REWRITE

Demonstrators' Environmental Histories: Timelines and Trajectories Intermediate Report

Project acronym: **REWRITE**
Project title: **Rewilding and Restoration of Intertidal Sediment Ecosystems for Carbon Sequestration, Climate Adaptation and Biodiversity Support**
Call: **HORIZON-CL-2022-D1-02-05**

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Executive Summary

This deliverable provides in-depth intermediate report on task 2.2.1 coordinated by Le Mans Université showcasing preliminary results and productions. The objective of this task is to reconstruct the environmental histories and long-term landscape trajectories of selected Demonstrator Sites (DMs) in order to better understand the socio-ecological foundations and historical contingencies that shape present opportunities and barriers for rewilding intertidal ecosystems.

Objectives and Rationale

Coastal wetlands and intertidal ecosystems are socio-ecological systems shaped by centuries of interaction between natural processes (e. g. tides, sediment dynamics, sea level rise...), human interventions (e. g. land reclamation, navigation infrastructures...), and evolving cultural representations and socio-economic values. By investigating how landscapes have changed over time – via a geohistorical approach – the task seeks to uncover the cultural and political frameworks that have driven land use transformations and to trace the roots of present land configurations and ecosystem states. The central goal is to produce timelines and historical trajectories of coastal landscapes by collecting, analyzing, and synthesizing diverse historical sources, such as early maps, layout plans, artworks, aerial imagery, written documents, press archives, and oral testimonies. These trajectories aim to reveal key turning points (e. g. land abandonment, change in economic value, storm-related destruction...) and to identify patterns of continuity, rupture, or bifurcation in landscape evolution. The integration of these materials into GIS software enables both diachronic visualizations and comparative analysis.

Methodology

The methodology adopted combines geohistorical research with spatial analysis. It follows a three-steps process: (1) archival research and metadata documentation, (2) georeferencing historical maps and integrating them into GIS, and (3) spatial and temporal analysis of landscape changes. Two levels of analysis are applied: large-scale reconstruction of major landscape transformations and small-scale focus on key areas where significant changes or rewilding initiatives have occurred and being promoted. This approach enables the identification of drivers of change (environmental, societal, political...), dependencies and interdependencies within the landscape, and the temporal rhythms that govern transformation processes. The methodology is illustrated through case studies in three Demonstrator Sites: the Loire Estuary in France (DM6), the Essex Estuaries Complex in UK (DM3), and the Ria de Aveiro in Portugal (DM7).

Preliminary Results

The reconstruction of landscape trajectories in the three Demonstrator Sites reveals distinct histories shaped by their geomorphological characteristics, socio-economic uses, and policy contexts and frameworks. Yet, several commonalities emerge.

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In all three sites, early land uses focused on the exploitation of coastal resources – grazing, agriculture, oyster farming, and salt production – which often led to land reclamation through diking and drainage. In the Loire Estuary, industrial development in the 20th century significantly altered the waterscape and triggered sedimentation dynamics that reshaped intertidal environments and coastal wetlands. In Essex, the catastrophic 1953 storm prompted shifts in coastal risks perception and new protective and restoration policies. In Aveiro, salt production has declined dramatically, with many salt pans now abandoned, leading to spontaneous/passive rewilding and heritage revaluation.

Across sites, the 20th century brought major changes, including the decline of traditional land uses, increasing urbanization, infrastructure expansion, and the rise of nature-based tourism mostly since the 90s. These shifts altered both physical landscapes and cultural imaginaries, often leading to the patrimonialization of former productive landscapes. In such context, rewilding initiatives – whether spontaneous, experimental, or policy-driven – have emerged in response to land abandonment, ecological degradation, and changing governance frameworks.

Local-scale analysis, particularly in Corsept (Loire Estuary, France) and Abbotts Hall (Blackwater Estuary, Essex, UK), demonstrate how heritage processes and ecological restoration often follow landscape degradation, and how land ownership and institutional frameworks (e. g. Essex Wildlife Trust, Royal Society for Protection of Birds, Conservatoire du Littoral...) are key drivers toward rewilding.

Relevance to Coastal Rewilding and WP Integration

By situating coastal rewilding within long-term socio-ecological trajectories, task 2.2.1 contributes to a more nuanced and historically grounded understanding of ecosystems restoration. Here, rewilding is not framed as a rupture from the past, but as one moment in a continuum of evolving landscape practices and imaginaries. The reconstruction of environmental histories reveals how legal, economic, and cultural drivers of change – such as coastal protection legal framework, agricultural decline, ecological compensation, and storm memory – interact to enable or constrain rewilding.

This task feeds directly into task 2.2.2 which explores ecological chronosequences and supports WP3 (Building new knowledge on intertidal soft sediment seascapes crossing natural, social sciences and humanities) and WP4 (Scenarios for rewilding intertidal soft sediment seascapes in Europe) providing a historical lens to stakeholder's engagement, land-use planning, and adaptive management and governance. It also offers critical insights into how coastal rewilding can operate within complex landscapes of regulation, memory and social value.

Next Steps

The next phase (from M18 to M24) will complete the landscape trajectory for the Ria de Aveiro, incorporating local-scale analysis. Other Demonstrator Sites (Cadiz Bay DM8, Wadden Sea DM2, Dublin Bay DM4, Scheldt Estuary DM5, Gyldensteen Coastal Lagoon DM1 and Bay of Fundy DM9) will be progressively investigated. Collaborations with WP3 teams will provide qualitative narratives from local stakeholders to enrich the geohistorical analysis. A typology of landscape trajectories will then be developed to compare rhythms and paces of change and identify common drivers of change across European intertidal ecosystems and coastal wetlands.

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1 Context and overview

1.1 Intertidal ecosystems and coastal landscapes in the Anthropocene

Coastal areas as artificial landscapes

Coastal areas are inherently deeply multifunctional, supporting a wide range of activities such as industry, tourism, leisure activities, residential development, and serving as community hubs. European coastlines has undergone significant transformations, with changes becoming increasingly pronounced since the 20th century, leaving a lasting imprint on landscapes and seascapes (Miossec, 2004). The coast's growing attractiveness (rooted through the *désir de rivage* emphasized and demonstrated by the french historian Alain Corbin, which can be translated by the desire for shorelines, a socio-cultural process and transformation born in Western Europe at the end of the 18th century) has led to the development of highly urbanized areas, with economies increasingly driven by tourism and industrial activities (Corbin, 1988).

Since the Middle Ages (Rippon, 2009) and particularly since the 17th century (Morera, 2010), coastal wetlands have frequently been altered, primarily through hydraulic engineering practices, combining the construction of dams and dikes to protect land from coastal flooding and land reclamation for agricultural purposes, sometimes also for navigation purposes along estuaries. Embankments and drainage have continued during the 20th century leading to a significant loss and alteration of coastal wetlands (Day et al., 2024; Doody, 2004). Approximately 1.5 millions of hectares of intertidal ecosystems have been historically embanked on the European coastlines (Goeldner-Gianella, 2013).

Coastal wetlands and intertidal ecosystems as natural heritage

Nowadays, coastal wetlands are increasingly the focus of conservation efforts. Even of the origins of nature conservation can be traced back to the 19th century (Depraz, 2008), it has evolved progressively layering differing paradigms of conservation practices and targets. Initially, nature conservation was framed within an anthropocentric perspective, particularly influenced by the Romantic movement, and focused on landscape scale and on wilderness as untamed nature. Over time and mostly since the 1950s, this shifted towards an biocentric approach that emphasized preservation of ecosystems and biodiversity from human impacts, highly influenced by the development of ecology as a science and by environmental NGOs. Since the last decades, nature conservation has embraced a more ecocentric perspective taking into account the intertwined human-nature interactions and recognizing the influence of human societies in producing and being part of biodiversity and ecosystems. Today, these paradigms often coexist depending on nature conservation regulation framework and depending on stakeholders involved, sometimes diverging both regionally and internationally. Beyond this evolution of worldviews, nature conservation has also evolved with regard to “what” should be protected. Originally focused on natural landscapes and later on species-oriented approaches, the scope of nature conservation has expanded to include habitats and cultural landscapes, particularly also emphasizing on corridors and ecological networks concepts and its application.

In this history, coastal wetlands and intertidal ecosystems have usually been protected later than other ecosystems and landscapes such as iconic mountain landscapes or forests because of their negative associated values and imagineries which lasted well into the 60s. Since the 70s, intertidal environments have been receiving more attention for their biodiversity and landscapes, as demonstrated by the creation of an increasing number of protected areas in Europe (mostly through nature reserves and national parks), strengthened internationally by the implementation of the Ramsar Convention in 1971 and at the european scale by Natura 2000 (Birds and Habitats Directives). Today, their values are reinforced by recognizing the ecosystem services they provide such as buffer zones against flooding, carbon sequestration, tourism activities etc...

Coastal wetlands and intertidal ecosystems as nature-based solutions for coping with climate change

In the context of climate change and clear evidence of sea level rise, intertidal ecosystems are deeply affected by coastal squeeze (Doody, 2004), as they are regularly unable to migrate landward because of shoreline artificialization such as dikes or other human features. At the same time, shorelines are also threatened by related processes and hazards such as erosion, flooding and storms that especially jeopardize low-lying agricultural land and brackish water and freshwater ecosystems that sometimes have been able to flourish behind the dikes where agriculture declined during the last decades.

In such context and since several decades, many projects have been implemented to restore or to help intertidal environments to recover in relation to shoreline management plans and regulation frameworks often through managed realignment strategies. The database set up in task 2.3 (Provision of success stories, and identifying causes of failure, in coastal rewilding) thus inventories 277 projects developed from the 60s (essentially through unmanaged realignment) until now along the eight countries that were investigated (Denmark, Germany, Netherlands, Belgium, UK, Ireland, France, Spain). According these aggregated data, nearly 60 000 hectares of embanked agricultural land or diked wetlands have been or are in the process of being restored and reconnected to the sea (De la Vega-Leinert and al., under review). This indicates also that the 8 european DMs of REWRITE are embedded in a broader European history in which scattered and fragmented initiatives are emerging.

Managed realignment can then be considered as a tool for restoring intertidal habitats and is historically driven by ecological compensation when such habitats are deteriorated or destroyed by development projects (depending on the regulation frameworks such as EU Water Framework Directive, national biodiversity regulations...). However, managed realignment has also arise as a lever for climate change adaptation (Esteves, 2014 ; Goeldner-Gianella, 2013). These solutions are layered upon existing nature protection policies for these environments and prompt a re-examination of the natural heritage in light of its anticipated evolution under climate change.

Toward coastal rewilding

In this context of rising managed realignment projects and needs for expanding intertidal ecosystems restoration, rewilding also appears to be an alternative practice to traditional restoration and management practices which are usually implemented. If rewilding can be regarded as a nature-based solution, this is particularly novel for coastlines. It is underpinned by the principle of “letting nature do the job” or “take its course” and is increasingly recognized as a strategy for enhancing the resilience of natural habitats, while simultaneously contributing to the development of a sustainable, modern, competitive, and climate-neutral economy.

In other words, rewilding introduces a fresh perspective on shoreline management and nature protected areas stewardship, fostering a paradigm and transformative shift in human-nature interactions. However, it remains a relatively new and ambiguously defined notion. Often described as a “plastic word” (Jørgensen, 2015), rewilding encompasses a variety of definitions and interpretations of human-nature relations and embraces various and plural practices. Scholars regularly agree that rewilding involves doing less, or nothing at all, to allow natural processes to regain autonomy—the “rewild” or “wild” aspect of the term. This approach tends to focus on the future, embracing ecosystem dynamics, rather than adhering to past ideals of restoration or maintenance of former ecosystems with historical baselines (Andreu-Boussut and Chadenas, 2022). Nonetheless, rewilding still references ecological states with a desire to reintroduce key-stone species, such as carnivores or large herbivores/grazers, that became extinct (Jørgensen, 2015), in so called trophic rewilding practices.

In the context of the Anthropocene, rewilding is increasingly considered as a nature-based solution to address climate change. Within the humanities and social sciences, one key area of interest is the paradigm shift in the management of nature protected areas. Currently, rewilding is primarily applied to abandoned agricultural landscapes or mountain ecosystems. In the context of coastal wetlands, however, does the application of rewilding represent a renewal in how we manage ecosystems and understand human-nature relationships, or does it mean the perpetuation and adaptation of outdated approaches to the challenges of the Anthropocene? Furthermore, how can coastal rewilding involve local communities?

Coastal landscapes as keys to interpreting socio-ecological systems through time and change

Coastal wetlands are often described as a “showcase for the environment” (Sajaloli, 1996) and cannot be disentangled from their historical trajectory, shaped by both natural and social processes as well as the evolving representations and values that societies ascribe to these landscapes. In such context, they are here defined as socio-ecological systems resulting from the intersection of natural processes (such as tidal dynamics, sea level rise, sediment dynamics...), social processes (including settlement patterns, land reclamation, tourism...) and political processes (such as nature conservation framework and land use regulations). The landscape and waterscape of coastal wetlands and intertidal environments emerge from the long-standing interactions between human societies and the natural environment, shaped not only by the resources provided by water and the sea but also by the perceptions and understanding of local communities regarding the ecosystems that structure and define them. Consequently, these landscapes can be considered as the legacy of the evolving relationships between these communities and their coastal environments.

It is then pivotal to explore and understand how the environmental history of coastal wetlands is intertwined with the development and implementation of rewilding projects and practices. What kind of narratives of transformation and change emerge in these places? Reconstructing coastal landscape trajectories offers valuable insights into the evolving relationships between humans and their environments, revealing how these interactions have been shaped by natural, social, economic, and political dynamics. These trajectories reflect paradigmatic shifts in the ways human societies engage with nature, and particularly through rewilding.

1.2 Task 2.2.1 Objectives

In this task, the reconstruction of landscape trajectories seeks to uncover the socio-cultural foundations and roots of human interactions with coastal landscapes and intertidal environments, including their uses, perceptions and values. By establishing local and regional environmental timelines and historical trajectories of landscapes, this approach aims to identify both common and divergent evolution patterns, as well as key points of disruption or key breakdowns/turning points (such as land abandonment, changes in land use, decline in land economic value, extreme events, raising local awareness of climate change and sea level rise...). The emergence of rewilding experiments within the DMs will be closely and analyzed to understand their historical context. By considering rewilding in relation to the environmental histories of the DMs, which encompass a wide range of tidal ecosystems, we aim to gain a deeper understanding of both the historical roots of the narratives of change (Task 3.2 in WP3) and the needs and opportunities for reform within coastal management frameworks.

5 main objectives can be identified here:

- Landscape trajectories for the 10 DMs
- Drivers of change shaping critical turning points in the landscape
- Chains of interdependence in the landscape
- A comparative analysis of the dynamics of landscape trajectories over time
- Typologies of landscape trajectories

1.2.1 Landscape Trajectories for the 10 DMs

A landscape trajectory is defined as a succession of landscapes that reveals the evolving relationship between local society and its environment during a specific time frame. Analyzing these trajectories clarifies the underlying processes driving landscape changes (Baud and Reynard, 2015) and allows for the identification of the temporal and historical dimensions of both the landscape and the anthroposystem (Valette, 2019).

1.2.2 Drivers of change shaping critical turning points in the landscape

The analysis of landscape trajectories emphasizes the drivers that have led to pivotal turning points in the landscape. In Coastal wetlands, these drivers can be environmental (such as storms), economic (such as industrial or tourism development), societal (e. g., the spread of nature conservation policies and legal frameworks), or social (such as conflicts over land use and planning, or evolving representations of nature...).

1.2.3 Chains of interdependence in the landscape

By focusing on the evolution of interactions between human and non-human elements, this analysis highlights chains of dependence and interdependence. This understanding, in turn, reveals the actions that have been triggered by these interactions and aims to link the historical trajectories of landscapes with the emergence and pathways to coastal rewilding projects.

1.2.4 A comparative analysis of the dynamics of landscape trajectories over time

Delivering all DMS landscape trajectories allows to focus on comparing the temporal regimes and dynamics of environmental histories across multiple sites. This enables to understand the commonalities within these landscape trajectories for coastal wetland and intertidal environments that have been experienced common evolutions and key turning points but also to identify and emphasize differences and variations in relation to local socio-cultural contexts.

1.2.5 Typologies of landscape trajectories

Drawing from a range of DMs that represent European coastal wetland and intertidal ecosystems diversity, a typology of their landscape trajectories can be developed. Such typology will illustrate the diverse paths these landscapes may follow, potentially leading to various forms and practices of coastal rewilding.

1.3 Scientific background

To fully understand the environmental history of coastal wetlands, the concept of waterscape is pivotal in characterizing the relationship between human societies and the environment and non-human entities. Studying the waterscapes entails considering coastal wetlands as an intricate amalgamation of political, ecological and socio-economic processes operating at various scales, from local to regional and international (Hurst et al., 2022; Swyngedouw, 2004). It illuminates the connections between water, discourses, imaginaries, people, institutions, and infrastructures across both space and time (Hurst *et al.*, 2022).

In this context, using history serves as an active tool for revealing the ongoing processes of invention. As Berdoulay and Soubeyran (2015) suggest, "recourse to history is a tool to aid invention and reflexive development", particularly when considering our conceptualization of nature and invoking adaptation in planning processes. In the context of climate change and environmental governance, a geohistorical approach is essential to understand past transformations and changes and better prepare for an uncertain future (Sajaloli *et al.*, 2023).

Geohistory is an intellectual framework that examines events over different time periods through the use of geographical tools (Grataloup, 2015). When applied to landscapes, this approach seeks to decompose and deconstruct time by analyzing the pace and nature of changes, which are characterized by specific dynamics (Jacob-Rousseau, 2009). Such an analysis clarifies the processes driving landscape transformations (Baud and Reynard, 2015). By approaching landscape trajectories through the lens of relationships (*médiance* that can be translated into mediancy) (Berque, 2000), we uncover the hybridity of landscapes and the dialectic between subject and object, in other words, the interplay between how societies shape their environment and how that environment is interpreted. Berque's notion of trajectivity (*trajectivité* in french) encourages us to consider the dependencies between human and non-human entities and how the dynamics of landscapes might trigger actions. The landscape is thus defined as "the dialectic between the initiatives of the various actors who perceive, inhabit, and shape the environment according to their needs, and the surroundings that elicit and respond to these initiatives" (Germaine et Gonin, 2024). Ultimately, this approach enables us to transcend the nature-culture dualism and move beyond the segmentation in divided landscape components, allowing for the study of the landscape as a whole (Figure 1).

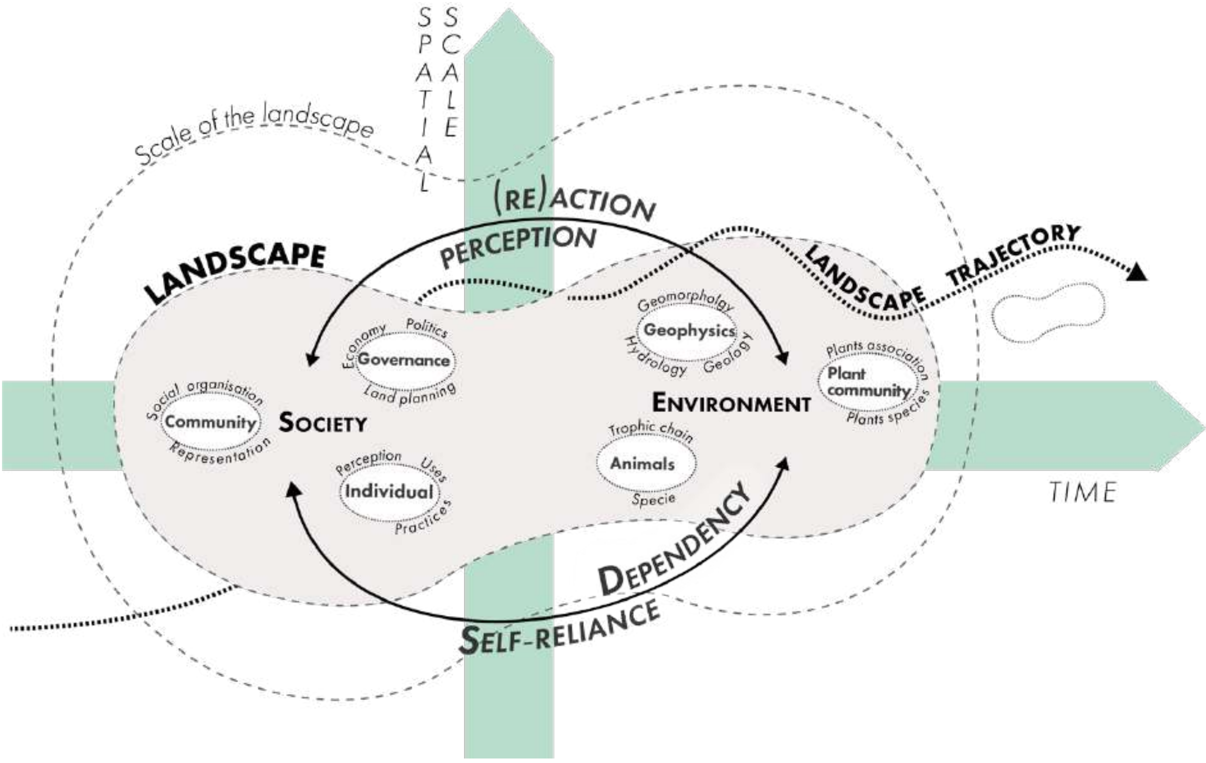

FIGURE 1: CONCEPTUAL SCHEME OF LANDSCAPE ACCORDING TO RELATIONSHIPS THEORY (LÉA PALY, 2024)

Paces of changes in landscapes can be categorized into three distinct types (Figure 2):

- **Landscape continuity**: This refers to the persistence and permanence of a landscape state over time. It implies that no modifications have occurred between two different periods of time, and that land use remains unchanged. Identifying this type of evolution thus depends on the time frame used to reconstruct a landscape trajectory.

- **Landscape break (or landscape rupture or turning point):** This category identifies major and significant changes in the landscape within a short time frame (Valette, 2019). It can be understood as a disruption of equilibrium in the socio-ecosystem, leading to a transformation of the landscape due to variations in physical and/or social factors. This results in the crossing of a threshold in landscape dynamics.

- **Landscape bifurcation**: This denotes a structural change in the landscape characterized by an increase or decrease in land use in favor of another (e.g. the reduction of grasslands in favor of agricultural crops). Bifurcation, however, must not be perceived as a dramatic and intense change (Elissalde, 2000) as it is less abrupt and sudden as landscape break or rupture.

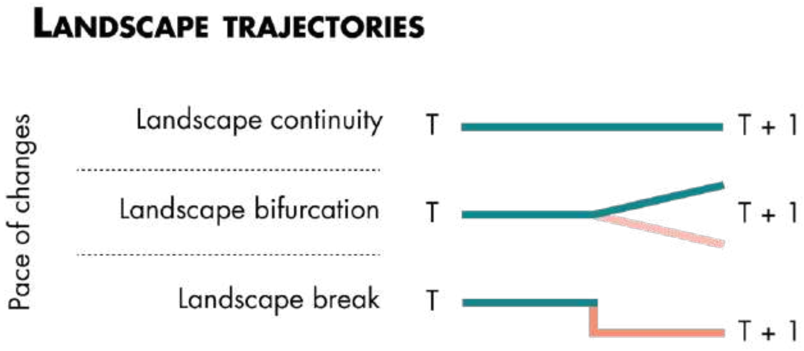

FIGURE 2: GRAPHIC ILLUSTRATION OF THE THREE CATEGORIES OF PACES OF CHANGES OF LANDSCAPE TRAJECTORY

2 Building a methodology combining environmental geohistory and a GIS mapping protocol

2.1 From historical sources toward a comprehensive corpus

To study past and current evolution of landscapes, various types of sources can be used (Table 1).

TABLE 1: TYPES OF SOURCES USED IN ENVIRONMENTAL GEOHISTORY STUDIES (JACOB-ROUSSEAU, 2024)

Source Type	Period	Observations
Artworks (paintings, engravings, postcards...)	19th-21st centuries	Landscapes, practices, representations and imaginaries
Maps, layout plans	17th-21st centuries	Land use/land cover, landscape morphology, land planning, settlement...
Land and properties registers	18th-21st centuries	Land use, land cover
Aerial photographs	20th-21st centuries	Landscape, processes
Topographical document	21st century	Land development, land elevation, risk
Oral memory	20th-21st centuries	Land uses, practices, knowledges, toponymy, perceptions
Audiovisual media	20th-21st centuries	Landscape, knowledges, practices, events
Press and media review	20th-21st centuries	Events, conflicts, perceptions

For long-term environmental changes, proxies such as pollen and sediment cores can provide valuable data and information, allowing for the investigation of broader time scales. However, using these proxies requires specialized knowledge, methodologies and resources. For investigating shorter-term environmental changes, particularly over the past three centuries, a different set of materials and sources can be used, including iconographical and written sources. Iconographical sources, when produced with written documentation, provide an ideal type of resource.

2.1.1 Artworks: paintings, engravings and postcards

Artworks, including paintings, postcards, and engravings, serve as valuable documents due to their three-dimensional representation of landscapes. However, it is essential to consider the intentions of the artists, as these representations rarely offer an exact depiction of reality.

2.1.2 Maps

For each Demonstrator Site (DM), historical maps are identified and incorporated into GIS software through georeferencing. While 17th-century maps typically present a figurative landscape (Chapuis, 2007) and cannot be georeferenced, they offer qualitative insights that allow the identification of past land uses, changes in route layouts, and human development, as well as toponyms (Valette, 2019). Additionally, shifts in symbology reflect the evolution of territorial representations. Various types of maps—such as military, topographic, bathymetric maps, and land registers—can be used for landscape analysis.

2.1.3 Layout plans and associated written archives (reports, memories...)

These documents provide critical information for understanding the motivations behind wetlands and intertidal environments transformations, the processes and work implemented, the stakeholders involved, the acceptance or the rising conflicts within the local communities, the ways these lands and places were and still are managed and the heritage values associated with the various landscape's features.

2.1.4 Oral memory, audiovisual media and press review

These sources offer insights into both completed and abandoned development projects, highlighting specific events and potential conflicts. They also provide valuable representations and perceptions of nature, reflecting societal views and engagement with the environment.

2.2 A Three Steps Methodology

The geohistorical approach, when applied to landscapes and natural environments, offers valuable insights into the reasons behind and the consequences of development projects on biodiversity and landscapes (Girel, 2010), as well as facilitating the monitoring of changes in the waterscape (Ballut and Michelin, 2014; Cavero, 2010). The analysis of archival data can be approached both synchronically and diachronically. A synchronic reading of various development projects, alongside the associated dynamics of actors, provides an accurate description of landscape changes through distinct temporal sections. However, it restricts the analysis of evolution by overlooking the continuity between each period of synthesis (Verdier and Chalonge, 2018). The methodology outlined below combines both diachronic analysis—through the identification of large-scale landscape dynamics and trajectories—and synchronic analysis—by describing development projects within key sectors of the sites.

All data and metadata are stored on the Rewrite Cloud REWRITE, following the recommendation of the Data Management Plan (D1.2).

2.2.1 Step 1: Research of maps and fill in metadata

The first stage involves compiling a corpus of archival materials through the examination of communal, departmental, and national archives, as well as military archives, among others. Rare private sources, such as those from associations or individuals, are also of considerable value. Maps and plans are integral for narrating the transformation of the landscape. Much like historical research, the analysis of these documents begins with a critical assessment of the sources. It is important to recognize that most maps and written materials are produced in response to specific demands or offers, which may introduce inherent biases. Therefore, each iconographic and textual source must be contextualized within its historical period to avoid over-interpretation. This first step entails cataloging the archives, along with relevant metadata, including the creation date, author(s), purpose, scale, source, and any observable, reliable information provided by the source.

2.2.2 Step 2: Georeferencing maps into a GIS software

The second step involves georeferencing historical maps and aerial photographs, and integrating pre-existing georeferenced data into GIS software. Particular attention is paid to fluctuations in coastlines and the identification of major localized changes within the sites. This stage of analysis is conducted diachronically.

Maps are imported into QGIS, utilizing early aerial photography to identify reference points. Care must be taken to consider the map size and the number of reference points to prevent distortion of the areas of interest. The polynomial transformation of degree 3 is employed to correct planimetric errors (in meters) during the transformation process. Subsequently, the Thin Plate Spline transformation is used to generate georeferenced maps.

2.2.3 Step 3: Analysis

Two distinct methods of analysis are applied, depending on the spatial scale of the study, as the Demonstrator Sites (DMs) can have very different spatial perimeters that can be complex to compare.

Large-scale analysis: Broad historical landscape trajectories

The reconstruction of landscape trajectories through a qualitative analysis of georeferenced maps allows for the identification of major trends responsible for landscape changes, including the pace of change (rupture, bifurcation, continuity) and associated timelines. Leveraging the geographic data within these maps, a quantitative analysis of coastline evolution is conducted. The diachronic analysis of the landscape trajectory is then presented with a chronological timeline, highlighting the dynamics that led to landscape changes, focusing on the paces of change and their rhythms (e.g., turning points, bifurcations, continuity). Key temporal milestones (e.g., before and after a significant turning point in the landscape trajectory) are illustrated with schematic graphics of the landscape at pivotal moments in time.

Small-scale analysis: Drivers of change

The second phase of the methodology focuses on closely examining changes in specific sectors where major changes have occurred and/or rewilding initiatives have been implemented. These sectors are selected based on their significance within the larger-scale analysis, as well as to align with those examined in Task 2.2.2 on chronosequences, which investigate the successional stages of intertidal ecosystems following rewilding. Furthermore, interpretations of landscape trajectories and their rhythms of evolution are constrained by temporal gaps in the available data and the sources used. Thus, for the identified sectors, moments of continuity, rupture, and bifurcation in the landscape trajectories associated with wetland landscapes are analyzed through qualitative assessments of archival documents. The corpus of archives for this analysis primarily consists of plans and written reports concerning various kinds of past development projects. To better understand the factors driving landscape changes, chronological timelines of events influencing or resulting in changes are produced.

Hence, the small-scale analysis will offer relevant insights into the past environmental history of specific sectors within the DMs. It will contribute to Task 2.2.2 by highlighting specific developments that have driven landscape changes in the studied sectors. In parallel, the chronosequence analysis will provide meaningful information on landscape evolution following rewilding, with a focus on ecosystem succession.

3 Data Collection

To investigate on landscape trajectories, historical maps are the most critical and important piece of data to collect and gather. These historical maps can be very diverse as drawn on various scales for different past purposes (for military purposes, for implementing a specific project, for land planning...) and can have been produced with a wide range of accuracy levels. These data can be found online on dedicated websites (such as geoportail.gouv.fr or remonterletemps.ign.fr from the National Geographical Institute in France...) but need most commonly archival research (in national archives or local archives...). The three next sections exemplify some of the key historical maps that were used to build the landscape trajectories for Loire estuary (DM6) in France, Essex estuaries complex (DM3) in UK and Ria de Aveiro (DM7) in Portugal. Most of these maps have been georeferenced (Figure 3) in order to produce geographical data needed for designing comprehensive maps.

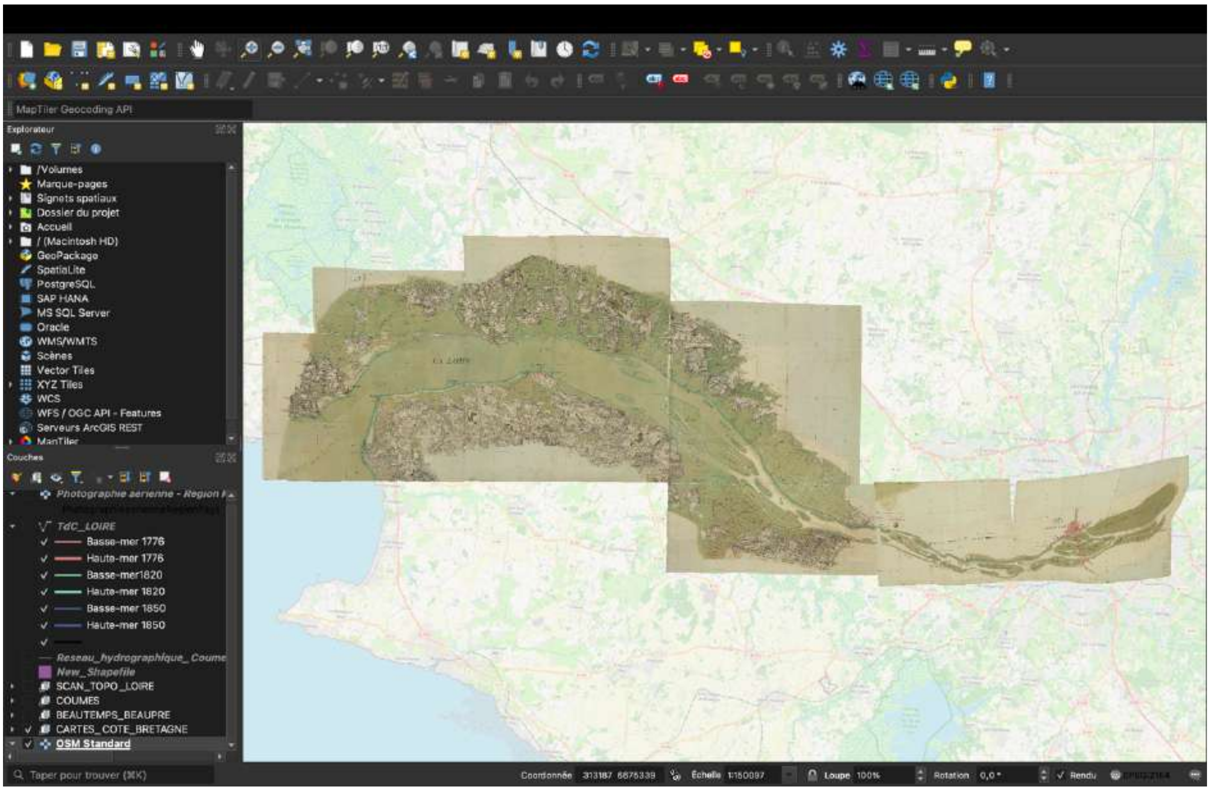

FIGURE 3: SCREENSHOT OF GEOREFERENCED MAPS IN QGIS FROM CARTE DES CÔTE DE BRETAGNE (1776) FOR THE LOIRE ESTUARY

3.1 Loire Estuary

For the Loire estuary, several historical maps have been georeferenced (Table 2):

- From the 18th century: The “cartes des côtes de Bretagne”, designed in 1776, have been georeferenced as they cover all the DM from West to East, from Saint-Nazaire to Nantes.

- From the 19th century: The bathymetric maps drawn by Charles-François Beautemps-Beaupré have been georeferenced as they cover a large area from Saint-Nazaire to Lavau, located on the northern bank of the estuary, halfway to Nantes.
- From the 20th century: Unfortunately, no maps cover the whole DM perimeter during the early 20th century. The only data available at this period are the aerial photographs from 1950.

3.2 Essex Estuaries Complex

For the Essex estuaries complex, many maps have already been georeferenced and can be found on the National Library of Scotland website (maps.nls.uk). These maps were able to be integrated into a GIS software using WMS flux. These data have been completed with the maps from the first Ordnance survey of 1799 which have been georeferenced with QGIS and aerial photographs from the 1950s (Table 2).

3.3 Ria de Aveiro

Historical maps from the mid 18th century, the 19th century and early 20th century have been georeferenced and integrated into GIS software (Table 2). Some of these maps don't cover the whole area of the DM but provide precise data through the description of specific projects related to sand dunes management.

TABLE 2: MAPS USED IN SIG SOFTWARE TO BUILD THE LANDSCAPE TRAJECTORIES FOR LOIRE ESTUARY, ESSEX ESTUARIES COMPLEX AND RIA DE AVEIRO

Site	Name	Date	Scale	Author(s)	Source	Purpose	Observation
Loire estuary	**Carte des Côtes de Bretagne**	**1776**	1:14000	Military topographical engineers supervised by Count d'Hérouville	Service Historique de la Défense (France)	Military : description of land in order to deploy army	Land-use, land-cover, toponymy, shoreline
	Beautemps Beaupré maps	1820	1:14400	Beautemps-Beaupré	SHOM	Navigation	Bathymetry, shoreline
	Coumes maps	1850	1:20000	Coumes and Pont-et-Chaussées engineers	National archives, departmental archives	Developed followed a major flood of the Loire in 1846	Land-use, land-cover, toponymy, shoreline
	Aerial photographs	1930-today	variable	IGN	IGN	aerial tracking of the earth	Land-use, land-cover, shoreline

Essex estuaries complex	**Map of the County of Essex 1777**	1774	1:31380	John Chapman & Peter André	Virtual Library of Bibliographical Heritage,	Land description and military purpose	Land-use, land-cover, toponymy, shoreline
	Ordnance Surveyors Drawings	1799	1:21,120 to 1:31680	Unknown cartographer	British Library	Land description with an attention on area of military importance	Land-use, land-cover, toponymy, shoreline
	Ordnance suvey	1830-1930	1:2500 to 1:63360		Scotland National Library	Land description	Land-use, land-cover, toponymy, shoreline
	Aerial photographs	1944 - today	variable		British Library	aerial tracking of the earth	Land-use, land-cover, shoreline
Ria de Aveiro	**Map of the Ria de Aveiro**	1753	≈:60000	François Hiacinte de Polchet and Louis d'Alincourt	Instituto Geográfico e Cadastral	Development project on the aperture of the dune belt	Land-use, land-cover, toponymy
	Topographical maps of the Ria de Aveiro	1813	≈:60000	Luìs Gomes de Carvalho	Biblioteca Nacional Digital	Development project on the aperture of the dune belt	Land-use, land-cover, toponymy, shoreline
	Sketch of the plan of Barra in 1843	1843	≈:25000	Silvério Pereira da Silva, João Luiz Lopes	Arquivo Histórico-Documental do Porto de Aveiro	Development project on the aperture of the dune belt	Land-use, land-cover, toponymy
	Plano hydrographico da barra e porto da ria de Aveiro	1887	1:20000	F. Folque and engineer A. M. dos Reis	Direcção Geral dos Trabalhos Geodésicos	Hydrographic and topographic description	Land-use, land-cover, toponymy, shoreline
	Plano hidrográfico da barra e foz da ria de Aveiro : costa Oeste de Portugal	1915	1:10000	J. H. Herz	Biblioteca nacional digital	Hydrographic Mission of the Portuguese Coast	Coastline and hydrographic description

4 The environmental history of the Loire estuary: preliminary results

The Loire estuary is the outlet of an extensive watershed and is characterized by wide reclaimed wetlands and a major port that drove industry development on its northern bank. To investigate landscape trajectories in such DM, two scales were selected. The large scale includes all the estuary from Saint-Nazaire to upstream Le Pellerin covering the vast wetlands and marshes along the northern and southern banks (Figure 4). The small scale is here focused on Corsept estuarine marshes on the southern bank (Figure 4), where a managed realignment project is currently being discussed. The history of these marshes has also been investigated in a PhD (Paly et al., 2022). Two other small scale sites will be explored and added later on where Conservatoire du Littoral is already planning management realignment, especially for Lavau marshes and La Maréchale island. The large scale will also be refined and completed using historical press review and interviews (in Lou-Ann Beaupuis PhD).

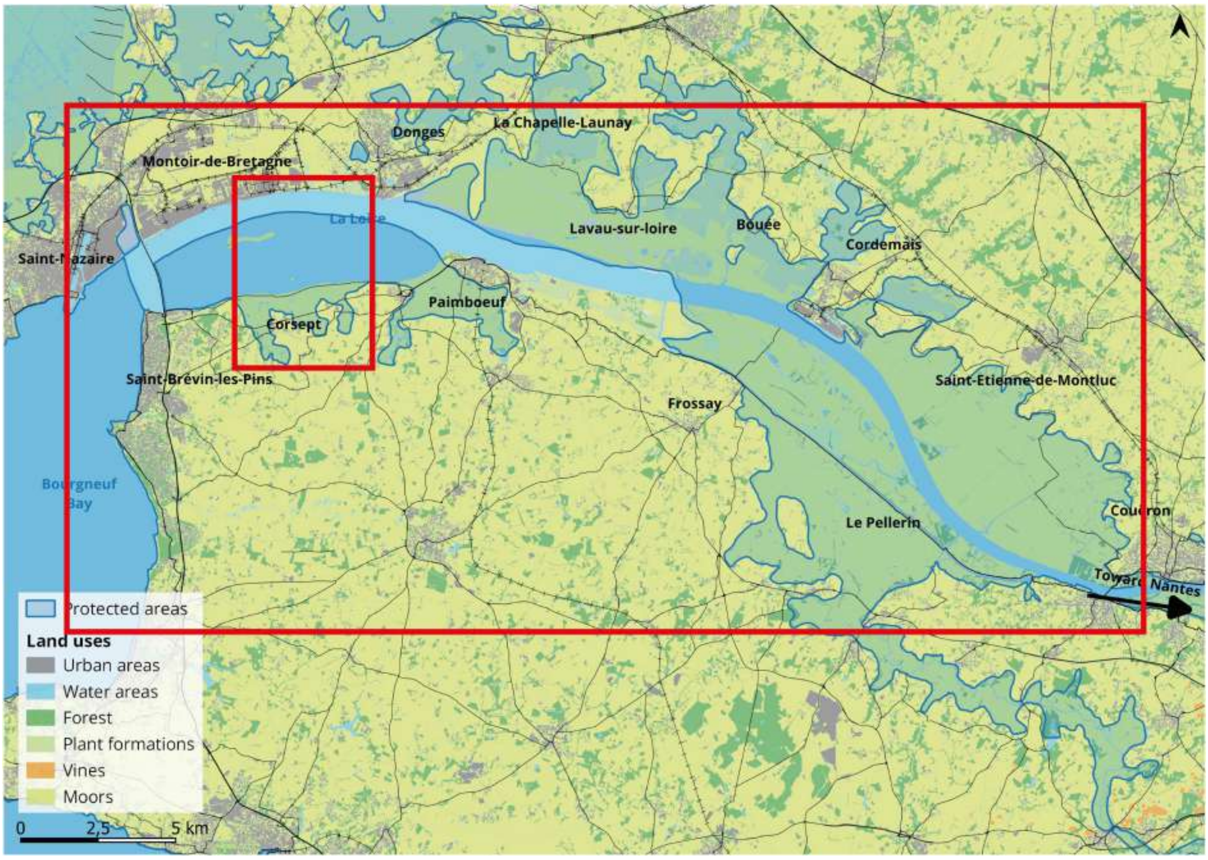

FIGURE 4: THE TWO SELECTED SCALES IN THE LOIRE ESTUARY FOR INVESTIGATING LANDSCAPE TRAJECTORIES (LOU-ANN BEAUPUIS, 2025)

The large scale was here selected to align with WP3 further needs and the small scale sites were also choose because they will be investigated in next field campaigns providing data on many ecosystem services. In this way, this will enable making links between the history of the environment and the way ecosystems function today.

4.1 Landscape trajectory at the large scale

The Loire estuary is currently home to the Port of Nantes–Saint-Nazaire, the fourth largest port in France. Its economy is primarily based on industrial and port-related activities, including shipbuilding, energy production (gas, oil, etc.), and agri-food industries such as animal feed manufacturing.

Maintaining navigability in the Loire estuary has been a major concern and has led to numerous changes in its morphology. Historically located in Nantes, the port faced increasing difficulties due to the silting up of the riverbed, especially since it is situated 60 kilometers from the river mouth. In response, numerous engineers proposed a range of development projects aimed at increasing the draft and improving access to the Port of Nantes.

Figure 5: Drawing of hte port of Nantes in 1675 by Jean Boisseau (© Szilas in Nantes History Museum)

In the past, the port of Nantes was renowned for its specialization in the wine trade, and later in the slave trade during the 18th century, a period that marked its golden age. A downstream port located in Paimbœuf allowed ships to lighten their load so they could navigate up the Loire River to Nantes.

Figure 6: The Port of Paimbœuf in 1776, viewed from the adjacent shore on the eastern side, par Nicole Marie Ozanne. ; Yves Marie Le Gouaz (Source : Gallica)

From 18th to mid-19th century: the conquest of the islands and marshes

Between the 18th and 19th centuries, the Loire estuary underwent numerous developments, driven by two major dynamics: on one hand, the improvement of navigation, and on the other, the reclamation of marshlands for agricultural purposes.

From the 18th to the 19th century, the improvement of maritime and river bathymetric surveys facilitated the development of navigation on the estuary, with the gradual increase in the draught necessary to access the port of Nantes. In 1750, it ranged from 2.50 to 2.64 meters, between 3.70 and 4 meters in 1850, and reached between 5.50 and 6.95 meters in 1901. This evolution was accompanied by a dredging strategy aimed at maintaining these depths (Vauthier-Vézier, 2015). However, navigation remained strongly dependent on meteorological, maritime, and river conditions.

Regarding navigation from the 18th to mid-19th centuries, the development projects mainly aimed to improve the draft of the Loire by increasing its depth and laterally reducing the width of its bed. The goal was to strengthen the river flow to extend its influence toward the ocean. The proposals, particularly those by engineer Magin, focused on the construction of lateral and transverse embankments downstream of Nantes. Many dams were then erected in the river's secondary branches to concentrate the flow into a single channel. Other engineers, such as Wiotte, recommended regular dredging to promote navigation. Groynes were also implemented (Fattal, 2002).

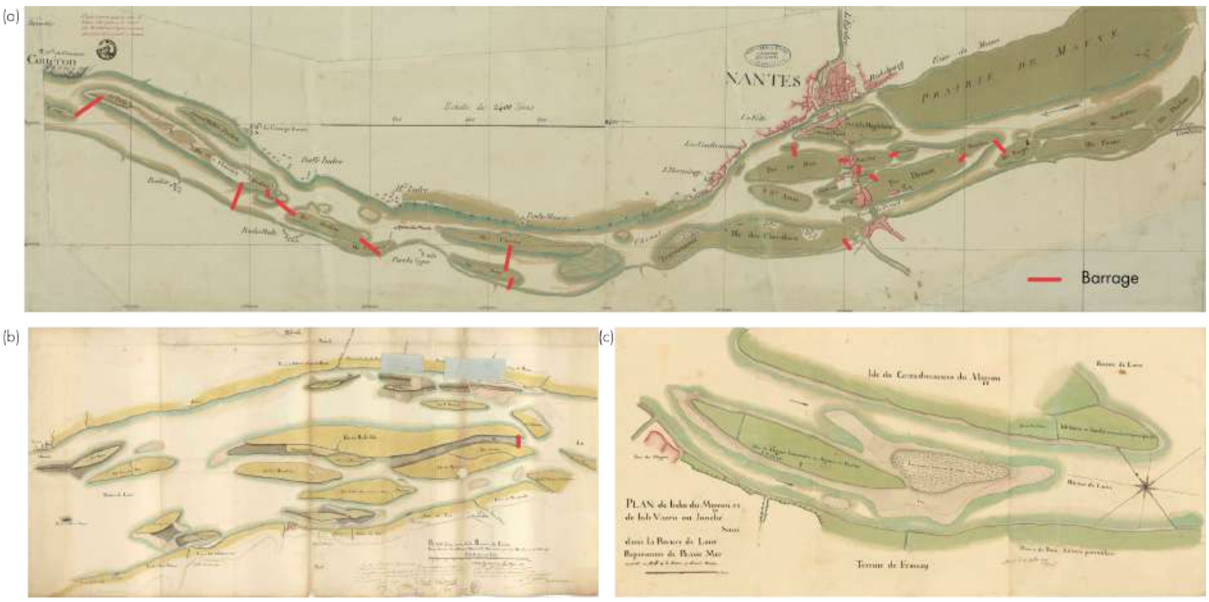

Figure 7: Illustration of various lateral embankments aimed at structuring a single channel:(a) Map of the coasts of Brittany, 1776;(b) Plan of a section of the Loire near Lavau, 1763;(c) Plan of the Migron islet and the Vazeu or Jonche island, in the Loire, 1780.

The georeferencing of old maps dated 1776, 1820, and 1850 allows us to track the evolution of the Loire riverbed as well as the gradual silting of the islands. More numerous and fragmented in 1776, these islands tended to merge over time, forming larger islets—a phenomenon greatly amplified by human activity through lateral embankments, transverse embankments, and the installation of groynes.

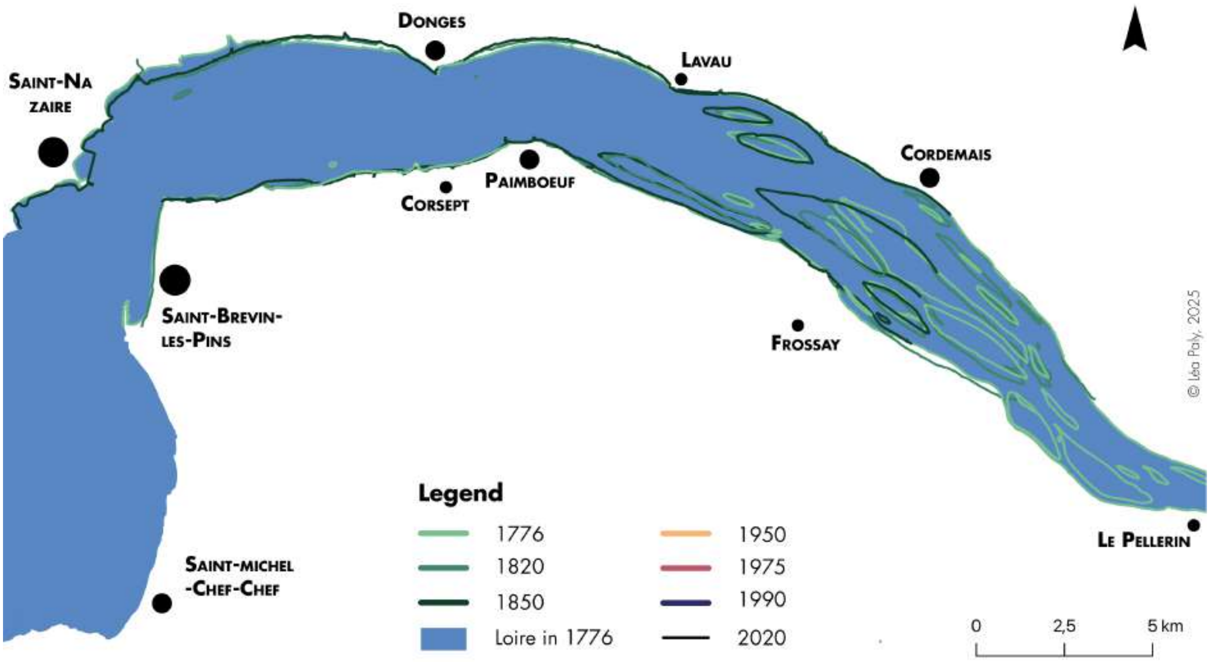

FIGURE 8: LOIRE ESTUARY COASTLINE FROM 1776 TO 1850

Despite the various development projects, the draft continued to decrease, reaching 3.5 meters in 1875, due to the gradual silting of the Loire (Fattal, 2002). The canal de la Martinière, opened to navigation in 1892 on the southern bank of the Loire, was designed to bypass the difficult crossing of the river's intermediate section. The goal was to open the port of Nantes to international trade by allowing larger vessels to pass through (Vauthier-Vézier, 2015).

FIGURE 9 MAPS OF THE CANAL DE LA MARTINIÈRE (SOURCE : LOIRE-ATLANTIQUE ARCHIVE)

At the same time, the construction of the first floating dock at the port of Saint-Nazaire in 1856, followed by a second one in 1881, marked the gradual decline of the port of Nantes. This phenomenon is linked to the emergence of a port on the coast starting in the second half of the 19th century (Cabanne, 1985). Development projects related to navigation on the Loire thus evolved, now turning toward the sea to facilitate tidal entry.

Regarding the landscape dynamics of the marshes, it is observed that the drainage of the Loire marshes was more belated than in other regions. This is explained by their absence from the 1599 edict as well as from documents designating areas to be drained as a priority, such as the Association pour l'Assèchement des Lacs et Marais de 1605 (Lelièvre et al., 2015). An excerpt from the map of the coasts of Brittany (1776) illustrates this situation, showing numerous marshes still in the process of being drained.

In the 19th century, these estuarian marshes were completely drained with the creation of an extensive network of canals and sluices. These lands were then primarily used for grazing and hay cultivation. Water management was done locally, often through syndicate associations of marshland owners. The demand for hay from the meadows along the Loire, and more generally for estuarine resources such as fertilizers or reeds, made these spaces highly sought after between the 18th and 19th centuries, leading to many concession requests. This also resulted in higher taxation and prices of the land (Lelièvre et al., 2015).

Late 19th to early-20th century: The industrial development of the waterscape while opening the estuary to the sea

Between 1868 and 1870, the engineer Lechalas, under the direction of engineer Jegou, developed an approach that aimed to promote the penetration of the tide up to Nantes and, consequently, to improve navigation. This theory, based on eliminating obstacles to marine flows—by lowering the Loire riverbed downstream and dredging upstream from Nantes—did not come to fruition until the early 20th century due to the competing project of the Martinière canal. Development projects resulting from this approach included the riprapping of the concave banks of the Loire, the closure of the river's secondary channels, the installation of longitudinal dikes, and, finally, the dredging of the channel. In 1903, the Martinière canal became obsolete due to the modification of the riverbed on the northern bank, with a draft reaching up to 8 meters. It was then repurposed for regulating the water levels of the marshes on the south river bank of the Loire.

The decision to develop an industrial-port axis on the northern bank, notably with the growth of the port of Saint-Nazaire, not only altered the landscape—by introducing an industrial complex visible from the southern bank—but also disrupted hydrosedimentary processes. From the 1930s onwards, the development of the Port Autonome de Saint-Nazaire, followed by the Grand Port de Nantes-Saint-Nazaire, led to the displacement of the natural estuary channel toward the northern bank. This channel, with a draft of about 10 meters, allows the passage of large vessels. It requires constant dredging to maintain this depth. This process resulted in the gradual filling of the southern channel and the formation of new mudflat areas, followed by saltmarshes.

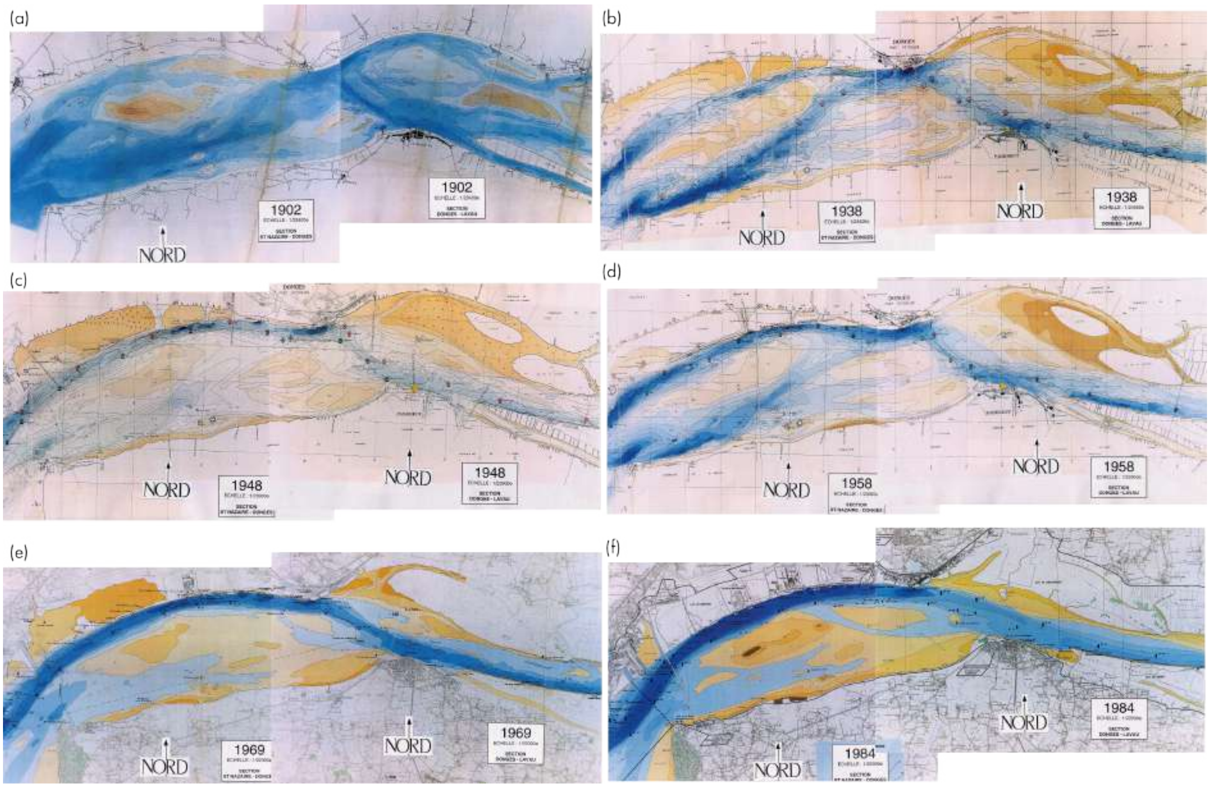

FIGURE 10: EVOLUTION OF BATHYMETRY IN RELATION TO THE DEVELOPMENT OF THE LOIRE RIVERBED ON THE NORTHERN BANK (BLUE INDICATES DEEP BATHYMETRY, WHILE ORANGE INDICATES SHALLOW BATHYMETRY) (SOURCE: GRAND PORT DE NANTES-SAINT-NAZAIRE).

In the mid-20th century, the estuary is dominated by agricultural economy, with marshes converted into meadows and cultivated areas on the heights, as well as industrial-port economy that have been developed around Saint-Nazaire and Donges, primarily in the second half of the 20th century.

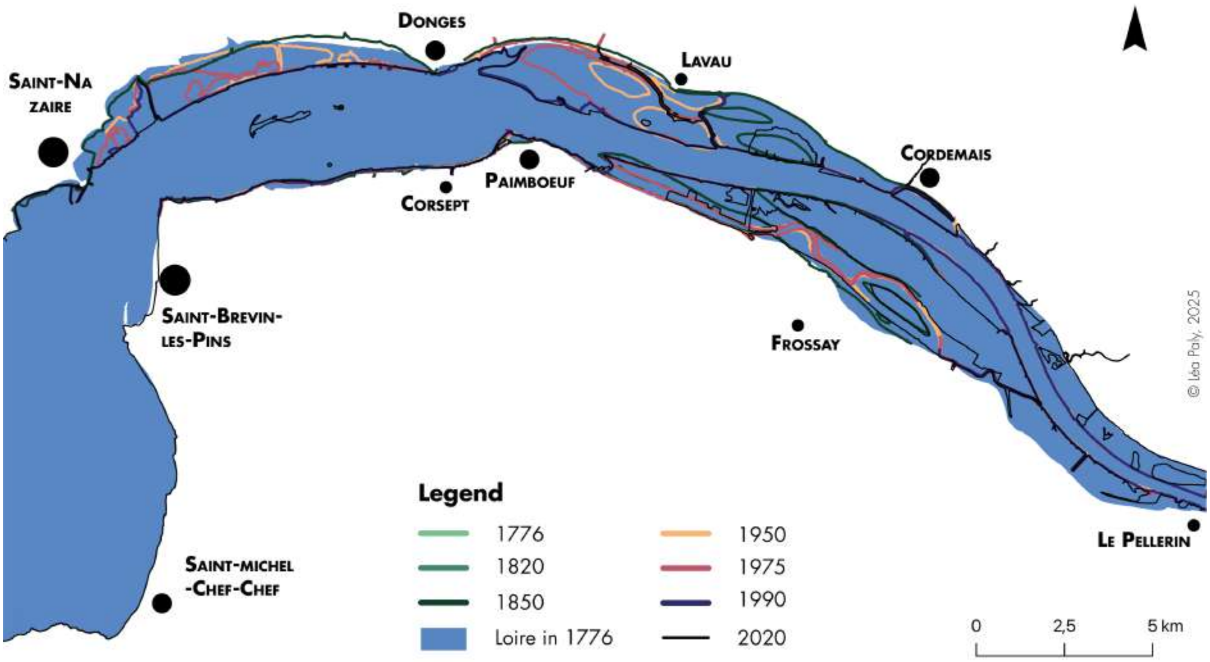

FIGURE 11: LOIRE ESTUARY COASTLINE FROM 1850 TO 2020

The second half of the 20th century signaled the end of an era during which the Loire estuary was primarily shaped by large-scale engineering interventions (Figure 12).

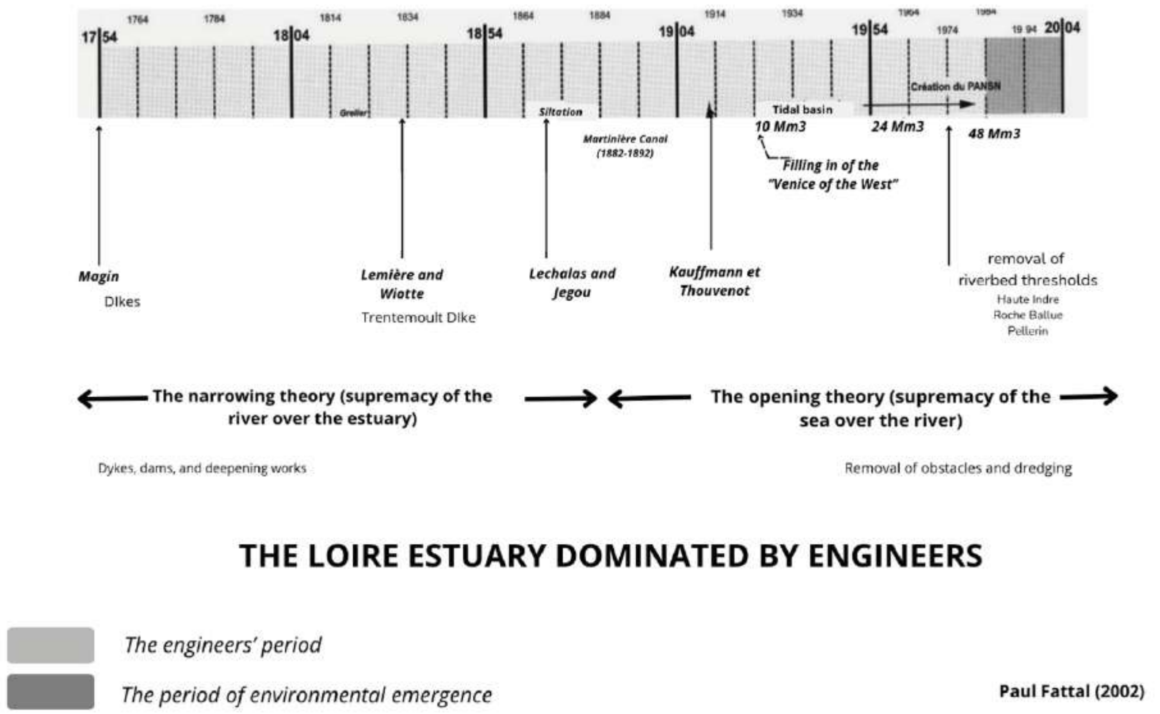

FIGURE 12: TIMELINE OF ENGINEERS PROJECT DEVELOPMENTS ON THE LOIRE ESTUARY (SOURCE : FATTAL, 2002)

From mid-20th to 21st century: toward an increasingly protected waterscape and landscape

The second half of the 20th century was also marked by the emergence of protection measures for the Loire estuary. The first heritage protection measures on the Loire estuary was oriented on specific area of the estuary with the establishment of a hunting reserves on the entry of the estuary in 1973 and on Massereau island in 1991, land acquisition by French department (Loire-Atlantique) and biotope protection order in 1992 (Figure 14).

The Loire estuary gained broader protection in 1996 when it was included in the Natura 2000 network under the Birds Directive. Although this directive was enacted and integrated into French law as early as 1981, and the Loire estuary had been designated as a Important Bird and Biodiversity Area (IBA), no Special Protection Area (ZPA) had been established in the estuary during the 1990s.

This situation led France to be brought before the European Court of Justice (Fattal, 2002; Mallier, 2002). It was only after the publication of a report by Loïc Marion on the implementation of the Birds

Directive in the Loire estuary that a detailed environmental assessment of the estuary was carried out. This report highlighted both the ecological richness of the site and the anthropogenic impacts affecting it (Marion, 1994). It was only from the 1990s that these directives were effectively applied.

The integration into the Natura 2000 network was accelerated by a project to expand the port of Nantes-Saint-Nazaire, which included the development of three specific sites (Figure 13) :

- Port-Aval: This project spans 2,500 meters of riverbank and involves filling in a mudflat downstream of Saint-Nazaire on the northern bank (Méan mudflat) to extend the port.

- Two projects on the Bilho bank: The first, called "Île de Bilho," involves developing a docking front on the northern bank of this area, affecting about 200 hectares of mudflats and intertidal zones. The second project, called "river-port," envisions the extension of the Bilho bank and its connection to the northern bank via a viaduct (Mallier, 2002).

- Donges-Est: This project, one of the most controversial, was the subject of a report by Loïc Marion, which highlighted the ecological richness of this area. Ultimately, this site was selected by government authorities for the expansion of industrial-port activities (Essig, 1996).

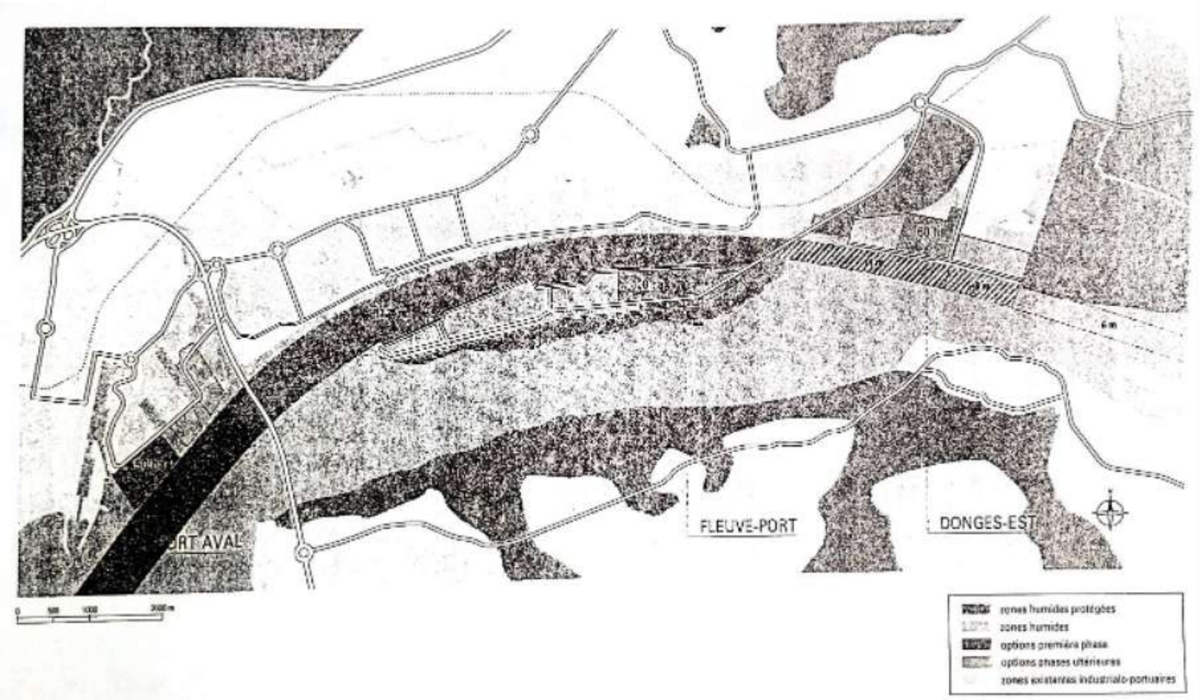

FIGURE 13: THE THREE SITES CONSIDERED FOR THE DEVELOPMENT OF THE ESTUARY AS PART OF THE EXPANSION OF THE NANTES-SAINT-NAZAIRE AUTONOMOUS PORT (SOURCE: ACEP, NOVEMBER 1995).

This project, strongly contested, strengthened the opposition from various groups (fishermen, hunters, farmers, etc.). Attention then shifted to the environment of the Loire estuary, which became a central point of reflection regarding its development. The challenge was now to reconcile economic development and environmental protection. In 1994, the Plan Loire Grandeur Nature was created by an Interministerial Committee for Land Planning, confirming the extension of port activity at Donges-

Est and the Île du Carnet, on the condition that the port would cede 1,500 hectares of wetland areas to the Conservatoire du Littoral (Marcadon, 2008).

The establishment of Natura 2000 coincided with the Donges-Est port project, but it was not simply a compensatory measure. It was a prerequisite, negotiated before the launch of the project (Chadenas et al., 2009), just like the transfer of land to the Conservatoire du Littoral in 2000. The classification of the estuary in 1996 as a Special Protection Area (ZPA) was based, in particular for the definition of its perimeter, on existing naturalist inventory perimeters (“Zones Naturelles d'Intérêt Écologique, Faunistique et Floristique”). In 2004, this site was also designated as a Site of Community Importance (SCI), and in 2014, it was classified as a Special Area of Conservation under the Habitats Directive, due to the presence of several habitats of community interest.

The Loire estuary is now safeguarded by various layers of protection, creating a 'millefeuille' of conservation areas and perimeters (Figure 15).

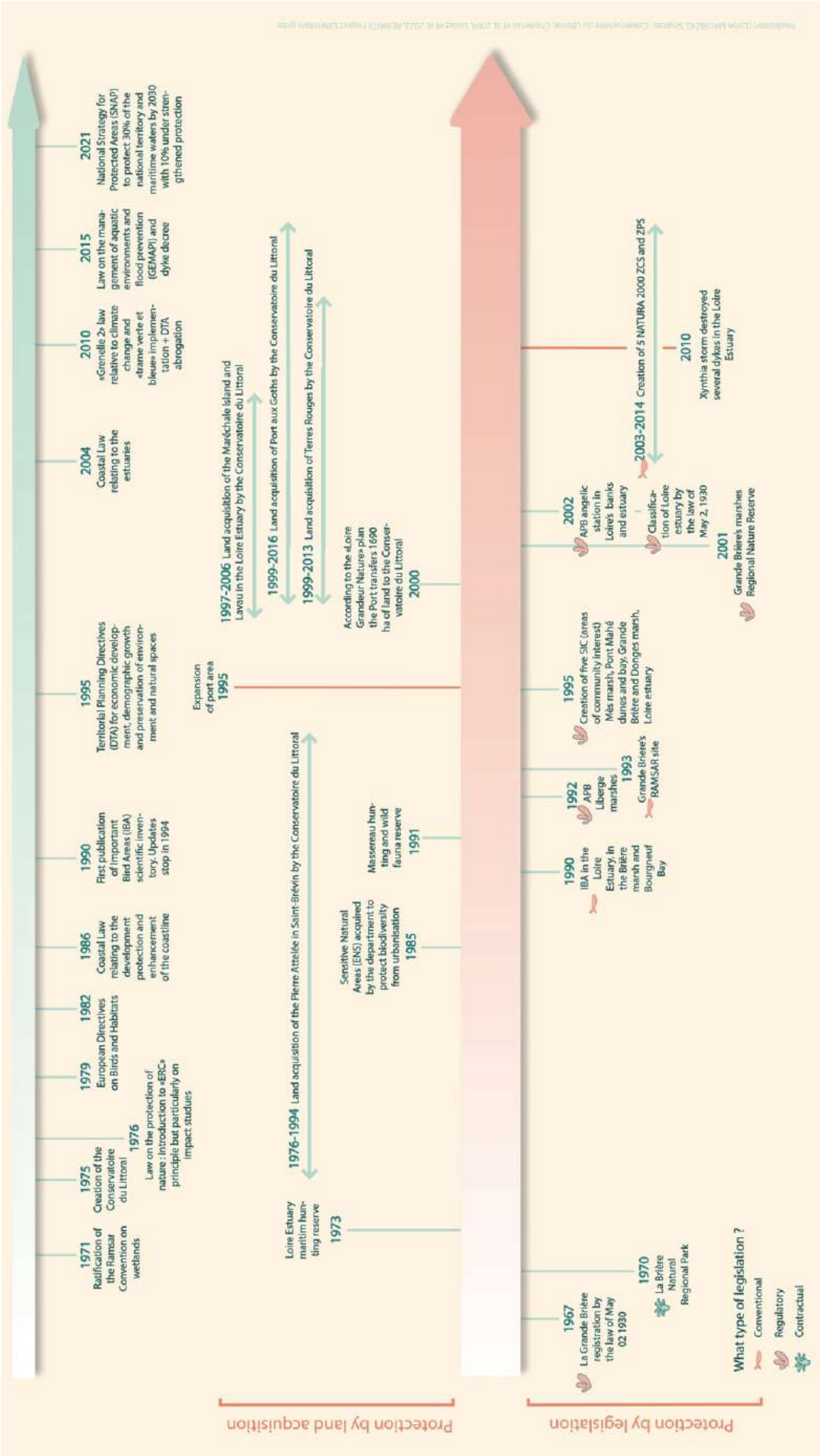

FIGURE 14: TIMELINE OF THE HERITAGE DEVELOPMENT OF THE LOIRE ESTUARY (PRODUCTION: LISON MAURIZIO, 2025)

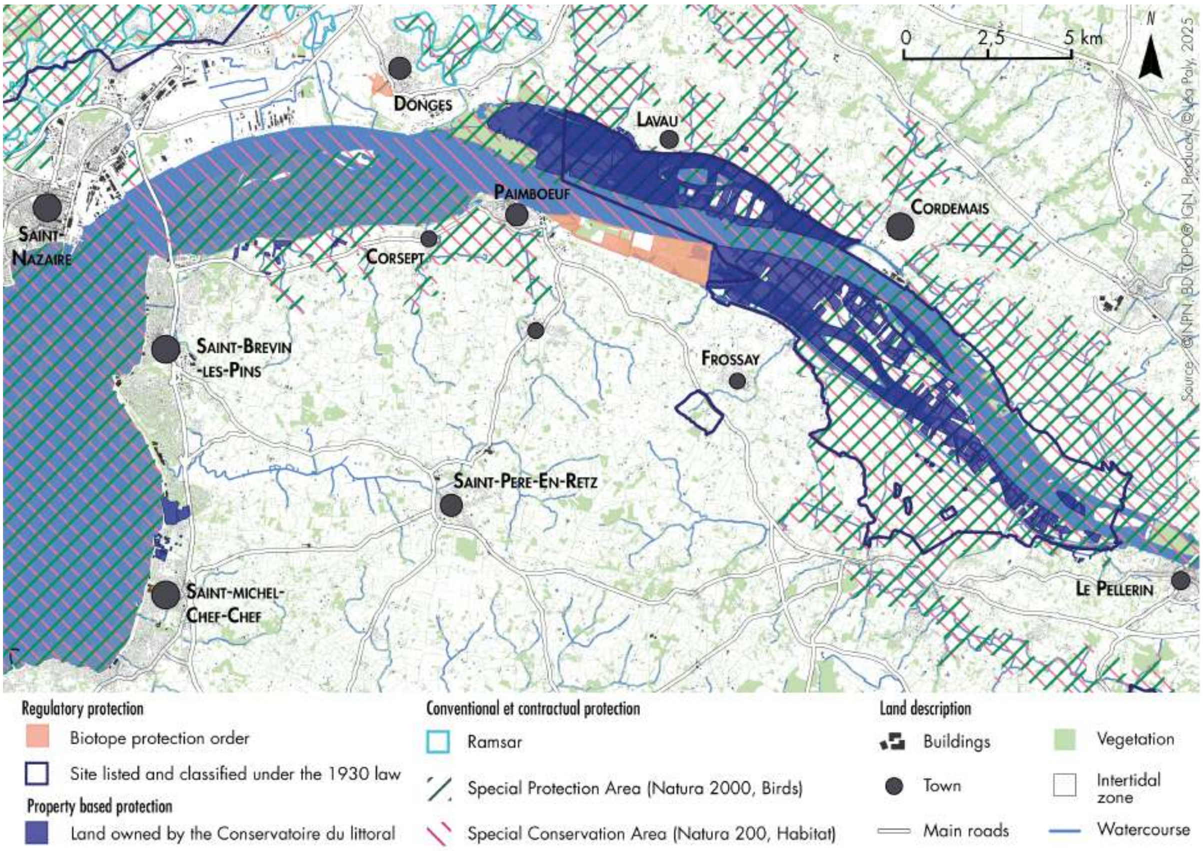

FIGURE 15: PROTECTION PERIMETERS IN THE LOIRE ESTUARY

Currently, discussions are underway to consider restoring or rewilding parts of the estuary that were previously reclaimed. Maréchale island, Lavau marshes, and Corsept marshes are part of a project led by the Conservatoire du littoral that explores the potential abandonment or removal of old embankments.

In order to illustrate these changes, landscape trajectory of Corsept estuarine marshes is developed here to highlight specific drivers of changes.

4.2 Landscape trajectory at the small scale: Corsept estuarine marshes

18th century: a changing waterscape

During the 18th century, the marshes at the bottom of the alluvial plain had not yet been drained. Most of these areas were used for grazing or as meadows for mowing. On higher ground, the landscape consisted of croplands bordered by hedgerows on the slopes. On the plateau, agricultural plots were more open and larger. To the west, the dunes of Saint-Brevin were covered with grass, while to the east, the development of Paimboeuf focused on its harbor. Located on a hill, Paimboeuf appeared to have been an island, based on descriptions of spring tides that regularly surrounded the town.

Water management was carried out through canals and sluices that controlled the water levels to prevent flooding of the meadows from tides or rainfall. The Loire estuary featured a flood tide stream on the northern bank of the river and an ebb tide stream on the southern bank. While maps of Brittany's coast do not show mudflats, historical literature (Verger, 2005) and the toponymy of earlier maps suggest that mudflats were present and have been shifting and changing until the 20th century.

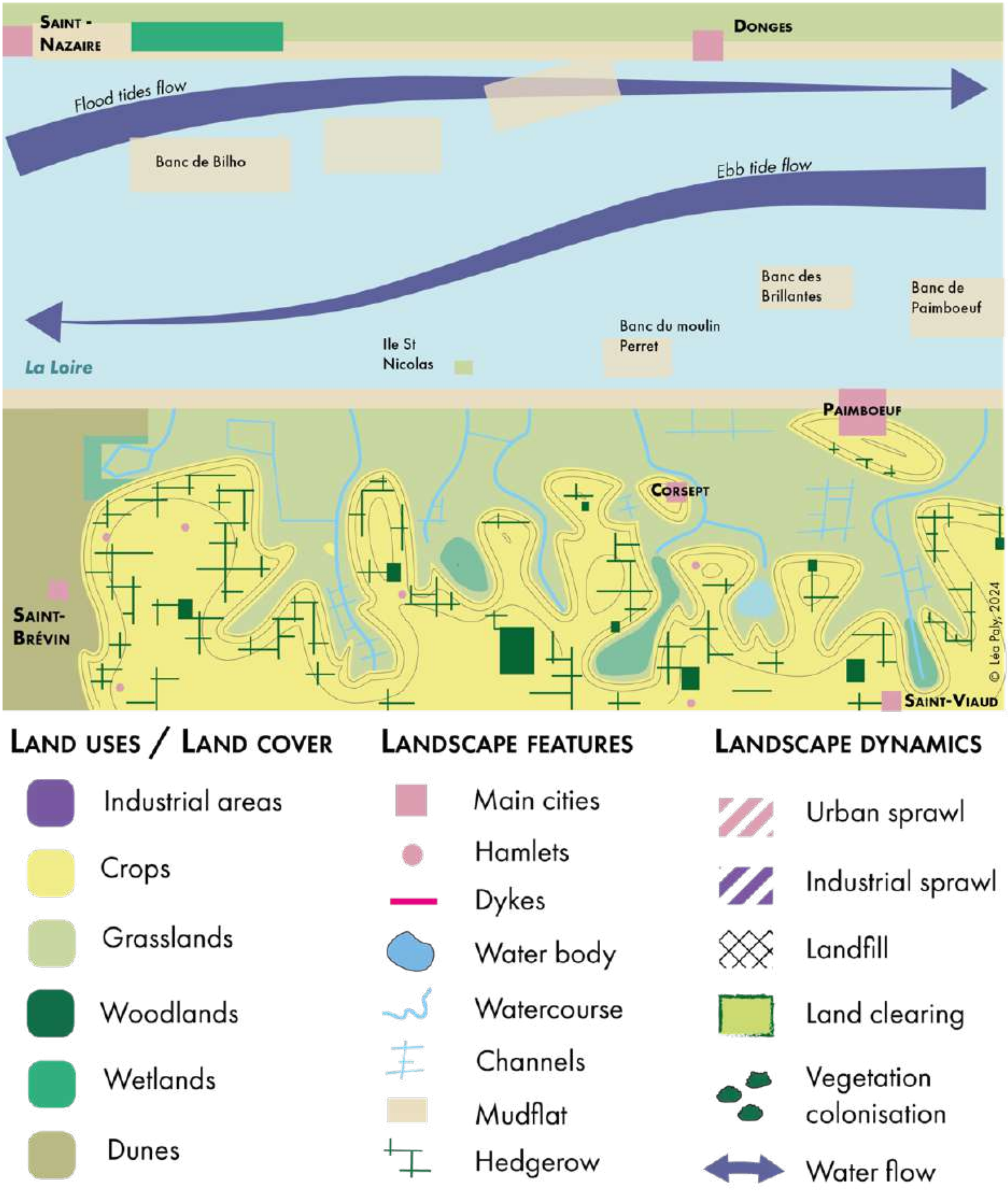

Figure 16: Loire estuary landscape and waterscape in 1776

19th century: a productive waterscape

Maps from the 19th century show that the wetlands had been fully drained at that time and were used for pasture or for producing hay. Higher lands were devoted to crop cultivation. During the 19th century, the Loire estuary has undergone a period of transformation with the artificialization of ecosystems driven by resource exploitation and harvesting and improvements in navigation. Navigation in the Loire estuary had always been a challenge due to shifting sands. In the 19th century, it was difficult for boats to reach the port of Nantes upstream. Several mudflats were filled along the riverbank to improve water flow in a single channel. A canal known as the Canal de la Martinière was dug on the southern riverbank among former islands to allow larger vessels to reach the port of Nantes.

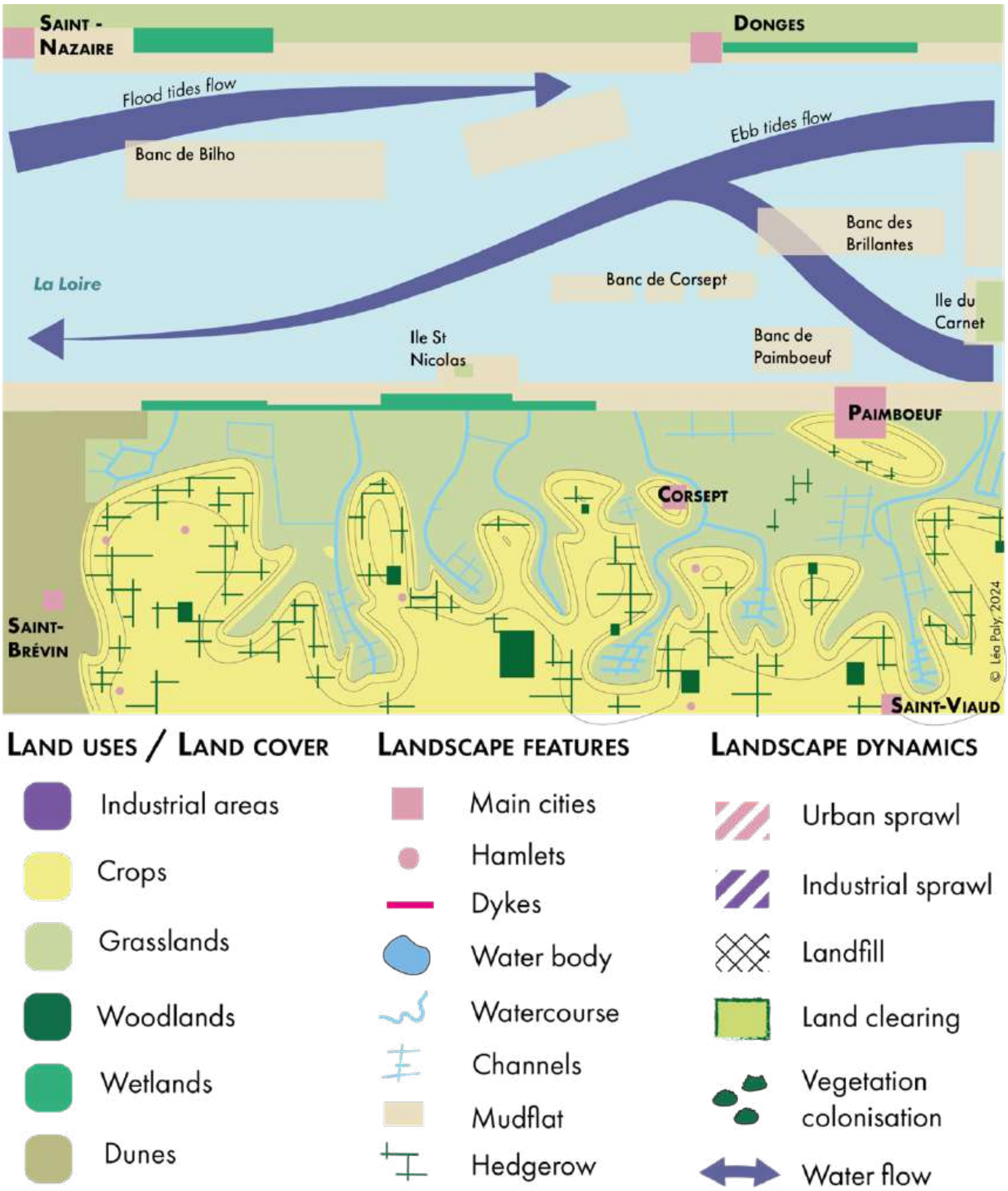

Figure 17: Loire estuary landscape and waterscape in 1850

Early 20th Century: an artificial landscape driven by the harbor development

During the 20th century, land development focused on improving navigation. The Canal de la Martinière was abandoned due to the harbor development on the northern riverbank in Saint-Nazaire downstream. Despite the canal and the filling of mudflats along the riverbanks, it remained difficult for boats to reach Nantes. As a result, local authorities decided to move the harbor closer to the city of Saint-Nazaire, where basins and docks were created. Furthermore, to enhance navigation, a concave dike was built along the northern riverbank between Saint-Nazaire and Donges to promote land reclamation and improve water flow. Consequently, sediment accretion occurred to the east of Donges.

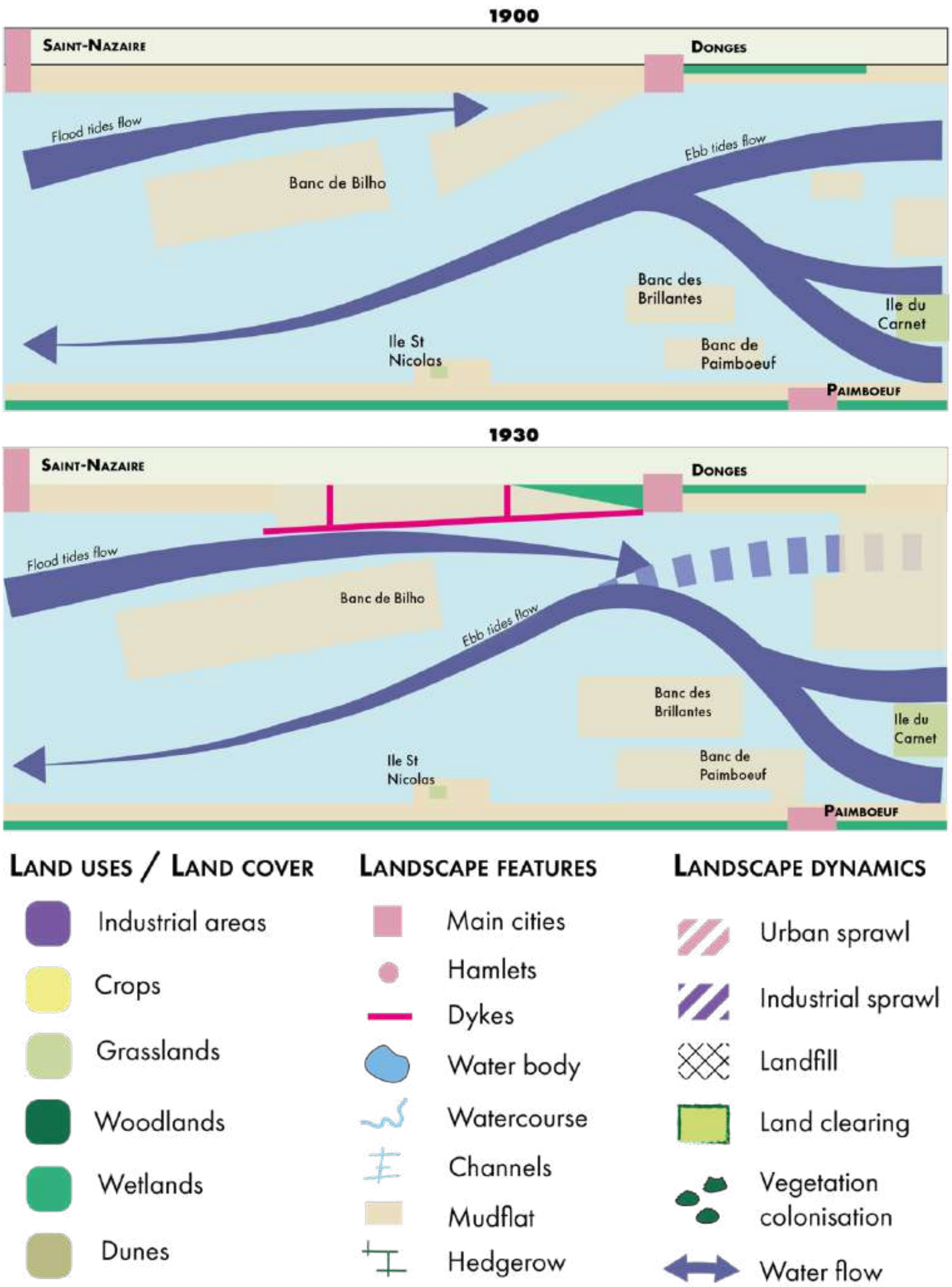

FIGURE 18: LOIRE ESTUARY WATERSCAPE IN 1900 AND 1930

Mid 20th Century: a growing mudflat landscape

During the mid-20th century, the ebb tide flows weakened due to the promotion of the northern channel. To the east of Donges, the mudflat area expanded and began to be colonized by vegetation. The mudflats of Paimboeuf and Brillantes merged, forming a large area, while the Banc de Bilho extended. Wetland vegetation colonized the mudflats created by the northern embankment between Saint-Nazaire and Donges. By the mid-20th century, the flood tide and ebb tide flows almost entirely followed the same northern channel. This period also saw a shift in agricultural practices, with the specialization of lowlands and uplands in livestock farming, resulting in an increase in meadows for grazing or hay. Additionally, the foundations of tourism development in Saint-Brevin were laid, alongside the gradual expansion of the city. The dunes were afforested with maritime pine.

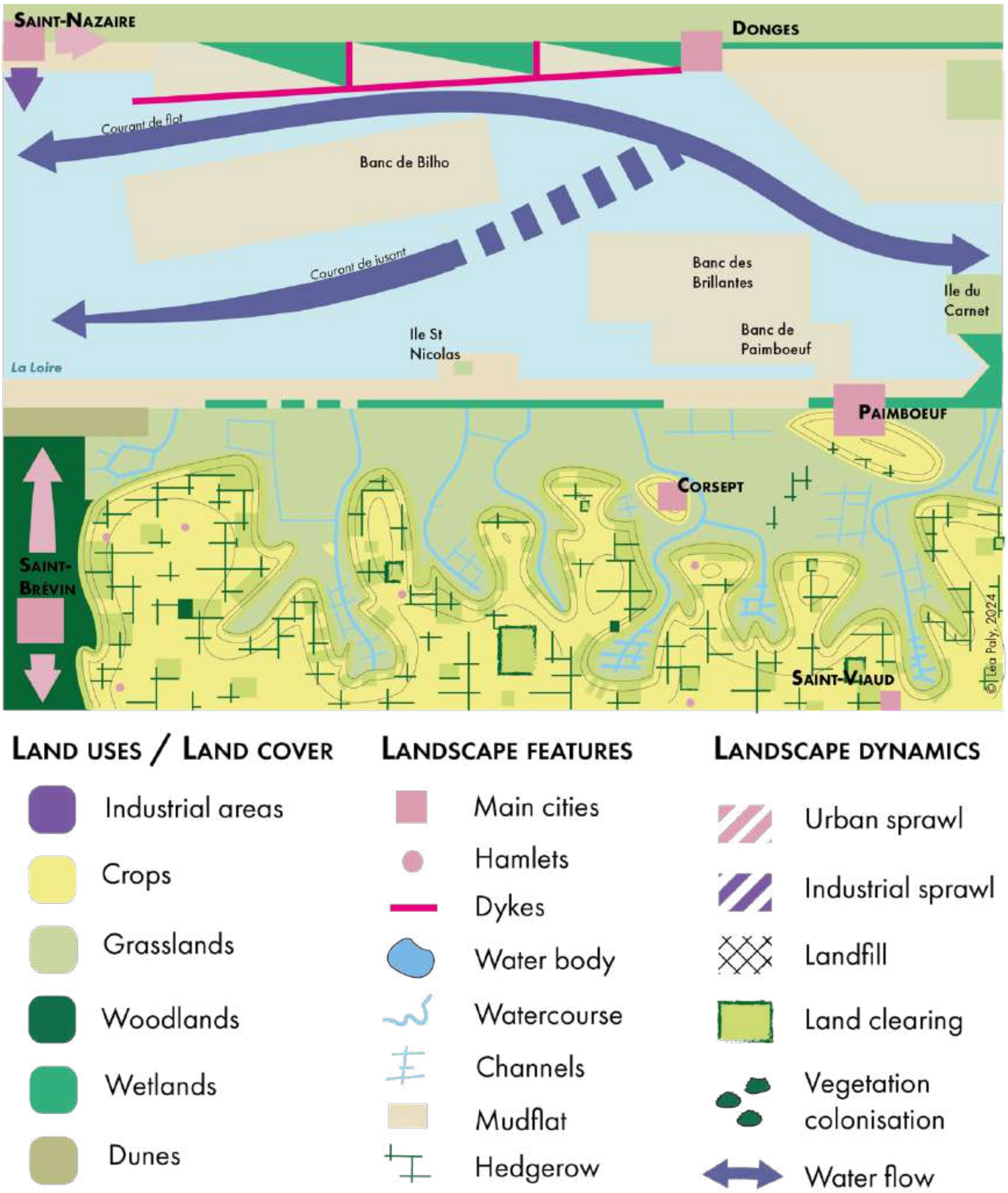

Figure 19: Loire estuary landscape and waterscape in 1950

Late 20th Century: a growing divide between an artificial landscape on the north bank and a protected waterscape on the south bank

In 1977, land development focused on industrial expansion around the Saint-Nazaire port and tourism growth around Saint-Brevin. A bridge was built to connect the northern and southern riverbanks. The land behind the concave dike was filled in to extend the industrial area. The mudflats to the east of Donges were fully colonized by wetland vegetation. The northern channel was dredged, and sediment residues were deposited on the Banc de Bilho, which was subsequently extended.

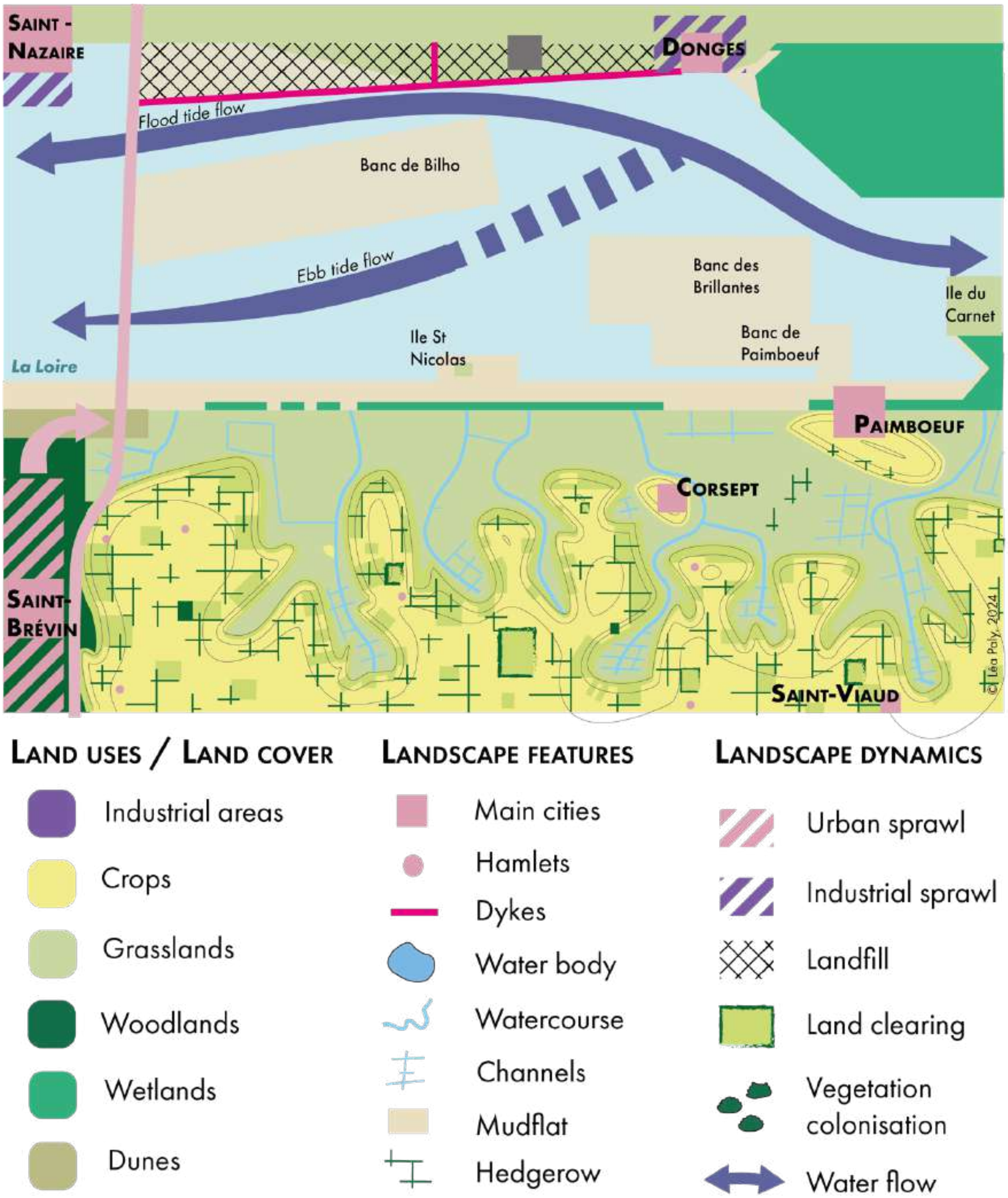

FIGURE 20: LOIRE ESTUARY LANDSCAPE AND WATERSCAPE IN 1977

The end of the 20th century in characterized by the first nature conservation measures in the Loire estuary when the Conservatoire du Littoral (a public national agency) purchased the first pieces of land. The focus was on the Lavau marshes and Maréchale Island, while Corsepts was not yet protected. The Natura 2000 program began to be implemented on the Loire estuary and was formally established in 2004.

Early 21st Century: a declining productive landscape shifting to a recreational landscape

In the 21st century, industrial sprawl continues to expand around Saint-Nazaire and Donges. The reclaimed land behind the concave dikes is dedicated to the petrochemical industry. New land reclamation has occurred on the newly formed salt marshes to the east of Donges. An extension of the Saint-Nazaire harbor had been planned, but this project was abandoned due to nature conservation concerns and local opposition. The northern channel is regularly dredged, and the Brillantes mudflats have extended. The main water flows now occur in the northern channel, which induces sedimentation in the south, particularly at the Banc des Brillantes.

The main changes in the landscape are related to agriculture and urban development. Cities have expanded around existing towns and into agricultural land, leading to urban sprawl especially in Saint-Brévin. Agriculture on the Corsept marshes remains the dominant land use, primarily focused on livestock farming. As part of land consolidation, the network of hedgerows has become sparser, and the size of parcels has increased. Sedimentation on the southern riverbank, driven by the water flow from the north, has hindered water evacuation from the Corsept marshes. As a result, a ditch was created to collect water from the marshes and direct it into the less sedimented part of the Loire near Saint-Brévin. The construction of the ditch also led to the creation of a new dike, isolating the Corsept marshes from the tides.

In addition, decoy ponds for hunting have been established on marshes at the bottom of the alluvial plain and on meadows adjacent to the Loire. This shift in land use reflects a decline in traditional agricultural practices in the area and the growing development of recreational activities on the marshlands.

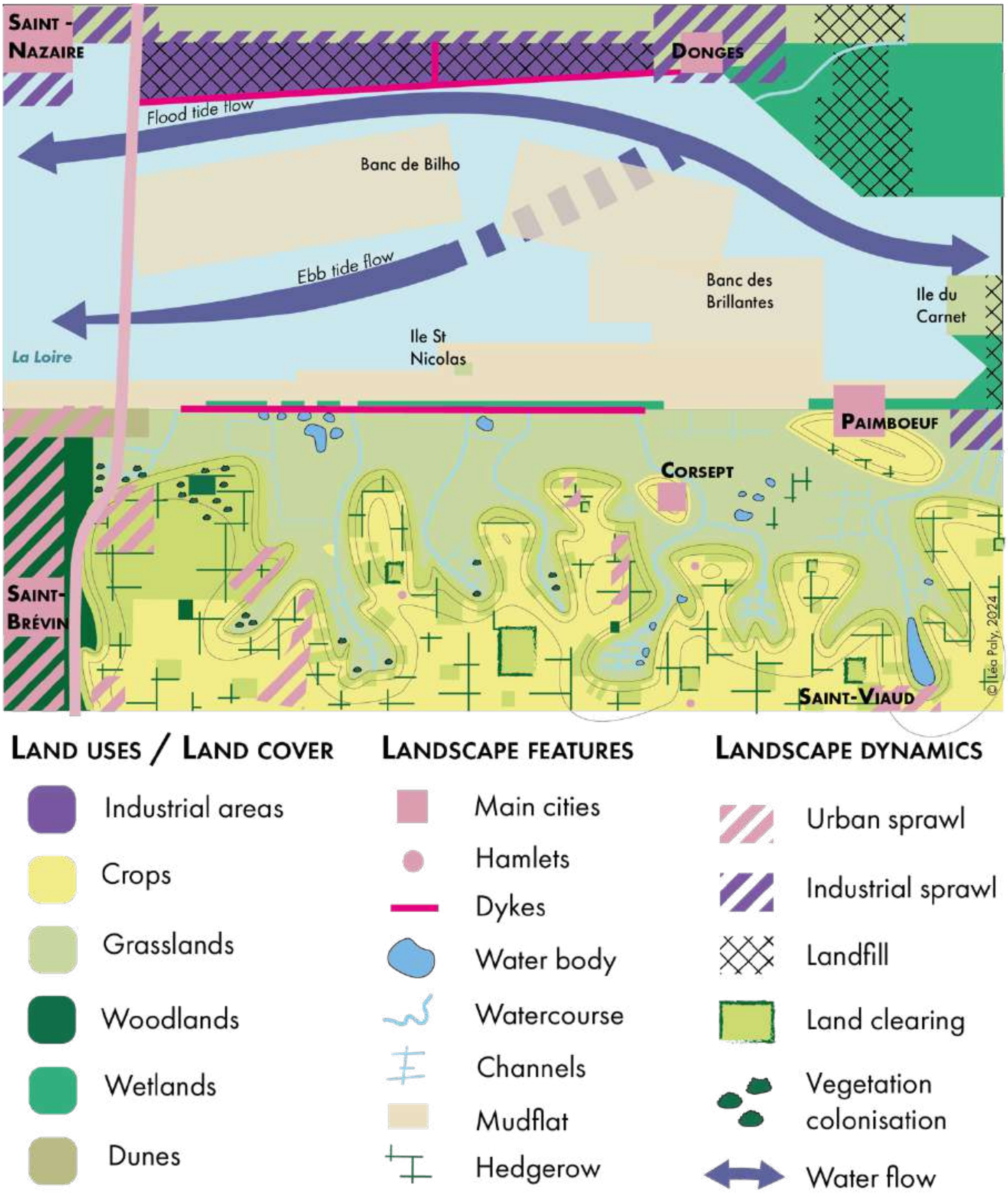

FIGURE 21: LOIRE ESTUARY LANDSCAPE AND WATERSCAPE IN 2000

In 2018, both the flood and ebb tides occurred in the north channel. Industrial development continued to sprawl, particularly along the southern riverbank, where an area had been reclaimed by the port. Saint-Brevin expanded to the west, encroaching on former agricultural land. The number of decoy ponds increased. As a result, the Conservatoire du Littoral extended its acquisition policy by establishing an intervention perimeter in Corsept, enabling them to purchase parcels in the area and granting them priority rights for acquisitions.

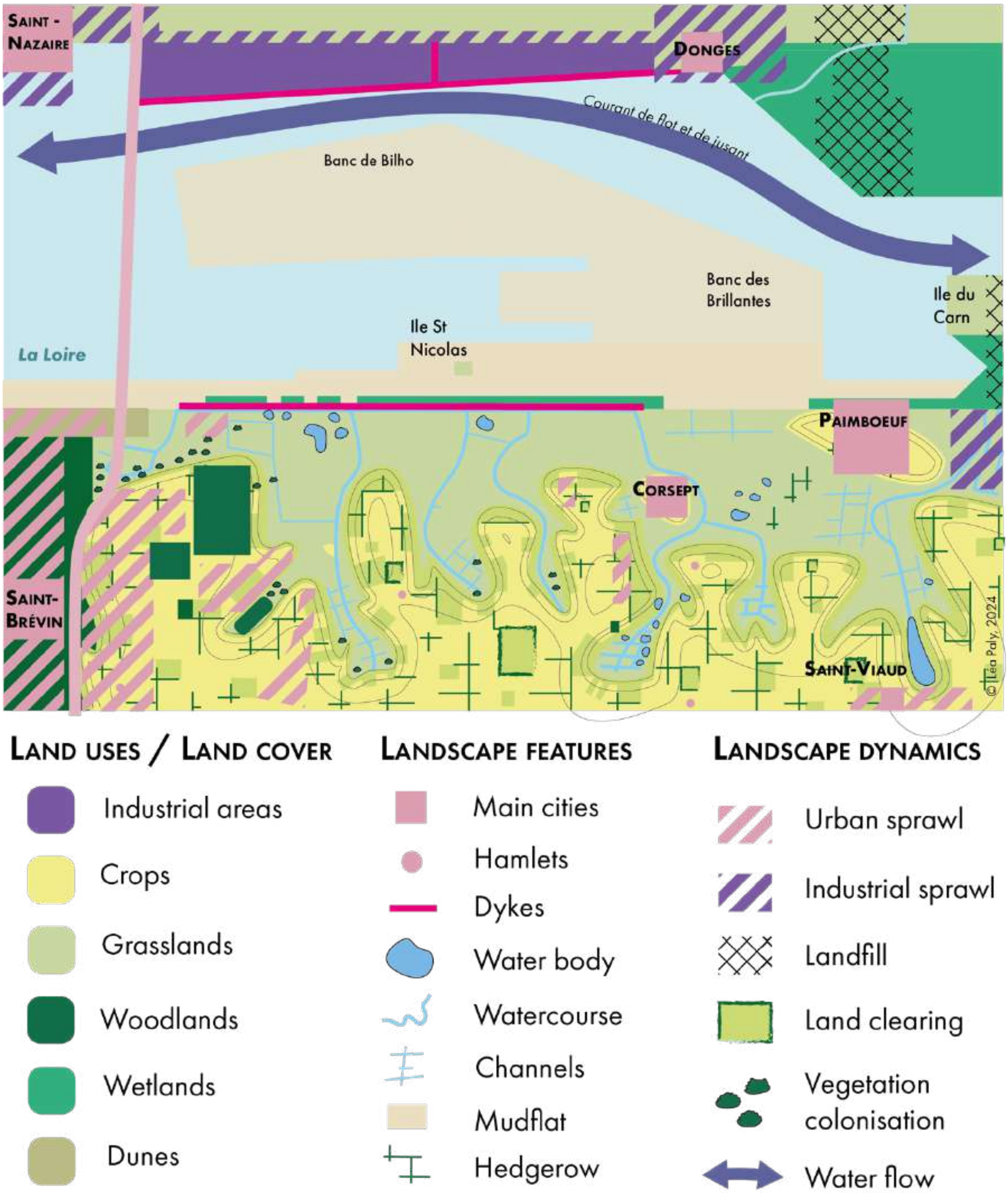

FIGURE 22: LOIRE ESTUARY LANDSCAPE AND WATERSCAPE IN 2018

4.3 Timeline for landscape trajectory

The following timeline (Figure 23) allow to sum up this long-standing history of landscape change though comparing the evolution of the main drivers of change: agriculture development through embankment and drainage, industrial development and navigation improvement (with major consequences on the sediment dynamics along the estuary), tourism and nature conservation.

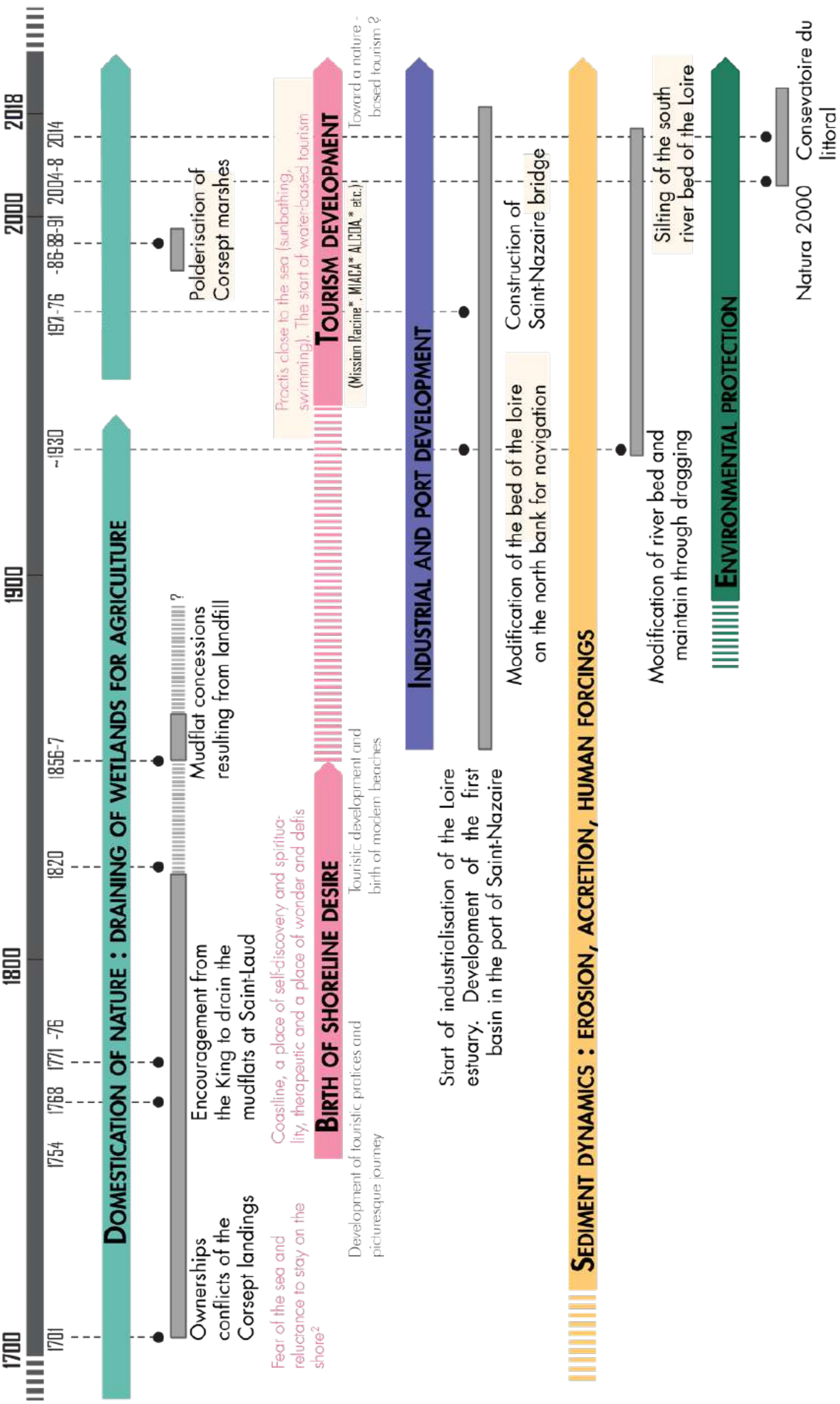

FIGURE 23: DRIVERS OF CHANGES OF CORSEPT MARSHES

5 Environmental history for the Essex estuaries complex

The Essex estuaries complex is a vast area where the three rivers Colne, Blackwater and Chelmer converge in a large estuary dotted with several islands (Mersea, Osea and Northey Islands from East to West). To investigate landscape trajectories in such DM, two scales were selected. The large scale includes all the shoreline from River Colne from Brightlingsea to Tollesbuy on the Blackwater and then from Fingringhoe marshes to Tollesbury marshes including Mersea Island (Figure 24). The small scale is focused on Abbotts Hall (Figure 24), where the first managed realignment project was implemented in the 1990s.

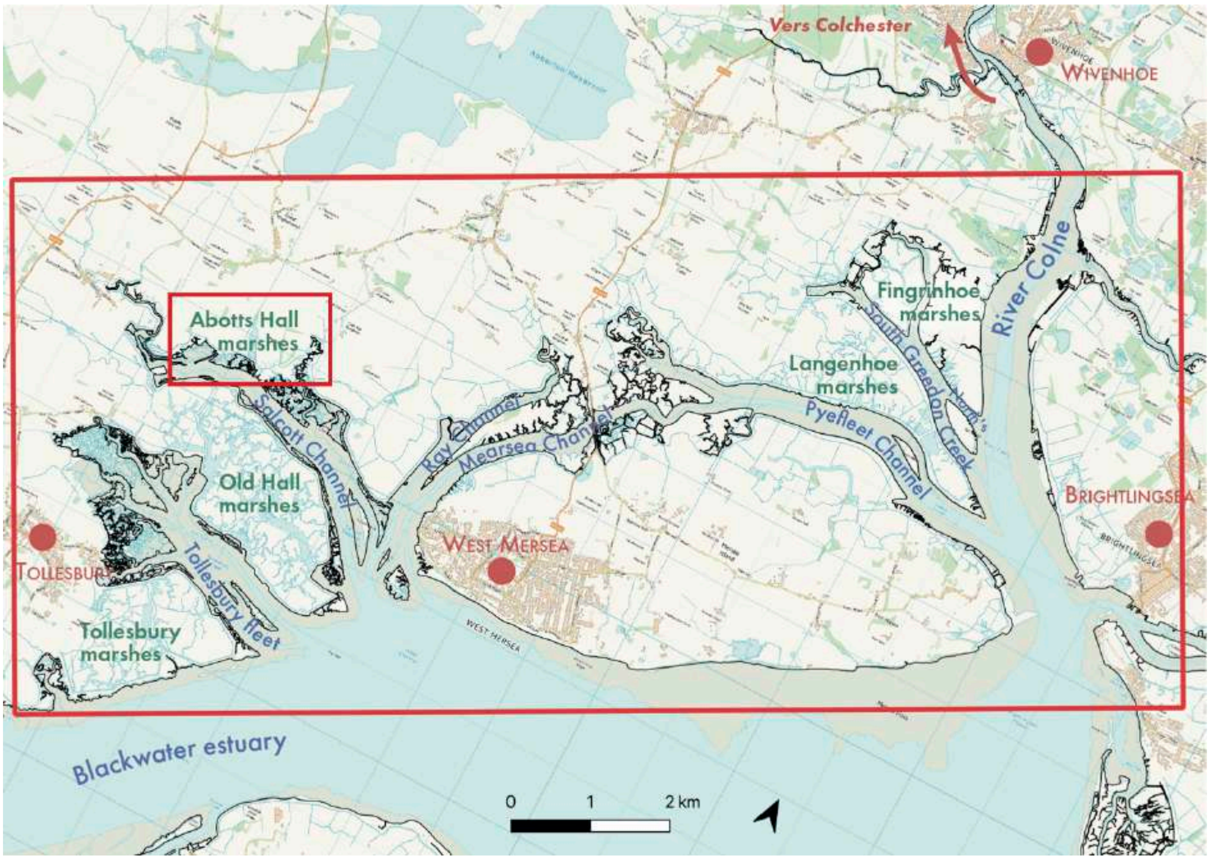

FIGURE 24: THE TWO SELECTED SCALES IN THE BLACKWATER ESTUARY FOR INVESTIGATING LANDSCAPE TRAJECTORIES

These two scales were selected to ensure consistency with the data collection for chronosequences in Task 2.2.2 and with the field campaigns planned under WP3, facilitating the reconstruction of environmental histories that will subsequently be linked to local environmental knowledge.

5.1 Landscape trajectory at the large scale

18th century: a landscape evolving from sheep grazing to cropland

Land reclamation in Essex dates back to the Middle Ages, though it is known that in some areas, it began earlier during the Roman times. Reclaimed lands were primarily used for sheep grazing, and Essex was known for its cheese production.

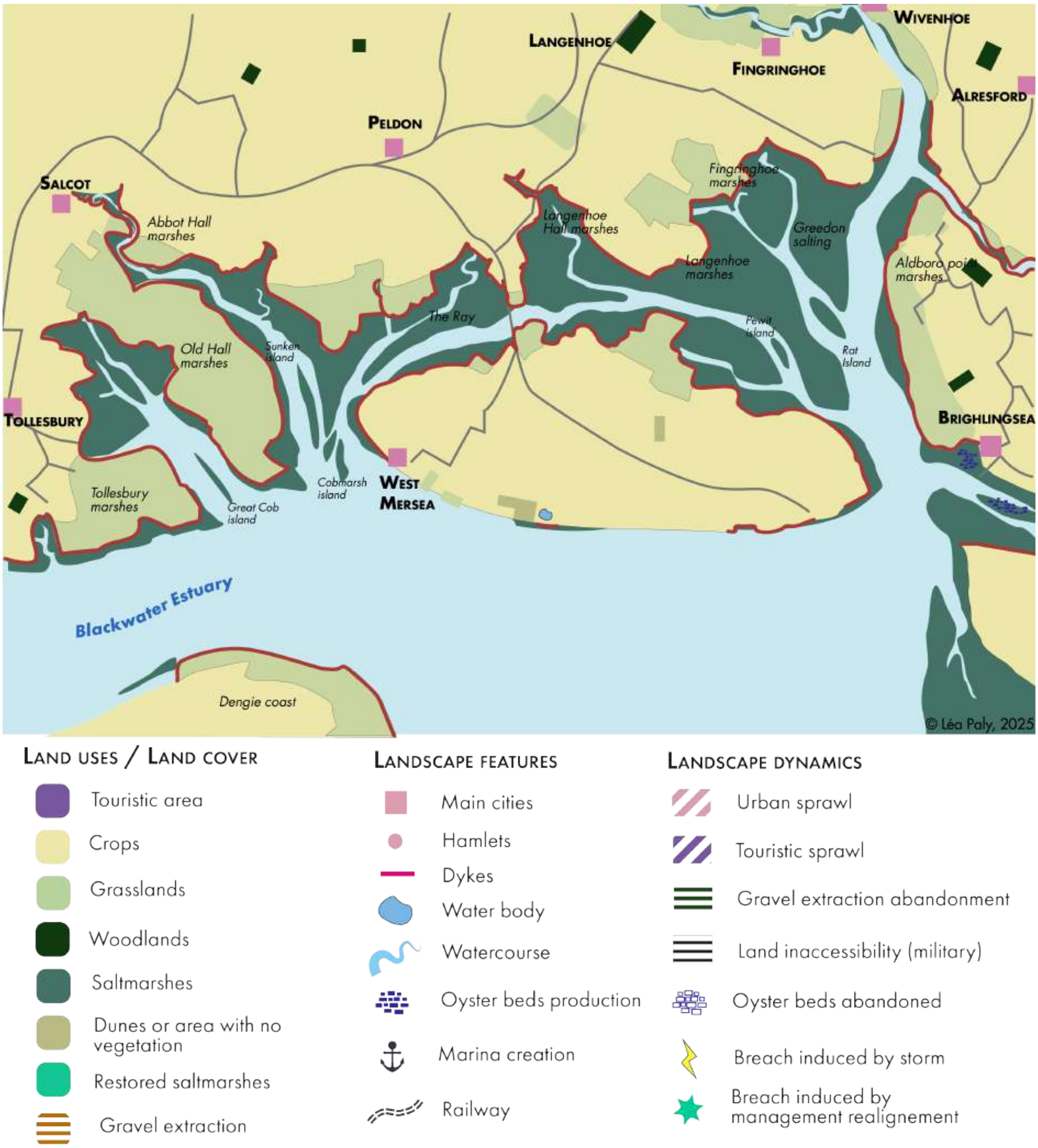

Figure 25: Blackwater landscape and waterscape in 1799

However, analyzing maps from the 18th century (such as the Maps of Essex County from 1777 and the Ordnance Survey drawing from 1799), clearly demonstrate not all saltmarshes had been reclaimed at that time and, when not embanked yet, were extensively used for sheep grazing (Figure 25). This is also evidence that land reclamation and embankments did not endure even it started earlier.

Agricultural and drainage developments in the late 18th century, with the use of hollow and under-draining systems instead of surface ditches and furrows, along with the good prices of agricultural land, made tilling the Essex marshland a more viable option. This encouraged farmers to invest money and labor into the reclamation of saltmarshes. Older reclaimed land, such as those reclaimed during the Middle Ages, were then used for crops.

Saltmarshes were also used for oyster production in oyster beds. Until the 11th century, natural oyster beds were used to harvest oysters. These beds, mainly located near Brightlingsea Creek, were cultivated in the muddy creeks with a rectangular shape in the saltmarshes. From the 13th century onwards, on Cindery Island and Brightlingsea (Figure 25), oyster cultivation involved constructing low sea walls to create pools of seawater where young oysters were cultivated before being sold (Fautley et Garon, 2004).

19th century: an agrarian landscape

The 19th century appears as the final stage of land reclamation in the Blackwater Estuary (Figure 26). Reclamation efforts were formalized in the 19th century through the establishment of sewer commissions and the development of specific legislation.

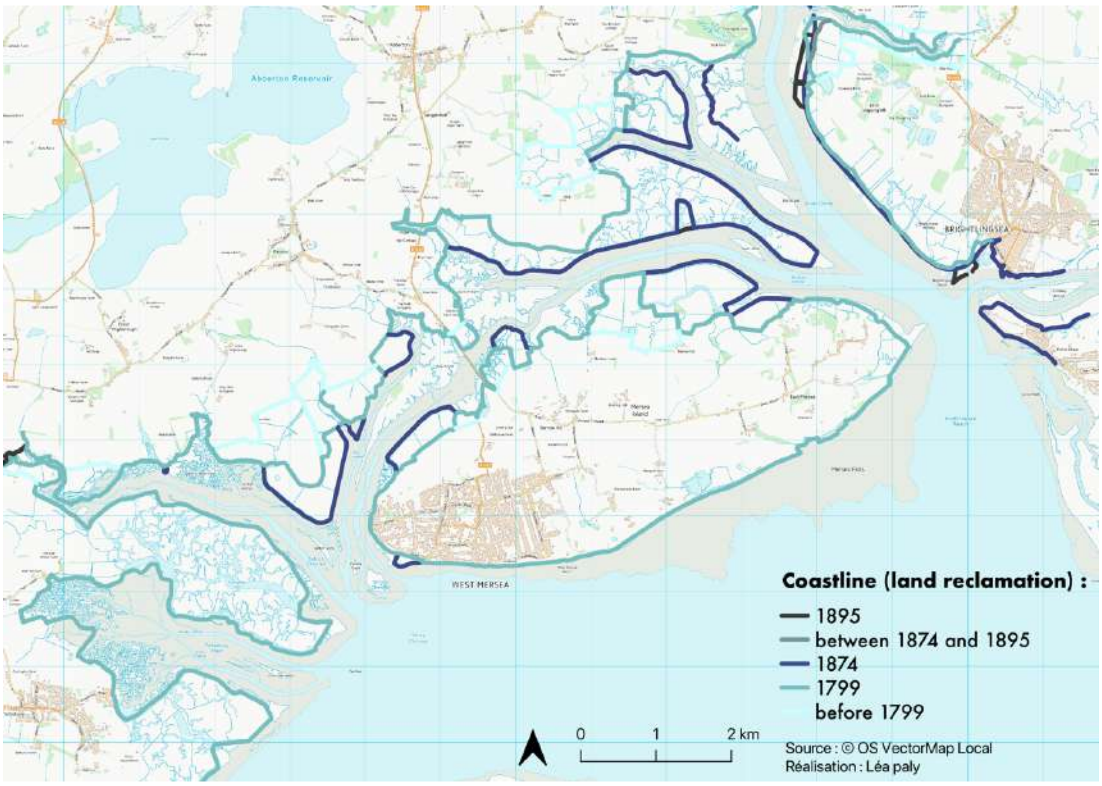

FIGURE 26: LAND RECLAMATION AND SHORELINE EVOLUTION IN THE BLACKWATER ESTUARY DURING THE 19TH CENTURY

First, the Sewer Act of 1833 allowed sewer commissions to borrow money to purchase land that was too expensive at the time. Then, the Sewer Act of 1841 and the Land Drainage Act of 1861 enabled these commissions to mortgage the land that was to be reclaimed (Grieve, 2020). 19th-century land reclamation primarily aimed to extend pre-existing embanked areas, such as the Fingringhoe saltmarshes and Langenhoe marshes (Figure 27). Newly reclaimed land was used for pasture, while older reclaimed land was cultivated using tillage methods and new drainage techniques.

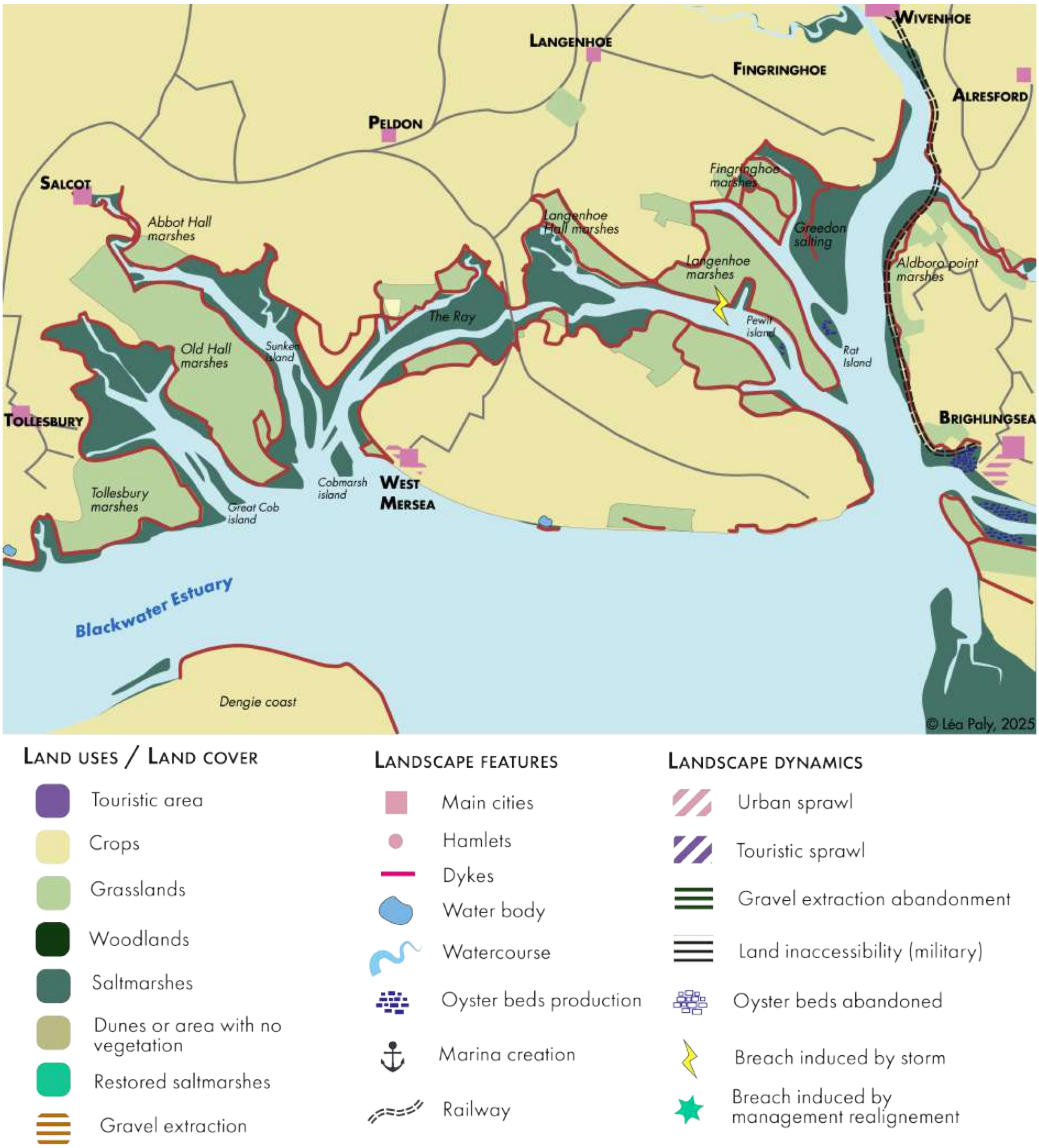

FIGURE 27: BLACKWATER LANDSCAPE AND WATERSCAPE IN 1890

Oyster production reached its peak in the 19th century, around 1850, and was mainly concentrated near Mersea Island and Brightlingsea, employing hundreds of people until the early 1900s. Around 500 million oysters were sent to London's Billingsgate Market every year, with even more consumed locally. However, traditional oyster beds were overfished, leading to a decline to 40 million oysters by 1890. The oyster bed areas were never embanked, even after their abandonment.

At the same time, local communities of farmers, fishermen, and hunters, who had fought for centuries to maintain sea defenses at great cost, began to change with the arrival of new populations brought by the development of the railway. The Thames Estuary is a prime example, with industrial sprawl supported by improved transportation. In the Blackwater Estuary, however, these changes were less intense, and are reflected in the arrival of new populations who envisioned marshlands for residential purposes, particularly during seasonal holidays, and especially during summer. Canvey Island serves as a good example of this shift toward tourism (Grieve, 2020).

In the 19th century, the Blackwater Estuary was dominated by an agrarian landscape, the result of successive land reclamation and the continued maintenance of sea defenses despite several storms that caused significant flooding (1703, 1736, 1856, 1881, 1897). The 1897 storm, known as "Black Monday," led to several breaches in the dikes. Between 30,000 and 35,000 acres of land in Essex were submerged, halting railway traffic between Wivenhoe and Brightlingsea (Grieve, 2020).

20th century: A changing waterscape shaped by the revival of traditional practices

The early 20th century was marked by the deterioration of dikes due to a lack of management (Grieve, 2020). It also saw the beginnings of tourism development along the coast, primarily near Tollesbury and Brightlingsea (Figure 28). Near Fingringhoe and Alresford, gravel pit extraction also continued and expanded into other areas (Figure 29).

Figure 28: Brightlingsea in 1949 (© Historical England)

The mid-20th century on the Essex coast was primarily marked by the 1953 storm, known as the Great Storm. It affected more than 49 000 acres of land, including 41 760 acres of agricultural land. The sea breached the banks during the night, leading to the loss of more than 119 lives, and over 21 000 people were left homeless (Grieve, 2020), particularly in areas like Canvey (Figure 28), Jaywick, and central Lincolnshire (Steers, 1953).

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FIGURE 29: ON THE LEFT : MERSEA ISLAND AFTER 1953 FLOOD (PHOTOGRAPH : BRIAN JAY, PROVIDED BY THE MERSEA ISLAND MUSEUM) ; ON THE RIGHT : CANVEY ISLAND AFTER 1953 FLOOD (© PA ARCHIVES)

This storm seriously damaged the dikes leading to several breaches and the loss of reclaimed land, including Fingringhoe Marshes, Aldboro Point Marshes, and Mersea Island Marshes (Figure 30). The saltwater invasion of agricultural land caused the conversion of reclaimed land, previously used for crop cultivation through tillage, into meadows.

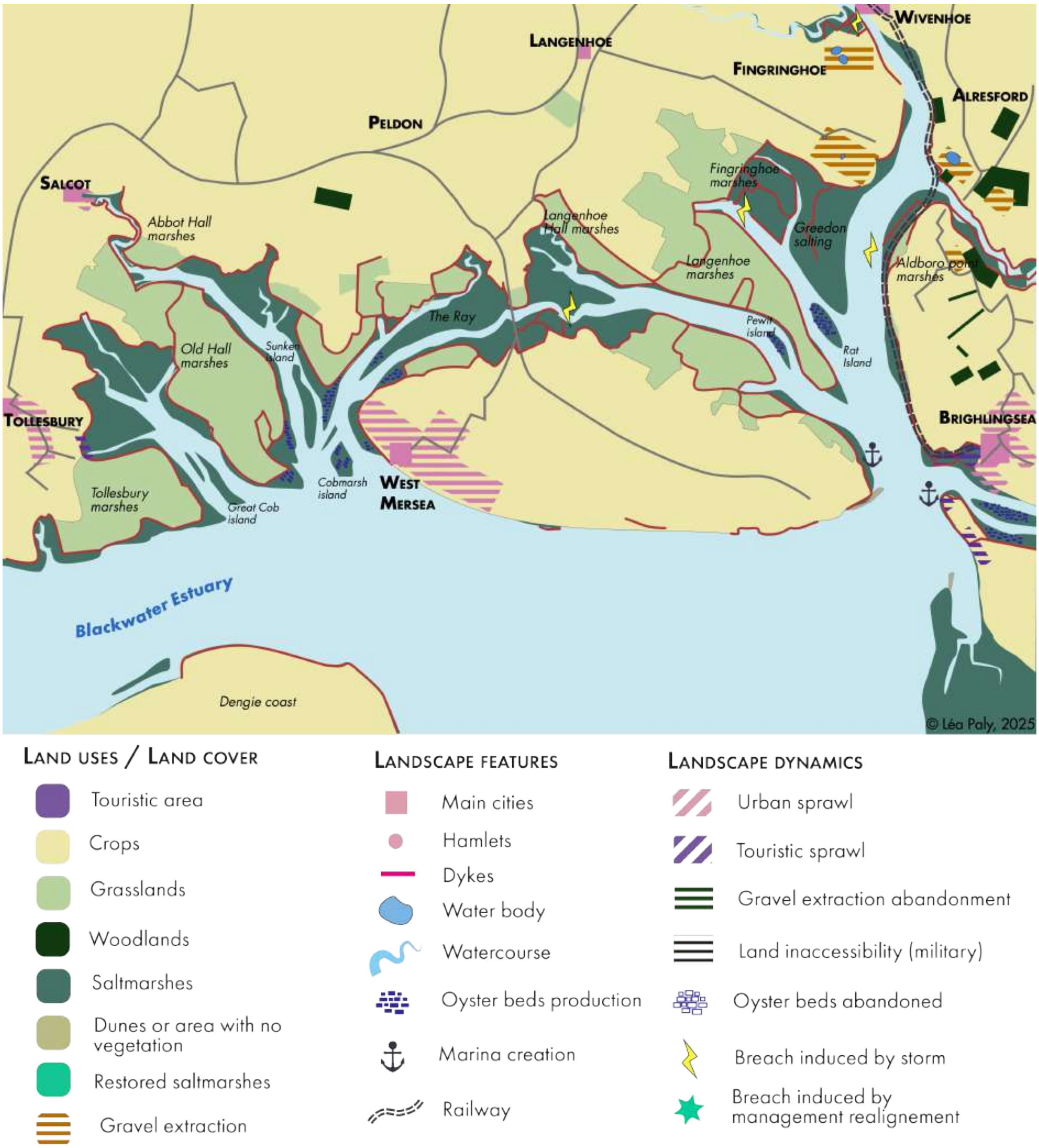

FIGURE 30: BLACKWATER LANDSCAPE AND WATERSCAPE IN 1955

Late 20th century: a waterscape progressively transformed by coastal tourism and nature conservation

The second half of the 20th century was marked by the recovery after the 1953 storm. It also led to the reinforcement of coastal defenses against future storms and preventing from flooding. Despite this disaster, the second half of the 20th century is here characterized by rapid urbanization, with the growth of tourism development. On Mersea Island several campsites were developed and the town has considerably expanded on the western part of the island (Figure 32). Near Brightlingsea, areas that were not yet urbanized were used for tourist accommodation, such as Point Clear. Several marinas were also developed, especially in Tollesbury, while others consist of mooring areas (Mersea Island, Brightlingsea) (Figure 31).

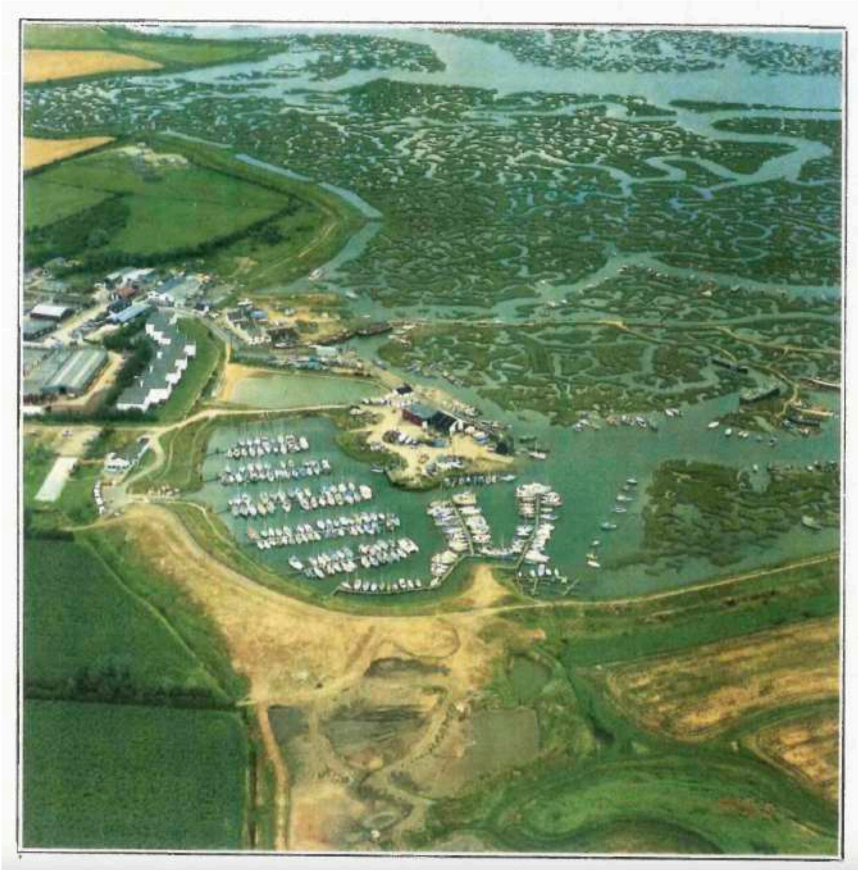

Figure 31: Tollesbury Marina

The second half of the 20th century also saw the implementation of nature conservation along with the establishment of the first nature protected areas starting with Old Hall Marshes and following with Fingringhoe Marshes, Howland's Marshes, Tollesbury Wick Marshes, and others.

The first pioneer nature conservation measures started on the Blackwater Estuary with a private initiative, with the acquisition of Old Hall Marshes by Brigadier R. Colwin, who wanted to leave the marshes undrained in order to create a shooting area and to improve the coastal wetlands as a hunting estate for wildfowl. In 1978, the area was leased to the Nature Conservancy Council, and in 1984, the entire marshland, along with the nearby farms, was purchased by the Royal Society for Protection of Birds for £780 000. It is now one of several RSPB nature reserves and is managed for bird conservation. Former arable land has been converted into meadows. Public access to the marshes is not allowed, which has led to local disputes. However, access is permitted along the seawall. This area was the first designated by the Nature Conservancy Council as a Site of Special Scientific Interest (SSSI).

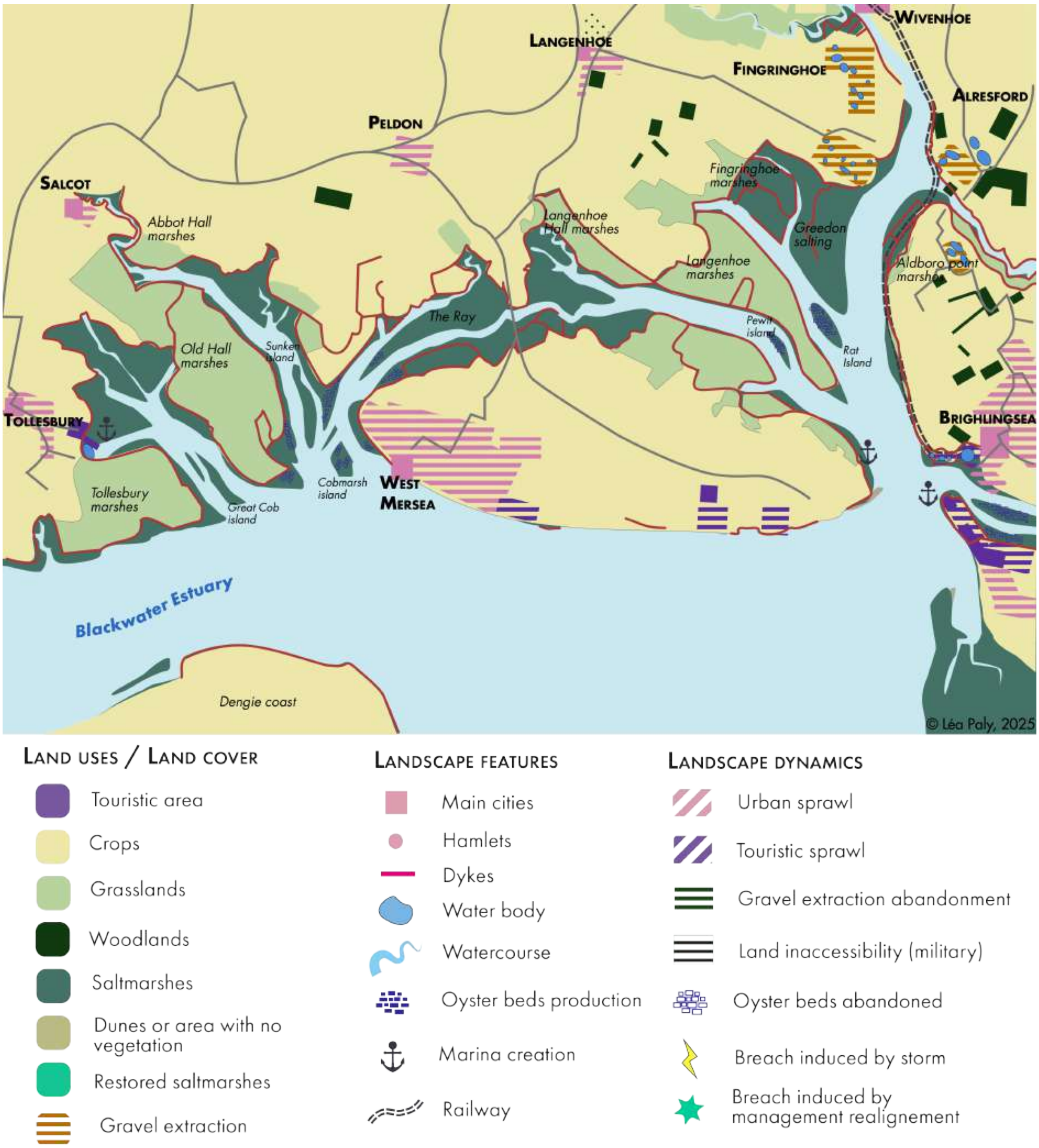

Figure 32: Blackwater landscape and waterscape in 1975

The second nature reserve implemented in the Blackwater estuary is the Fingringhoe Nature Reserve. In 1921, the land of Wick Farms, where the reserve is now located, was sold to a gravel extraction company and was taken over by the Freshwater Sand and Ballast Company in 1928. After World War II, Brightlingsea Aggregates Limited took over the extraction of 30 000 tons of gravel per year, which led to the creation of a water body known as Freshwater Pit. In 1959, the extraction at Freshwater Pit ended, and the land was sold to the Essex Wildlife Trust for £4 000. This land was the first acquisition of the Essex Wildlife Trust, and the reserve was officially opened to the public in 1967 (Fautley et Garon, 2004).

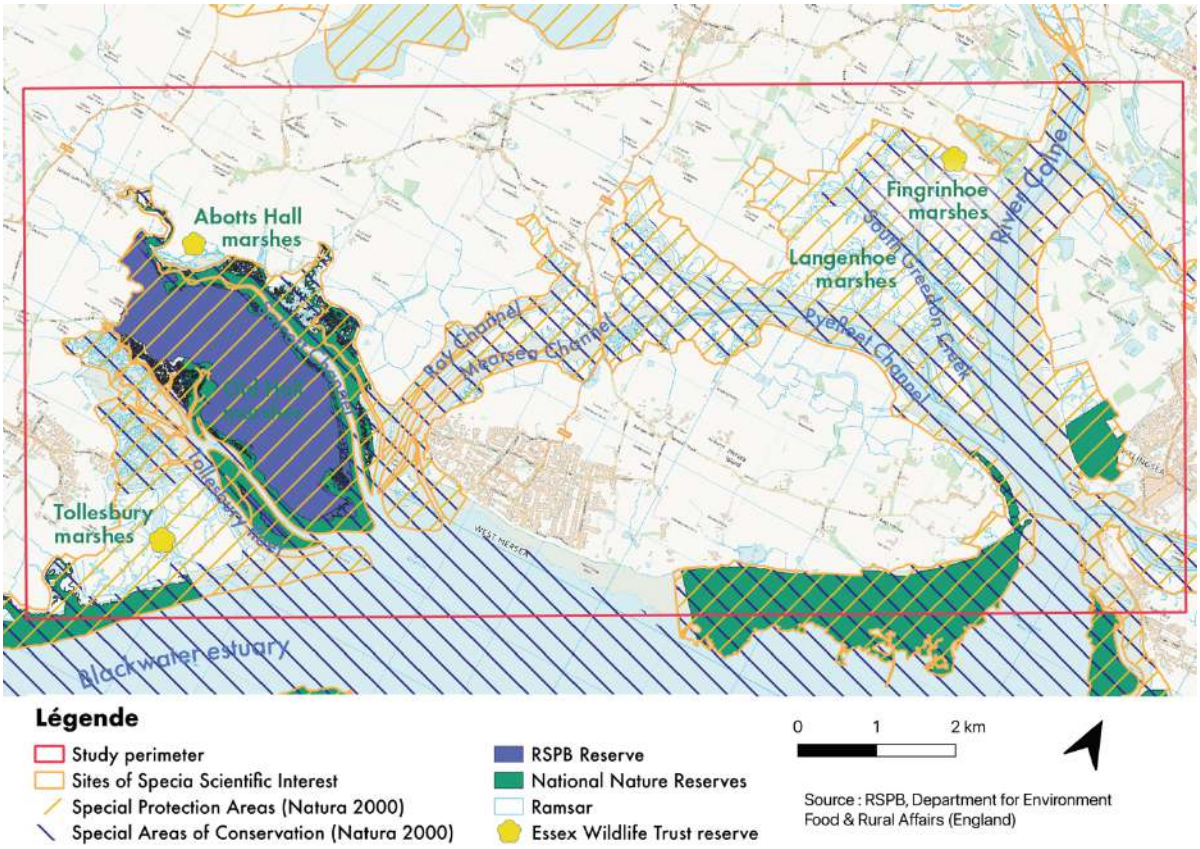

FIGURE 33: NATURE PROTECTED AREAS IN THE BLACKWATER ESTUARY

The Essex Wildlife Trust has been an important player and stakeholder in the protection of saltmarshes in Essex. Later, in 1986, the Trust bought 186 acres from the Priory of St Osyth and established a nature reserve at Howland Marshes and then acquired the remaining of this saltmarsh with the help of the Royal Society for Nature Conservation, the World Wide Fund for Nature, and private donations.

The entire Blackwater Estuary was finally included in the SSSI perimeter in 1993, and later, 4 395 hectares were designated as a Ramsar Wetland of International Importance. 1 099 hectares are also designated as a Special Protection Area within the Natura 2000 network (Figure 33).

21st century: A new waterscape driven by managed realignment

The end of the 20th century and the early 21st century are characterized by increased awareness of the coastal squeeze effect on the decline of saltmarshes in England, particularly in Essex. It is estimated that around 22,7% of the 880,2 hectares of saltmarshes in 1973 have been eroded on the Blackwater estuary, resulting in a loss of 200,2 hectares of saltmarshes between 1973 and 1988 (Doody, 2004). By 1997-1998, the total area of saltmarshes had reduced to no more than 682.6 hectares (Cooper et al., 2001). As a result, several programs were implemented to restore and enhance saltmarsh accretion. These began on Northey Island with the removal of a dike and continued with a process known as managed realignment, followed by projects in Tollesbury in 1995, Orplands in 1996 (Dengie Coast), Abbotts Hall in 2000, and finally Fingringhoe Wick Reserve in 2015. Sea-defense strategies emerged in the landscape, including short groynes, which were mainly implemented around Mersea Island to protect the shoreline and the reclaimed land.

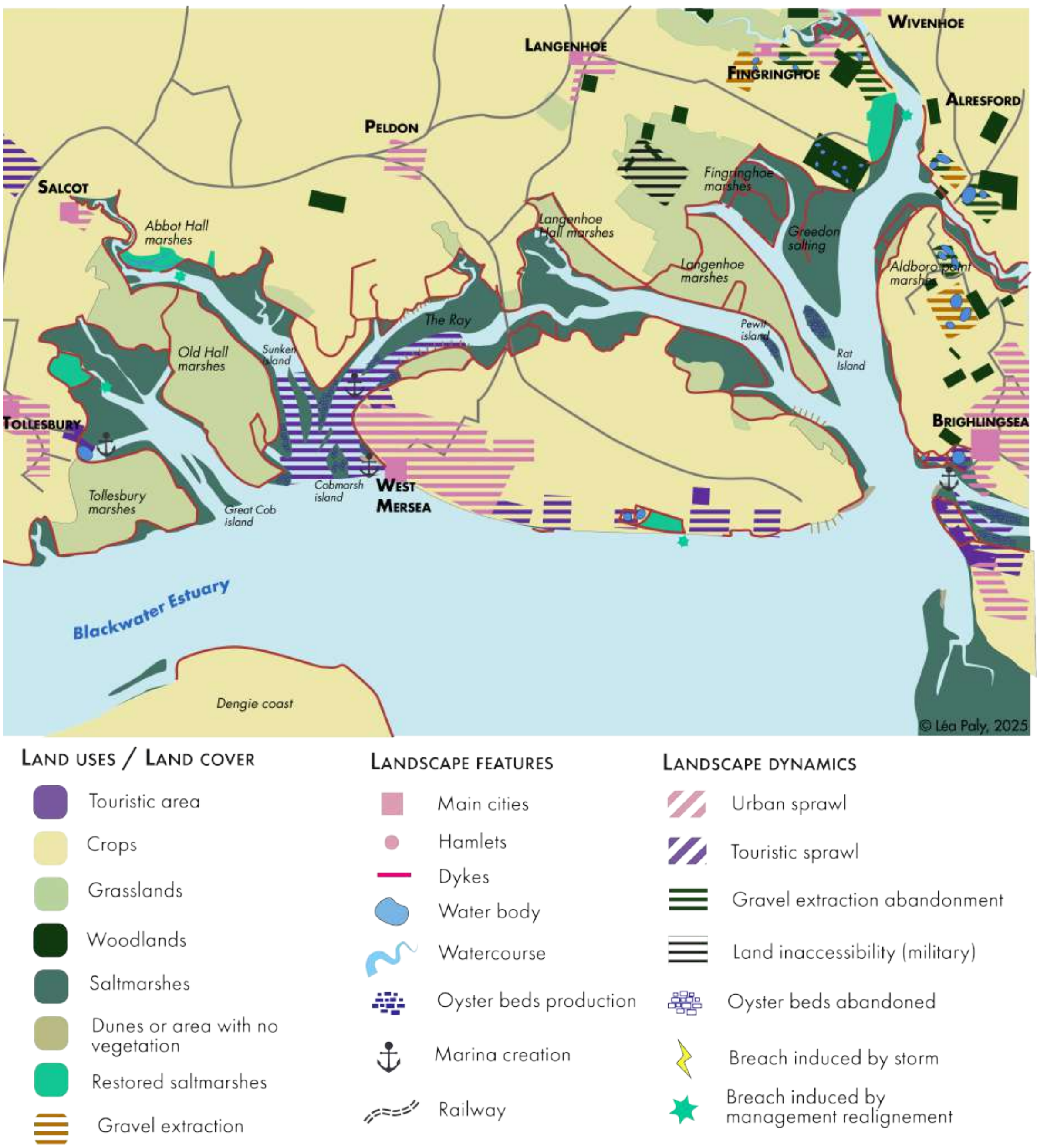

FIGURE 34: BLACKWATER LANDSCAPE AND WATERSCAPE IN 2024

In the 21st century, gravel extraction continued and expanded into other areas around Fingringhoe and Wivenhoe. Tourism development also continued, with the creation of new campsites and the densification of tourism development such as Point Clear (Figure 34).

5.2 Landscape trajectory at the small scale: Abbotts Hall

By the time of the 1771 Chapman maps, Abbotts Hall had already been reclaimed. The area was depicted as pasture, which, during that period, was typically used for sheep grazing in Essex. It continued to be utilized as pasture thereafter (Figure 36).

In the 1990s, several experiments in coastal realignment management were undertaken in the UK. In 1990, English Nature (formerly the National Rivers Authority), The National Trust, and MAFF (Ministry of Agriculture, Fisheries, and Food) launched a program to restore coastal wetlands in the Blackwater Estuary. This led to the managed realignment of Northey Island (1991) and Tollesbury (1995), a managed retreat in Orplands in 1996, and a saltmarsh restoration project in Abbotts Hall in 2000.

The Blackwater Estuary was selected in 1999 as a case study for an international exchange between United States and the United Kingdom, known as the Countryside Exchange. This exchange stemmed from a memorandum of understanding between the USA and the UK regarding cooperation "on the conservation and management of cultural, natural, and recreational resources." The aim of the exchange in the Blackwater Estuary was to explore how to engage local communities and stakeholders in the development of sustainable planning and long-term management of the Essex coast. It included managed realignment and intertidal habitat restoration. The sponsors of this exchange were the RSPB, English Nature, and the Blackwater Estuary Project.

FIGURE 35: ABBOTTS HALL BREACH (2002)

The Abbotts Hall project sought to experiment with a method for restoring saltmarshes by modifying the differential elevation of low-lying lands. Landowners' cooperation at Abbotts Hall, with agreements on habitat payments through MAFF, enabled the NRA to approach the Essex Local Flood Defence Committee (ELFDC). In return, landowners benefited from long-term payments (20 years) from MAFF. However, many landowners preferred a direct payment, which would allow them to purchase other lands as compensation for the lost land (Dixon et al., 1998). Essex Wildlife Trust describes the outputs of the Abbotts Hall experiment in the following way : ” the previously farmed land was rapidly transformed as saltmarsh plants quickly colonised the area and new coastal wildlife moved in. It is considered a good case study for managed realignments and as a key nature-based solution”.

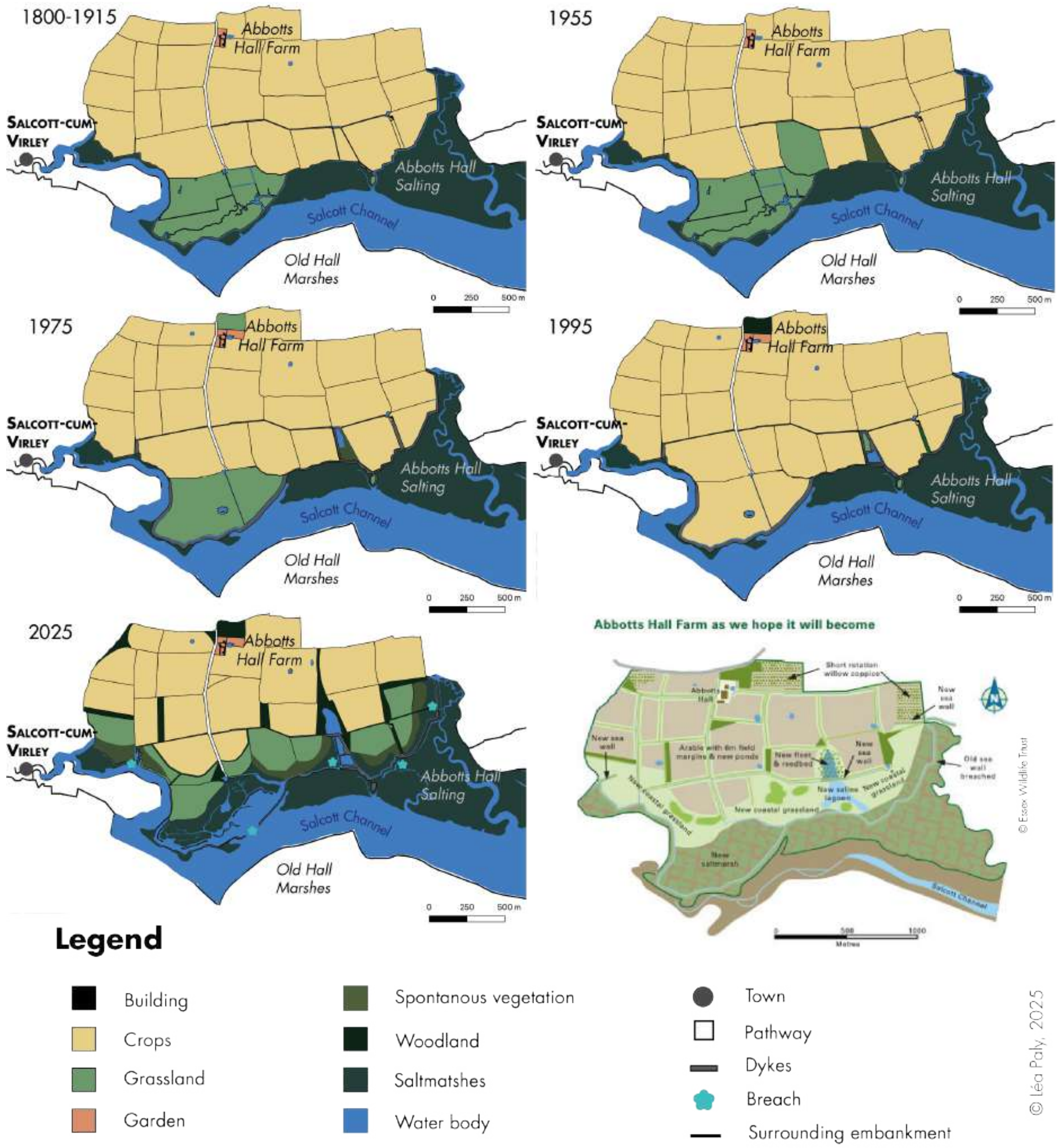

FIGURE 36: ABBOTTS HALL LANDSCAPE FROM THE 18TH TO THE 21ST CENTURY

5.3 Timeline for landscape trajectory

The following timeline (Figure 37) summarize the trajectory of landscape on the two different scales highlighting key drivers: oyster production, agriculture through drainage, coastal tourism development, urban sprawl and the rise of nature conservation.

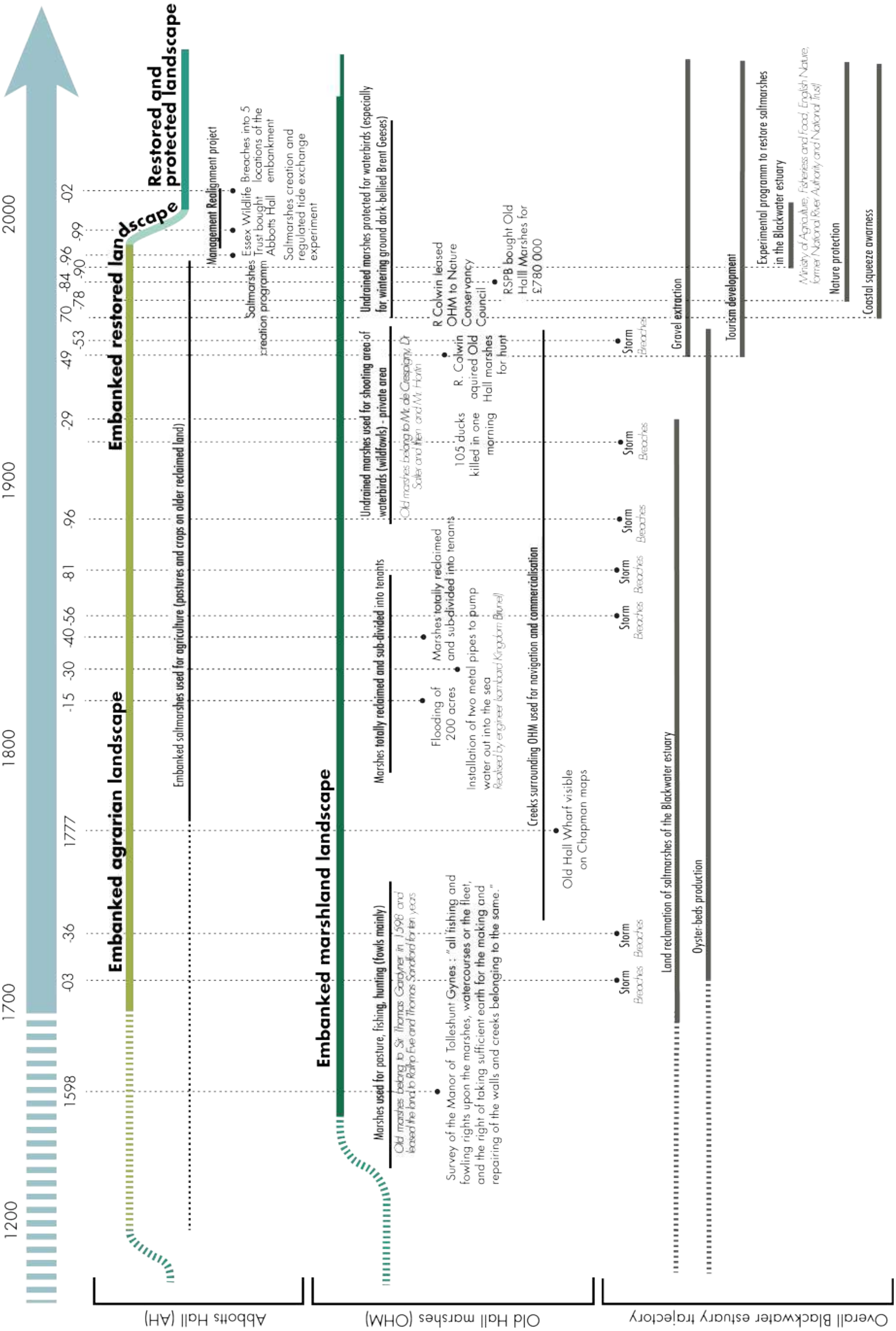

FIGURE 37: DRIVERS OF CHANGES ON ESSEX ESTUARY

6 Environmental history of the Ria de Aveiro

Data collection for the Ria de Aveiro has just started. The first historical maps are presented here also with some key elements of the landscape trajectory whose Investigation is ongoing.

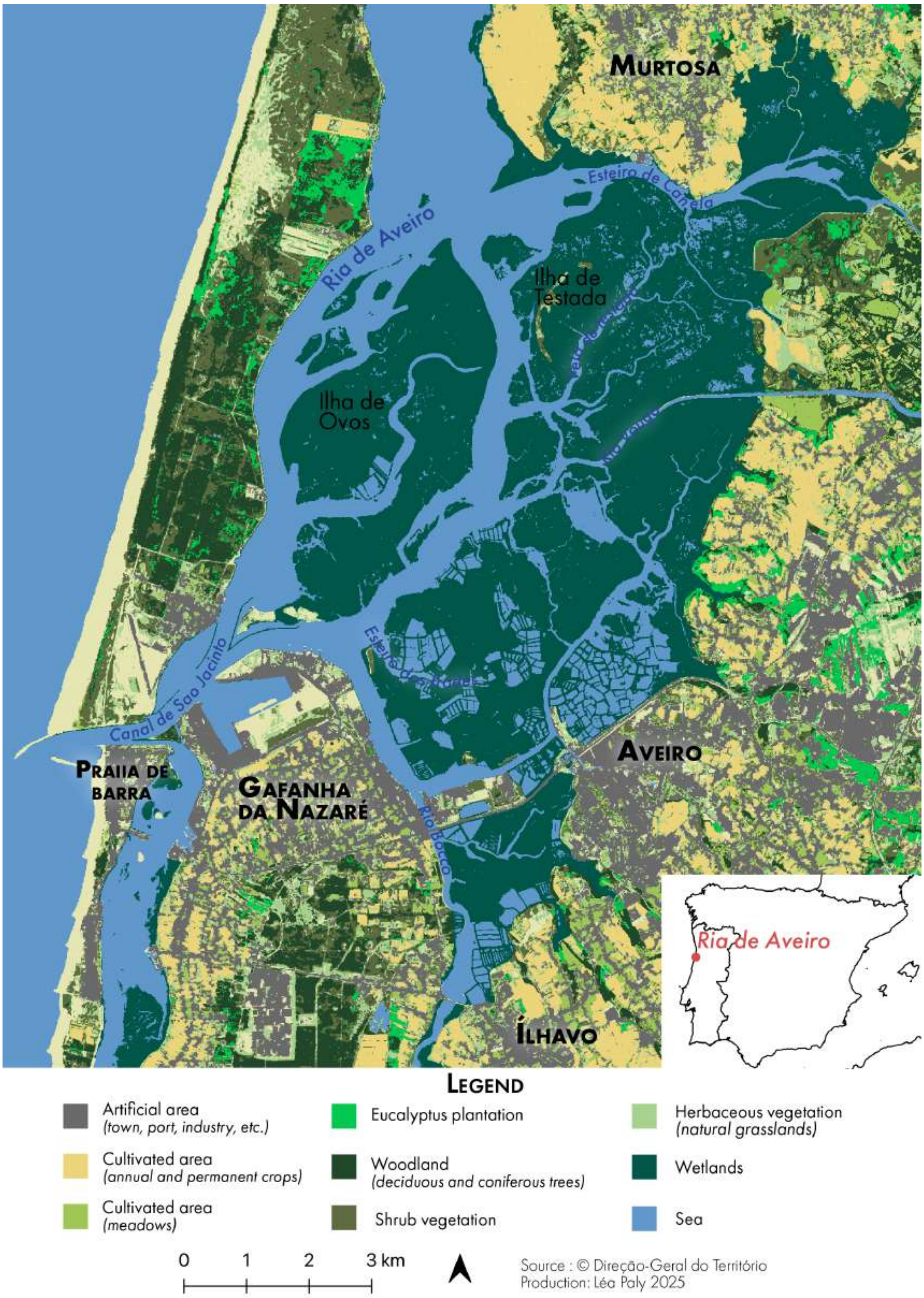

FIGURE 38: RIA DE AVEIRO (PORTUGAL)

The Ria de Aveiro is the estuary of the river Vouga closed by a sand belt with an inlet whose position has changed significantly over time. In the 18th century, the maps collected depict a coastal lagoon that was used for salt production while its surroundings are used for agriculture. The ria was also dominated with saltmarshes. Agricultural development has been notable since the 13th century, along with significant salt production activities (Tavares, 2021). Ria de Aveiro was also a place of coastal merchant shipping since the 15th century. Despite fishing activities, the region remained predominantly agricultural until the mid-18th century, with low urban development based on maritime activity remaining (Tavares, 2021).

During the 19th century, efforts was made to stabilize the entry of the ria de Aveiro and the dune belt. Later, connection to the dune led to its urbanization.

Figure 39,Figure 40,Figure 41,Figure 42 andFigure 43 showcase the first historical maps from the 18th and the 19th centuries which have been georeferenced for detailing spatially the landscape and waterscape trajectory for the Ria de Aveiro.

FIGURE 39: MAP OF THE RIA DE AVEIRO IN 1753 : "CARTE PARTICULIERE DES ENVIRONS DE AVEIRO DEPUIS LA RIVIERE DU VOUGA JUQSQU'A LA NOUVELLE BARRE"

FIGURE 40: TOPOGRAPHICAL MAPS OF RIA DE AVEIRO OF 1813

FIGURE 41: SKETCH OF THE PLAN OF BARRA IN 1843

FIGURE 42: HYDROGRAPHICAL MAPS OF RIA DE AVEIRO AND ITS DUNE IN 1887

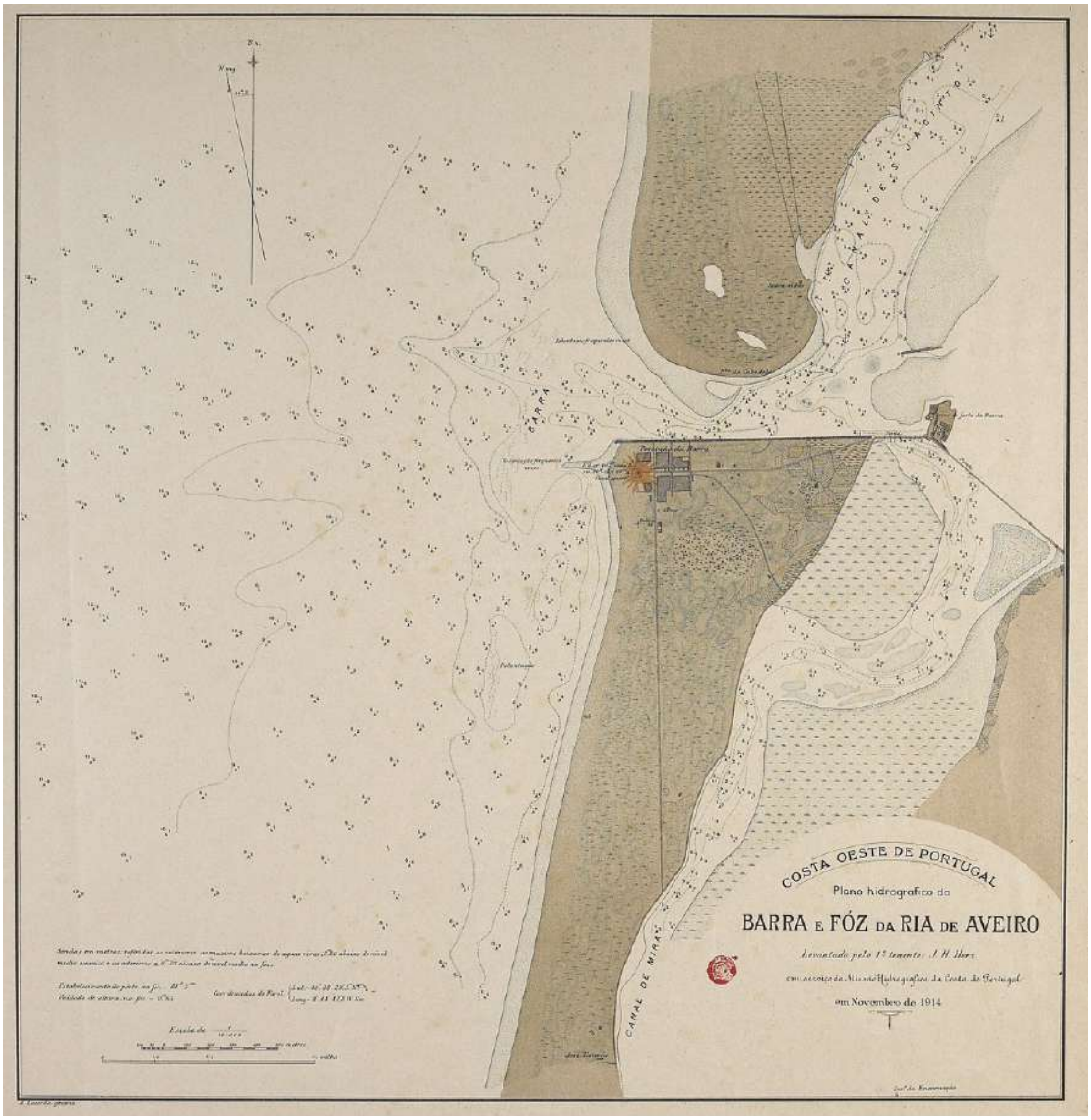

FIGURE 43: BATHYMETRIC MAPS OF THE ENTRY OF THE RIA DE AVEIRO : BARRA E FOZ DE RIA DE AVEIRO IN 1914

The ria de Aveiro is a multifunctional area with an economy mainly based on tourism but also on agriculture, fishing and shellfish production. Salt production has significantly declined since the 19th century: while 351 saltpans were in operation in 1865, only seven remained by 2021 (Amorim, 2023). These remaining saltpans are now part of heritage conservation efforts aimed at protecting the area's cultural and historical significance. Through touristic and territorial dynamics let to its renewal through patrimonialization processes (Hueso-Kortekaas et Carrasco-Vayá, 2024).

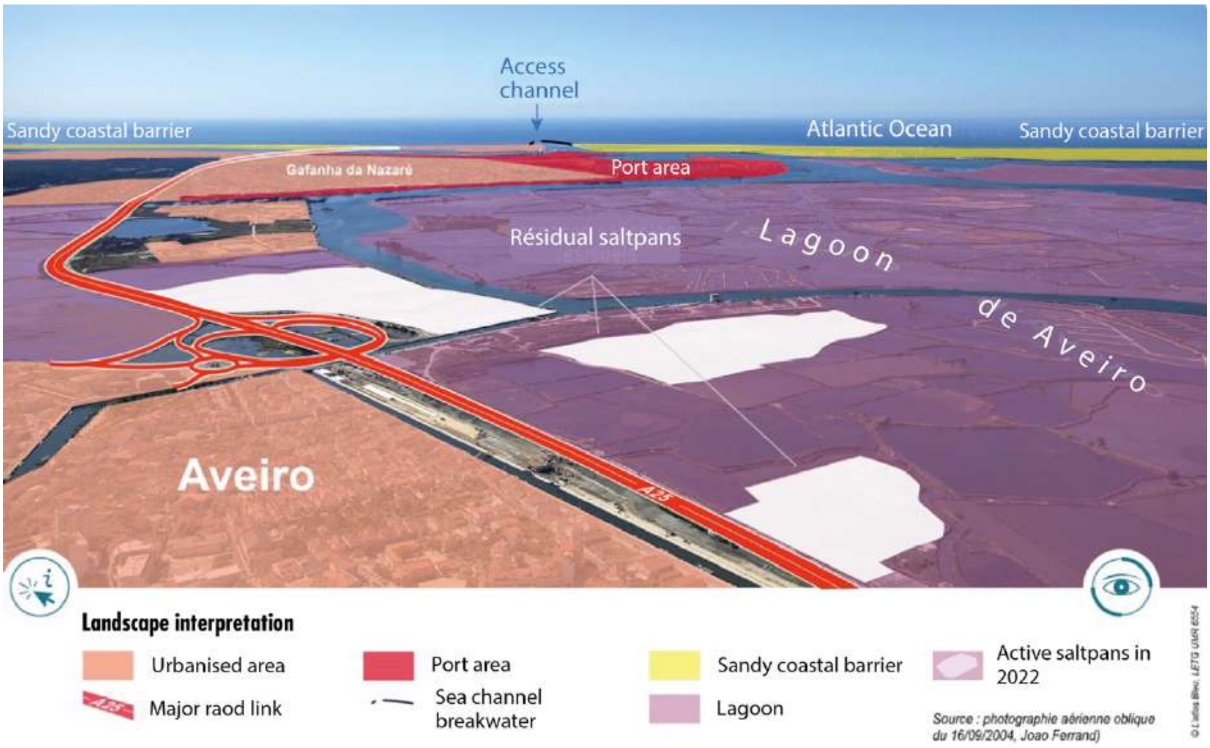

FIGURE 44: CURRENT LANDSCAPE OF THE RIA DE AVEIRO WITH THE REMAINING USED SALT PANS (SOURCE : ©AMORIM, 2023, L'ATLAS BLEU, LETG UMR 6554, TRANSLATION FROM FRENCH : LÉA PALY)

Even if the landscape trajectory for Ria de Aveiro is currently under investigation, a preliminary analysis of historical and contemporary maps suggests that specific drivers of change, such as saltpan production, shellfish farming, and dune dynamics, are likely to play a significant role. These drivers will complement the list of key factors already identified for the Loire estuary and the Essex estuaries, contributing to a broader understanding of the processes shaping coastal wetland evolution.

7 Discussion, perspectives and next steps

7.1 Overall Discussion

The preliminary results reveal distinct landscape trajectories across the three Demonstrator Sites which were investigated. These differences can be attributed to the unique geomorphological characteristics of each site, as well as to the varying cultural contexts that have shaped wetland use practices (such as the development of oyster beds).

However, when examining the drivers of change, some common patterns emerge. Firstly, across the three DMs, wetlands have been used for food production, either through fishing or agriculture. That led to the domestication of nature through land reclamation or saltpans creation and management. It has shown a relationship of struggle, adaptation, and benefit between humans and the sea. During the 20th century, communities and traditional practices began to change with the emergence of tourism (Essex estuaries, Loire estuary...) or industrial development (Loire estuary). In the Ria de Aveiro, both types of development occurred at different times. First, in the late 19th century, industrial development expanded with improvements in navigation and led to urban sprawl. Then, in the mid-20th century, the tourism economy emerged, accompanied by conservation efforts for salt marshes and saltpans.

Local scale analysis on the Blackwater estuary and Loire estuaries contribute to understanding the chains of dependency in the landscape, specifically landscape dynamics such as the loss of habitats that have triggered patrimonialization processes.

This is true for the Loire estuary: the loss of habitats due to the industrial port expansion that prompted the establishment of nature protected areas. This is also linked to increased awareness and the development of legal and regulation frameworks for nature protection. On the Blackwater estuary, the recognition of coastal squeeze led to efforts to protect salt marshes and even their restoration through managed realignment, such as at Abbotts Hall. Such efforts are still been currently negotiated in Loire estuary, especially for Corsept and Lavau marshes.

On both sites, rewilding projects (either completed or ongoing) are linked to the existence of landholding structures, either public or private land ownership, that focus on nature conservation, such as trusts in UK (Essex Wildlife Trust, RSPB, etc.) and the Conservatoire du Littoral in France. On the ria de Aveiro rewilding processes is more spontaneous due to saltpans abandonment.

7.2 Revealing past and current drivers of change in landscape trajectories toward coastal rewilding

Understanding the drivers of change is essential for analyzing rewilding processes in coastal areas, particularly in historically anthropized landscapes. These drivers are diverse, span multiple temporalities, and intersect with ecological, socio-economic, and regulatory dynamics. In rewilding contexts, they act either as pressures prompting degradation or abandonment, or as levers enabling ecological restoration and revaluation.

The two following boxes (Figure 45 and Figure 46) sum up the drivers of landscape change and trajectories for Loire estuary and for Essex estuaries complex, by differentiating past drivers that evolved over time since the last two or three centuries and current drivers of change that emerged since the last decades (mostly related to nature conservation or tourism).

BOX 1. Loire estuary	✓ Drivers of Change
Past Drivers of change	
Environmental drivers	✓ Storms ✓ Coastal flood risks ✓ Mudflats development (preventing water circulation from the wetlands)
Economic drivers	✓ Livestock farming and grazing ✓ Mowing for hay ✓ Cropland development ✓ Coastal tourism development and expansion (urbanization) ✓ Navigation development driven by the size of ships ✓ Harbor and industrial development
Political / institutional drivers	✓ Industrial and shipping national policy ✓ Key nature conservation landowners (Conservatoire du Littoral) ✓ Nature conservation and landscape protection frameworks (Loi Littoral, Natura 2000)
Technological drivers	✓ Dredging ✓ Hydrosedimentary control and management ✓ Agriculture intensification and consolidation ✓ Water management through drainage techniques ✓ Connection by the railway and by bridges
Socio-cultural drivers	✓ Hunting development (creating ponds) ✓ Awareness about nature conservation and opposition to industrial development
Current Drivers of change	
Environmental drivers	✓ Sea level rise ✓ Coastal flood risks
Economic drivers	✓ Industrial development ✓ Coastal tourism ✓ Urban sprawl ✓ Nature-based tourism (birdwatching...) ✓ Ecosystem services valuation ✓ Decline of traditional agriculture practices
Political / institutional drivers	✓ Nature conservation regulation framework (Natura 2000) ✓ Key nature conservation landowners (Conservatoire du Littoral)
Technological drivers	✓ Dredging ✓ Hydrosedimentary control and management
Socio-cultural drivers	✓ Little awareness of realignment strategies ✓ Agricultural heritage and attachment to farmland landscapes

FIGURE 45: PAST AND CURRENT DRIVERS OF CHANGE FOR LOIRE ESTUARY (DM6)

BOX 2. Essex estuaries complex	✓ Drivers of Change
Past Drivers of change	
Environmental drivers	✓ Storms (especially 1953 storm surge) ✓ Coastal flood risks ✓ Saltwater invasion of agricultural land
Economic drivers	✓ Sheep grazing (cheese production) ✓ Growth in the consumer market for oysters ✓ Good agricultural land value ✓ Cropland development and demand ✓ Coastal tourism development and expansion (urbanization, marinas...) ✓ Gravel extraction
Political / institutional drivers	✓ Regulation framework for enhancing drainage ✓ Lack of dike management (increasing cost of maintenance) ✓ Key nature conservation landowners (RSPB, Essex Wildlife Trust)
Technological drivers	✓ Oyster beds techniques ✓ Local drainage techniques (18th) ✓ Enhancement of new drainage techniques (19th) ✓ Connection by the railway ✓ Maintenance of sea defenses ✓ Reinforcement of coastal defenses (reform after 1953)
Socio-cultural drivers	✓ Hunting development ✓ Awareness about coastal squeeze
Current Drivers of change	
Environmental drivers	✓ Sea level rise ✓ Coastal flood risks
Economic drivers	✓ Coastal tourism ✓ Nature-based tourism (birdwatching...) ✓ Gravel extraction ✓ Ecosystem services valuation
Political / institutional drivers	✓ Nature conservation regulation framework (Natura 2000, SSSI...) ✓ Key nature conservation landowners (RSPB, Essex Wildlife Trust) ✓ Role of DEFRA (Environment Agency) ✓ Shoreline management plan
Technological drivers	✓ Coastal engineering for managed realignment (dike breaching, shoreline design)
Socio-cultural drivers	✓ Gradual public acceptance of realignment (initial resistance, evolving views) ✓ Agricultural heritage and attachment to farmland landscapes

FIGURE 46: PAST AND CURRENT DRIVERS OF CHANGE FOR ESSEX ESTUARIES COMPLEX (DM3)

Historically, extractive and productive uses such as land reclamation for agriculture, gravel extraction, and the exploitation of oyster beds and salt pans have deeply shaped coastal ecosystems, often leading to habitat degradation. However, the decline of traditional economic activities since the mid-20th century (e.g., oyster farming, salt production) has resulted in widespread land abandonment, creating new opportunities for passive rewilding, spontaneous succession, or conservation-led restoration. At the same time, urbanization pressures, especially from secondary housing and the shift to a residential and tourist economy, have transformed land uses and landscape perceptions. This change has been contested and regulated through planning instruments and heritage policies (e.g., coastal protection laws, flood risk prevention zoning, nature conservation regulations), which now act as drivers of ecological preservation or restoration.

In recent decades, tourism—both mass and nature-based—has become a powerful landscape driver. Coastal marinas, promenades, and tourist infrastructures have altered landforms and visual identities, while birdwatching and nature-based tourism have encouraged habitat restorations (e.g., island nesting sites within managed realignment projects) and educational infrastructure (visitor centers, footpaths). This shift reflects a changing imaginary, where previously marginal or utilitarian wetlands are revalued as emblematic "natural" spaces.

Additionally, extreme weather events and the memory of storm-related risks (e.g., coastal flooding) have influenced public perceptions and policies, accelerating managed realignment and ecological compensation strategies (e.g. in Essex estuaries), often under the framework of "coastal squeeze." The disappearance of key species or habitats has similarly justified rewilding projects, underpinned by regulatory and compensatory policies.

Finally, grassroots environmental movements and local contestations have played a key role in shaping trajectories of nature conservation (e.g. In Loire estuary) and rewilding, resisting development pressures, and promoting community-based conservation initiatives. These movements often intersect with broader discourses on ecological identity and the reconnection of people with natural coastal dynamics.

Together, these drivers—economic, socio-cultural, institutional/regulatory, technological, and environmental/climatic—form a dynamic system of interactions that both challenge and enable rewilding in coastal zones. Mapping their chronological articulation and relative influence is crucial for understanding site-specific trajectories and for drawing comparative insights across different managed realignment projects and various practices of coastal rewilding. By characterizing past and current drivers of change for the two first investigated Demonstrator Sites and using knowledge on the other DMs' environmental histories that just started, Figure 47 is an attempt to inventory and to merge all possible and potential drivers. We do not differentiate here between past and present/current drivers, as chronologies and timelines may vary from one DM to another. However, we try to categorize them and understand their links to a typology of coastal rewilding practices: from spontaneous rewilding, to passive rewilding, trophic rewilding or active rewilding (Figure 47). This summary and overview figure will be reviewed, improved and completed when all environmental histories will be collected and investigated.

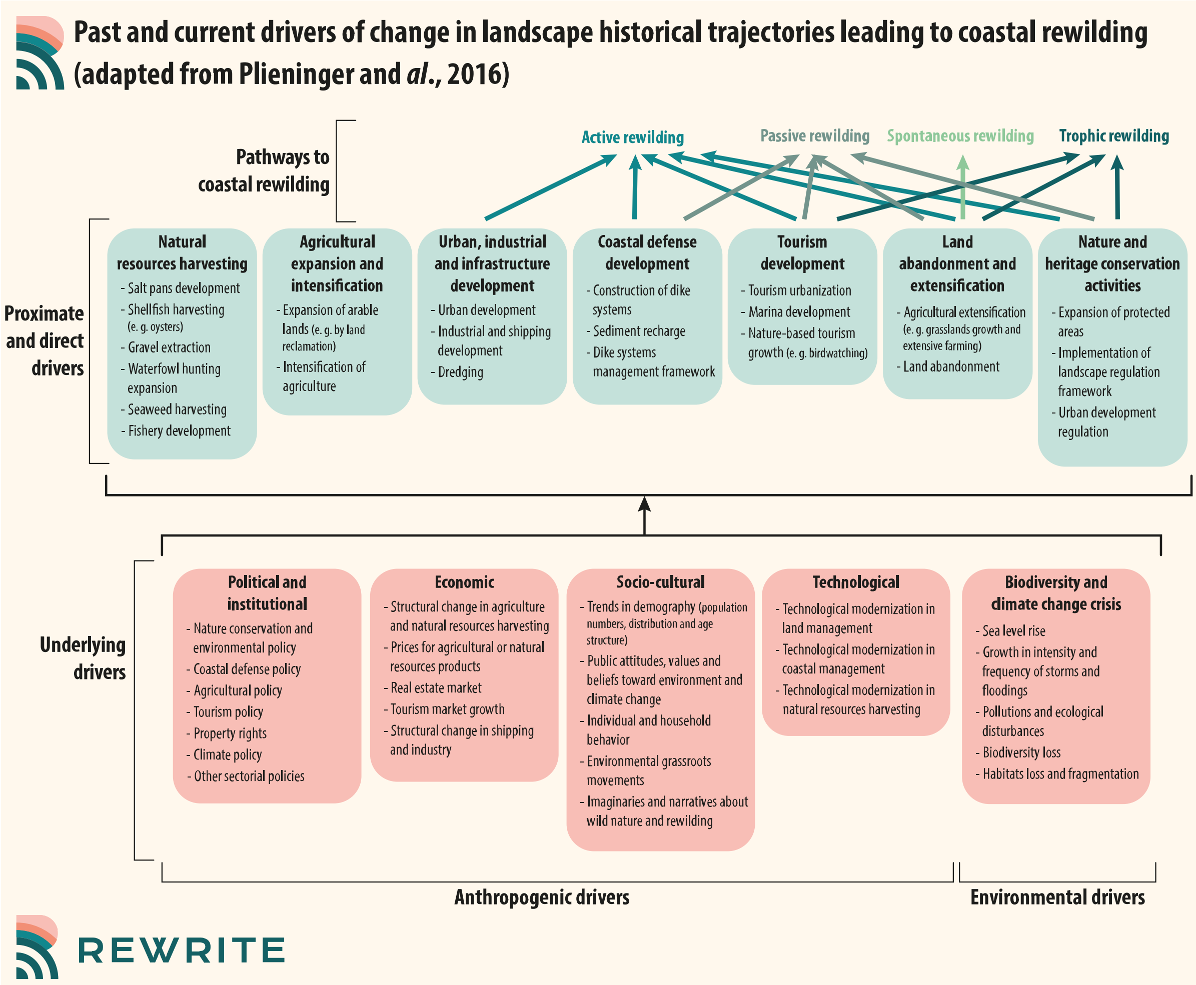

FIGURE 47: PAST AND CURRENT DRIVERS OF CHANGE IN LANDSCAPE TRAJECTORIES LEADING TO COASTAL REWILDING (ADAPTED FROM PLIENINGER AND AL., 2016)

7.3 Next steps toward final report

These preliminary results already allow to uncover socio-cultural, political and economical roots of coastal landscape and to identify major periods and turning-points in landscape change and evolution. By pointing out the related historical (e. g. agriculture development an associated land value for reclamation, industry, trade and shipping development, tourism…) and current drivers of change (e.g. shifts in economic values, new regulations for nature conservation, ecological compensation…), it is then possible to better highlight and understand the local/global contexts of past and current ecological restoration and rewilding projects. Doing so, coastal rewilding opportunities and readiness can be mapped locally.

This ongoing work will be continued at three different levels. First, both same methodology and approach will be used to investigate environmental histories through landscape trajectories for the other DMs, probably by continuing with the Wadden Sea (DM2), then the Cadiz Bay (DM8), the Scheldt

Estuary (DM5), the Dublin Bay (DM4), Gyldensteen coastal lagoon (DM1) and Bay of Fundy (DM9). This will enable to build broader comparisons and understandings. Secondly, environmental histories will be completed by additional historical data (archival research) especially for Ria de Aveiro (DM7) where we need to investigate the small scale locally. This need will no doubt arise also for other DMs. Thirdly, gathering environmental and historical data and knowledge will also be completed by the contribution of WP3 (task 3.2, 'Narratives of change'). The planned fieldwork starting in May 2025 will help enhancing this landscape trajectory approach by providing local stakeholders' and users' narratives of changes, which will enable to understand landscape evolution and potential conflicts over land use or nature conservation.

Two main challenges still also remain. The large scale and perimeters of the DMs are an ongoing difficulty and an issue. In other words, the larger the scale, the greater the amount of historical data to be processed, and at the same time, the lower the accuracy for delivering comprehensive maps. The implemented methodology also relies on the availability of sufficient and usable historical maps, and at best already georeferenced and online historical data. These conditions do not always apply for all DMs (e. g. DM7, DM8…). In that case, needed on-site archival research and digitalization and georeferencement can take more time than expected and provided by the dedicated time resources. This can lead to delays and challenges to provide the full qualitative analysis for all DMs.

Nevertheless, for each DM, large and small scales are systematically designed with DMs leaders to align with other tasks and fieldworks to allow a multidisciplinary approach. Various forms of iconography (diachronic maps, chronological timelines…) are presented in this report, but will be refined in order to deliver easy-to-read maps or documents which will be used in WP4 for implementing the local-MALs as well as landscape drawings or 3D-visualizations that can be produced from the environmental histories collected here.

Table of figures

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