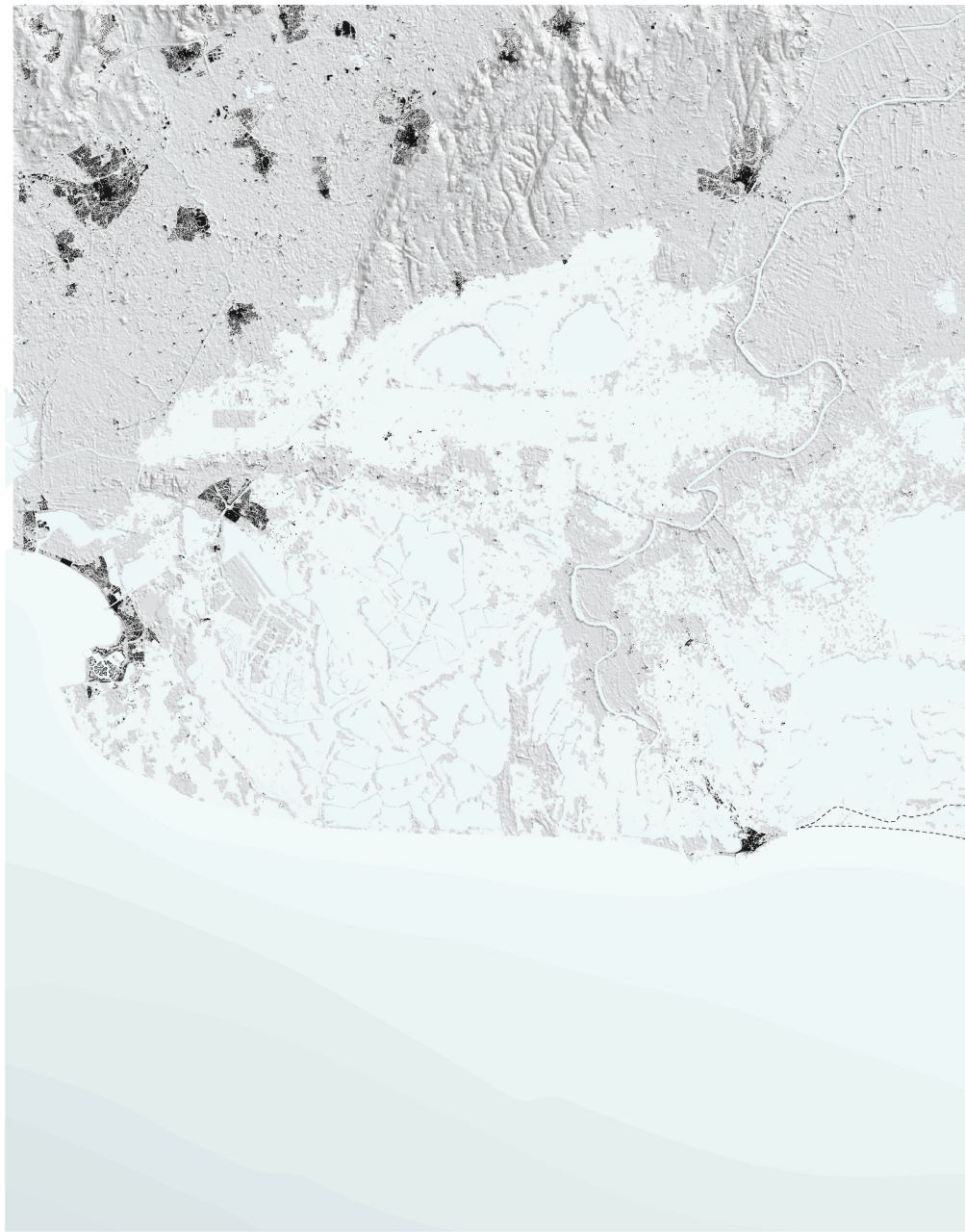


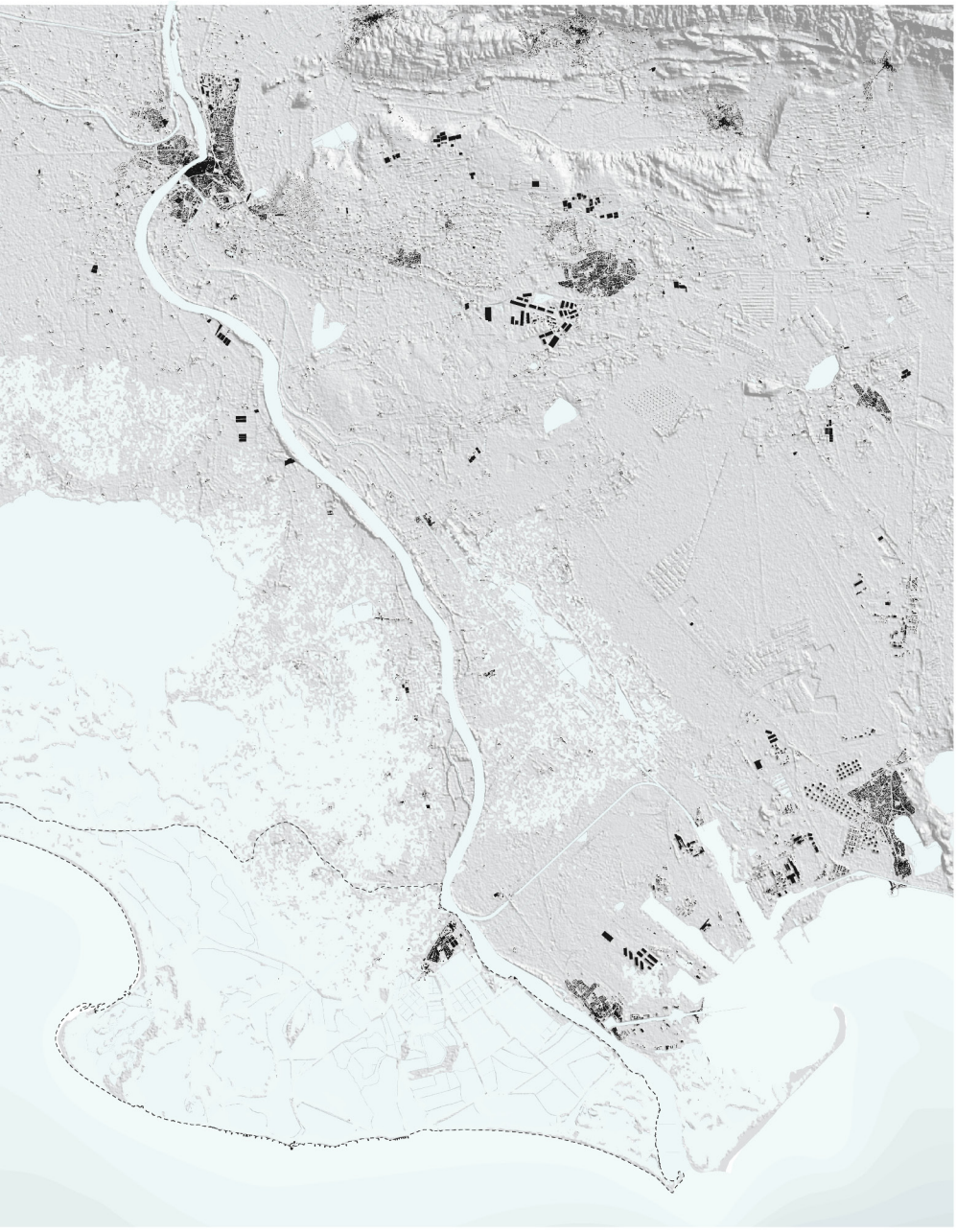

SEA- LEVEL RISE
2100/ Unchecked Pollution
0
5
10km
Land under water
Dry land



The future scenario taken is for 2100 with pollution rates unchecked as it is in the present.

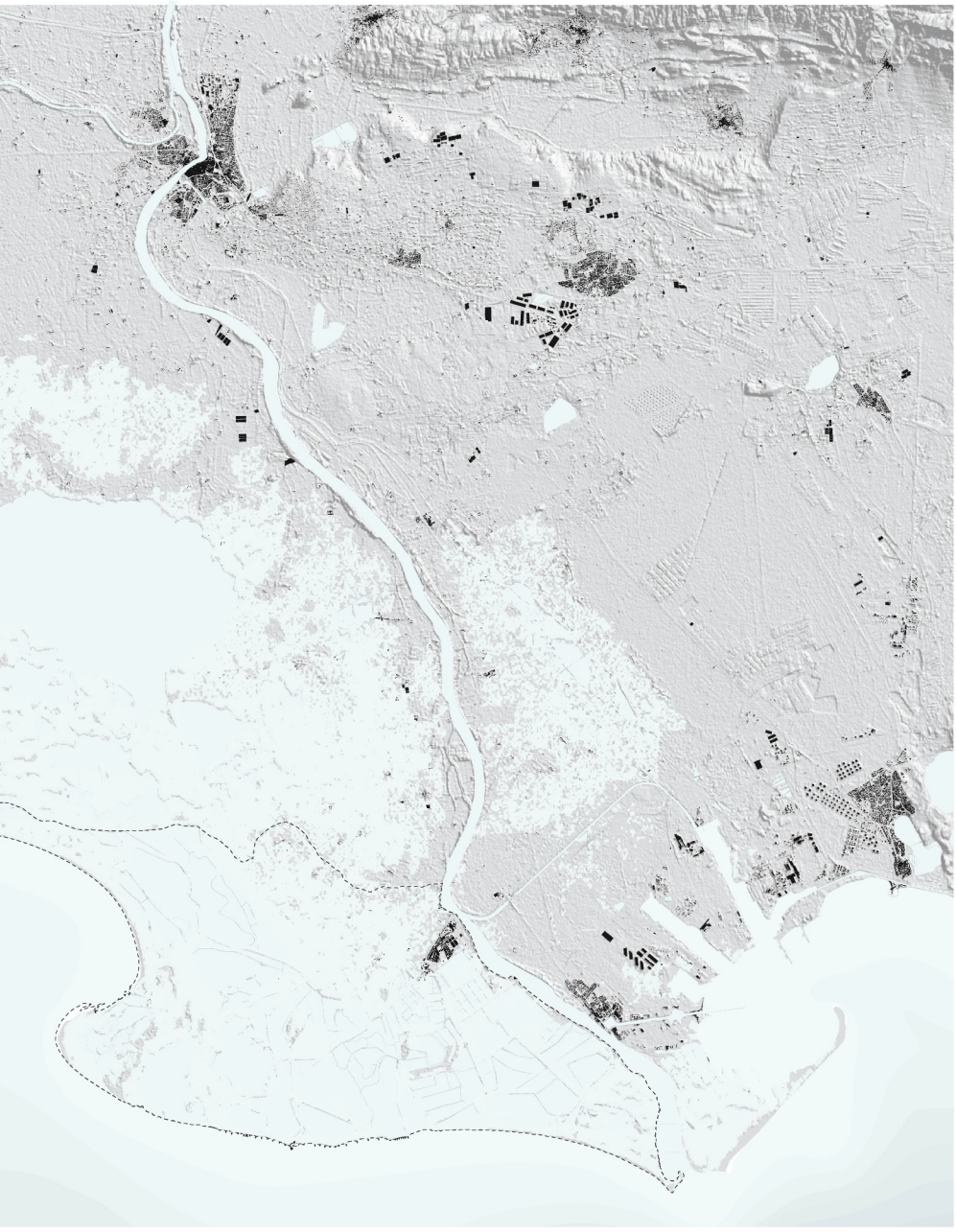
The data set is take from climatecentral.org which uses elevation data set of Kopp et al. 2014. The ‘luck’ level is set to medium.


Sea Level + ANNUAL FLOODS
2100/ Unchecked Pollution
0
5
10km
Land under water
Dry land



“Annual flood level” is used to denote the water level at the shoreline that local coastal floods exceed on average once per year. In other words, ten floods are statistically expected to exceed this level over ten years, although some years might have two or more incidents, and other years none.


Sea level+ MODERATE FLOODS
2100/ Unchecked Pollution
0
5
10km
Land under water
Dry land



“Moderate flood level” is used to denote the water level at the shoreline that local coastal floods have a ten percent chance of exceeding each year.

06
INTERVENTION

"Giraud Salins museum"
Author

06.1
VISION

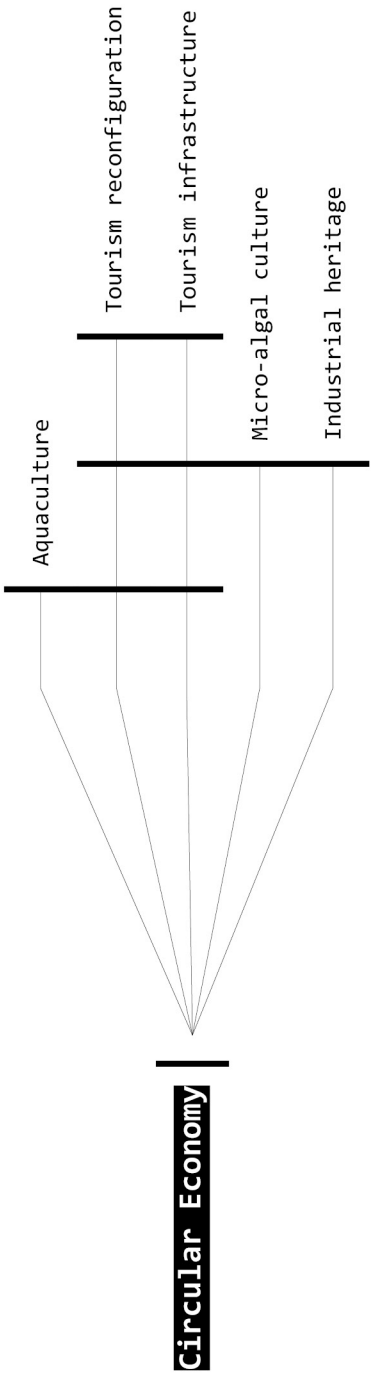
Charting a new trajectory for the future of Camargue by strengthening existing and creating new synergies in the territory.

06.2
STRATEGIES AND ACTIONS

Landscape Sponge

Salin-de-Giraud

Coastal Interface

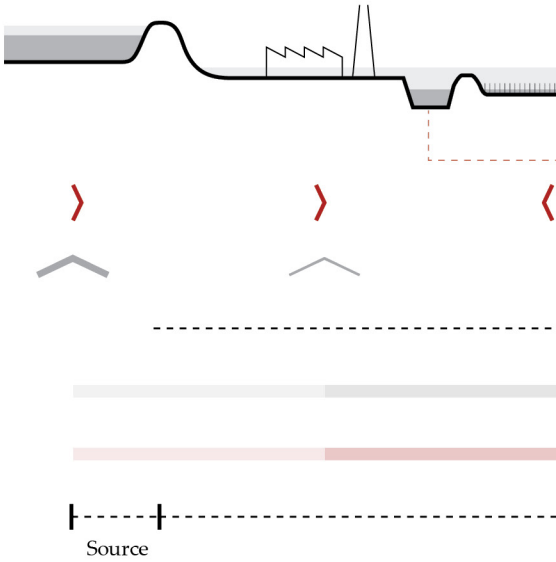


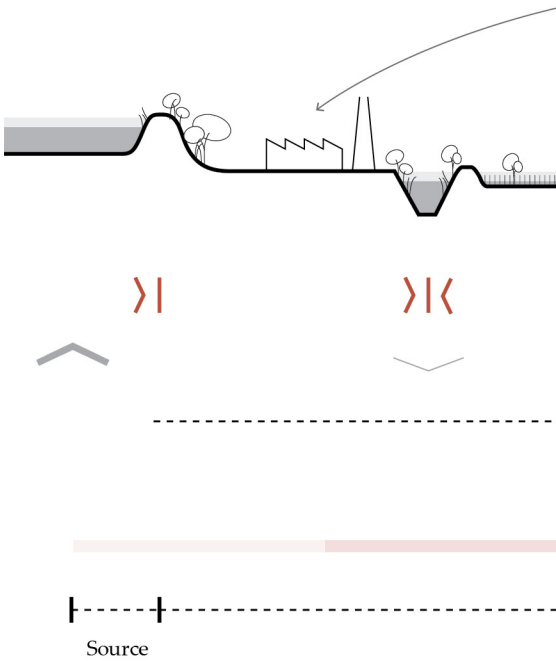
Living with Water
Flood sink
Flood conduits
Agrosilvoculture
Silvopasture
Fauna breeding islets
Flora islets
Adaptive Urbanism
Epistemological centres
Flood adaptive architecture
Phytoremediation
Interface Management
Riparian vegetative buffer
Tolerating vegetation
Beach Reinforcement
Strengthening sea wall
Sinkable inner dykes
Salt Marshes

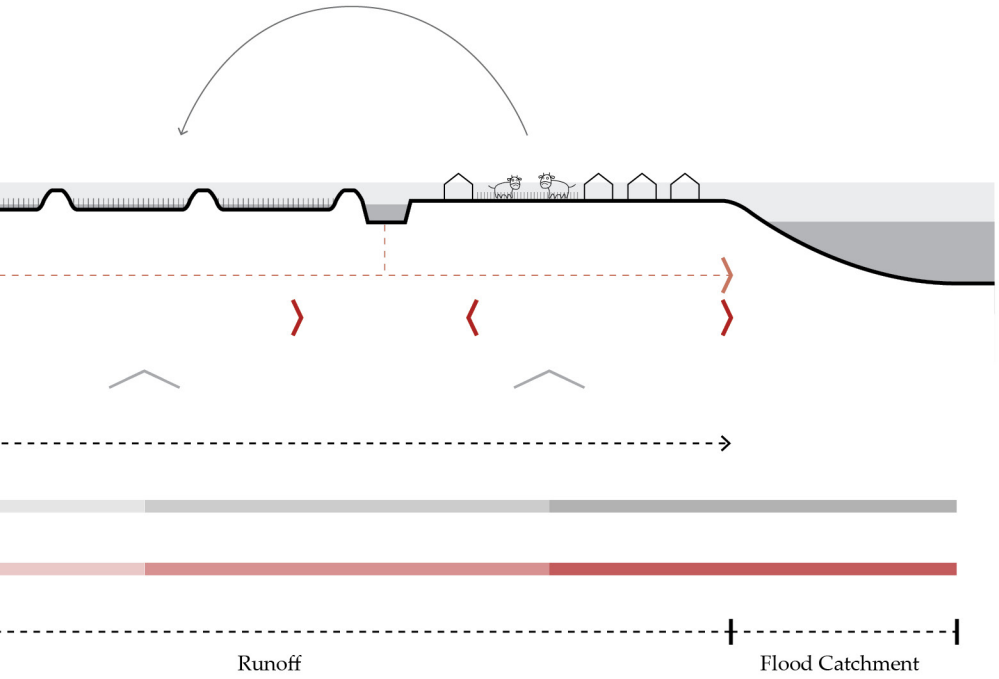
06.3
TRANSFORMATION OF THE TERRITORY

Many activities coexist in the Camargue, and even though they are located next to each other, their goals are often conflicting. However, with the multitude of new problems including that of extreme weather events due to climate change and mass tourism facing the territory, there needs to be extensive co-operation among the various actors. The project envisages transformation of a divided territory to a territory of blurred interests and functions. New synergies are created between the different stakeholders.

The strict management of water using grey infrastructure , loss of ecological density and monocultural agriculture is slated as important drivers of flooding in the Camargue. Pollution of the Etangs from agricultural runoff is a rising environmental issue. The project offers nature based solutions as solution for flood mitigation and pollution control.







System Flows

Pollution

Rising/ Absorption of Stormwater

Stormwater Movement

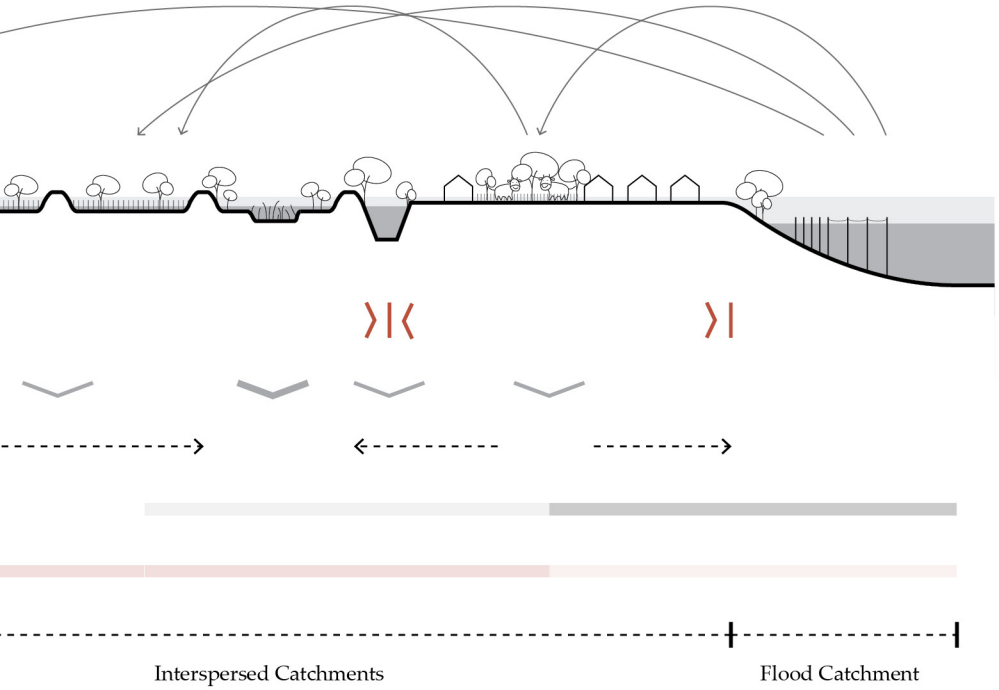
Saline Intrusion Gradient

Pollution Gradient

Runoff

Flood Catchment

Flood Terrain



System Flows

Pollution

Rising/ Absorption of Stormwater

Stormwater Movement

Saline Intrusion Gradient

Pollution Gradient

Interspersed Catchments

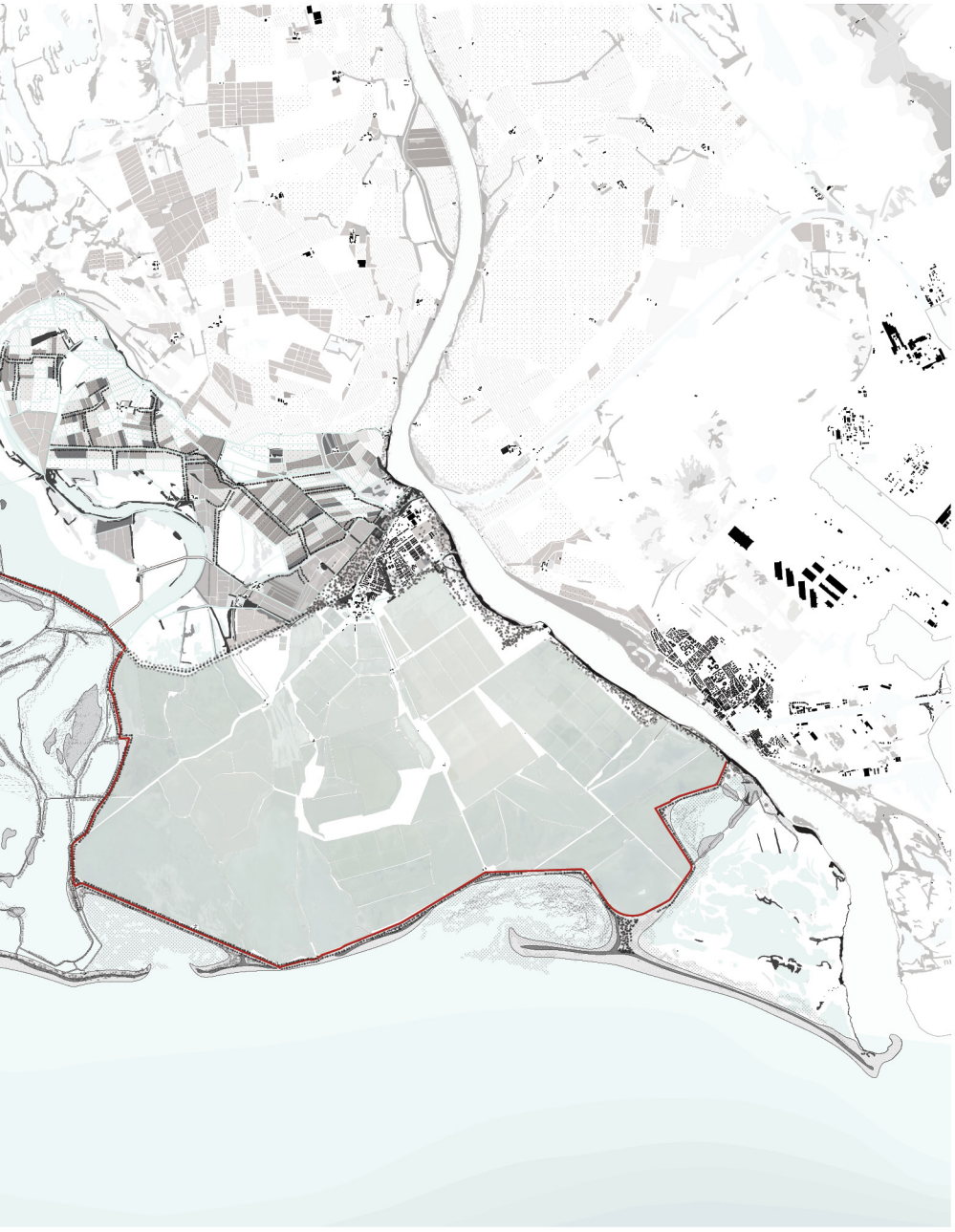
Flood Catchment

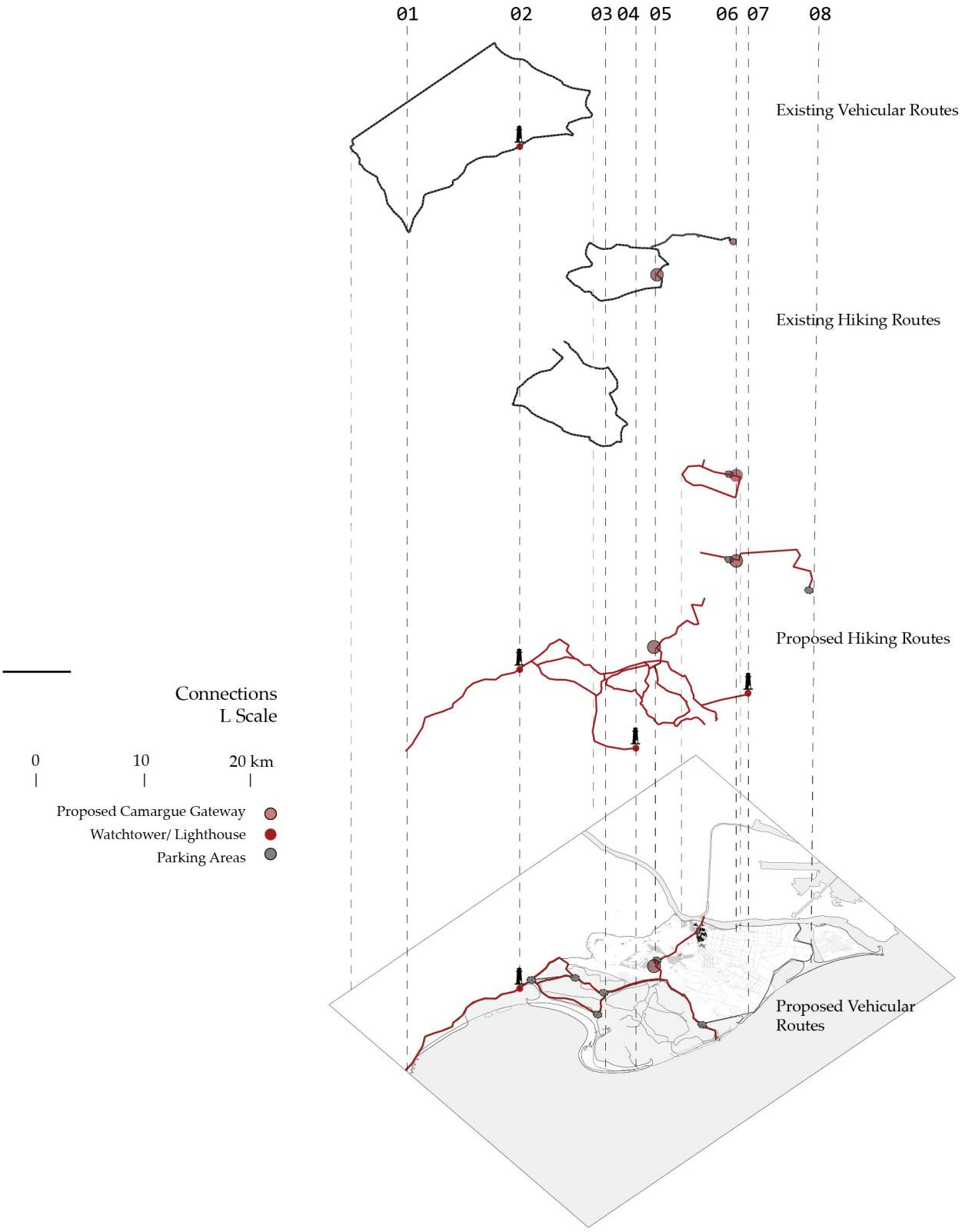
Flood Terrain

Strategy Plan
L Scale

0 | 2.5 | 5 km

06.3
OVERALL STRATEGY




01
02
03 04 05
06 07
08
Existing Vehicular Routes
Existing Hiking Routes
Proposed Hiking Routes
Proposed Vehicular Routes
Connections
L Scale
0
10
20 km
Proposed Camargue Gateway
Watchtower/ Lighthouse
Parking Areas

Beauduc Beach 01

Phare de la Gacholle 02

Beauduc Beach 03

Phare de la Beauduc 04

Chateau de Tourvieille/
Gateway of Camargue- Proposed 05

Salt Museum- Proposed 06

Phare de la Faraman 07

Domaine de la Pallisade 08

06.4
COASTAL FRONT

A new coastal front has been proposed for the Camargue, which focuses mainly on creating an interconnected system of reinforcement of the edges, creating an increased area for water to take over as the sea levels increase, new habitats as well as a tourist network. Thus an elaborate system of strengthening the existing dikes by increasing heights, providing elevated walkways, salt marshes and brakish vegetaion to hold the soil and prevent erosion due to increased water levels are proposed. These areas, due to their hypersalinity, also act as new habitats for multitrophic aquaculture that is proposed, the benefits of which are two fold- These help restabilise the soil and prevent erosion and hence loss of land, and act as economy generators for the people of Salin de Giraud, thus providing an alternate source of income. Thus the existing sea dike has been reinforced as is proposed as the new edge for the territory.

Strategy Plan
M Scale

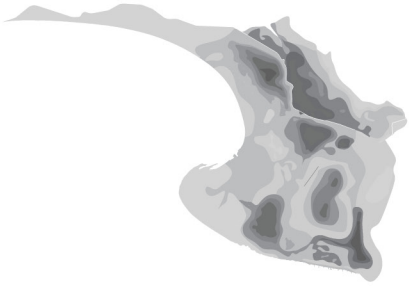
0 2.5 5 km

06.4
COASTAL FRONT

Analysis Layers

06.4
TERRITORIAL TRANSFORMATION

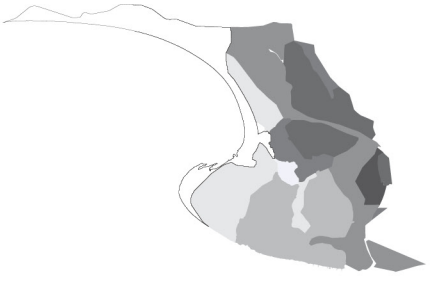
Reclaiming land in the sacrificed area to preserve existing ecologies. Preserving connection as memory of land and to promote alternate employment.



Bathymetry

Controlled ingress of sea to a new sea edge formed by raising the existing sea wall. Reclaiming land in the sacrificed area to preserve existing ecologies.

Creating new employment opportunites in hypersaline environments. Macro-algae, mussel and sea oyster culture.



Salinity

Existing Network

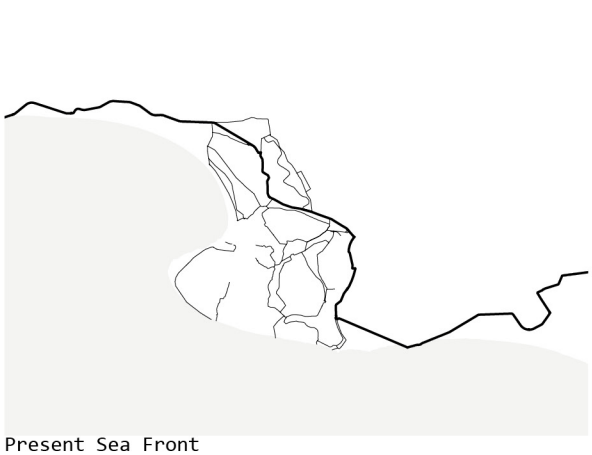
Proposed Network

LAND RECLAMATION

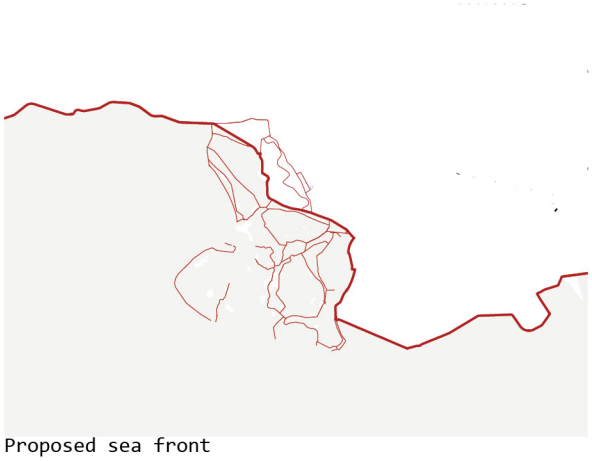
Existing Land

Proposed Land

NEW COASTAL FRONT



Present Sea Front



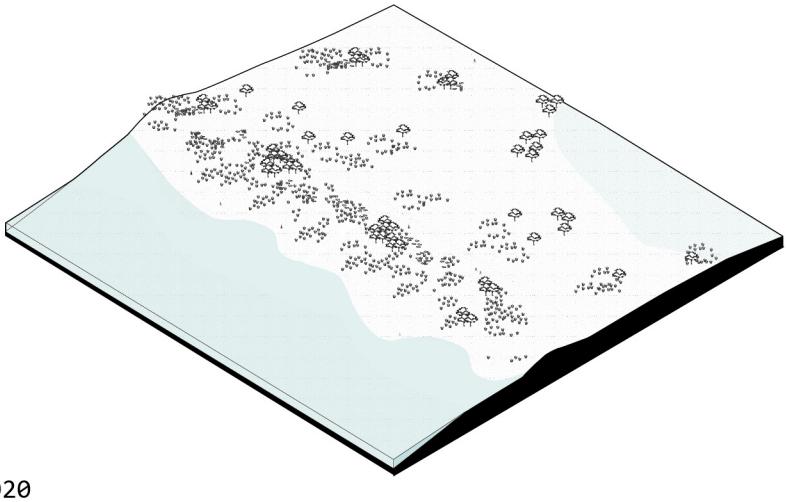
Proposed sea front

ECONOMY GENERATORS

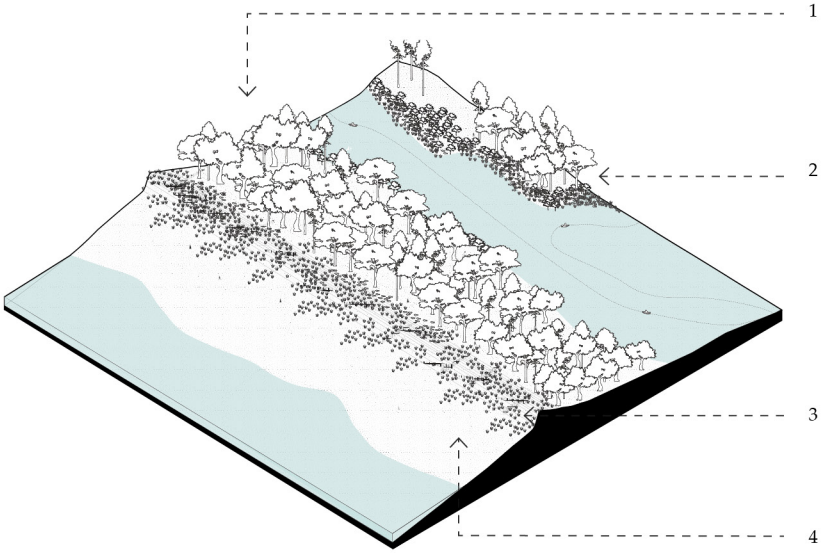
Present Economy Generators

Tourist functions and connectivity

06.4
DEVICES



2020

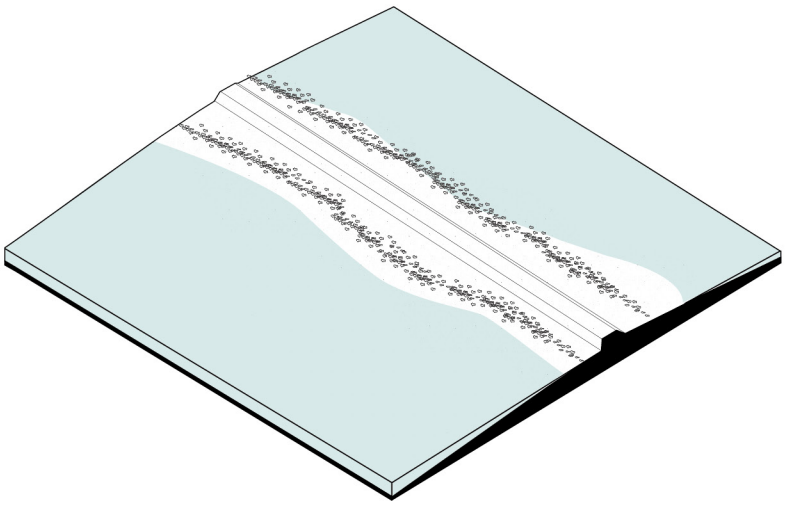


Scenario 2100

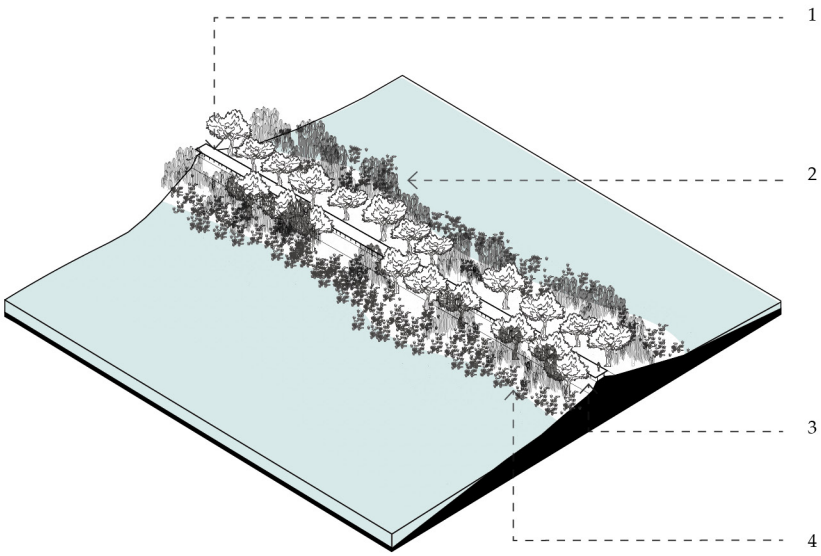
COASTAL FRONT

Beach Nourishment	1
Barrier Islands	2
Coastal shelter belt - *Pinus Pilaster, Pinus Pinea, Quercus Ilex*	3
Dune Reinforcement	4

Beach nourishment mitigates coastal erosion and increases coastal protection. Waves help in cross-shore transport and beach development.
Dune landscapes form a natural barrier to protect upland areas from flooding. Dune vegetation captures and stabilizes the sand. These can be designed to support habitat creation and recreation.



2020

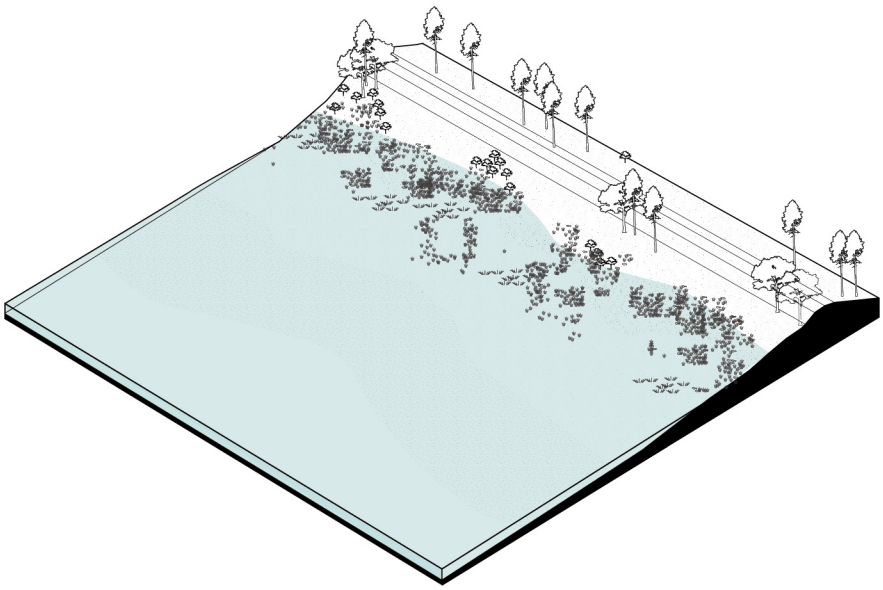


Scenario 2100

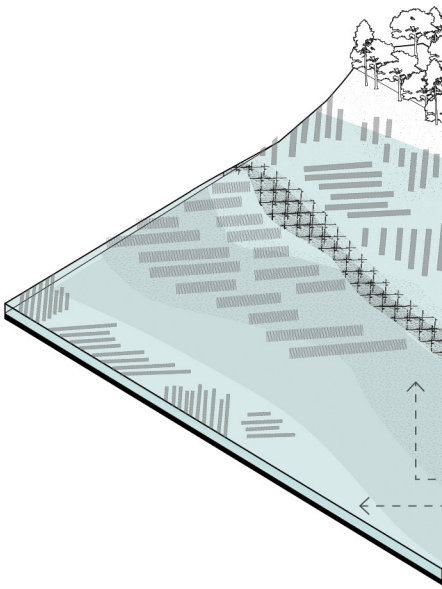
COASTAL FRONT

1 Elevated Walkway Cycle path at +3 m asl
2 Planting of *Pinus Pinea, salix alba*
3 Reinforcing existing dike with earthworks
4 Brackish ecosystem regeneration , creating habitats - *Tamarisk, Glasswort, Sea grass*

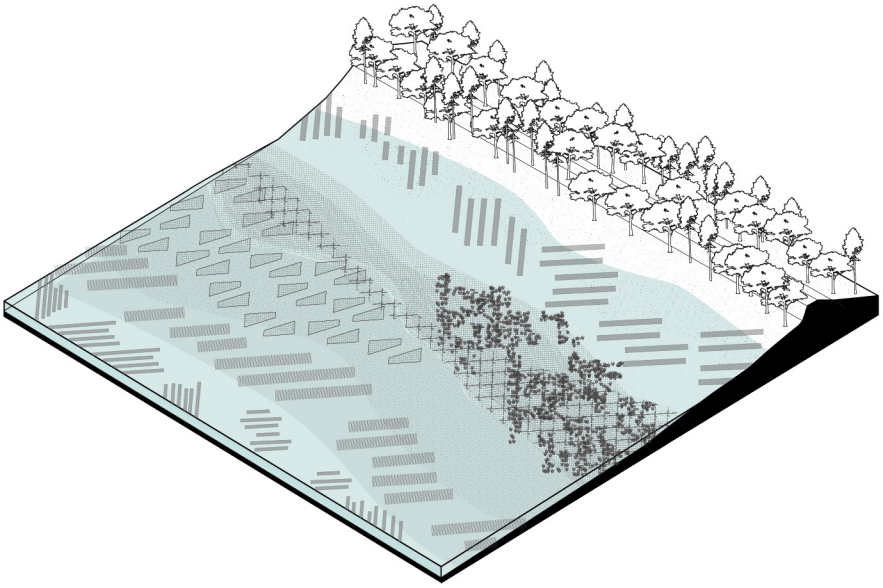
Foreshore environments improve dike resilience and enhance flood defenses by dampening wave forces with their shallow slopes, stabilizing the dike with additional mass. In silty environments, foreshores trap sediments and help soil formation, which enables sea level rise adaptation, and create a range of distinct vegetation zones.



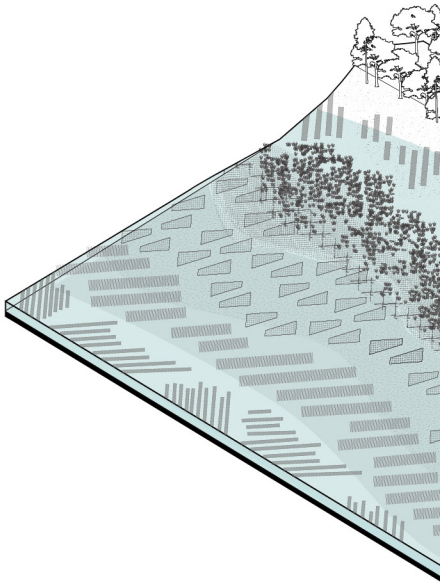
2020



Scenario 2030



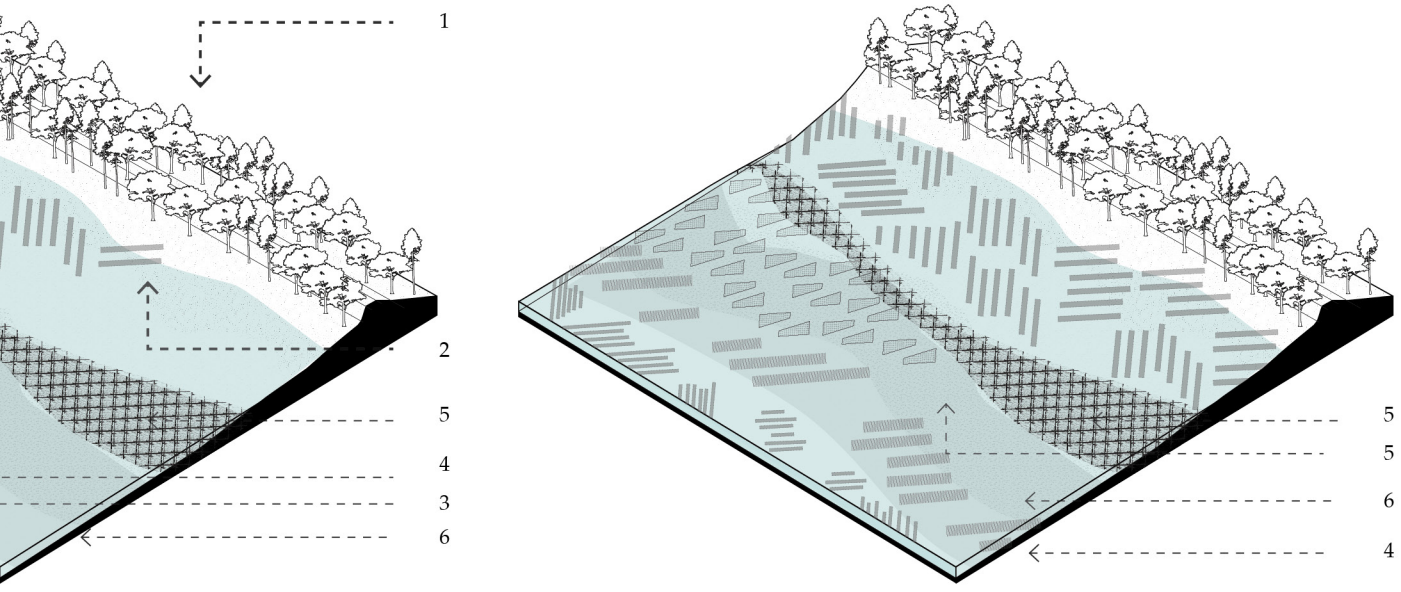
Scenario 2055



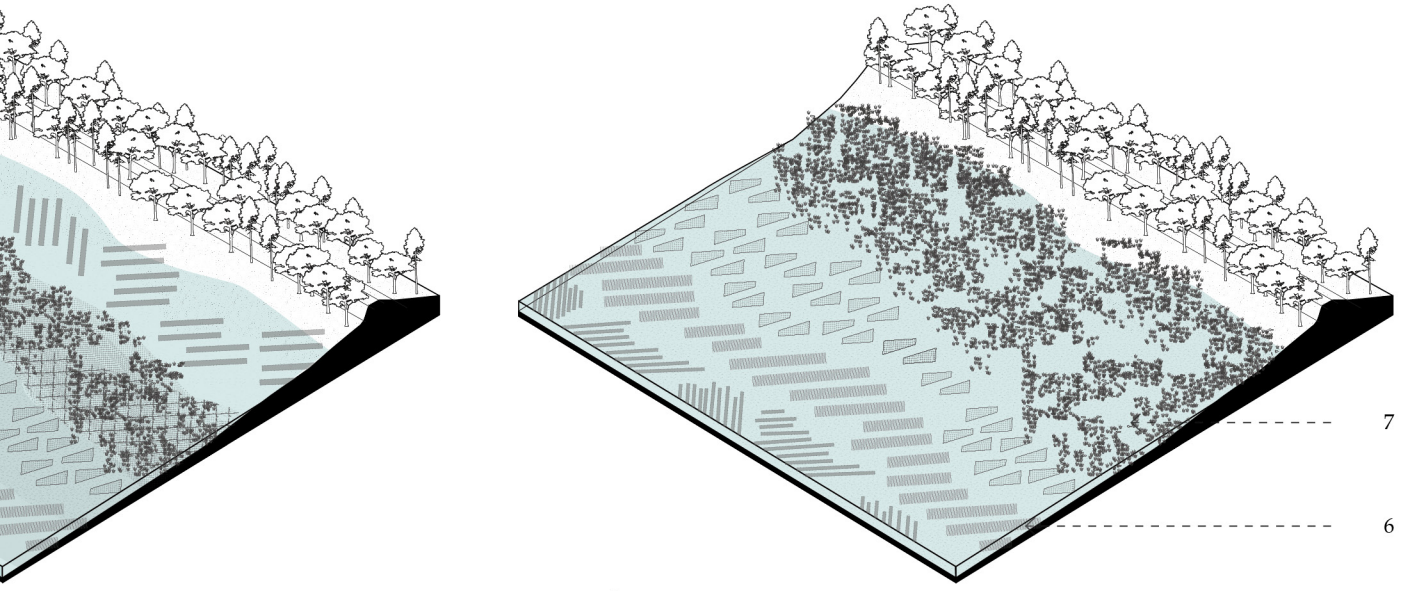
Scenario 2060

MULTI TROPHIC AQUACULTURE HABITATS

The newly constructe ecosystemic landuses contribute towards improving environmental, biodiversity and habitat values as well as a reorientation of the flood defence and water management. These form a natural breakwater with a demonstrated a capacity to withstand storm winds and waves, mitigating the impact of extreme weather on coastal communities. They



Scenario 2050



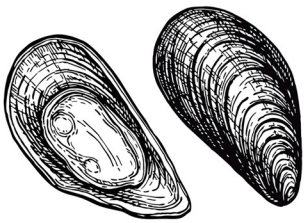
Scenario 2100

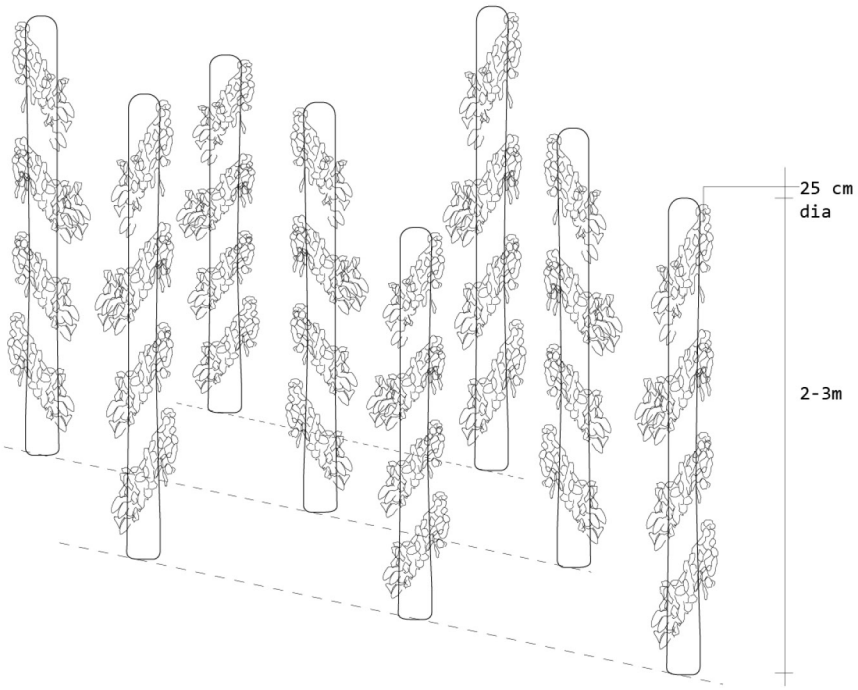
also contribute to reduced erosion in the coastal zone, thus enhancing coastal resilience. As filter-feeders, these habitats also contribute to improved water quality through filtration. Oysters and mussels can be harvested for food, providing a direct value in addition to supporting habitat for numerous other species.

1 Ecological Belt - *Pinus Pinea, Pinus Pilaster , Tamarisk, Glasswort*
2 Seaweed Plantation - *Sea Lettuce (Ulva lactuca)*
3 Palmaria Palmate, Porphyra umbilicalis
4 Mussel Pole Field
5 Oyster Reef
6 Fed Aquaculture
7 Salt Marsh

MULTI TROPHIC
AQUACULTURE HABITATS

Extractive Aquaculture -
Mussel Pole Field

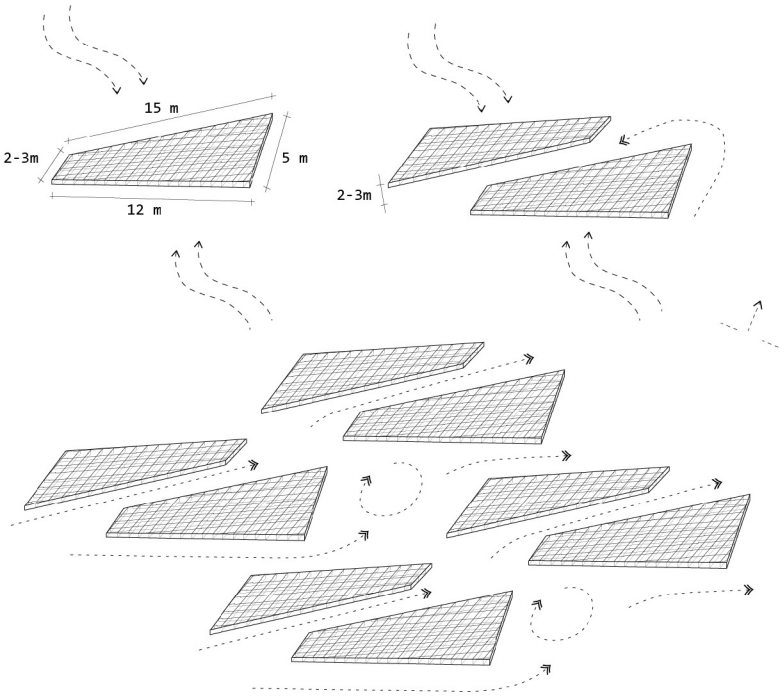




Nets are arranged in a spiral on poles located in intertidal areas (bouchots). An added benefit of this technique is that these fields can encourage sediment build up through normal deposition but also through bio-deposition of waste matter produced by the mussels.
This deposition could be used for the establishment of oster reefs.

MULTI TROPHIC
AQUACULTURE HABITATS

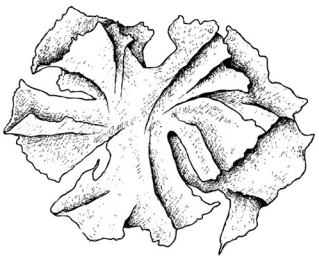
Extractive Aquaculture -
Oyster Reefs



Oyster reefs have the ability to attenuate wave energy and encourage sedimentation, whilst providing valuable and varied natural habitat. They also boost nutrient availability in the system as they enclose filtered sediments in faecal matter. Gabion basket format is utilised , with faces presented to the Mistral and SE winds, to protect against waves caused by these winds

MULTI TROPHIC
AQUACULTURE HABITATS

Extractive Aquaculture -
Macro algae Cultivation
- Sea Lettuce (Ulva lactuca)

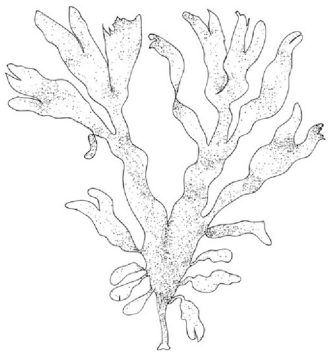


Sea Lettuce cultivation has economical and environmental benefits :

Infrasructural Benefits :

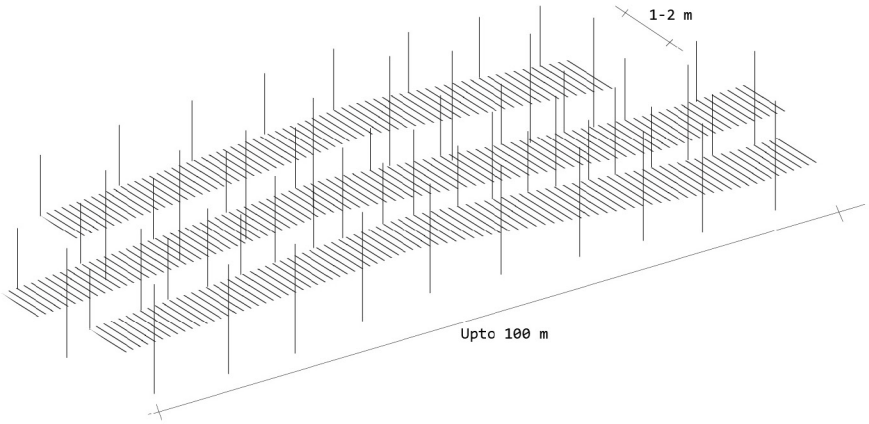
• Primarily an aquaculture crop containing proteins, iodine, vitamins and minerals for food, animal and fish feed, industrial chemicals, skincare and medicines

• Source of biomass and oils for production of bio-plastics, bio-fuels.



MULTI TROPHIC AQUACULTURE HABITATS

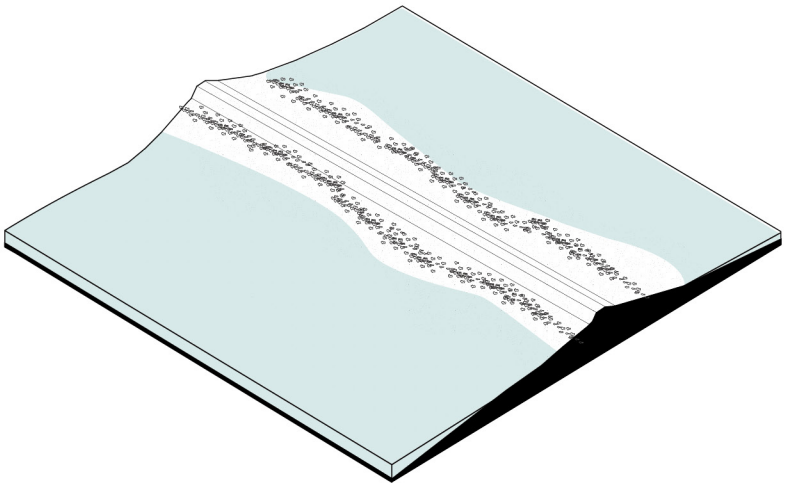
Extractive Aquaculture - Seaweed Plantation
Palmaria Palmate, Porphyra umbilicalis



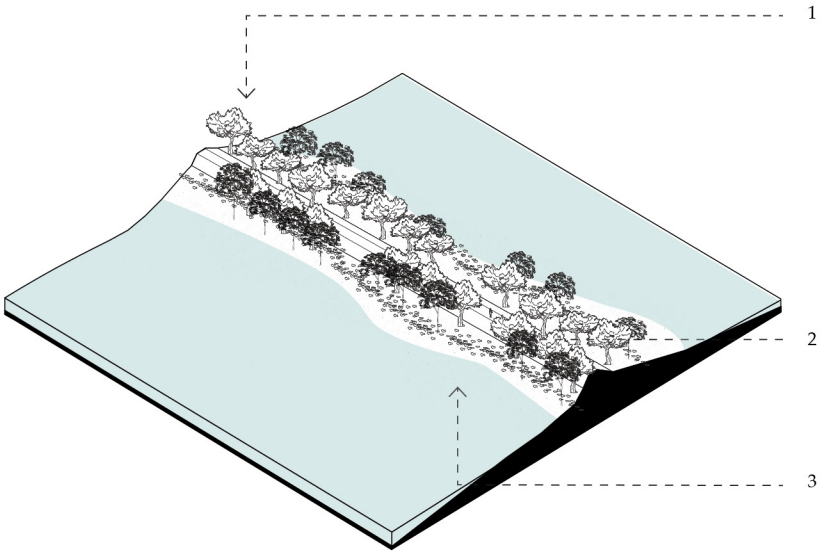
Environmental benefits:
• Some provision of shelter and habitat
• Nutrient trap to remove excess nutrients (agricultural runoff etc.) from eutrophic estuarine waterways. Could combine with aquaculture to reduce nutrient waste
• Indicator of pollution and excess Nitrogen in waterways

COASTAL FRONT

Planting of *Pinus Pinea, salix alba* 1
Reinforcing existing dike with earthworks to form MAIN SEA DIKE 2
Brackish ecosystem regeneration , creating habitats - *Tamarisk, Glasswort, Sea grass* 3

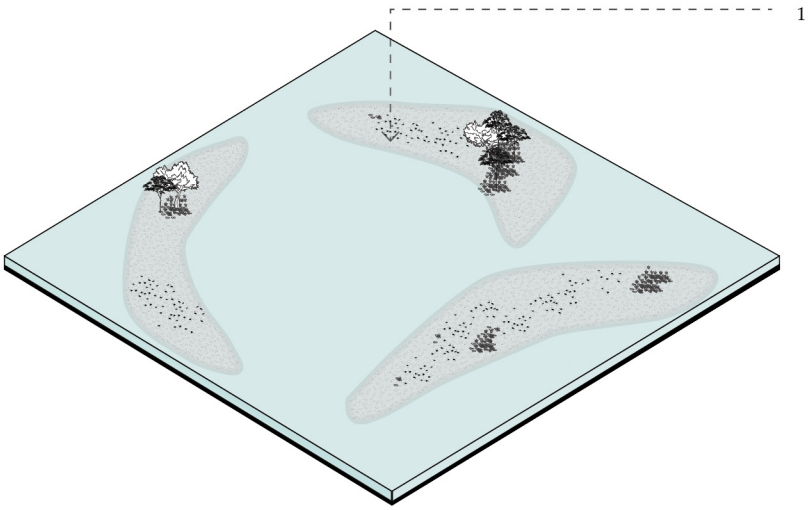


2020



Scenario 2100

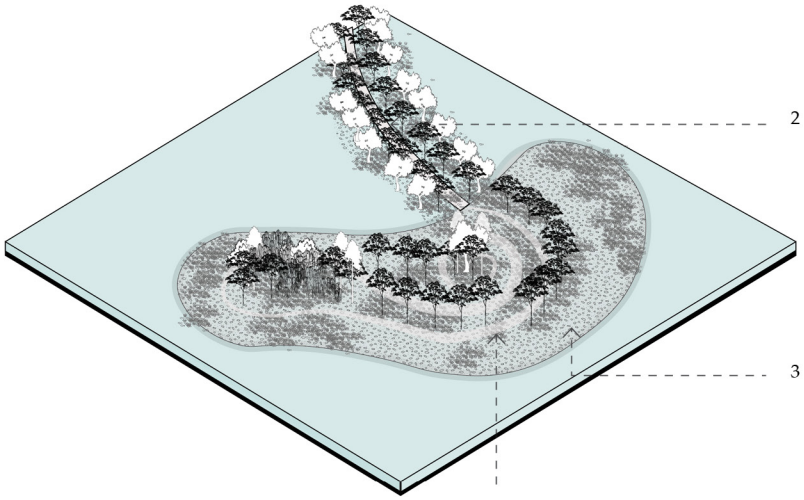
Combining wetland forests with traditional earthen barriers can reduce wave heights while providing habitat value and supporting biodiversity, along dikes. The design of dikes can integrate inundation-tolerant vegetation to maximize flood risk reduction. Here, the sea dike is further reinforced by tree belts and earthern works.



Scenario 2100

COASTAL FRONT

1 Creating BIRD ISLETS by earthernworks
2 Reinforcing existing dike with earthworks , tree edges
3 Islands for recreation

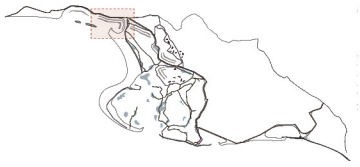


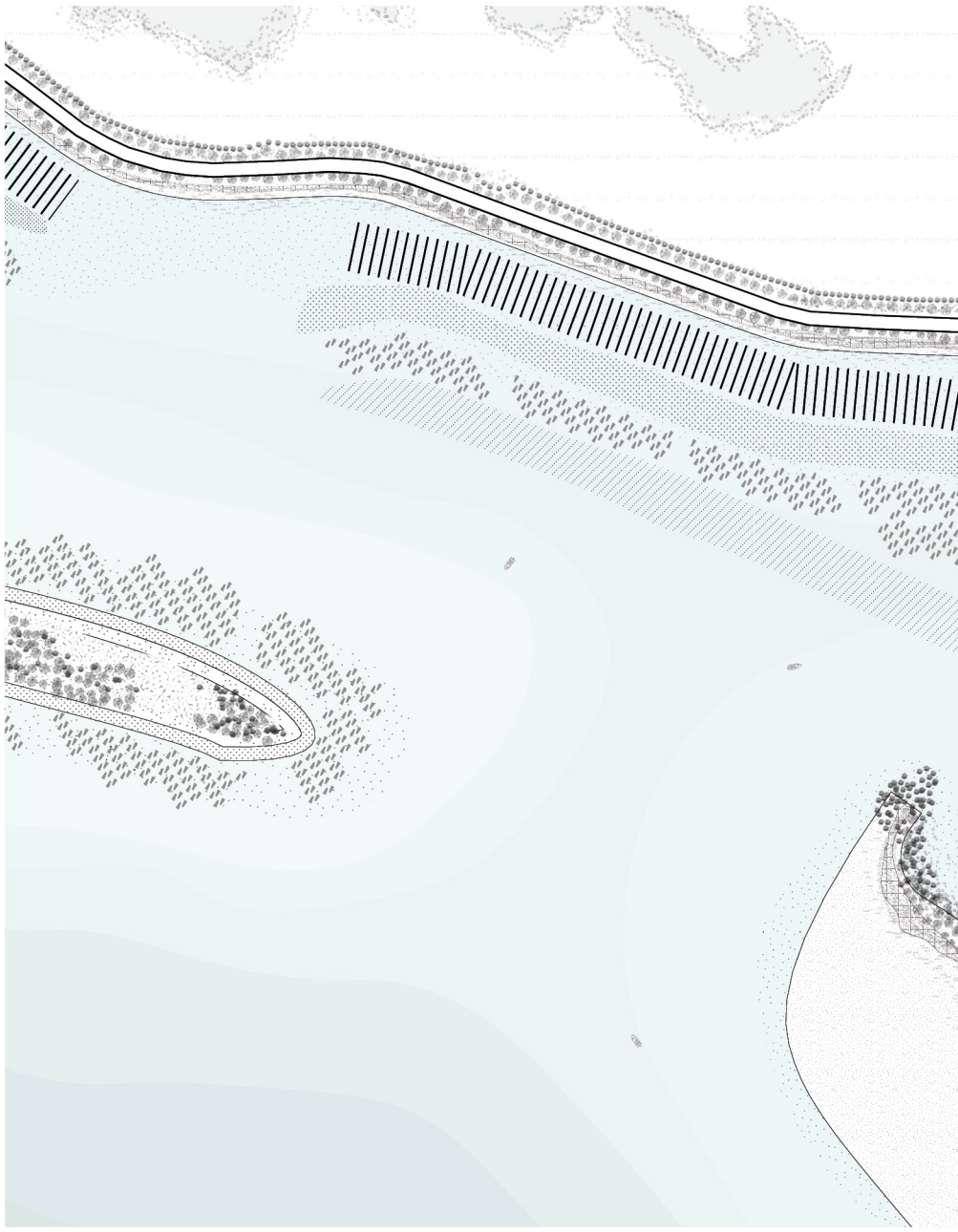
Scenario 2100

Fine sediments are dredged from lakes and harbours to improve heights and create new islands for recreational and environmental purposes. These are further reinforced by tree cover of Pinus Pinea, Pinus Pilaster, salix alba, quercus Ilex as the tall tree cover, with shrubs and planting of brackish vegetation. The bird islets also have a mesh line protecting it.

Coastal Front
Detail A

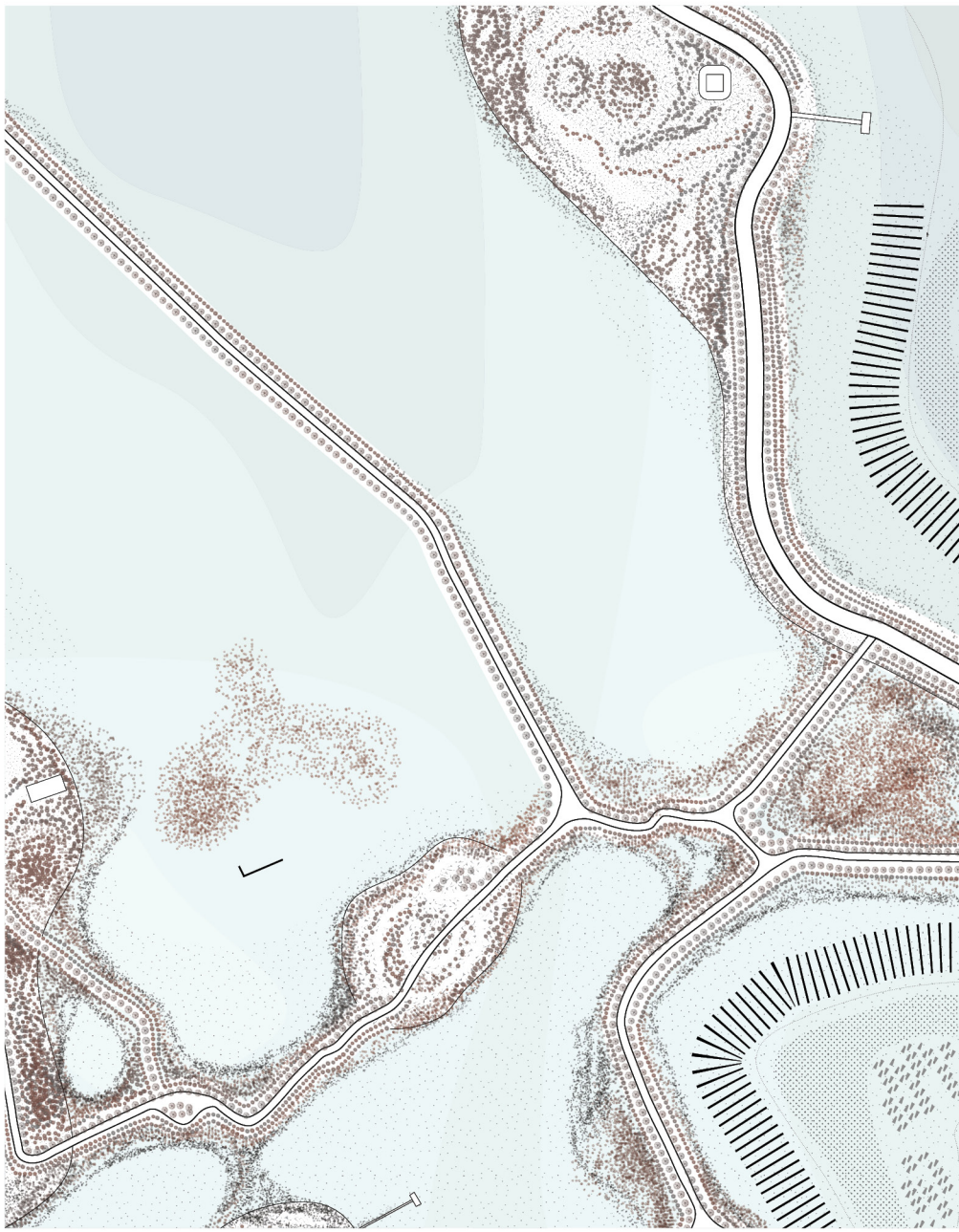
0 250 500 m

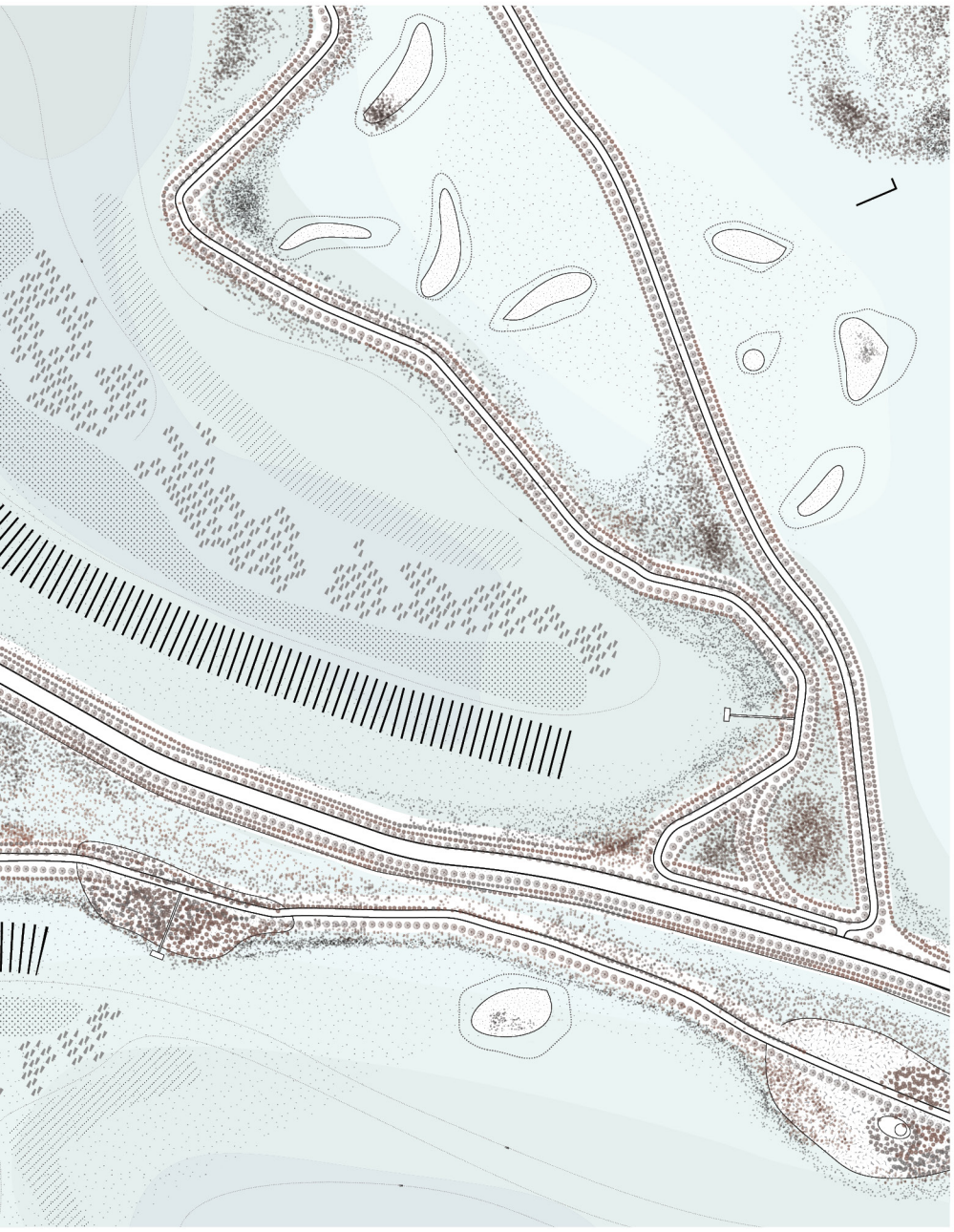


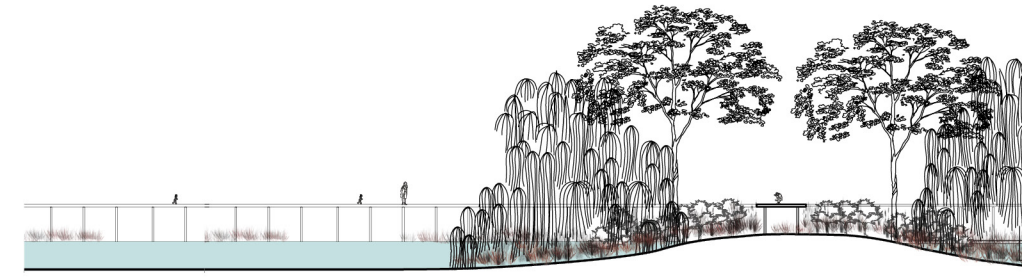


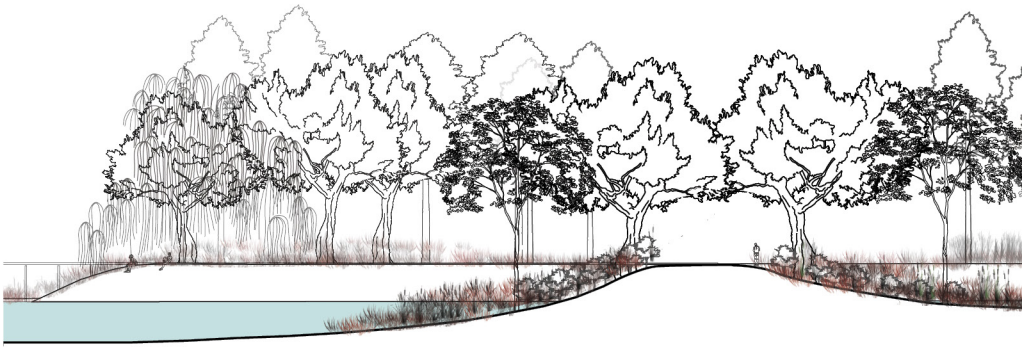
Coastal Front
Detail B

0 250 500 m

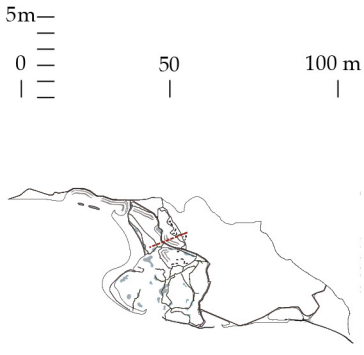


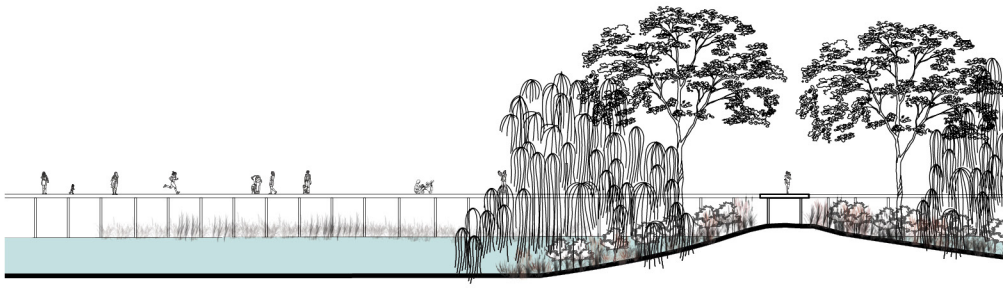


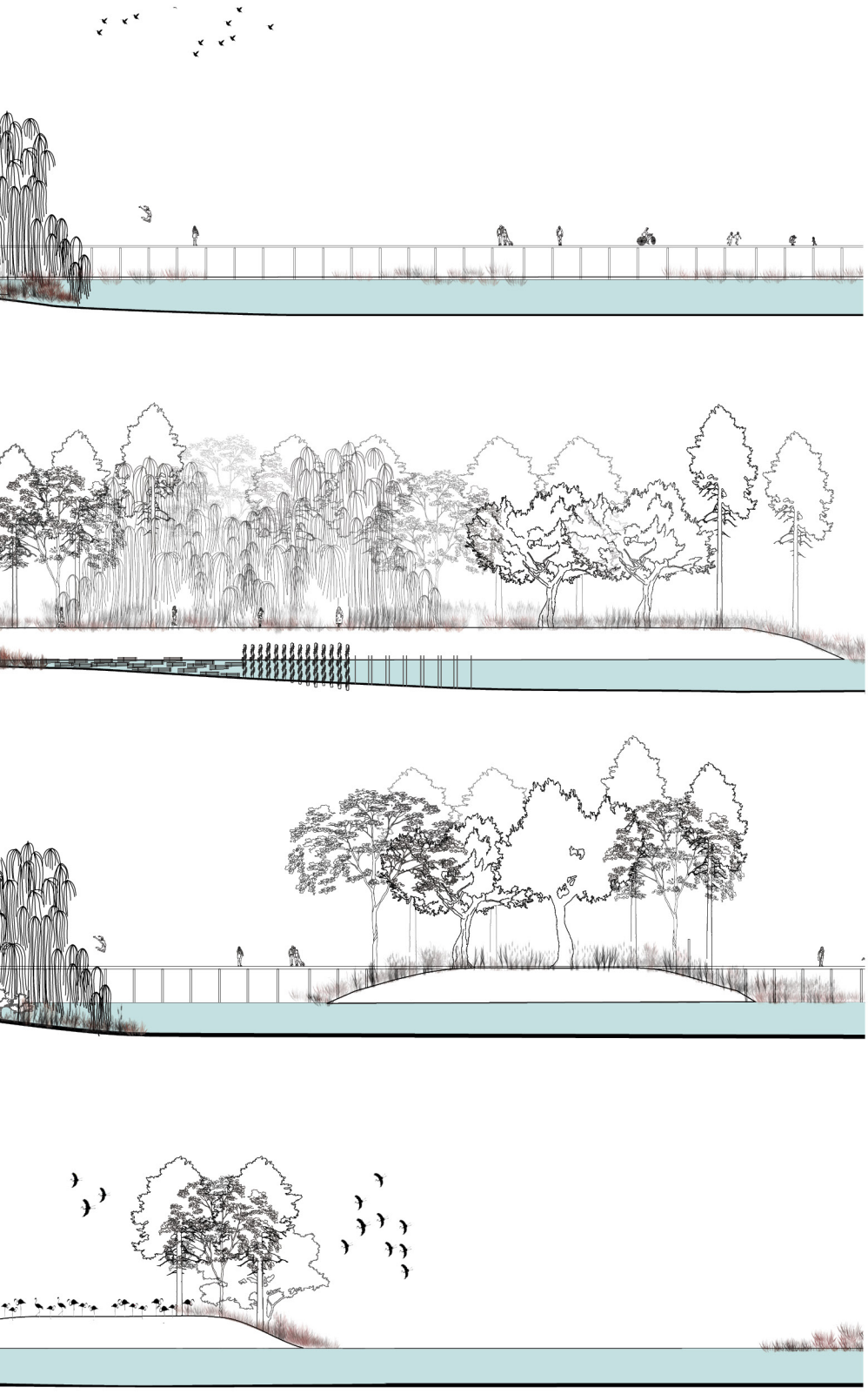




Coastal Front
Section

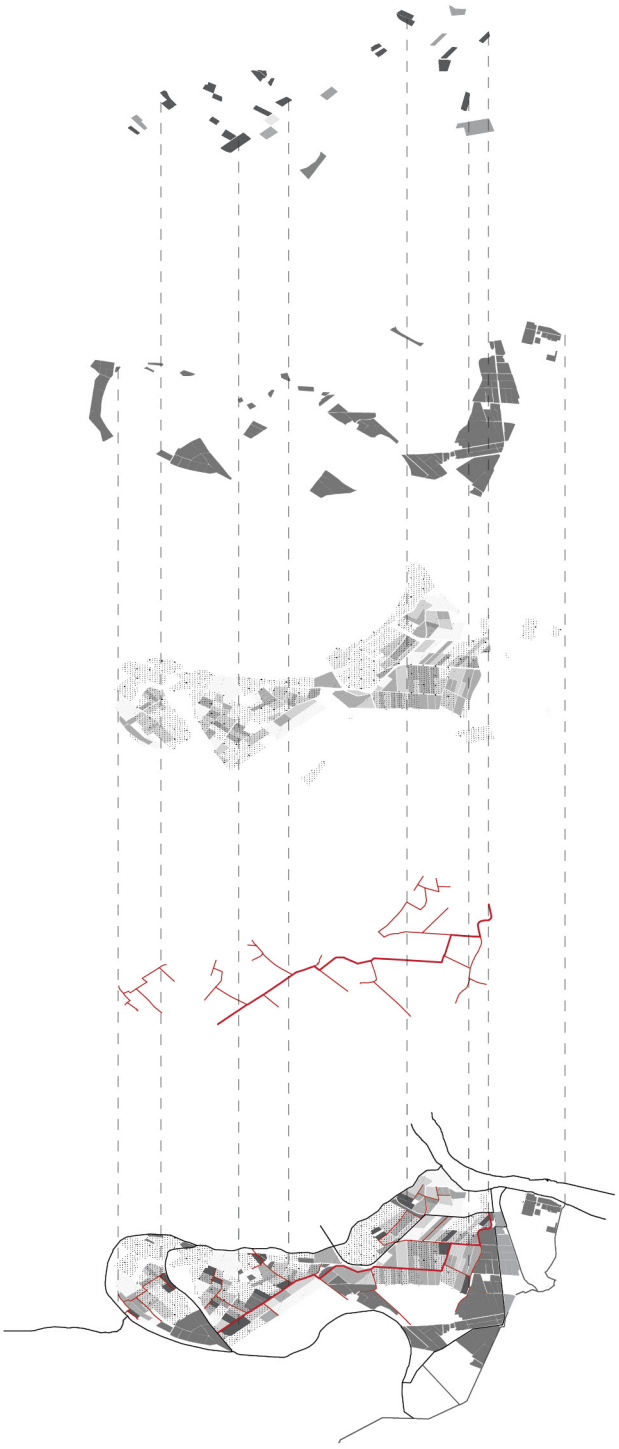






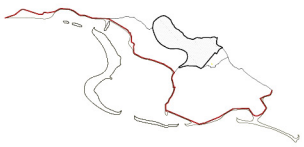
06.5
AGRICULTURE PARK

Based on the topography of the cultivated areas in the Camargue, a system of agroforestry was proposed for the area, to increase the ecological density that would in turn increase the water retention capacity of these areas. The Floods and Agriculture Risk Matrix is studied to arrive at a concept of re territorialisation and symbiosis between forested areas and cultivated areas to reap mutual benefits. This system is proposed as a mandatory initiative along the main canal, which is redesigned as a bioswale. Certain economic incentives are provided to the farmers, to enable them to adopt this into every plot in a few years, such that the entire area becomes a system of agroforestry. Tourist hiking paths are also provided through the area, thus reproposing the zone as an agricultural park, one that adapts to water instead of resisting it.



Strategy Plan
M Scale

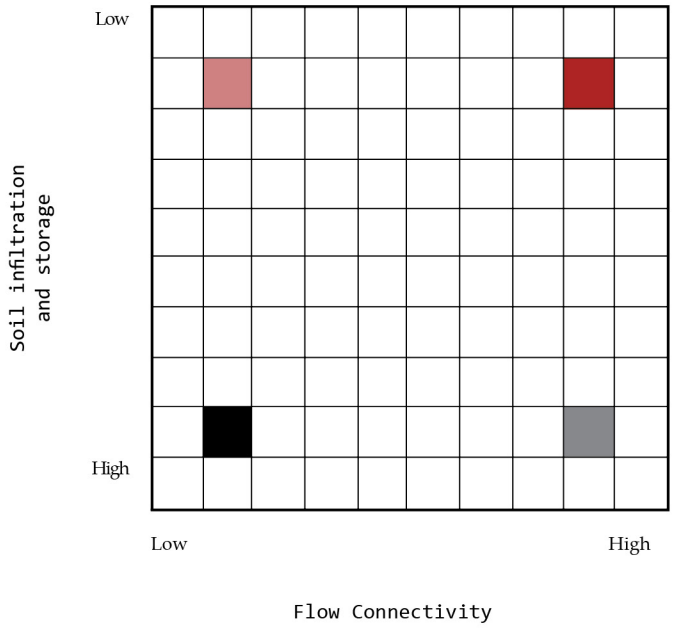
0 2.5 5 km



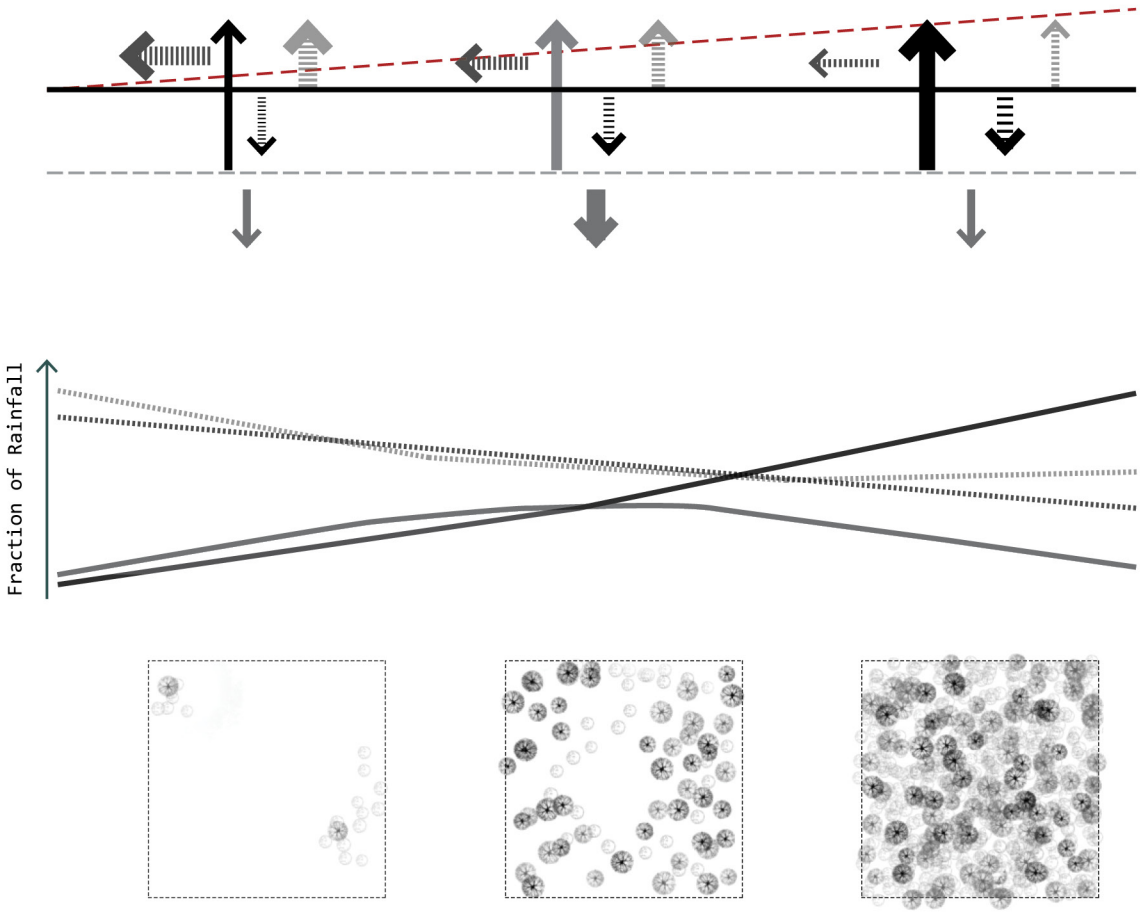
06.5
AGRICULTURAL PARK

Floods and Agriculture
Risk Matrix

High Risk
Low Risk



Source : Mark E. Wilkinson , Paul F. Quinn & Caspar J.M. Hewett (2013) The Floods and Agriculture Risk Matrix: A decision support tool for effectively communicating flood risk from farmed landscapes, International Journal of River Basin Management, 11:3, 237-252



Optimum groundwater recharge occurs at **intermediate tree cover in seasonally dry tropical areas.** Without trees, surface runoff and soil evaporation are high, leading to low groundwater recharge despite low transpiration. In closed productive forests, despite low surface runoff and soil evaporation, total transpiration and interception are high, leading to low groundwater recharge. At an intermediate canopy cover, low surface runoff and evaporation as well as intermediate transpiration optimize groundwater recharge.

Optimum Tree Cover Theory

- Transpiration and Interception
- Surface Runoff
- Soil evaporation
- Infiltration
- Groundwater recharge
- Ecological Density

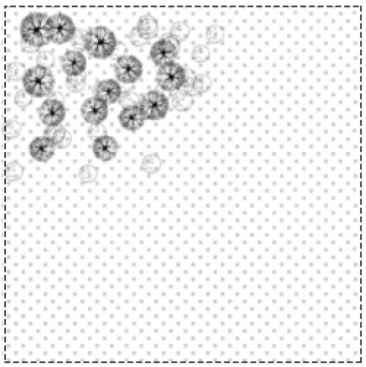
Source: Ilstedt, U. et al. Intermediate tree cover can maximize groundwater recharge in the seasonally dry tropics. Sci. Rep. 6, 21930

Types of Agroforestry

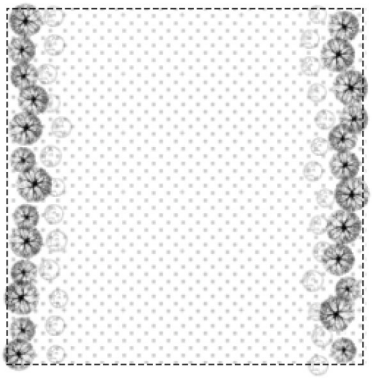
Agrosilvocultural

Silvopastoral

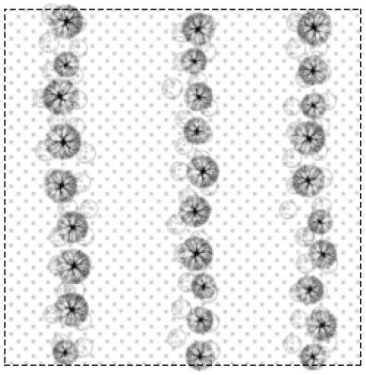
Agrosilvopastural



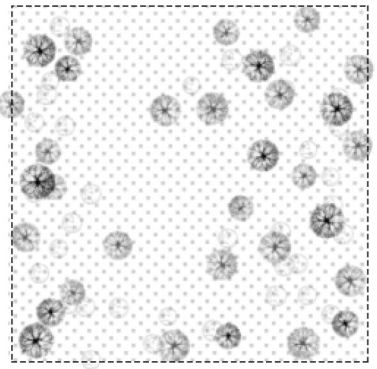
Wood Lots



Windbreaks or Hedgerows

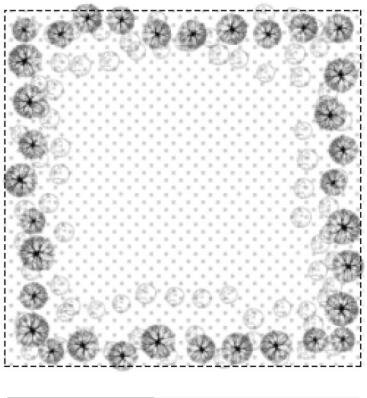


Alley Cropping

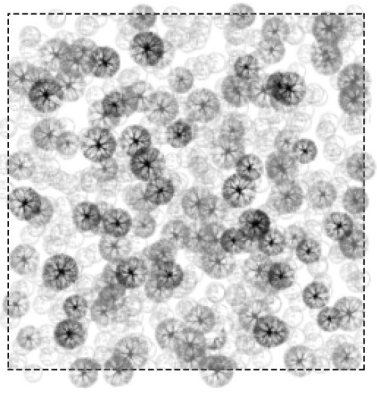


Dispersed Planting

Spatial Patterns of Agroforestry



Boundary Planting



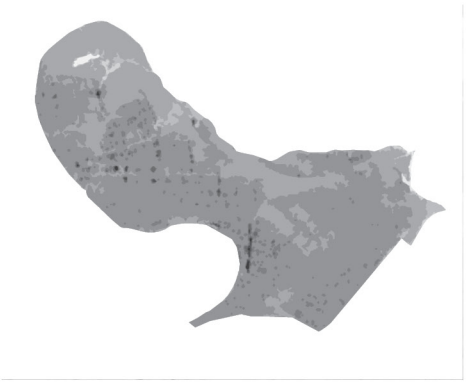
Fallow - Crop Rotation

Source : Young, A. (1989b) The environmental basis of agroforestry. In Meteorology and agroforestry. Proceedings of an international workshop on the application of meteorology to agroforestry systems planning and management, Nairobi 9-13 February 1987 [edited by Reifsnyder, W. S.; Damhofer, T. 0.]. Nairobi, Kenya; ICRAF. 29-48.

Analysis Layers

06.5
TERRITORIAL TRANSFORMATION

Identifying primary and secondary canals and developing them as main water channels in case of increased water levels. Identifying specific farmlands based on elevation to be converted as retention basins.



Elevation

Conversion of identified water channels bio swales. Adopting different techniques of agroforestry in the farmlands along the bio swale to act as vegetative buffers of varying ecological densities.

Agriculture

Inserting tourist points into retention basins to create a tourist network through the area, converting it into an agriculture park.

Existing Network

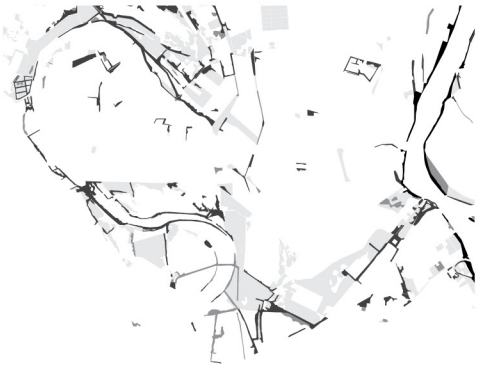
Proposed Network

BUFFER NETWORK

Canals

Flood retention network

GREEN NETWORK



Vegetation

New Vegetation

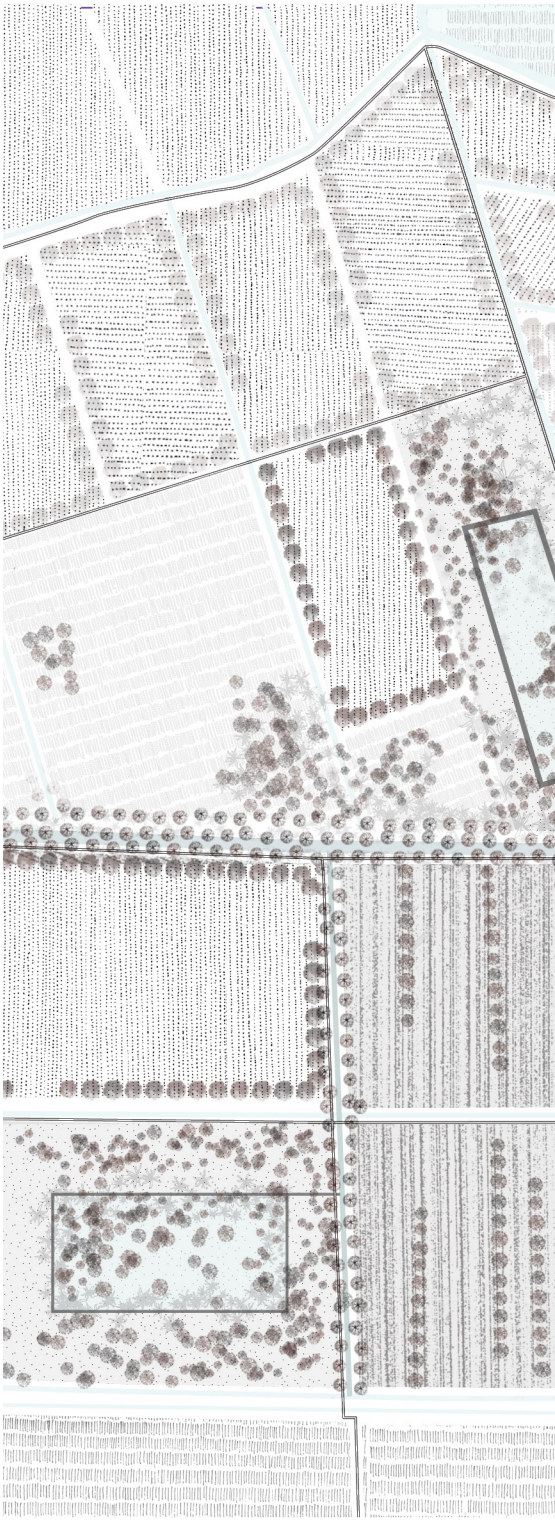
BUILT PROGRAM

Built fabric and Connectivity

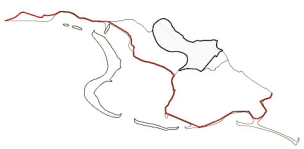
New built and tourist links

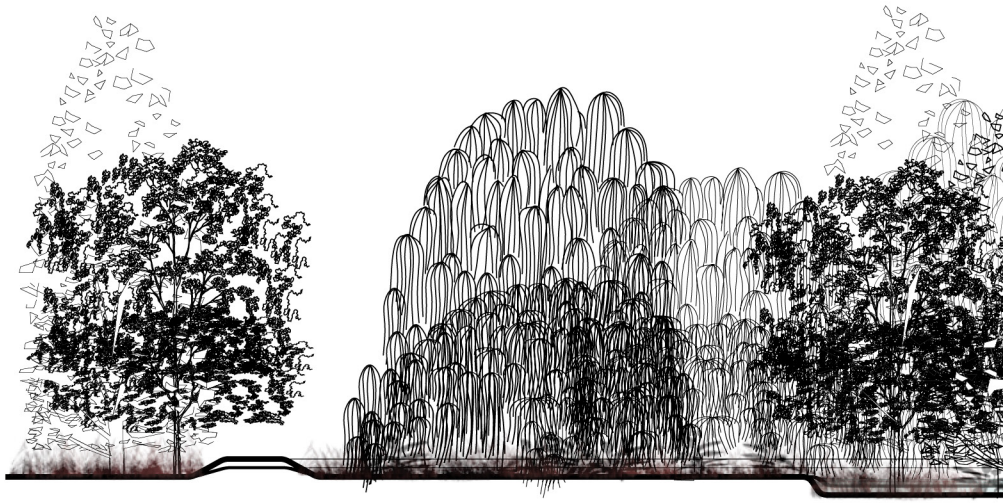
Strategy Plan
M Scale

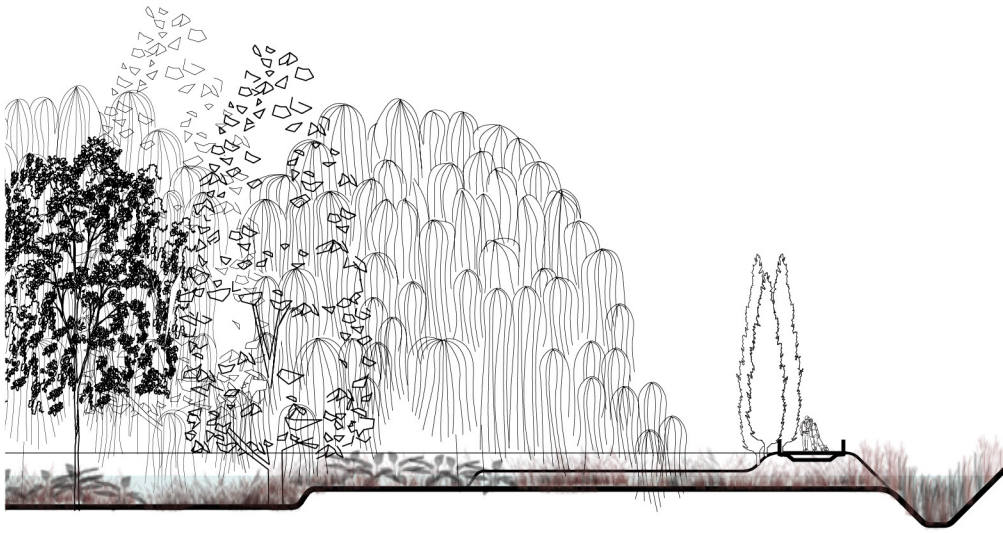
0 1 2km

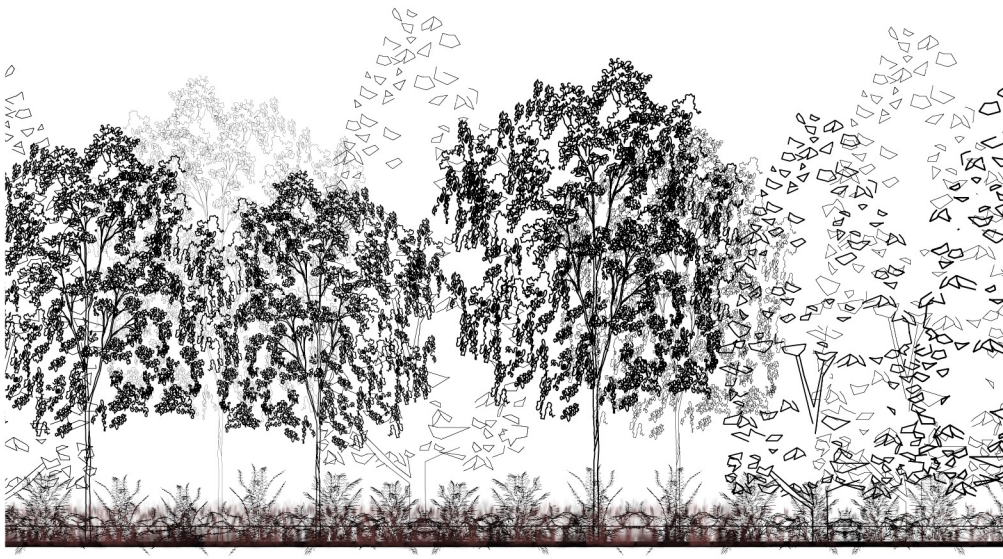


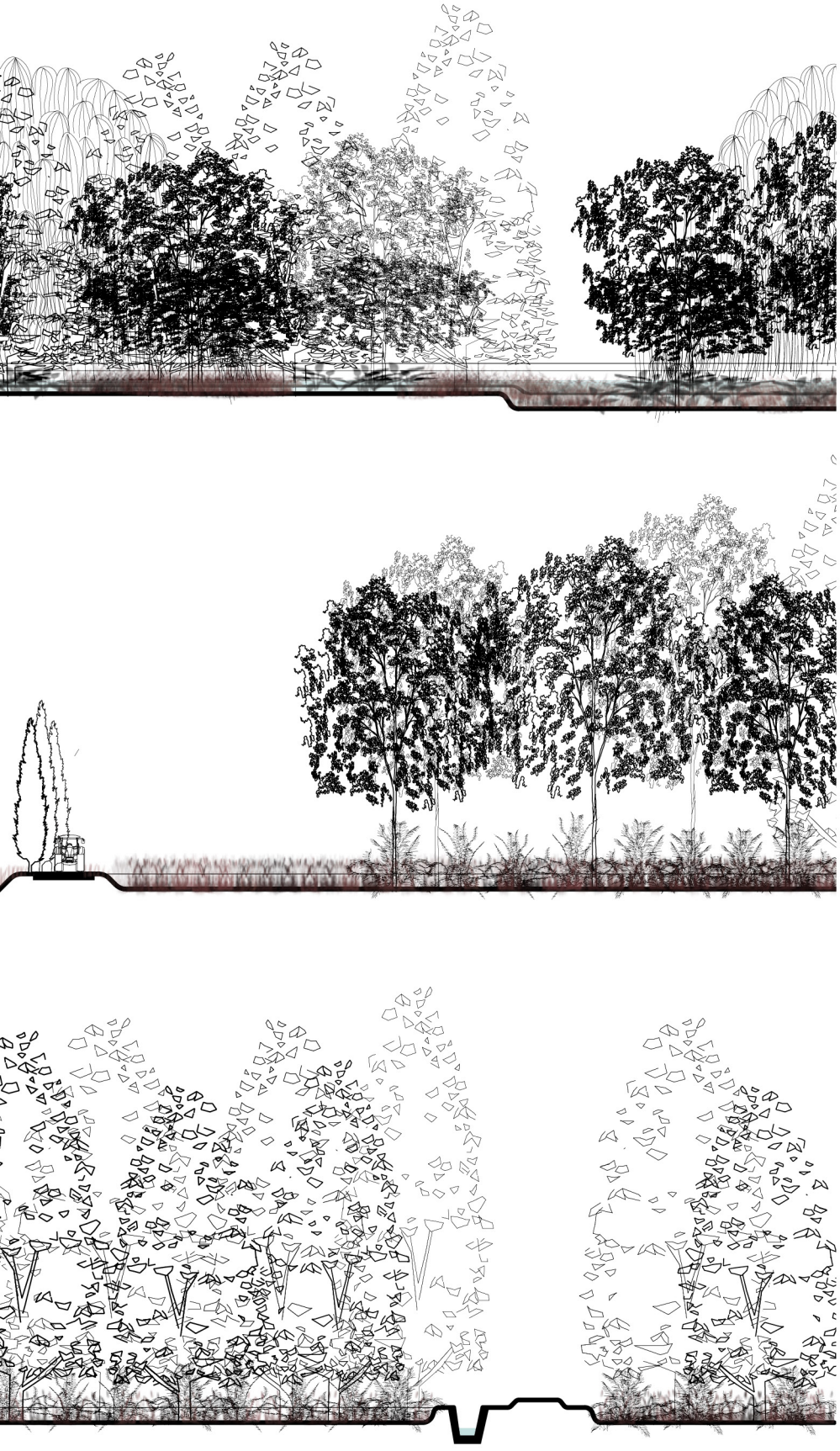

Section
0
20 m











06.6
SALIN DE GIRAUD

The area of Salin de Giraud is located on a higher elevation, compared to the cultivated areas, due to the unique geomorphology of the Camargue territory, and thus is relatively safer from annual and moderate floods that may occur. Thus areas are identified as wetlands especially along the banks of the river Rhone, and along the interfaces between the city and the salt flats, and the city and the agricultural park. These interfaces are redesigned as green buffer zones which can act as water retention areas, to prevent the rest of the area of Salin de Giraud from being affected. A salt museum is also proposed along the route from the bridge to Salin de Giraud to the salt flats, by the adaptive reuse of the industrial buildings of the mostly abandoned site of the Pechiney company. The site is designed as an elaborate landscape with a multitude of different species of vegetation found through the Camargue,and features salt installations.

Analysis Layers

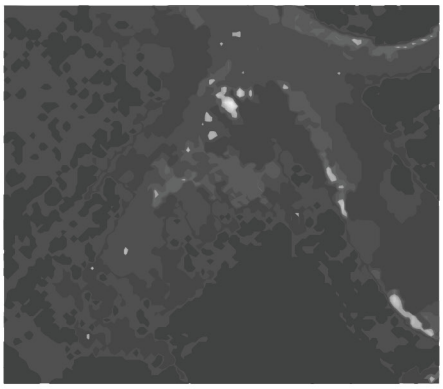
06.6
TERRITORIAL TRANSFORMATION

Creating wetlands as protective buffer zones in case of floods, by identifying wastelands and lower lying areas in and on the peripheries of Salin de Giraud.

Neighbouring Interfaces

The existing riperian forest on the edge of the river Rhone, is reinforced by increasing the vegetative buffer. The riperian buffer acts as a connecting element, being continued all along the river Rhone.

Interspersed tourist spots and links through low lying areas identified as wetlands. Tourist links modified from bridge to wetlands through Salin de Girayud, leading to the Salt Museum are proposed.

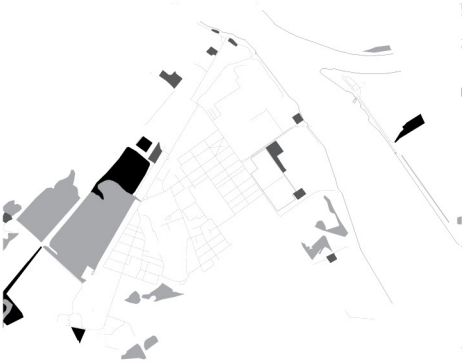


Elevation

Existing Network

Proposed Network

LIVING WITH WATER



Abandoned green areas

Proposed Wetlands and green edges

EDGE PROTECTION

Functional Green Zones

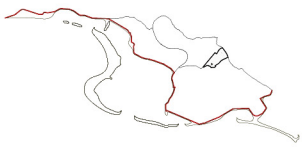
Riperian edge

ECONOMY GENERATORS

Built fabric and connectivity`

New tourist links and amenities

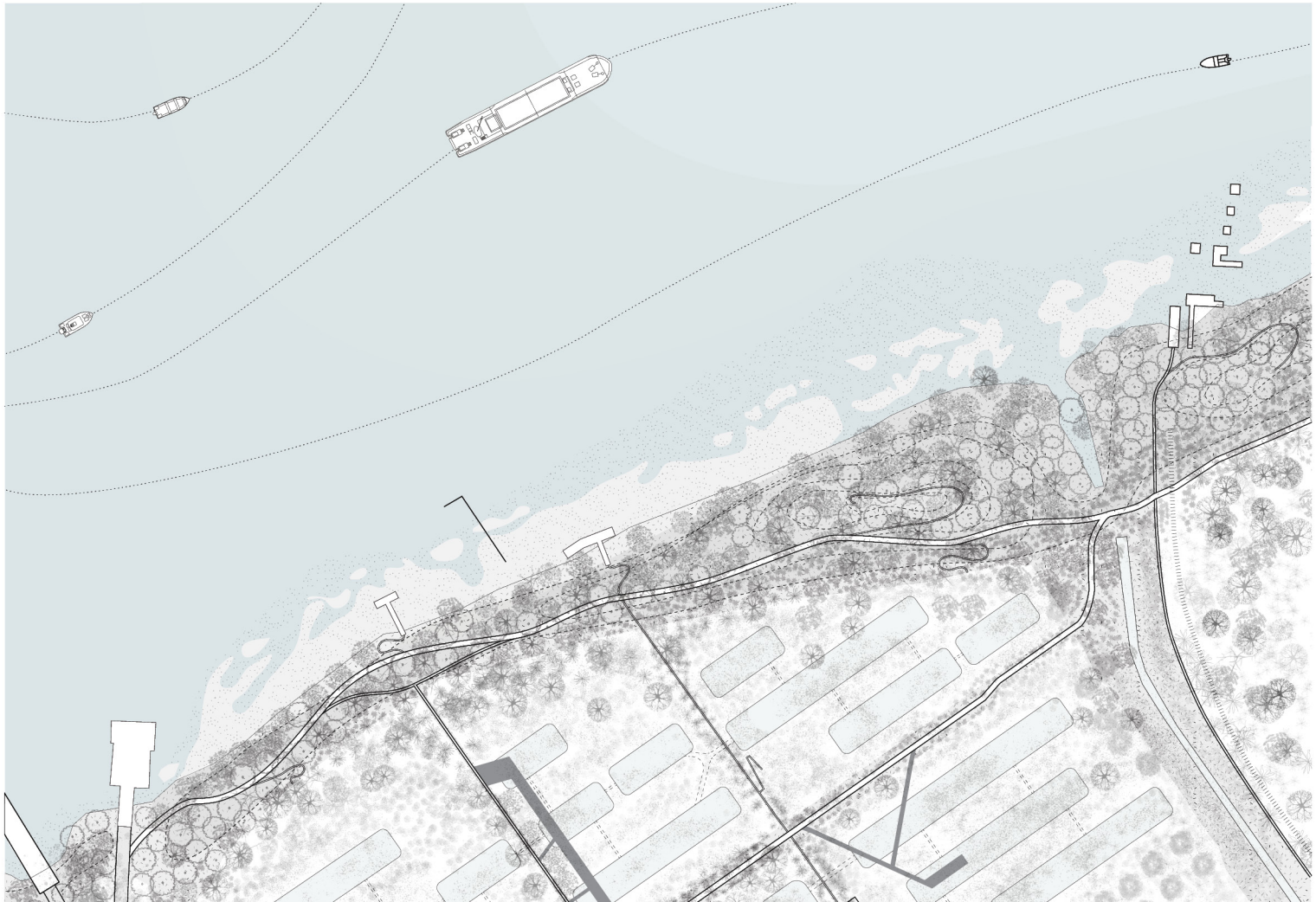
Strategy Plan
M Scale

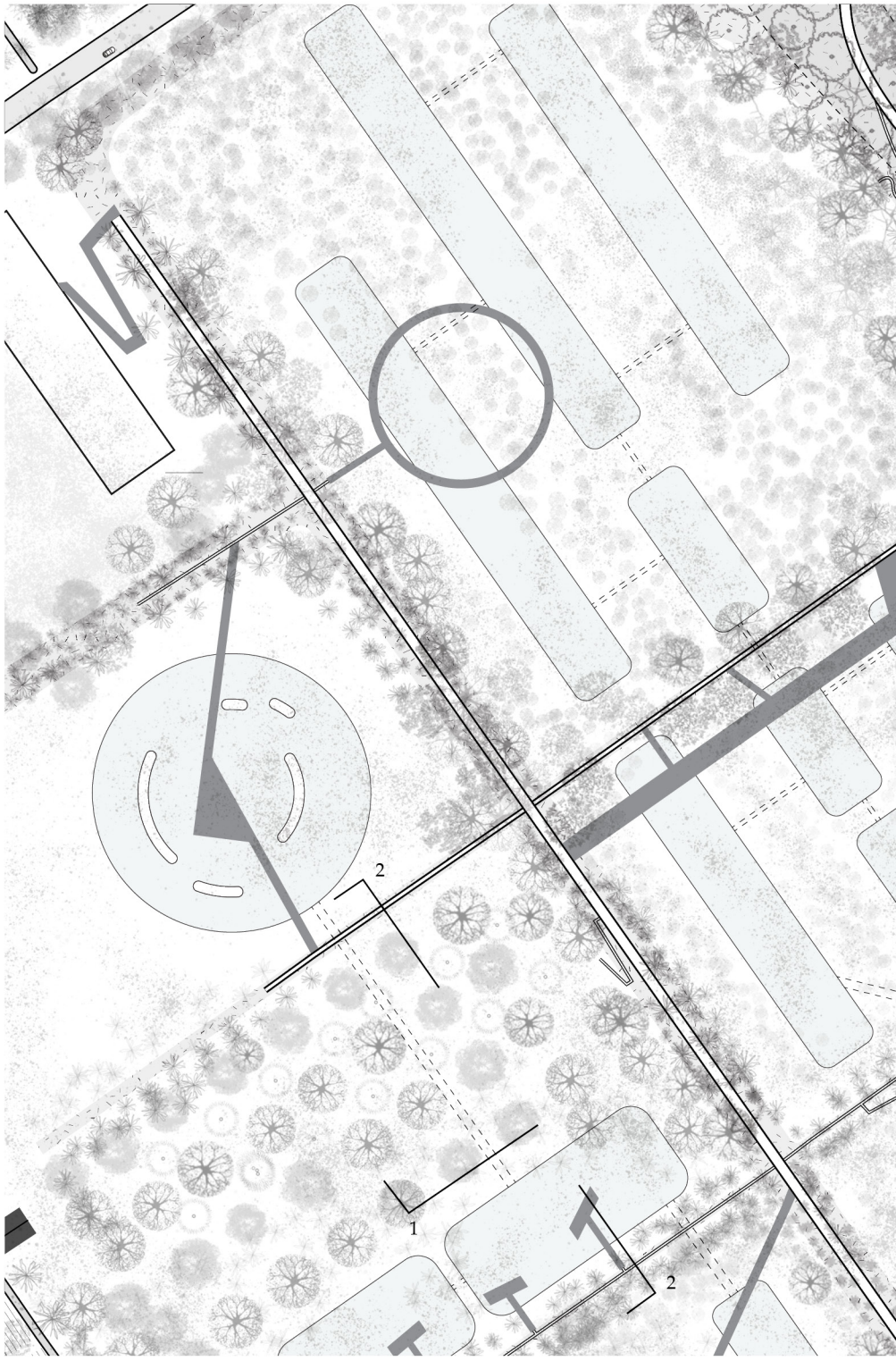


06.6
SALIN DE GIRAUD

Wetland Park
Plan

0 50 100 m

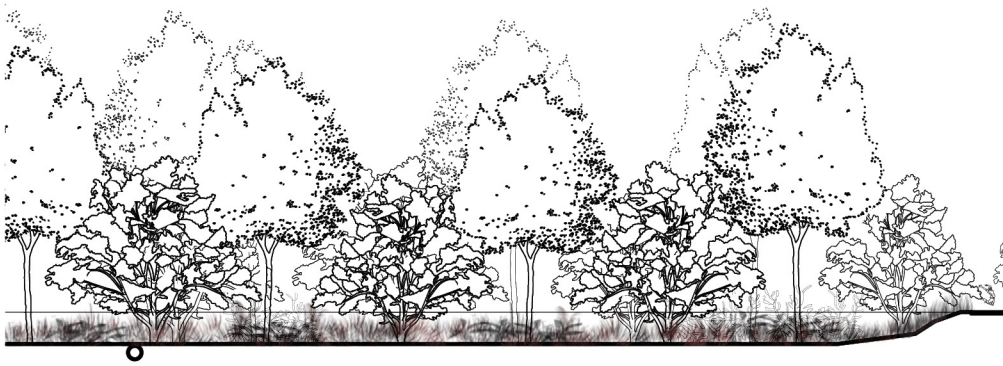




Wetland Park
Detail

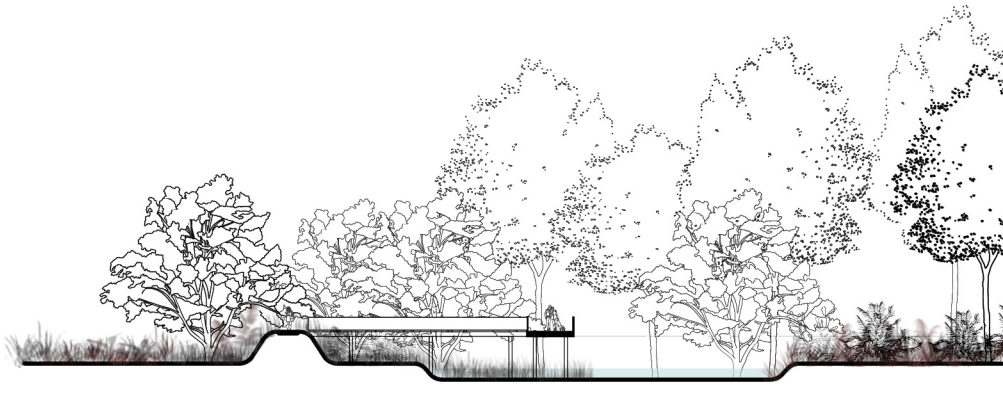
0 10 20 m


1



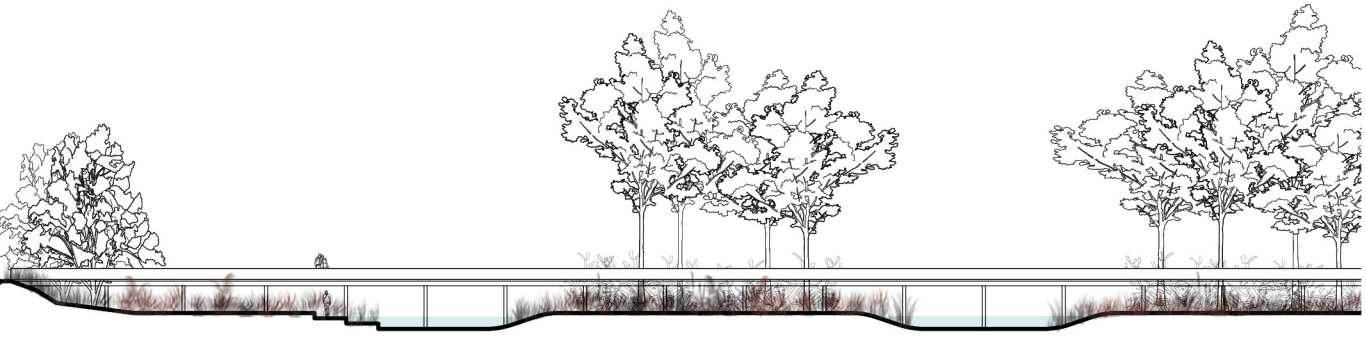
Wetland Park
Section 1

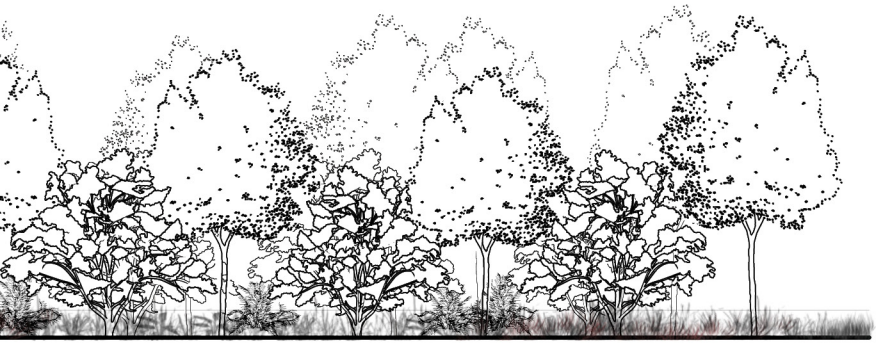
0 10 20 m

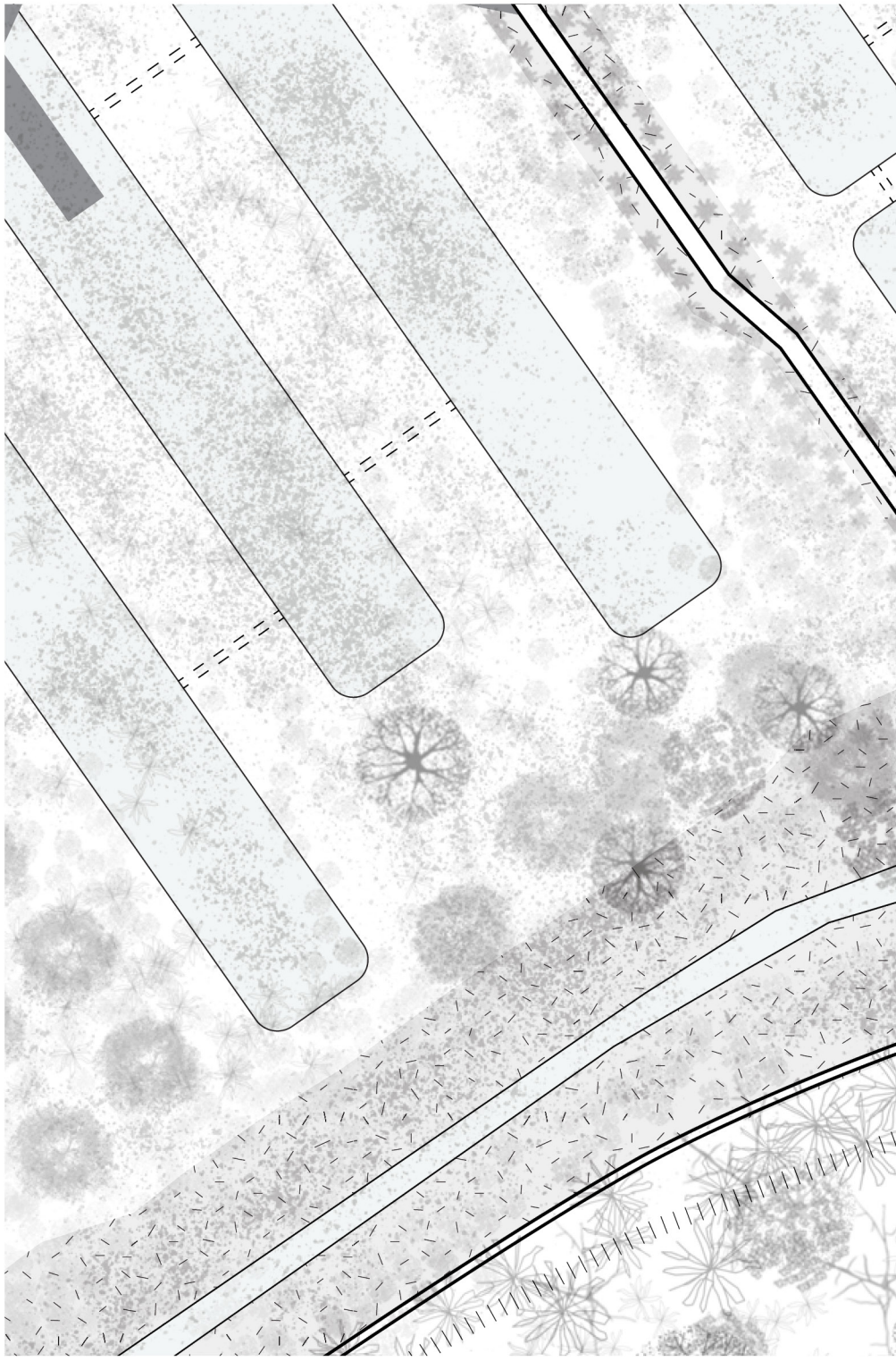


Wetland Park
Section 2

0 10 20 m

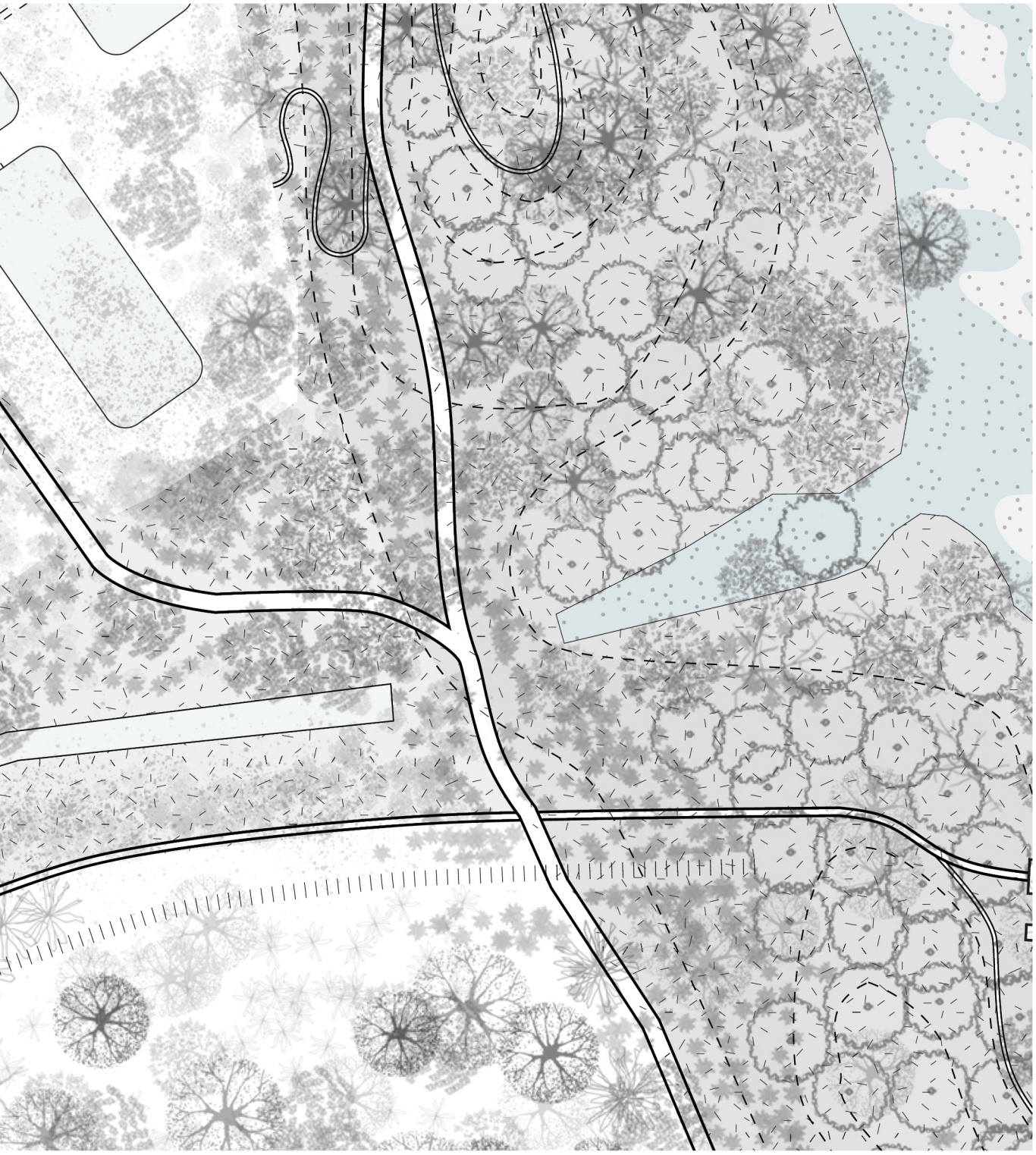


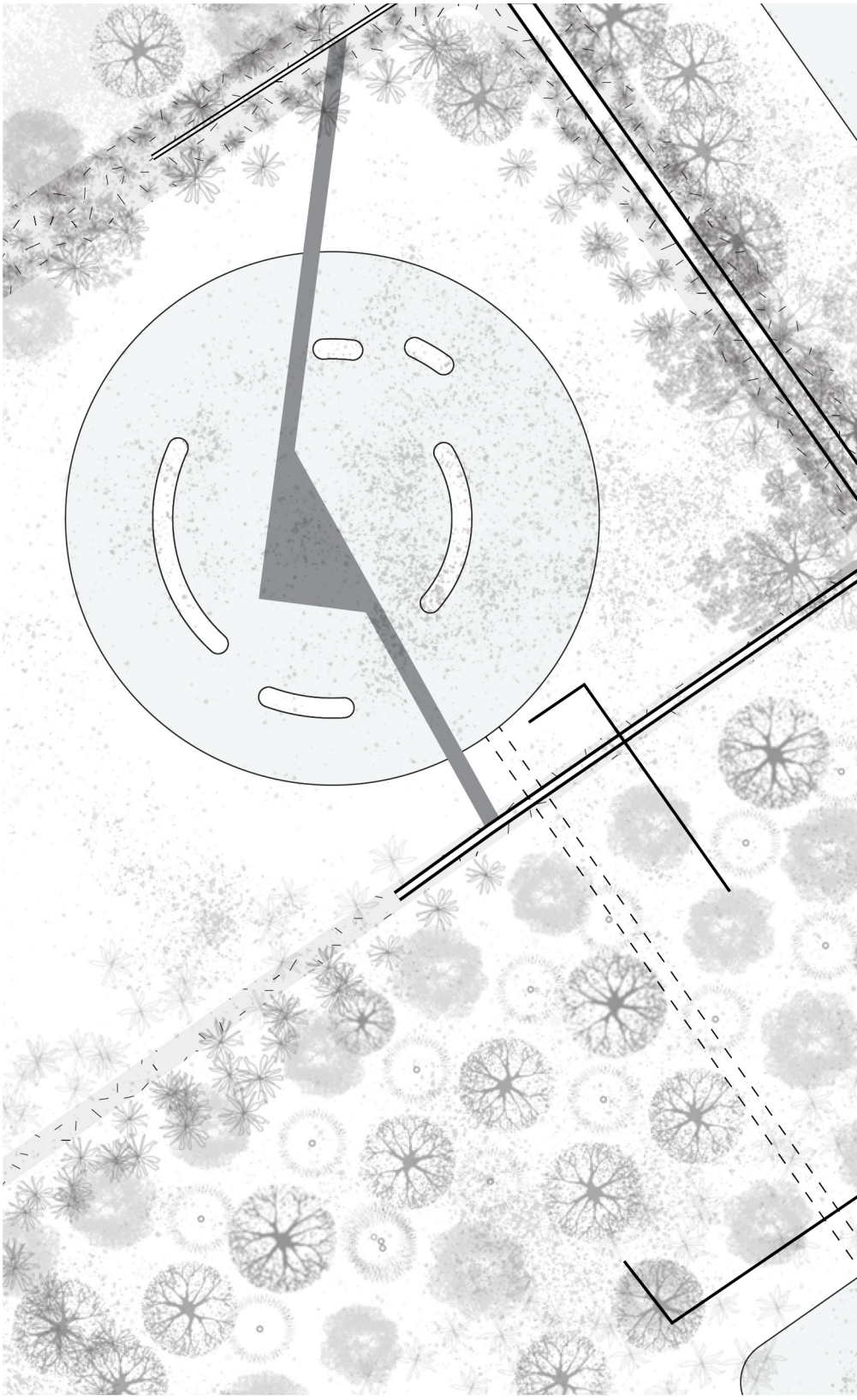




Wetland Park
Detail

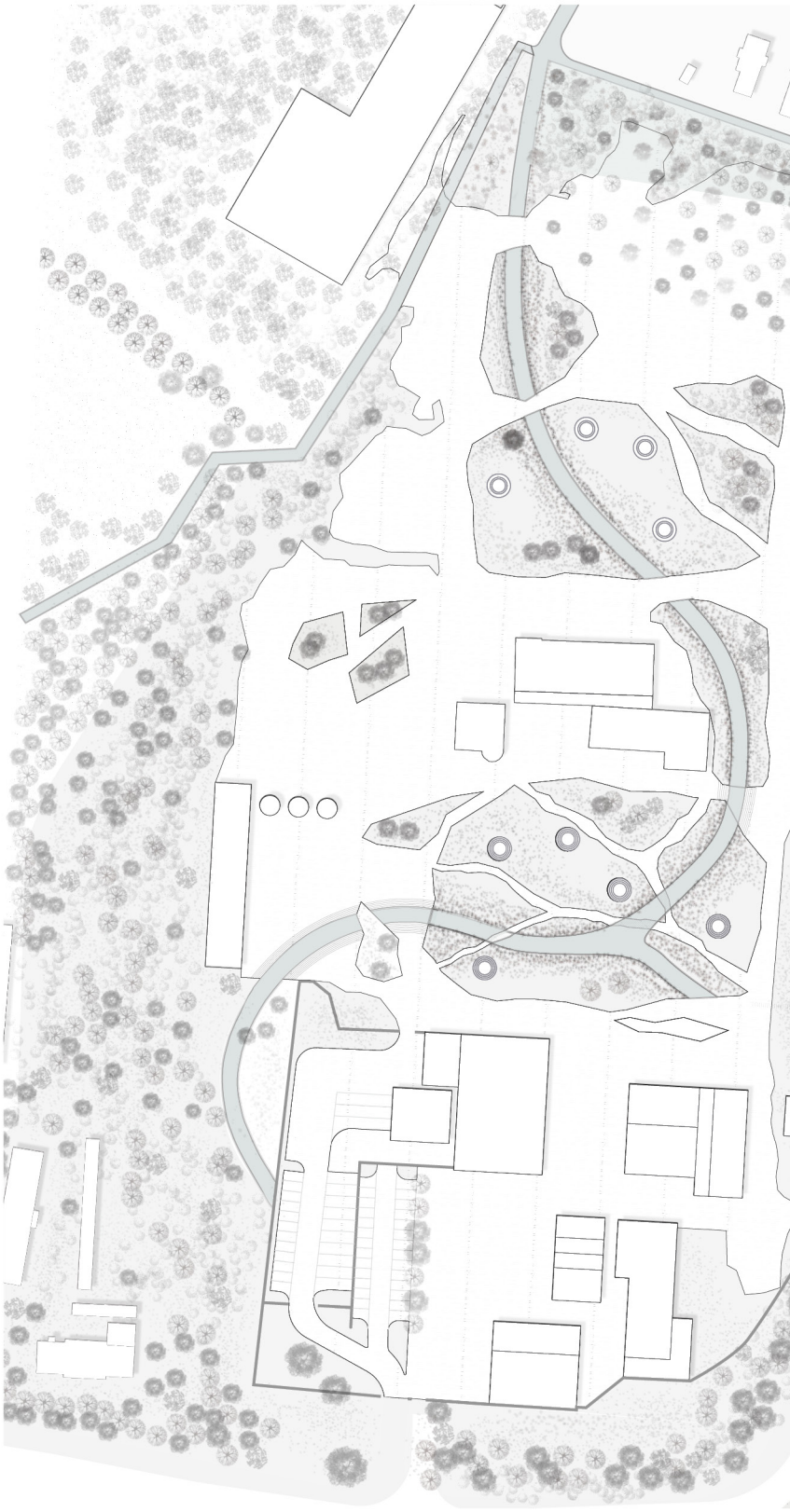
0 5 10 m





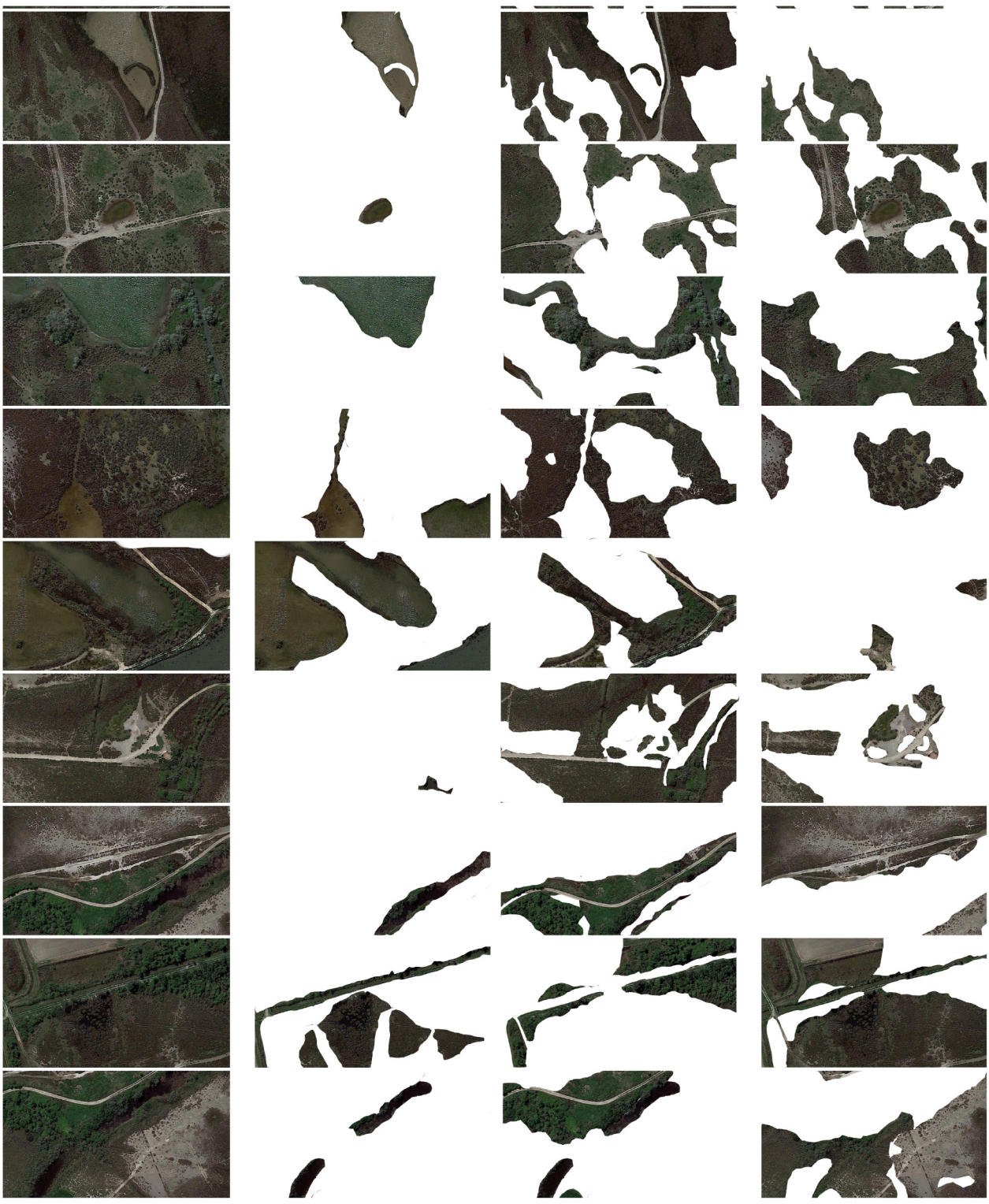
Wetland Park
Detail

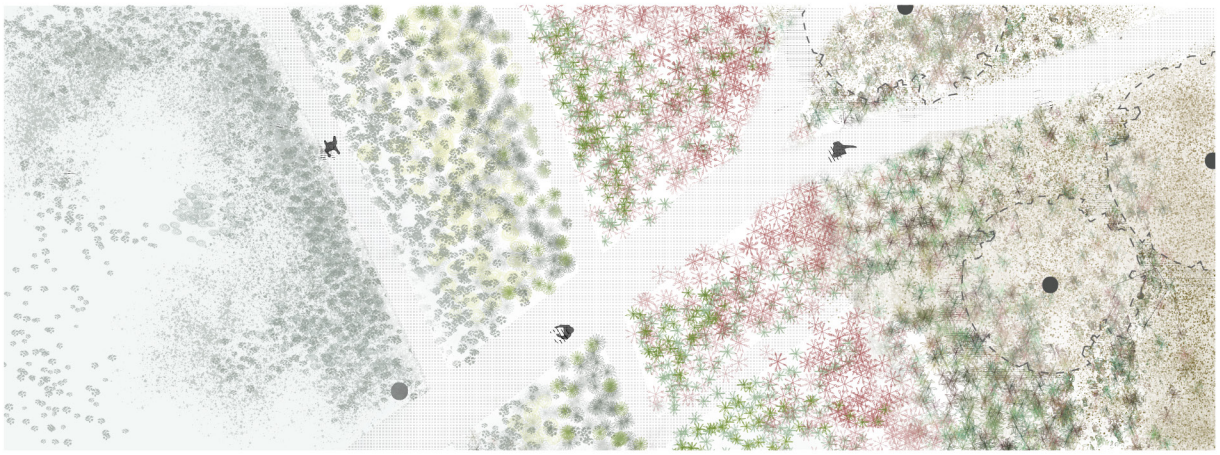
0 5 10 m

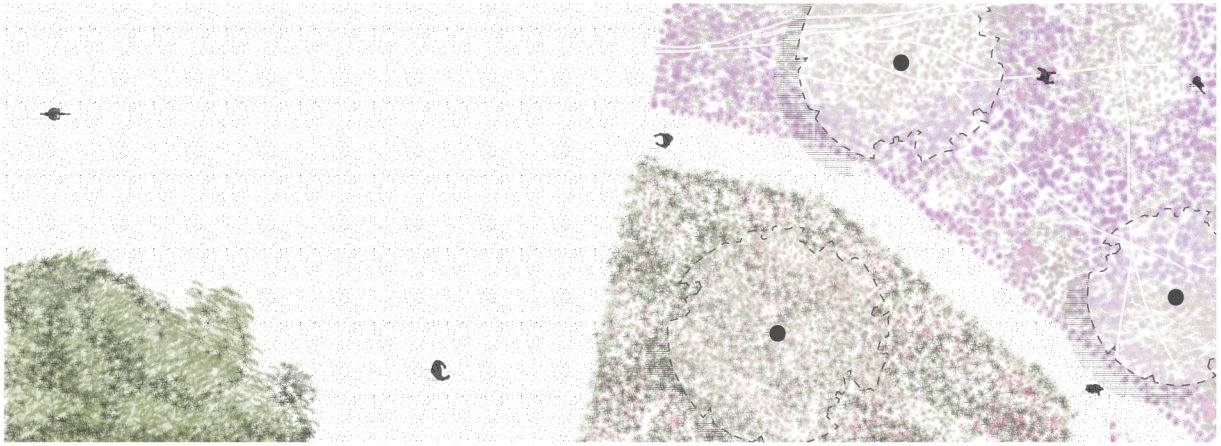


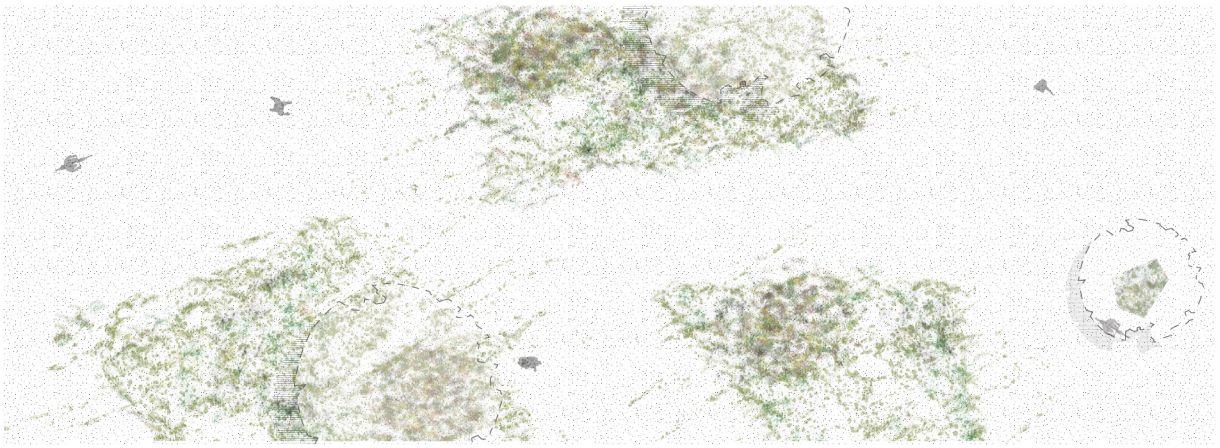
Plan
Salt Museum

0 30 60 m

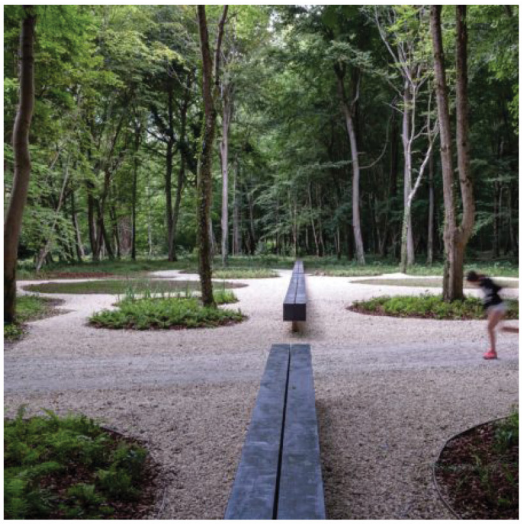


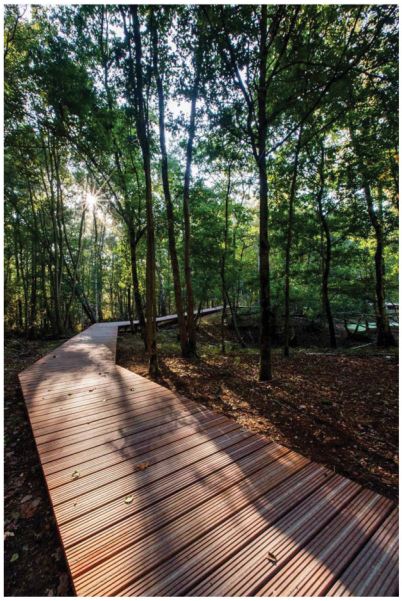




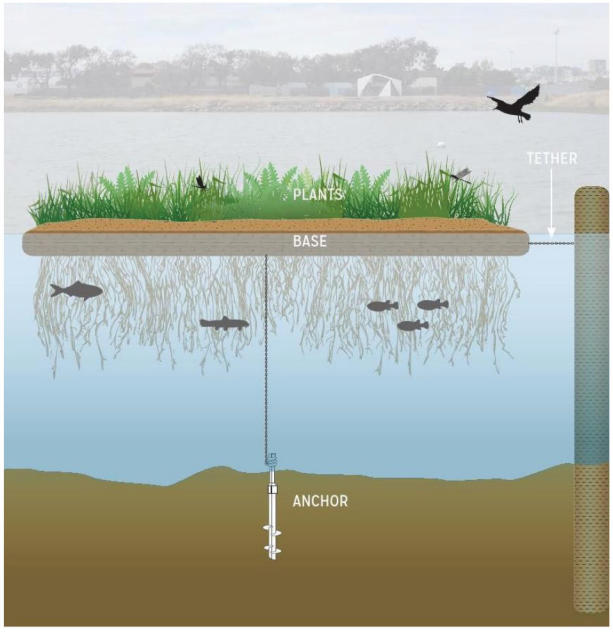


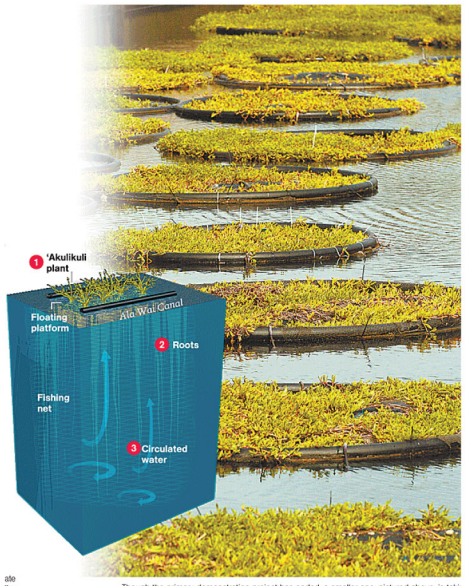
Visualisation





Source : landezine.com/museum-park-louvre-lens-by-mosbach-paysagistes





ate
the

Though the primary demonstration project has ended, a smaller one, pictured above, is taki
place in a canal next to the Ala Wai Golf Course.

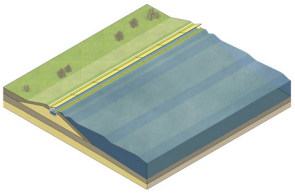
The Honolulu Adverti

07
CASE STUDIES

07
CASE STUDIES

INTERFACE MANAGEMENT



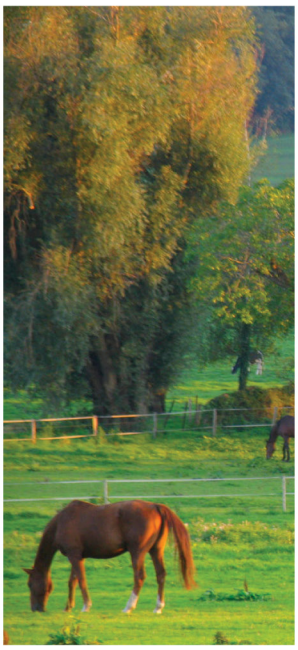





LIVING WITH WATER




URBAN REGENERATION



CIRCULAR ECONOMY

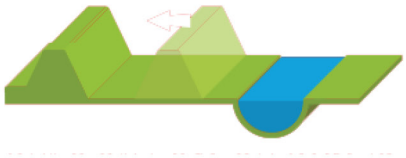
ROOM FOR THE RIVER
Netherlands
2006-2015

REINFORCING EDGES

https://www.lafargeholcim-foundation.org

ROOM FOR THE RIVER is a government design plan intended to address flood protection, master landscaping and the improvement of environmental conditions in the areas surrounding the Netherlands' rivers. The approach is to restore the river's natural flood plain in places where it is least harmful to protect those areas that need to be defended.

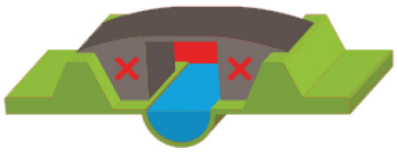
Excavation Floodplain
More space is created for the river as the water level increases by removing layers of soil from some areas of the floodplain.



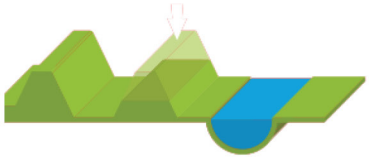
Relocated dykes
The floodplains become wider by relocating dykes further away from the river, allowing the river more space.

Excavation at Riverbed
By taking the top layer of the riverbed away, the riverbed is rendered deeper. There is more room for river water thus.

High water channel
Between two dykes, a high water channel is created. During high tide, the canal branches off from the river and transports water via another route



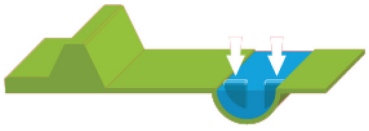
Removal of obstacles
Where possible, removing or redesigning obstacles in the riverbed ensures that the water flows faster.



Depoldering
The dyke on the riverside of a polder is relocated further away from the river. This depolders the area and enables water from the river to flood this area at times of high water.

Strengthening dykes
The dykes are strengthened at a number of locations where making room for the river is not an option.

Water storage
Particular areas serve as an area of temporary water storage



Lowering breakwater spurs
Breakwater spurs ensure that the river does not alter its course or lose depth. Lowering of spurs during high tides, the water has a better chance of being transported away faster.

THE SAND MOTOR
Netherlands
2011

H+N+S Architects, DHV and Deltares

REINFORCING EDGES

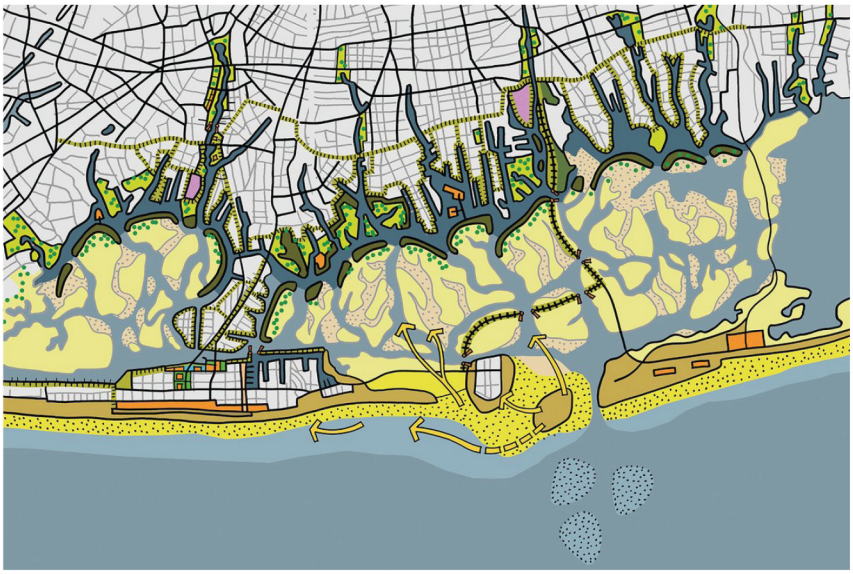
worksthatwork.com/1/zandmotor
www.thinglink.com/scene

The Sand Motor is a large-scale pilot project studying a new, sustainable method of coastal maintenance. The Sand Motor is a sandbank constructed as a hook-shaped peninsula. Wind, waves and current spread the sand along the coast, creating a broader coastline. This contributes to coastal protection and provides new nature and an extra recreational area.

This forms a more sustainable solution than the more conventional five-year sand replenishment solution, to battle an increased flood hazard because the flood defence does not meet the requirements and/or due to extreme conditions, and the fact that coastal sands are eroding due to external factors, compromising water safety.

LIVING WITH THE BAY
New York
2014

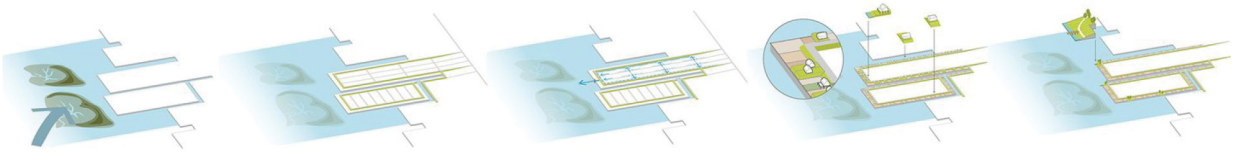
H+N+S Architects

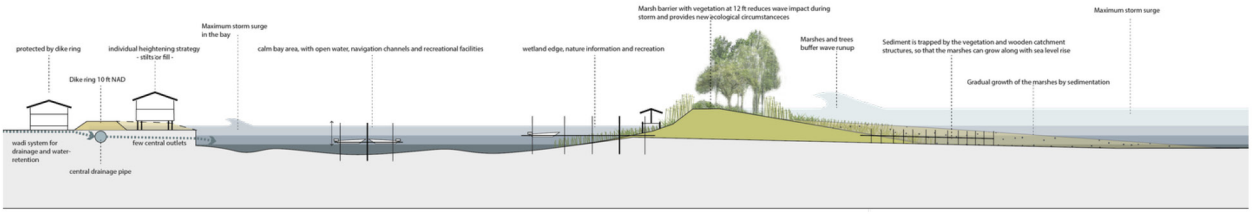


REINFORCING EDGES

worksthatwork.com/1/zandmotor
www.thinglink.com/scene

A ‘buffered bay’ was proposed . Through this technique, high water levels in the bay are eased, by expanding the marsh with vegetated ridges and innovative partitioning. An array of attractively designed dikes (including elevated roads) on the border between land and water provide extra safety. The existing urban area is, where possible, distanced and disconnected





from the water in the bay. The amount of green streets and creeks have been widened, to increase capacity for the storage of rainwater. Existing marsh and reef beds were used to subdue wave action. Raising the elevation of the roads and the adjacent ‘outer’ dikes or housing areas, can improve rainwater collection and drainage.

THE NEW HONDSBOSSCHE DUNES
Noord Holland
2014-2016

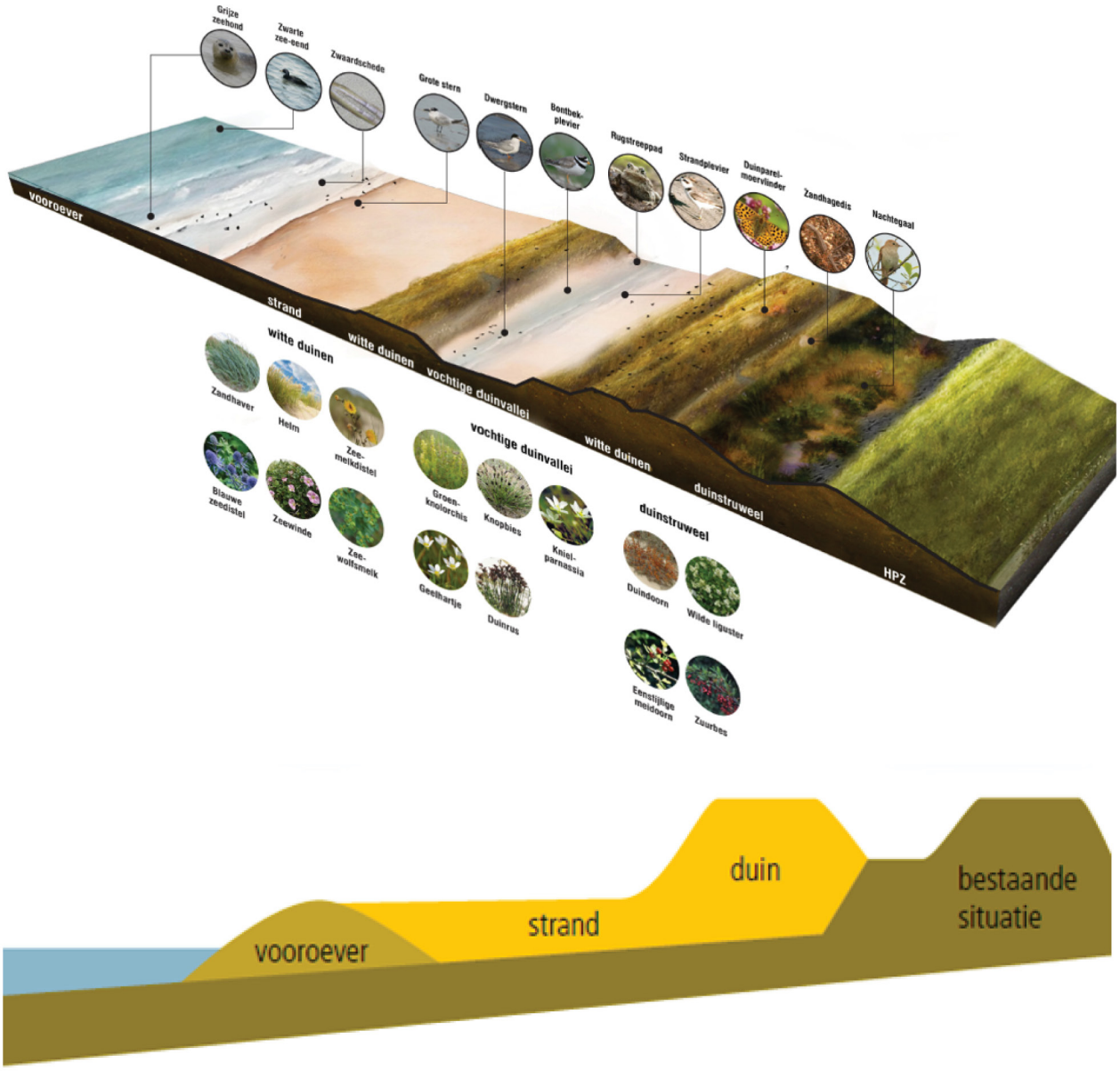
West8 Architects

REINFORCING EDGES

www.lafargeholcim-foundation.org
www.west8.com/projects/hondsbossche_and_pettemer_zeewering/

Opting for a sandy and dynamic solution instead of fixed or hardscape approach creates **opportunities to simultaneously strengthen the region, enhance and embrace the qualities of the natural environment and bolster recreational activities.**

In the project plan for the new sea defence a spatial zonation is applied In



the middle section nature development prevails with a wet dune valley and a large habitat for birds and plants. At both sides there is space for recreation and tourism.

The construction contains measures to capture the sand and reduce sand transport. Apart from planting marram grass, these measures included willow screens.

Sustainable post-tsunami reconstruction master plan Constitución, Chile

Ongoing

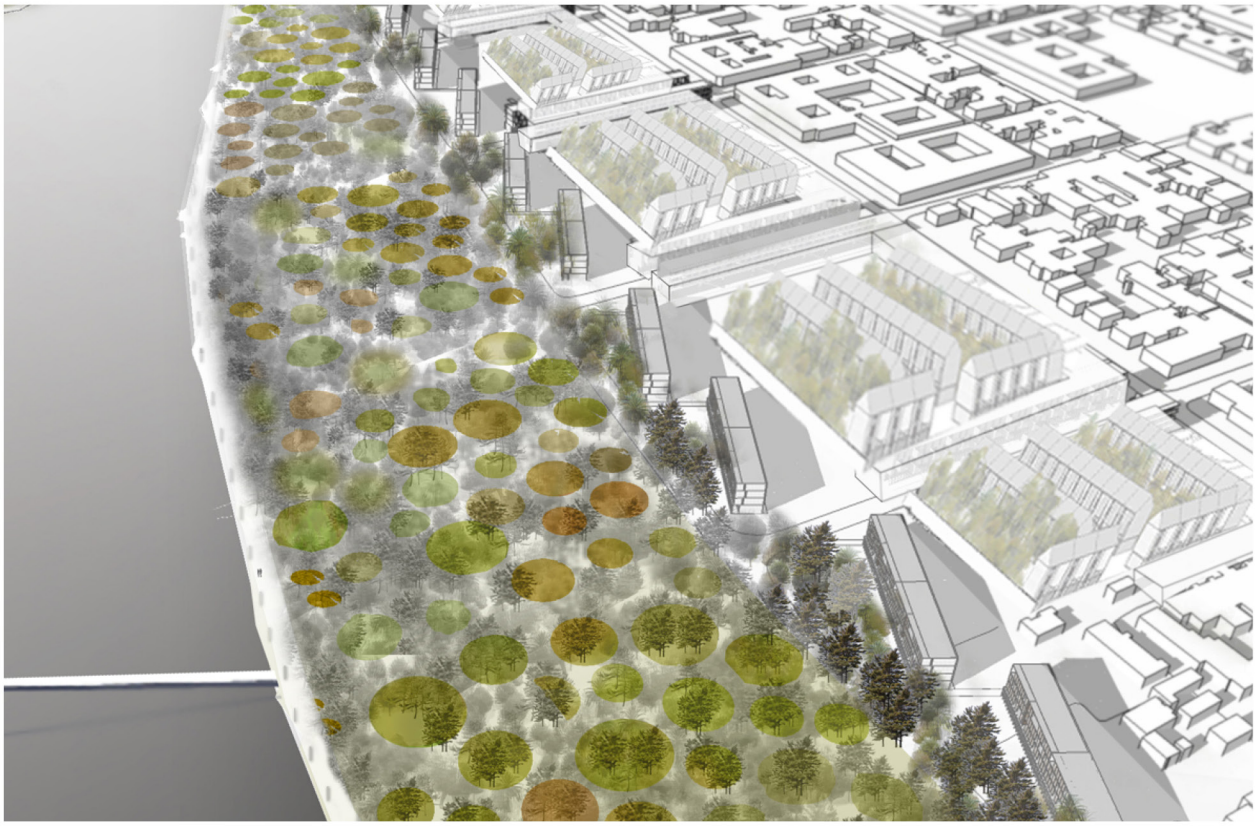
Tironi Asociados
Arup
Fundación Chile Marketek
Universidad de Talca

REINFORCING EDGES

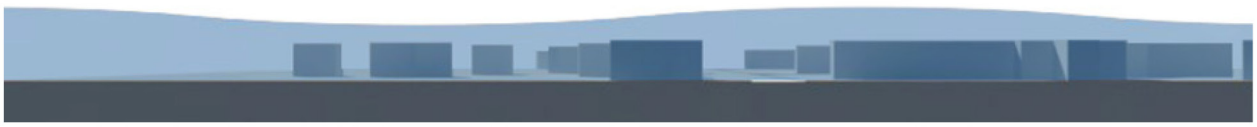
www.lafargeholcim-foundation.org

The project involves the sustainable post-tsunami reconstruction master plan for the city of Constitución, Chile.

Instead of implementing a construction ban or massive barrier along the risk zones, this project in Chile developed creative ways to improve resilience in the city of Constitución, using a process of extensive



Height average 3.5m to 4.5 m
The waves continues to advance five blocks



Height average 3.5m to 4.5 m
Wave decreases to 2.8m (1.42m/sec) after crash

community participation.

In addition to responding to the threat of tsunami, the approach enabled long-term preservation of the city at its historical position, created public spaces along the banks of the river that alleviate the lack of inner-city recreation areas, and also support the dissipation of rainwater runoff to avoid further flooding.

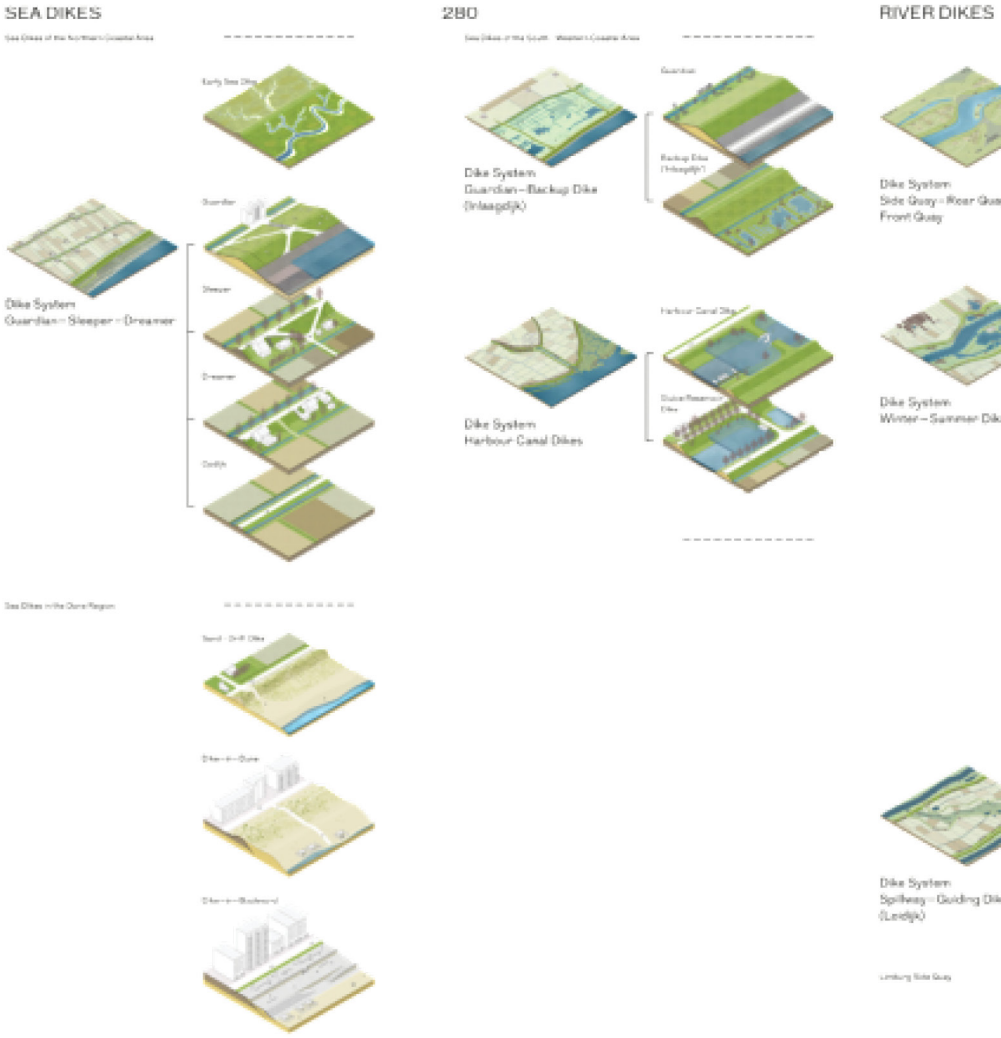
Dutch Dikes

Ongoing

LOLA landscape architects

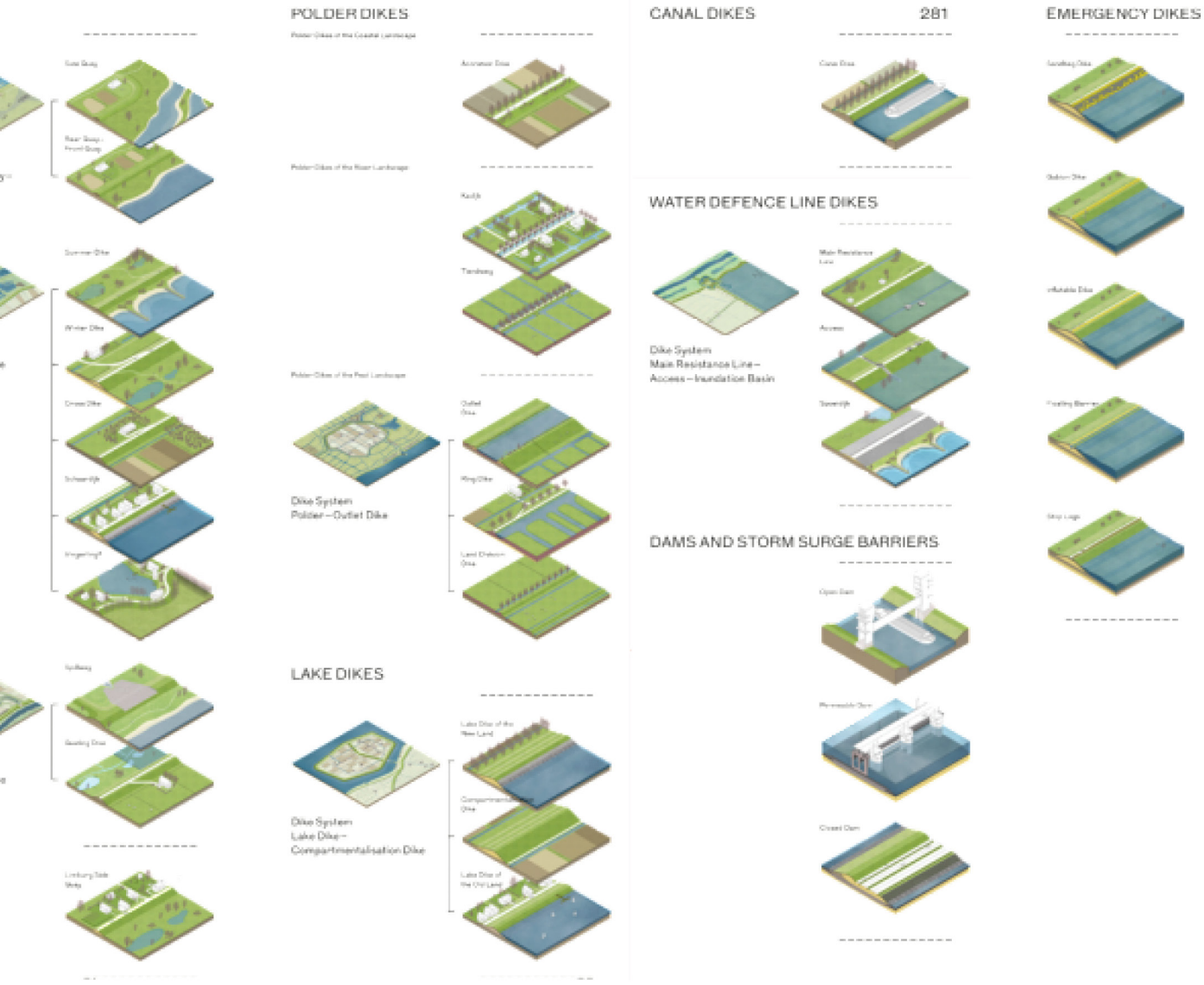
REINFORCING EDGES

dutchdikes.net



Dutch Dikes offers a complete overview of the Netherlands' most important invention: the dike. Dike networks are not isolated, but form part of their environment. What once began with mounds and culverts is now a network of more than 22,500 km of dikes, dams and dike relics.

Dutch Dikes presents an overview of the dikes in their current state, as



well as offers a look towards the future. Based on the first map of dikes in the Netherlands, the dikes are characterised, explained and categorised in all their diversity. From drift dikes to summer dikes, from sea dikes to waterline dikes, and from dreamer dikes to guardian dikes: all forms of dikes are brought together in a unique, systematic genealogy.

LIVING BREAKWATERS
New York
2015

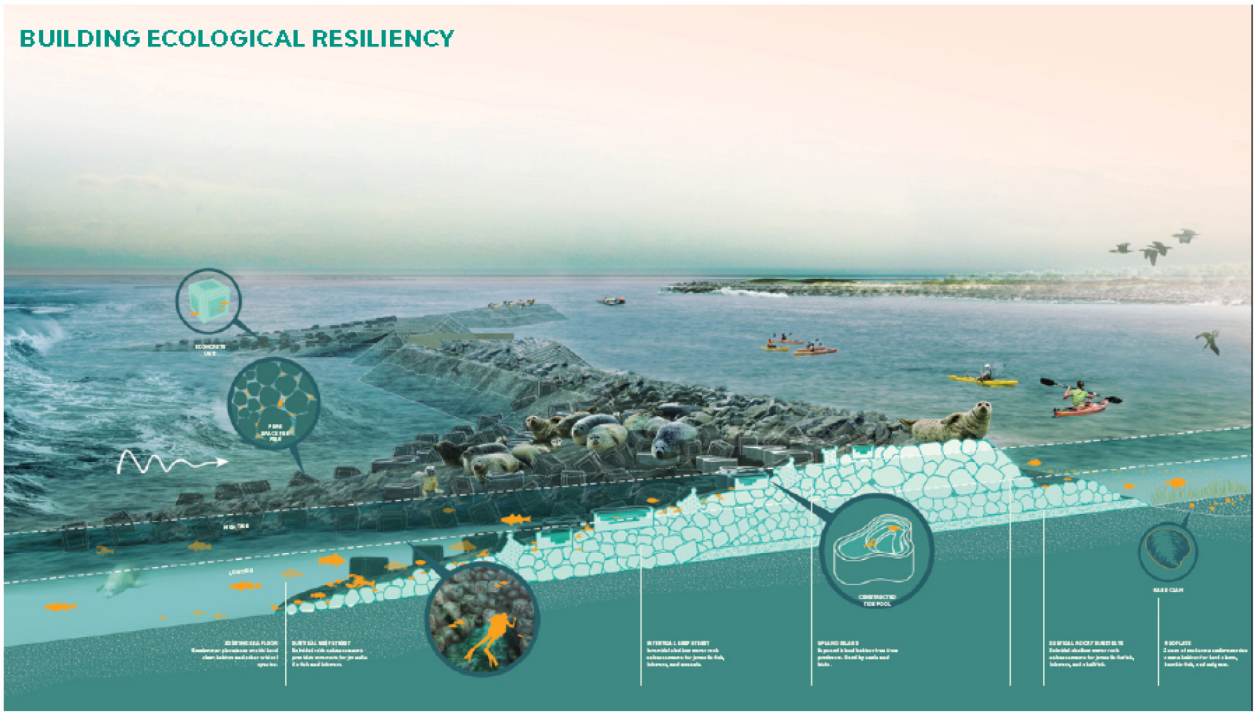
SCAPE / Landscape Architecture

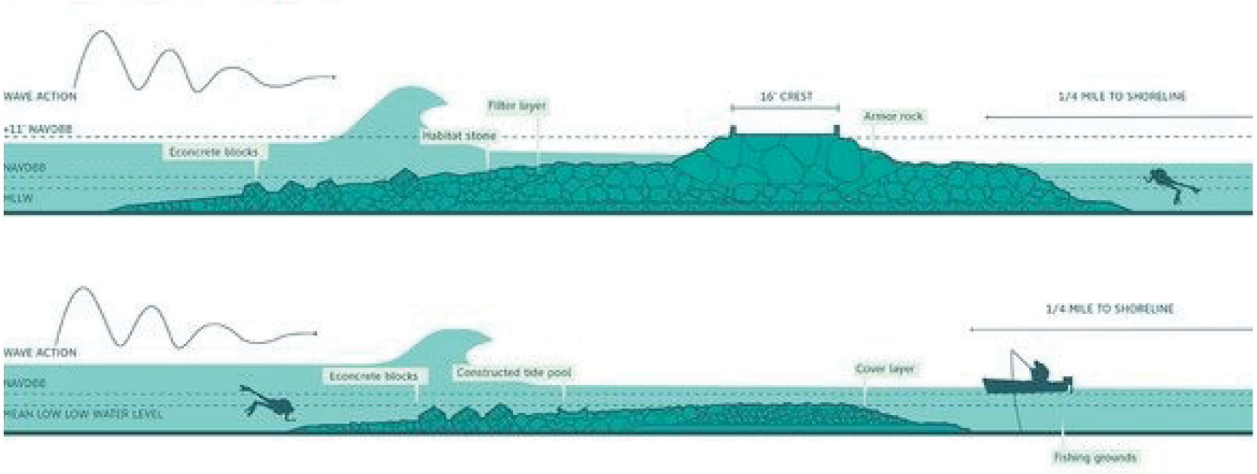
REINFORCING EDGES

rebuildbydesign.org/our-work/all-proposals/winning-projects/ny-living-breakwaters

Living Breakwaters was conceived to connect physical, social, and ecological resilience.

The proposal is a "necklace" of offshore breakwaters that will reduce risk, revive ecologies, and connect residents and educators to Staten Island's southeast shoreline. The structure will provide habitat to the Raritan Bay's rich

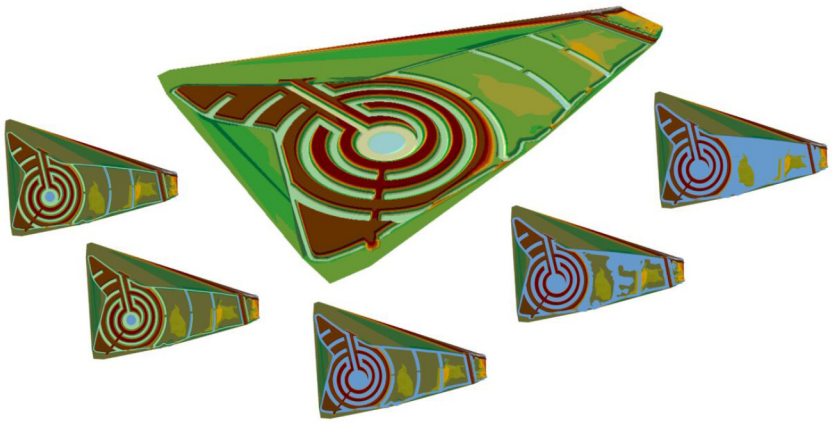




ecosystem of marine life. The vegetated dune system will be strengthened by the breakwaters, to provide a layered system of protection. The project combines COASTAL RESILIENCY infrastructure with HABITAT ENHANCEMENT techniques and COMMUNITY ENGAGEMENT models, deploying a layered strategy that links in-water protective forms to on-shore interventions.

PILOT KOOPMANS POLDER
Noord Holland
2010

LIVING WITH WATER



www.ecoshape.org/en/concepts/developing-inland-buffer-zones/practical-applications/

The pilot includes an inlet so that lake water can enter the polder, which is situated a bit lower than the lake. Water flows through a long spirally shaped ditch inside the polder with gentle slopes and is gathered into a small pond from which it can be pumped back into the lake. The pumping facility will be equipped with a fish-friendly axial pump and driven by a wind mill.

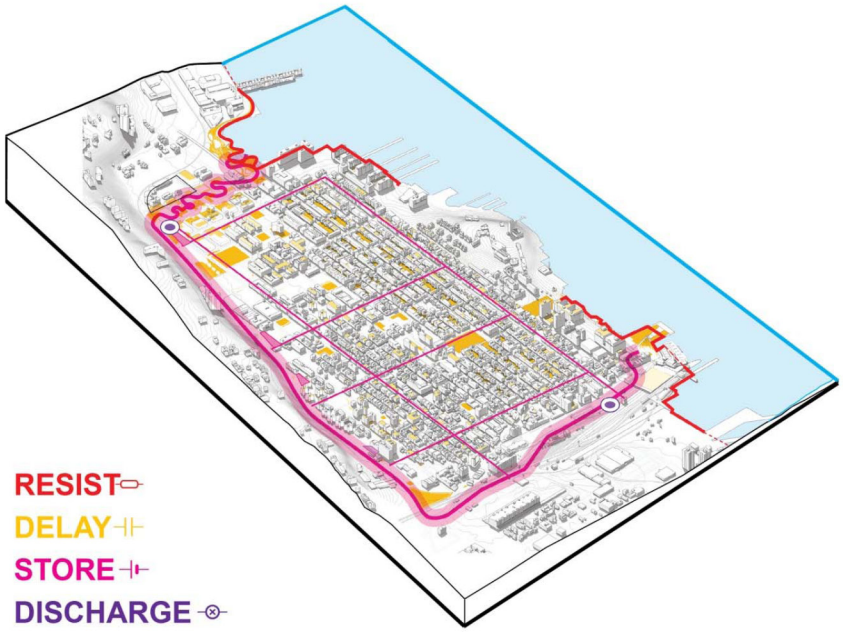
Due to the design, the polder will function as a helophyte filter improving the water quality. In addition, fish can encounter better conditions for spawning than presently available.

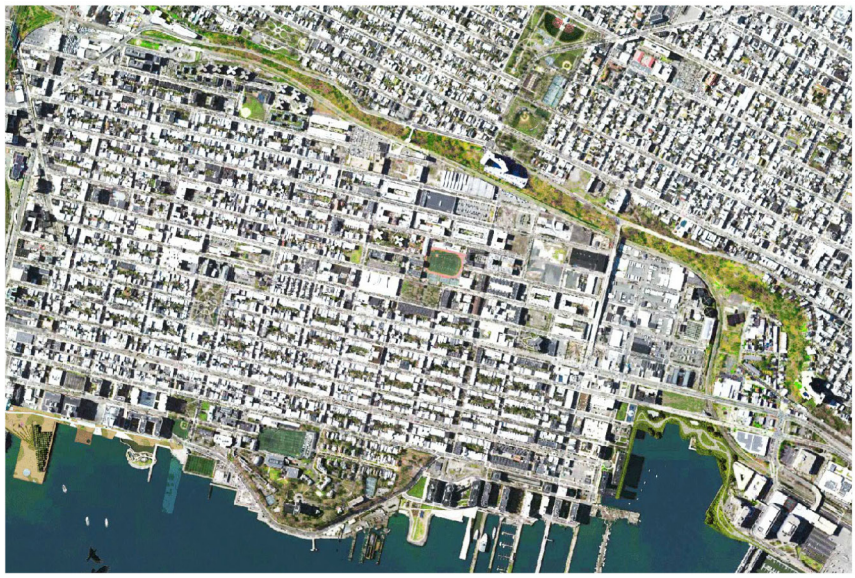
The polder can function as a climate buffer, providing a place to store water when there is too much, and withdrawal of water when there is too little.

RESIST, DELAY, STORE, DISCHARGE
New Jersey
2013

OMA Architects

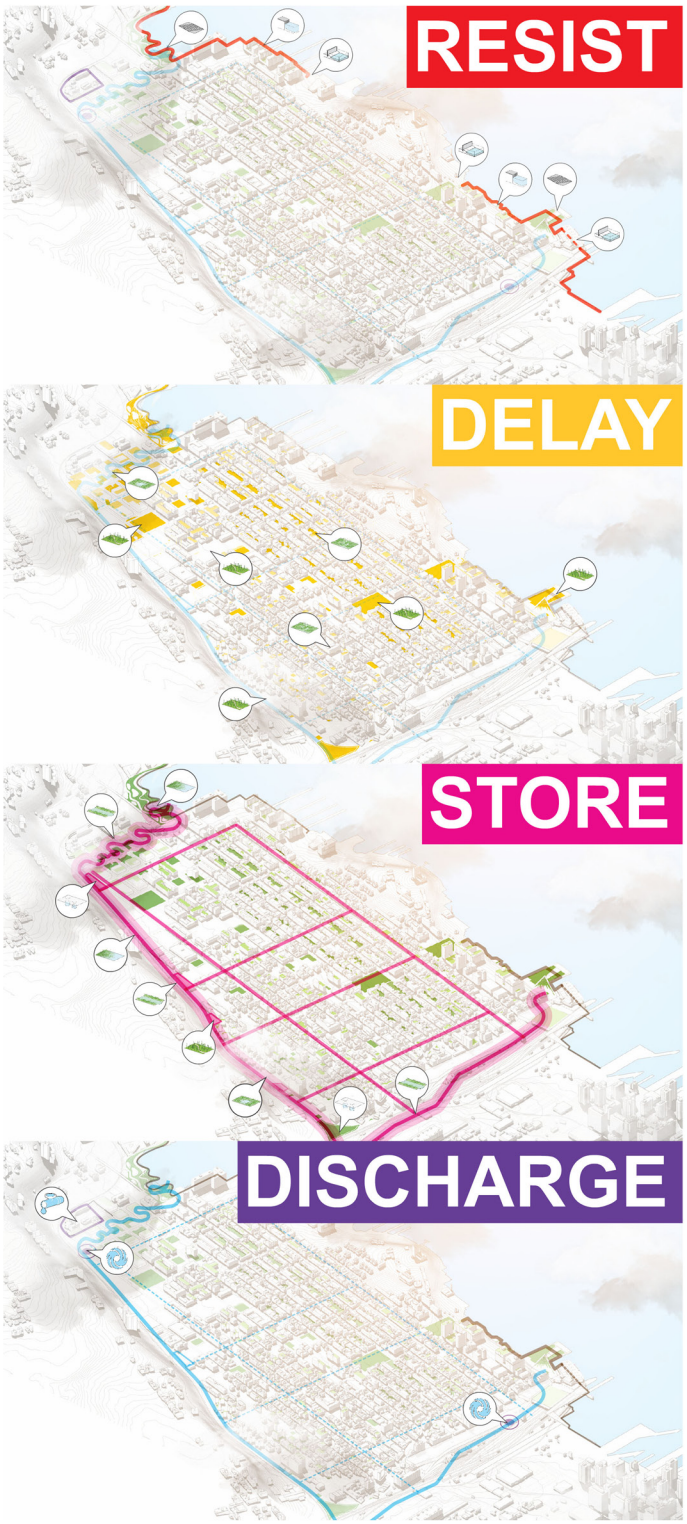
LIVING WITH WATER





oma.eu/projects/resist-delay-store-discharge-comprehensive-urban-water-strategy

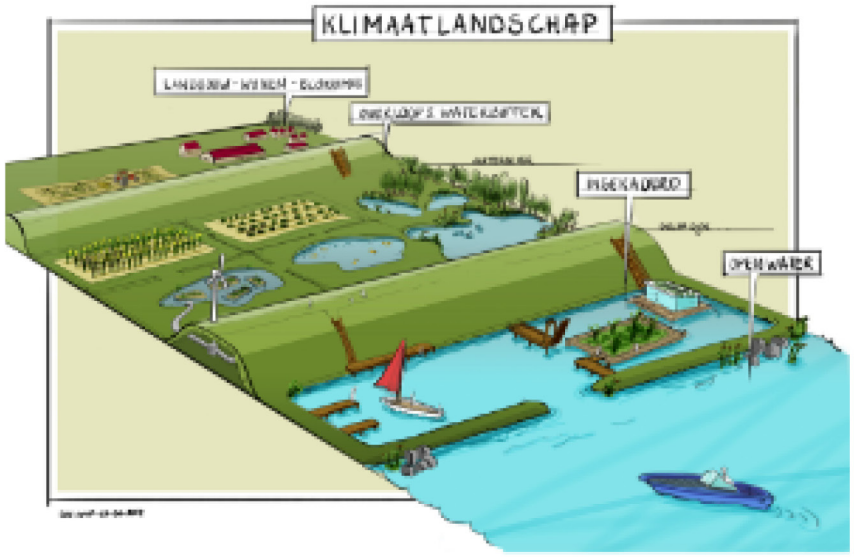
The comprehensive urban water strategy deploys programmed hard infrastructure and soft landscape for **coastal defense (resist);** urban infrastructure to slow rainwater runoff **(delay);** a circuit of interconnected green infrastructure to store and direct excess rainwater **(store);** and water pumps and alternative routes to support drainage **(discharge). This system**



serves as the foundations of a parallel green drainage infrastructure; reducing the risk of flash flooding from rain, filtering and cleaning storm water and serving as a park for the community.

WIERINGERMEERPOLDER
Hollands Kroon
2015

LIVING WITH WATER



www.rebuildbydesign.org/our-work/all-proposals/winning-projects/ny-living-breakwaters

This is a deep polder area in the north of the Netherlands which receives a high salt load through upward seepage. It lies 4 meter below surface level.
The polder is mostly mono-functional focussed on agriculture. Along the dike inland shores plans are developed for new business models focussing on water storage in combination with food production

LANDSCAPE PARK
Duisburg-Nord
1990 – 2002

LATZ & PARTNER

LIVING WITH WATER

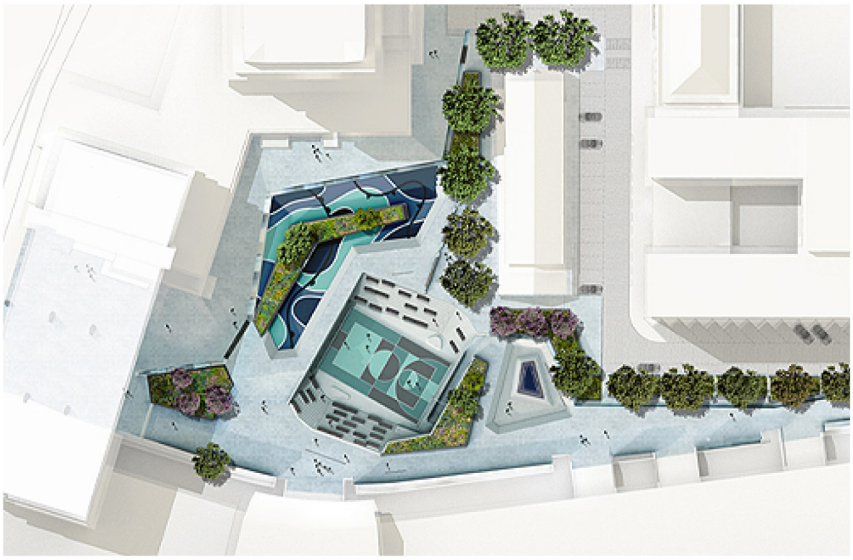
www.latzundpartner.de

The IBA-Emscherpark was created in order to give a new ecological, economic, social and cultural impulse to the old industrial area by means of these restructuring projects. In order to enhance the diversity of biotopes, several waterways have been implemented as wet biotopes. An important theme in the development of the plan was to make the water system visible.

WATER SQUARE BENTHEMPLEIN
Rotterdam
2012-2013

Hugh Maaskant

LIVING WITH WATER



urbanisten.nl

The water square combines water storage with the improvement of the quality of urban public space. The water square can be understood as a twofold strategy. It makes money invested in water storage facilities visible and enjoyable. It also generates opportunities to create environmental quality and identity to central spaces in neighborhoods.

WATER SQUARE TIEL
Tiel
2014- 2016

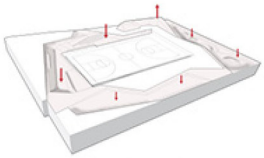
De Urbanisten

LIVING WITH WATER

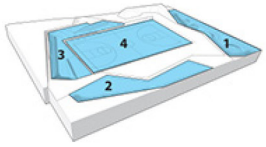
www.urbanisten.nl

Final design

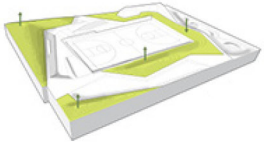
A playful snake curls around the central water basin...



...creating a topography of deep and high areas...



...that is also a sequence of basins for water storage...



...framed by a green landscape

The city of Tiel has to deal with several water related challenges like the risk of flooding, high groundwater and a need for waterstorage.A central square is designed that has two functions. It is both a vivid place to play and linger and a temporary storage of rainwater.It's a landscape with height variations that creates a sequence of smaller basins.

PONDS OF FOCOGNANO
Florence
1997

URBAN REGENERATION

https://www.wwf.it/oasi/toscana/stagni_di_focognano/

The WWF Oasis of Focognano is a complex of 5 lake basins, testimony of the typical historical landscape of the Florentine plain, constitutes an essential piece of the "waterways" followed by birds. **It is also a Special Protection Area.**
An important staging area for birds and a key microenvironment for the conservation of amphibians.

PARCO AGRICOLO SUD Milano

2007

URBAN REGENERATION

www.parcoagricolosudmilano.it

Intended as areas with the needs of protecting nature, the environment and cultural & recreational use, as well as oriented to the development of agricultural activities & other traditional activities aimed at promoting growth. economic, social and cultural community.

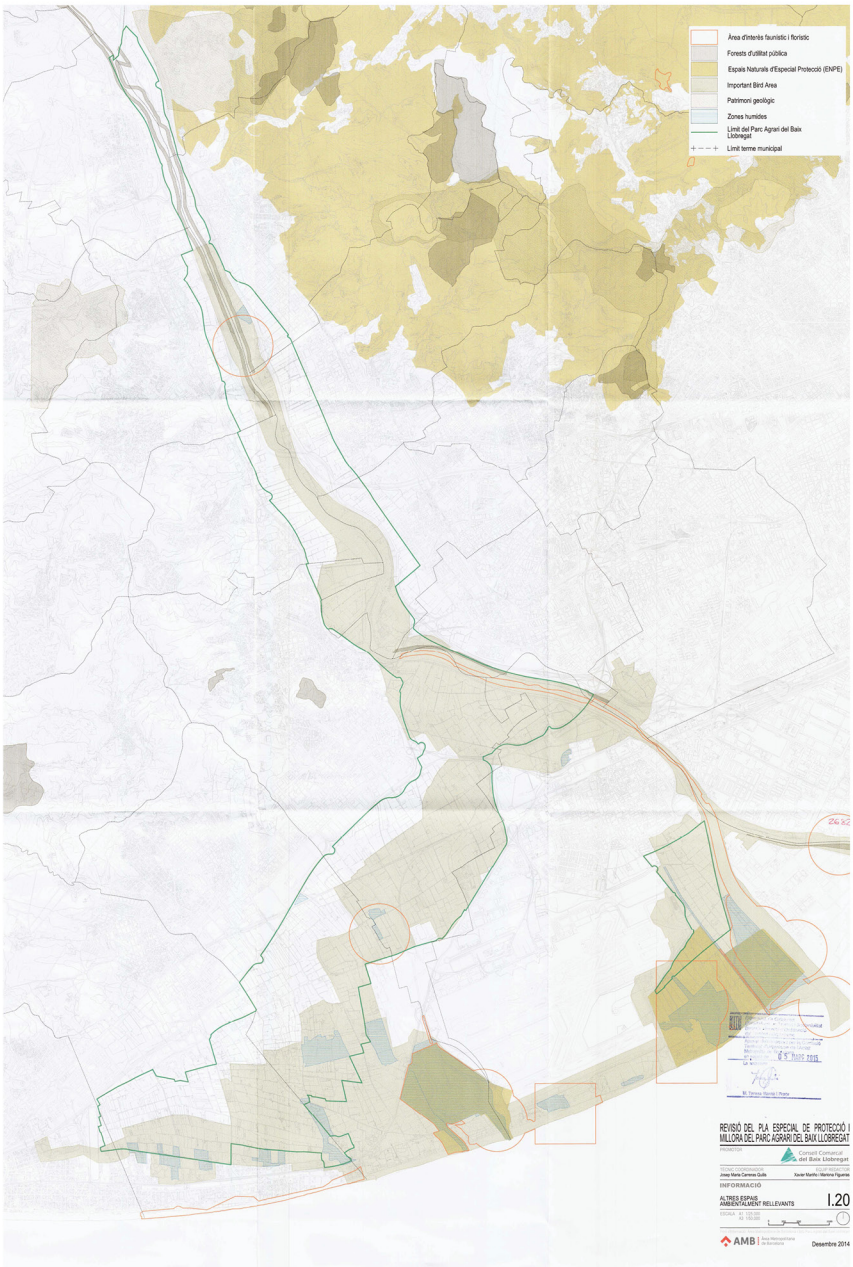
- peri-urban agriculture
- soil conservation
- food production.

PARCO AGRICOLO LLOBREGAT
Barcelona

1998

URBAN REGENERATION

salviamoilpaesaggiopd.wordpress.com/tag/parco-agricolo-del-baix-llobregat/



Strategies for Landscape Development Plan
a) Temporary flooding of fields
b) Collection of traditional fruit tree varieties.
c) Establishment of the Agropolos
d) Water management and its quality control.
e) Environmental and urban control.
f) Management of the network of tracks and irrigation

PFERDELANDPARK
Aachen
2008

URBAN REGENERATION

www.pferdelandpark2008.eu/

Pastures, hedges, courtyards, castles and horses, located on the routes of the green metropoli, linking over 30 kms od road networks.
Better development awakens the idyll behind the Lousberg by creating a "White Path" - leading the visitor past pearls of the landscape to hidden places, special vantage points and art objects.

JIANGBEI PARK
Taizhou City
2010- 2011

Turenscape architects

URBAN REGENERATION

www.turenscape.com/en/project/detail/4664v

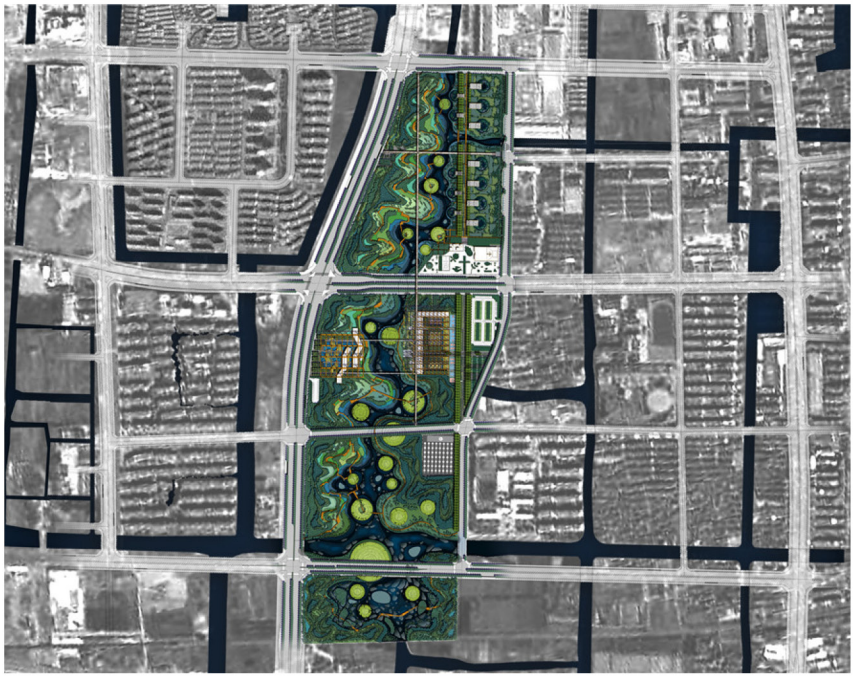
The scheme aims to purify the river of Yongning river through a riverside green belt, It provides a place for gathering, leisure and fitness for people live in the neighborhood. The three landscape belts are the terraced land belt, the inland river purification belt and the wetland conservation belt.

ECOLOGICAL CORRIDOR
China Ningbo, Zhejiang
2010- 2012

Turenscape architects

URBAN REGENERATION

www.turenscape.com/en/project/detail/4685.html



This introduces terraced wetland to slow down the flows of urban runoffs from the street down to the river and remove the nutrients.The river is transformed into a meandering eco-friendly waterway dotted with tree isles to increase the interface between organisms and water bodies to empower the river's purification capacity.

LANDGANGEN
Esbjerg

2018

COBE Architects

URBAN REGENERATION

www.cobe.dk/place/landgangen

From divider to connector : Pedestrian bridge and 220 meters of promenade connecting the historic center of Esbjerg with the harbour. Landgangen acts as a unifying element between three different contexts: City, industry and landscape. The light structure has a minimal impact on the green surfaces and mature trees, leaving urban nature & biodiversity untouched.

COMMUNITY GARDENS
Paris

2010

CIRCULAR ECONOMY

www.paris.fr/loisirs/jardinage-vegetation/jardins-partages/p9111

The area was set up as **jardin partagé,** defined as a community garden, set up and animated by local neighbourhood associations on small public plots. The Municipality makes available and cleans up plots which are disused or temporarily vacant, guarantees water supply and garden enclosing for a period that can be extended according to urban developments.

REGENERATION OF SALT MARSHES IN CADIZ
Cadiz, Spain
2002

Environmental Ministry of Spain

CIRCULAR ECONOMY

https://core.ac.uk/

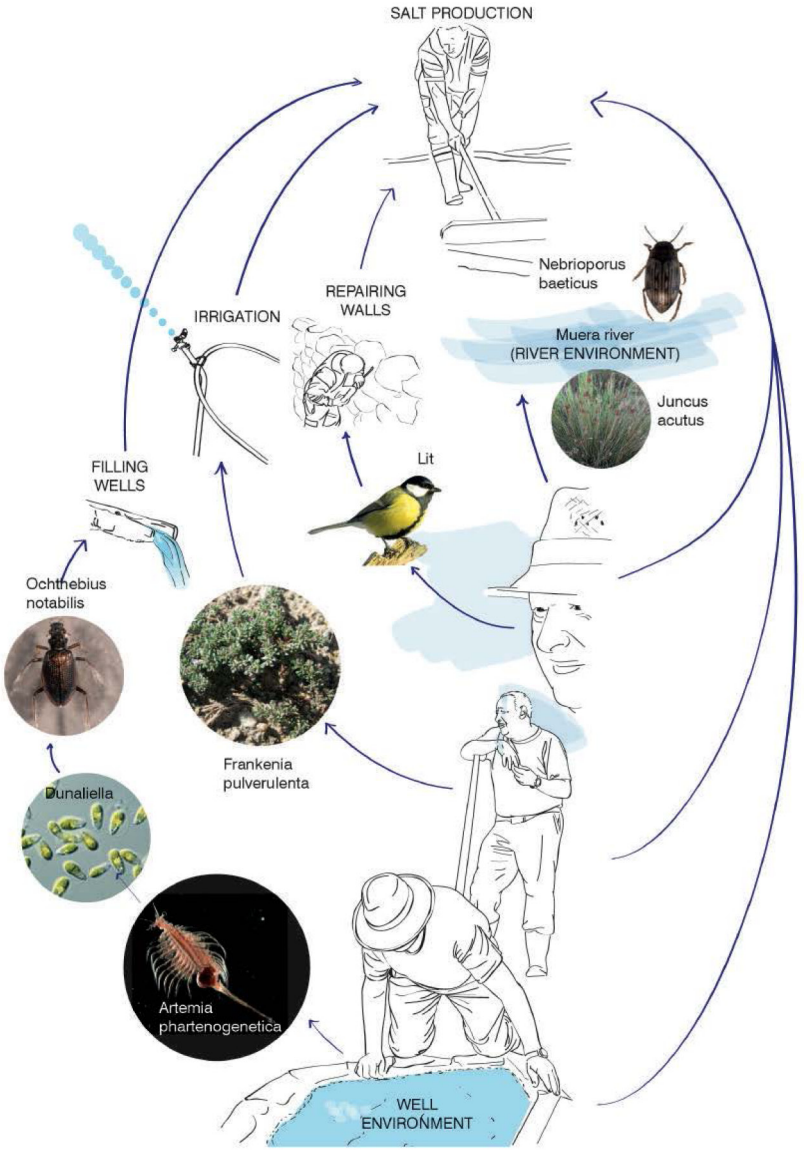
With the decline of salt industry over the 20th century many salt works were abandoned. In this new situation many ponds were partially adapted to extensive fish farming reutilising the evaporation areas by digging the ponds to increase depth and by opening more floodgates.
This adaptation consisted in enlarging the area used as estero favouring a better

water renovation. Other few saltworks were completely transformed in new brand ponds for semi-intensive fish monoculture.
Integrated farming systems combining semiintensive and specific extensive cultures in currently unused ponds have contributed to enhance sustainability and profitability.

REGENERATION OF SALT MARSHES IN ANANA
Anana, Spain
2002

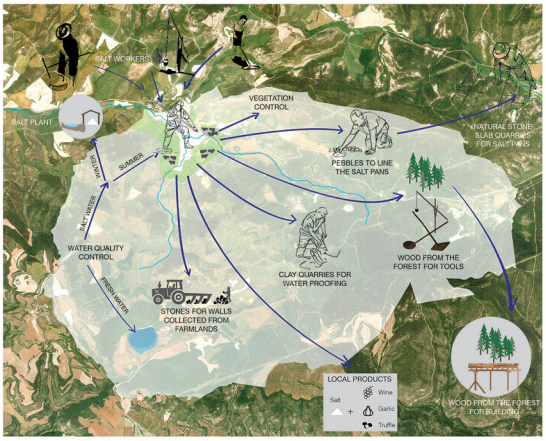
Environmental Ministry of Spain

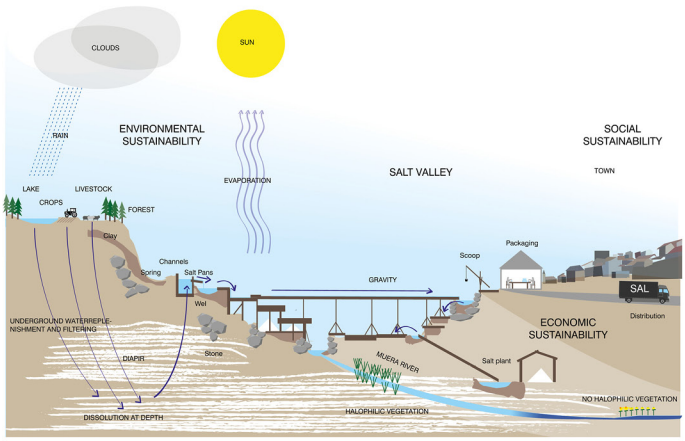
CIRCULAR ECONOMY



www.fao.org/giahs/giahsaroundtheworld/designated-sites/europe-and-central-asia/agricultural-system-valle-salado-anana/en/

One of the proposals of the project involves **setting up crops of Dunaliella** in two consecutive phases:
Phase 1: The medium-term objective is to develop a small local farm in the salinas, supported by an extensive farming technique that will only exploit the resources listed above, causing zero environmental impact to the saline ecosystem.





Phase 2: The scope of the long-term objective is to establish of a crop based on intensive farming techniques, to be established outside the boundaries of the salinas. In addition to the resources listed above, it will require a power supply to stir the crops, the supply of nutrients, and the harvesting and processing of the biomass produced

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