Interreg North Sea

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MANABAS COAST

Baseline Assessment for all pilots

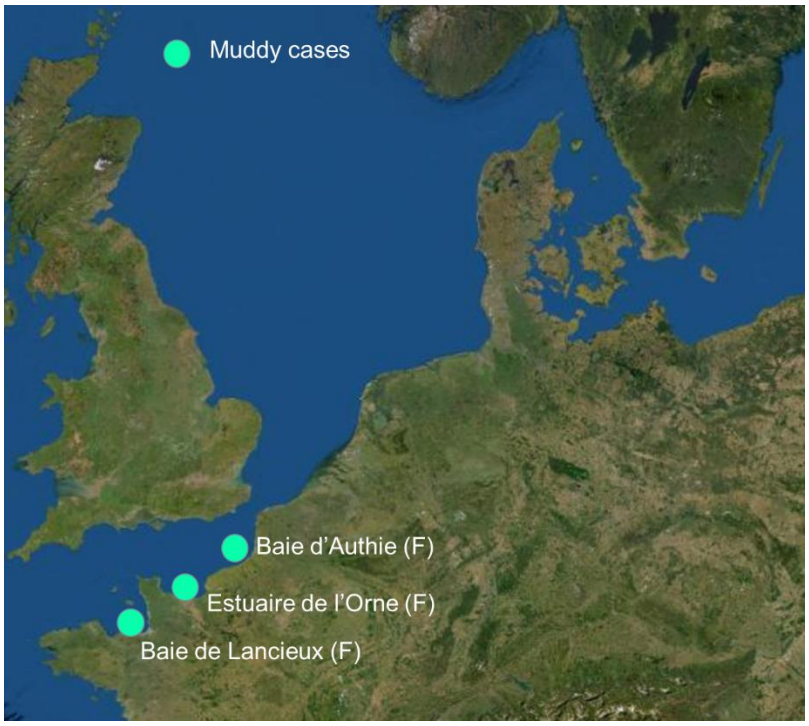
An initial activity of WP2 is a description and baseline assessment of each study pilot that will be used as the baseline to assess progress during the project and can aid in the future cooperation between the study pilots. The assessment also serves to establish the status of mainstreaming of NbS into the pilots. The assessment survey is divided up into three parts: 1) Description of the pilots, 2) Questions concerning how the enablers are currently addressed in the pilots, and 3) Brief questions about the MANABAS framework (inspired by ISBAM).

Part 1: Pilot description

Our aim is to mainstream nature-based solutions on the different coasts of northwest Europe. Therefore we need a description of the coastal system. This is divided into two sections: A) description of the coastal (natural) system of the pilot, and B) description of the governance system.

Name of pilot : Conservatoire du littoral

Location of pilot : north coast of France, along the chanel.



Orne Estuary

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Lancieux Bay

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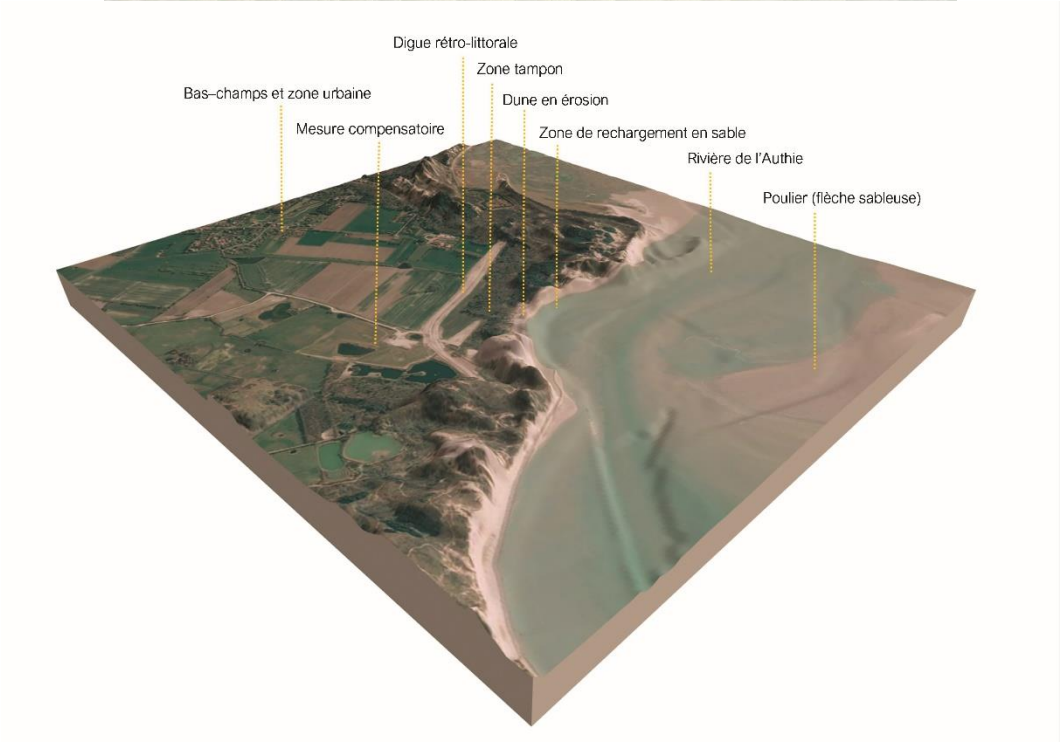
Authie Bay


Digue rétro-littorale
Zone tampon
Bas-champs et zone urbaine
Dune en érosion
Mesure compensatoire
Zone de rechargement en sable
Rivière de l'Authie
Poulier (flèche sableuse)

Please include a satellite map/orthophoto or aerial photo of the area in order to see vegetation, houses, gully's. bars etc. Provide coordinates for the center of the map and the corresponding coordinate system

Pilot aims/objective:

The Conservatoire's objective in supporting the MANABS experiment is manifold.
Firstly, it aims to extend the Adapto experience and maintain a technical presence among the designated local authorities, to ensure that they are aware of the issue and take it on board.
The other fundamental objective is to demonstrate, by example, the efficiency of NBS in the necessary adaptation of coastal territories to current changes (particularly climate change).
The overall objective can be summed up by the notion of appropriating NBS as the most efficient, least costly and most resilient technical solution for implementing long-term adaptation.

Which nature-based solutions will you be working with in MANABAS?
Reinforce the role of natural coastal spaces at the land-sea interface as the key to adapting territories subject to coastline erosion and marine submersion.
Avoid hard protection and favor NBS, supporting the restoration of functional estuarine ecosystems by anticipating the need for spatial recomposition and management realigment.
Ensure that land is ready for change, so that people are aware of the changing nature of the coastline and its landscape quality.

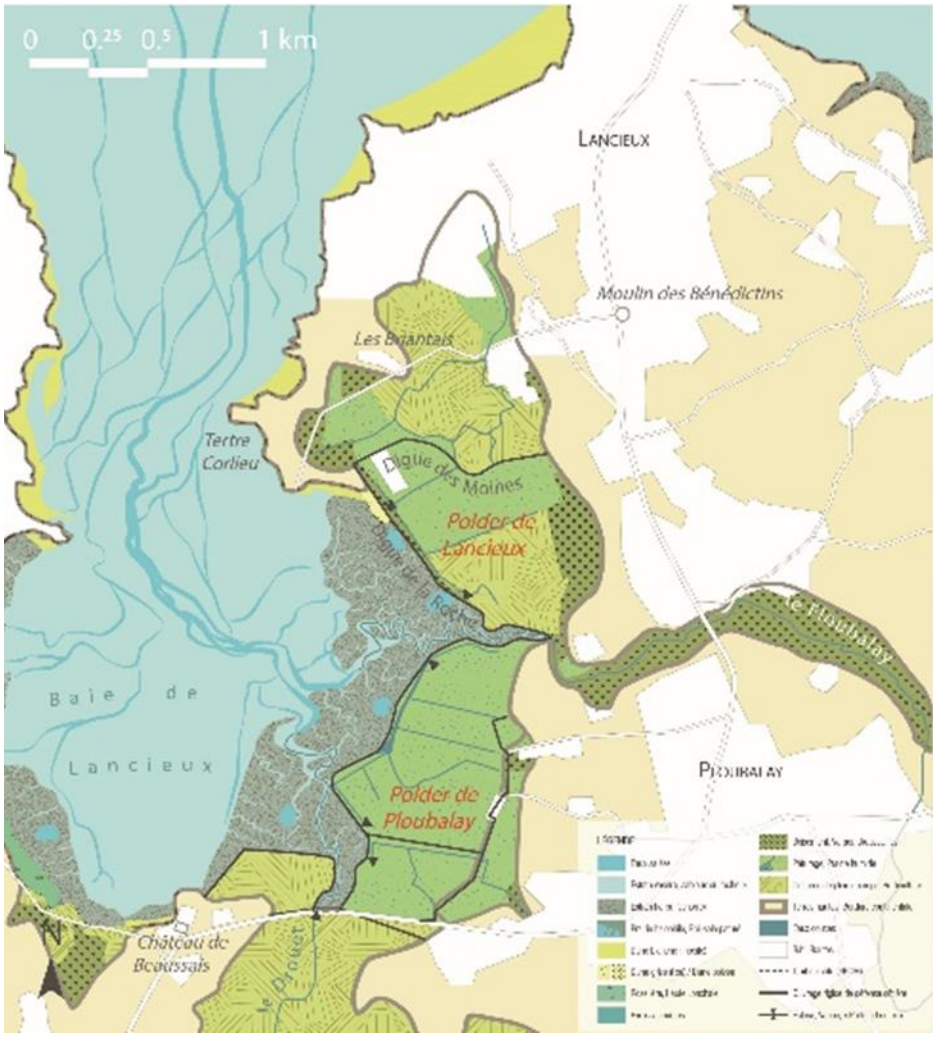
a. Description of the coastal system

Please briefly describe those areas that are relevant for your pilot:

1. The landscape including geology, morphology, and biology.

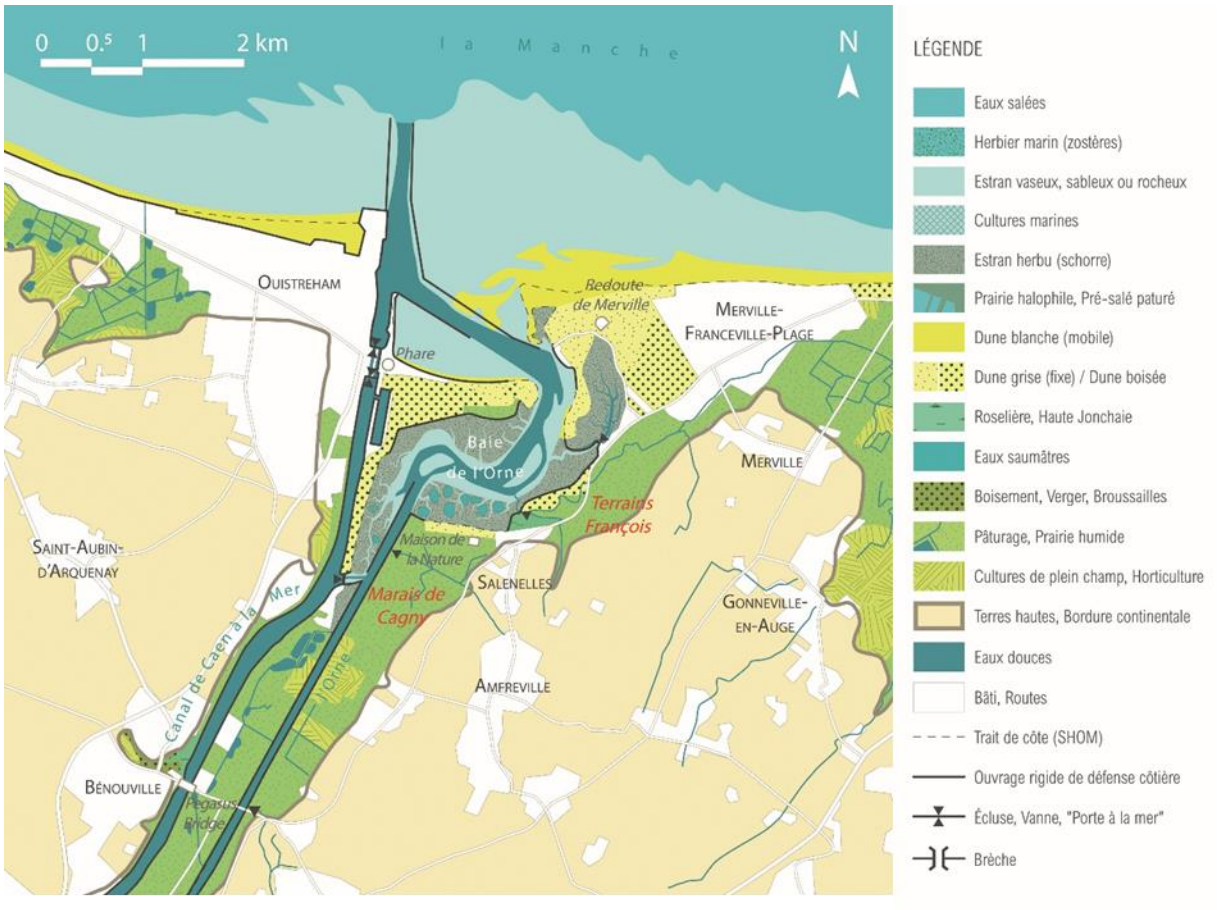
Lancieux :
210 ha of polders before reconnection–progression of salt marshes (46 ha in 1952 – 71 ha in 2015 - average annual colonization rate of over 4,000 m²) - Most of the coastline is fixed by dikes, or by the rocky coastline. At Briantais beach, the coastline is even advancing, as evidenced by the front of oyat vegetation that has progressed along the foreshore since 1952.
Historically, the land in the Bay of Lancieux was reclaimed from the sea by dikes, mainly for agricultural use. Since 1980, the site has been gradually reclaimed. Initially, the restoration of the Tertre Corlieu dune allowed it to evolve freely. On the polders, ploughed plots are gradually being converted to grasslands more resilient to marine intrusion. The recent ma-rine reconnection of the Ploubalay polder illustrates these new landscapes and natural habitats changing with the flow of water.

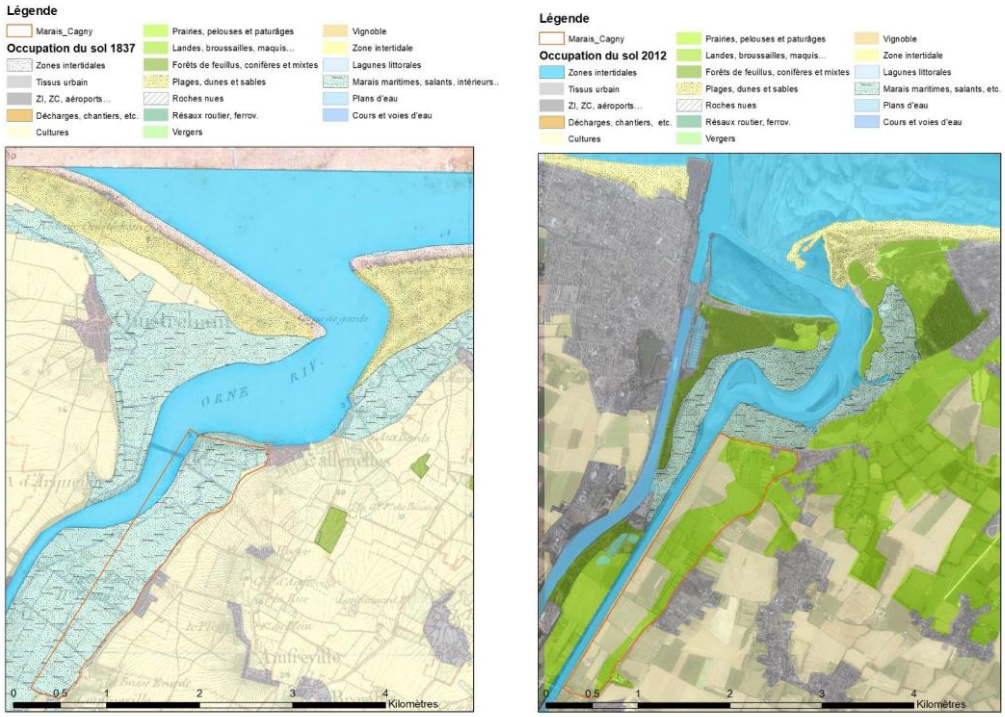
Coordinates of the region, based on google maps spans between
48.605425, -2.157426 and 48.576976, -2.166717



Orne :
Estuary length of 16 km - Area of the estuary: 10 km2 - 5,800 ha in a flood zone
A sandy estuary, with its interior entirely canalized by dykes, a defensive structure at the head of the estuary at Pointe du Siège, and a dam at the bottom of the estuary to feed the canal and prevent tidal intrusion into the city of Caen. Only the eastern shore (Mer-ville-Franceville coastline) is still "natural" and free-flowing. To the west, the Ouistreham sea-front comprises an accreting beach with no defensive structures, as the sedimentary tran-sit is blocked by the ferry terminal. Stable presalt. Between Caen and the sea, the Orne es-tuary was considerably altered by the creation of the canal in 1857. Downstream of the Montalivet barrage (Caen), tidal marshes now account for only 1/5th of the river's length. The Cagny marsh dike gave way in 2011 (due to be breached in 2020), resulting in flooding of low-lying areas.

MANABAS COAST





Evolution of morphology, land use and anthropization of the Orne estuary and its margins between 1837 and 2012 (left: land use 1837: BRGM; topographic map of 1837; right: modified Corine Land Cover, ortholittoral v2 background).

Coordinates of the region, based on google maps spans between 49.292851, -0.230726 and 49.179944, -0.345494

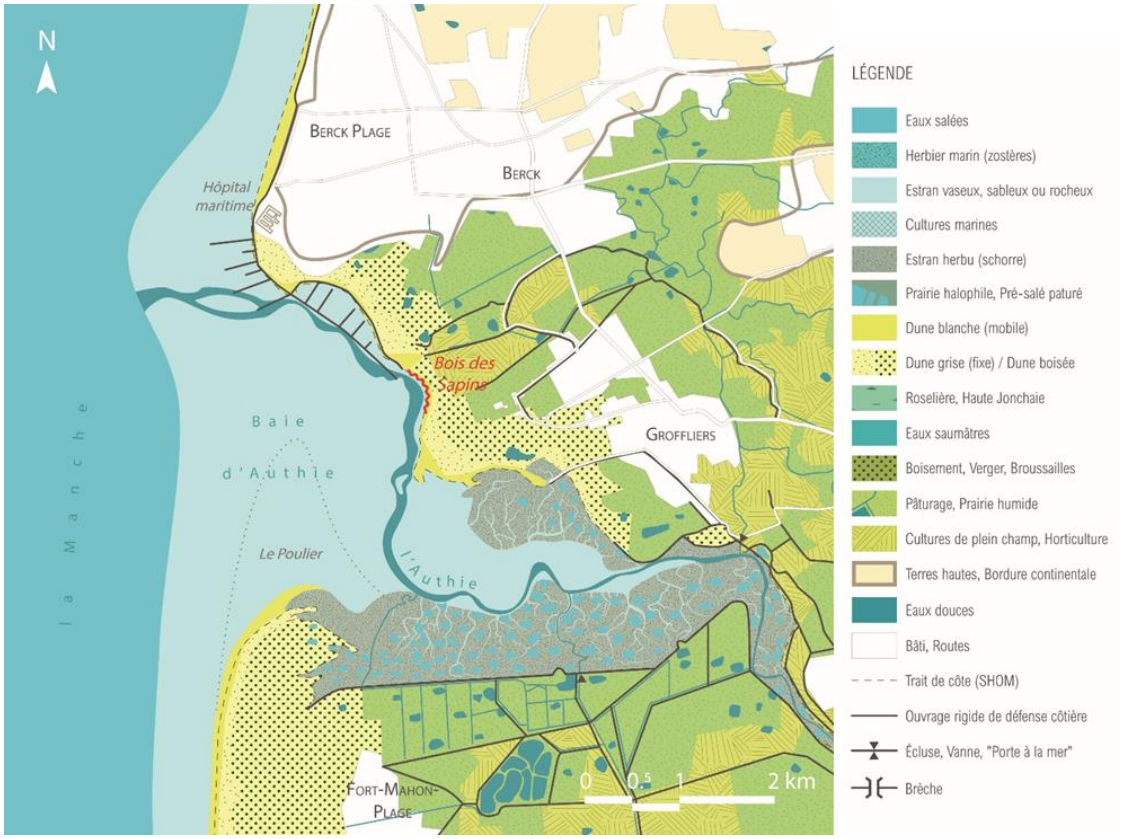
Authie :

Area of the estuary: 12 km2 (30 km2 including dunes and polderized marshes) - 5,000 ha in a flood zone

The bay functions asymmetrically, with the sandy river to the south becoming fatter and half-greater towards the north, resulting in a rise in the seabed and a progression of schorre along the entire south shore. The corollary of this phenomenon is the northward displacement and narrowing of the Authie and tidal channels, subjecting the north shore to severe erosion. Since the mid-nineteenth century, the north bank has been equipped with a number of structures to try and stem this phenomenon.

From the 13th to the mid-19th century, as the ship's sails advanced, farmland was gradually reclaimed from the salt meadow by building dykes to form polders. With each new conquest of the sea, new dikes replaced the old ones. Today, this network of dikes helps to limit the spread of water in the event of flooding. In 1960, the dune was fixed by the planting of Bosi des sapins and the construction of lot of defensive structures (groins, submersible dykes, etc.). In 1985, a storm breached the dyke on the southern shore, flooding 400 hectares. Since 1990, erosion has shifted to the Bois des Sapins area, the sandy spit to the

south has continued to advance and the salt meadow surface is slowly filling in the bay. In this way, the sea and the Authie River continuously shape the coastline.



Coordinates of the region, based on google maps spans between
50.401256, 1.555753 and 50.336326, 1.655574

Biology :
Estuarine habitats provide the following functions for fish and birds at these 3 sites: feeding, nursery, spawning grounds, reproduction, diadromy, etc.

2. The hydrodynamic forcing from tide, water level, wind and waves. If possible, include some statistical values

- **Lancieux :**

Hydrographic parameters

Semi-diurnal macrotidal tide regime (tidal range over 4 m, two low tides and 2 high tides of similar amplitude per day). Exceptional spring tide range: 13 m to 13.5 m, 5 m in neap.

Tidal current speeds can exceed 3 knots3 offshore, and are generally less than 1.5 knots1 near the coast. Maximum tidal currents would exceed 3 knots1 at the entrance to the bay.

Numerical simulations confirm an acceleration of currents in the Narrows, but indicate a maximum speed of the order of just over 2 knots.

Due to the orientation of the bay, some wave beams may impact more directly on the Beaussais breakwater (up to 30 to 40 cm). It is precisely in this area of the dike that chronic erosion of the dike has been observed and the breach created.

Ultimately, wave conditions have little influence on the flooding that can occur in the Bay of Lancieux, apart from the erosive effects that could cause a breach in the polder dikes.

	Water level m NGF
HAT Highest Astronomical Tide	7.12
MHWS Mean High Water Springs	
MHWN Mean High Water Neaps	
MSL Mean Sea level	0.43
MLWN Mean Low Water Neaps	
MLWS Mean Low Water Springs	
LAT Lowest Astronomical Tide	-1.5

Water level during storms

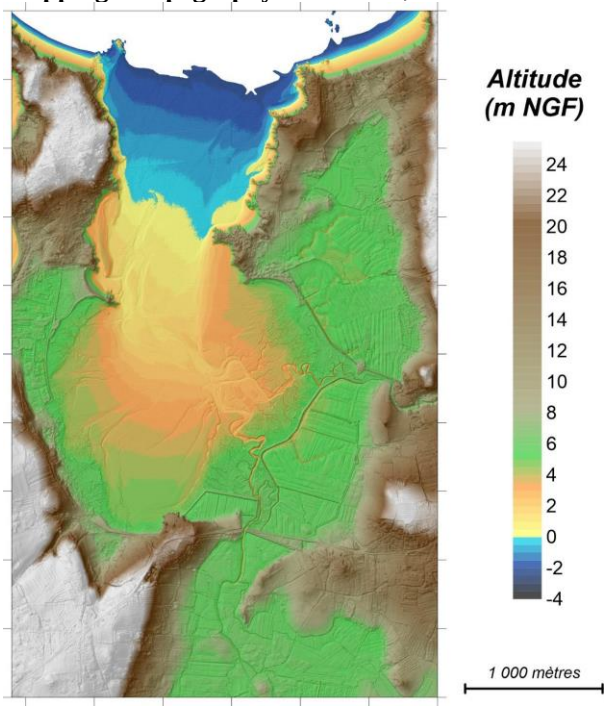
Return period	m NGF
10 years	7.3
100 years	7.55

Forecast of high water levels at Les Hébihens as a function of tidal coefficients over the period 2006-2015

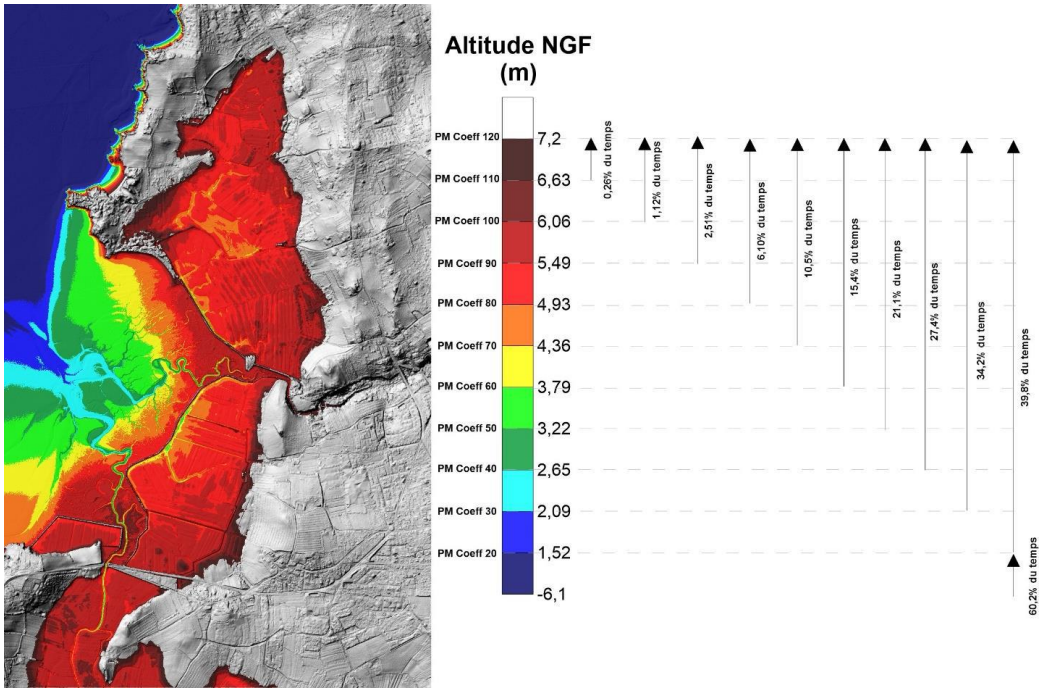
Coefficient	PM_NGF	BM_NGF	Marnage
20	1.518	-0.833	2.351
30	2.086	-1.359	3.445
40	2.654	-1.885	4.539
50	3.222	-2.411	5.633
60	3.79	-2.937	6.727
70	4.358	-3.463	7.821
80	4.926	-3.989	8.915
90	5.494	-4.515	10.009
100	6.062	-5.041	11.103
110	6.63	-5.567	12.197
120	7.198	-6.093	13.291

At left selection of high and low water levels and representative tidal ranges by tidal range decile (right).

Mapping of topography in m NGF ;



Mapping of potential submergence durations estimated according to high water levels and tidal coefficients



- **Orne :**

Hydrographic parameters

Storm Xynthia hit Calvados on February 28, 2010, causing extensive property damage. A maximum sea level of 4.38 m NGF was recorded at the Ouistreham tide gauge during the storm. The downstream crest of the Amfreville dike was below this level, resulting in marine submersion. The storm events of 1980, 2018, 2019 and 2020 had sea levels close to the low point (4.20 m NGF) of the dike. Only during the tide of November 15, 2020, were sea pack crossings recorded.
The maximum value for wave set-up is 30 cm.
The influence of discharge on water levels in the Orne estuary is negligible (concomitant flooding of the river - high sea level)

	Water level m NGF
HAT Highest Astronomical Tide	4.04
MHWS Mean High Water Springs	3.62
MHWN Mean High Water Neaps	2.32
MSL Mean Sea level	0.55
MLWN Mean Low Water Neaps	-1.38
MLWS Mean Low Water Springs	-3.08
LAT Lowest Astronomical Tide	-4.03

Water level during storms

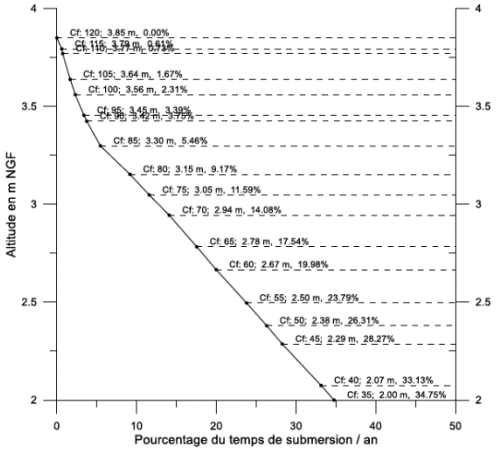
Return period	m NGF
10 years	4,58
20 years	4,61
50 years	4,69
100 years	4,78

Correlation table between tidal coefficients, mean high tide elevation (t0, circa 2030 = + 20 m sea level rise to 2030, circa 2050= + 40 m sea level rise to 2030) **and percentage of annual flooding time**

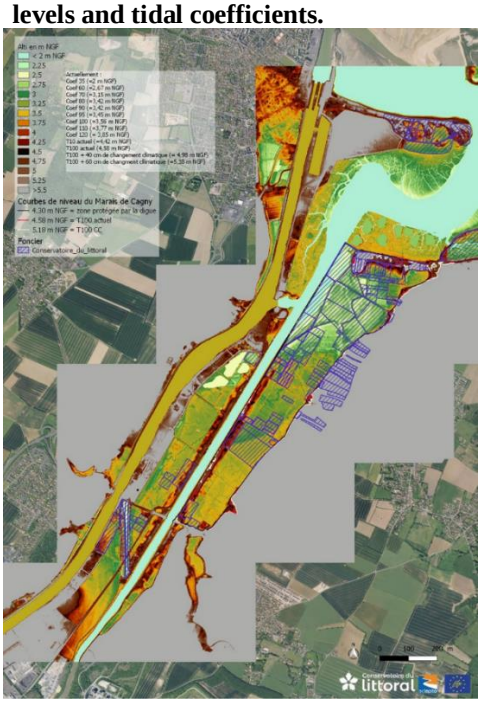
		Actuel	Circa 2030	Circa 2050	
Ouistreham	Coefficient	Elevation moyenne des PM (m NGF)	Elevation moyenne des PM (+0.2m)	Elevation moyenne des PM (+0.4m)	% temps de submersion
	35	2.00	2.20	2.40	34.95
	40	2.07	2.27	2.47	33.39
Morte-eau moyenne	45	2.29	2.49	2.69	28.48
	50	2.38	2.58	2.78	26.54
	55	2.50	2.70	2.90	23.99
	60	2.67	2.87	3.07	20.21
	65	2.78	2.98	3.18	17.76
Marée moyenne	70	2.94	3.14	3.34	14.31
	75	3.05	3.25	3.45	11.79
	80	3.15	3.35	3.55	9.42
	85	3.30	3.50	3.70	5.66
	90	3.42	3.62	3.82	3.88
Vive-eau moyenne	95	3.45	3.65	3.85	3.52
	100	3.56	3.76	3.96	2.40
	105	3.64	3.84	4.04	1.74
	110	3.77	3.97	4.17	0.81
	115	3.79	3.99	4.19	0.66
Vive-eau exceptionnelle	120	3.85	4.05	4.25	0.39

At left selection of high and low water levels and representative tidal ranges by tidal range decile (right).

Relationship between tidal coefficient, water level and hydro-periodicity (% immersion time per year)



Mapping of potential submergence durations estimated according to high water levels and tidal coefficients.

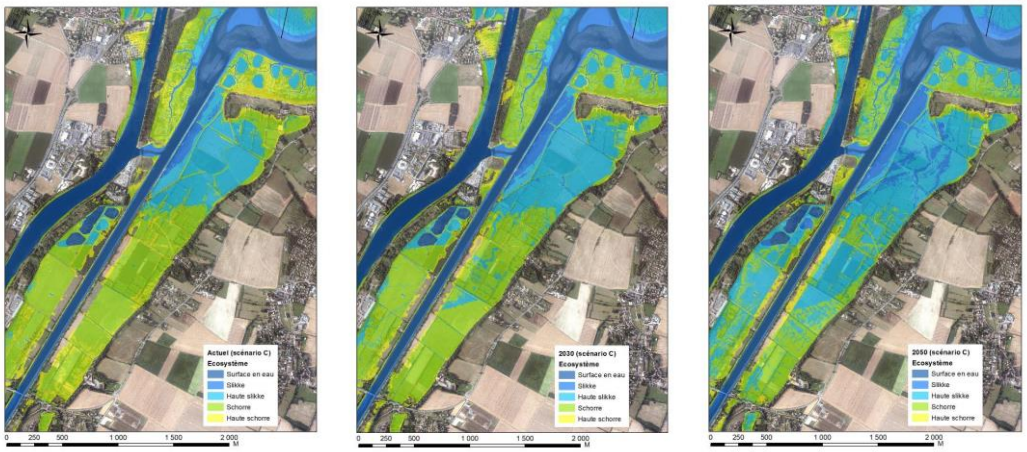


Zonation and tiering of estuarine vegetation in the event of reconnection

By mapping the limits of high tide at different coefficients, it is therefore possible to determine the boundaries between ecosystems. The coefficients used to define the boundaries between the maritime marsh ecosystems are :

Limite	Coefficient de marée
Slikke / haute slikke	45
Haute slikke / Schorre	70
Schorre / Talus Parhalien	95
Haut schorre / Supratidal	120

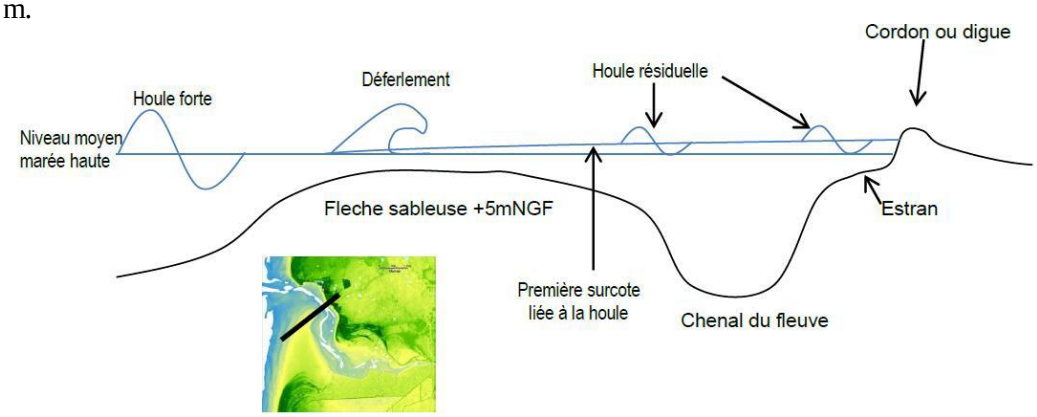
Potential evolution of ecosystem extension in the event of total opening of the Cagny marsh dike. From left to right: present, 2030 (+20 cm sea level rise), 2050 (+40 cm sea level rise).



- **Authie :**

Hydrographic parameters

The particular morphology of the Baie d'Authie, and in particular the presence of the sandy spit at the entrance to the bay, leads to the breaking of high swells and the generation of a wave setup that propagates throughout the bay. While the offshore swell is imposed at a height of 7.3 m, at the head of the bay and after breaking, the residual swell is less than 0.5 m.



Hundred-year swell fields (Hm0 = 7.3m, Tp = 11s, Dir =270°N, centennial level) and swell behavior on a South-West/North-East cross-section (axis shown on figure below) with identification of swell-related heights (from Artélia, PAPI BSA 2015).

	Water level m NGF
HAT	5.91
MHWS	5.12
MHWN	3.22
MSL	0.74
MLWN	-1.68
MLWS	-3.48
LAT	-4.34

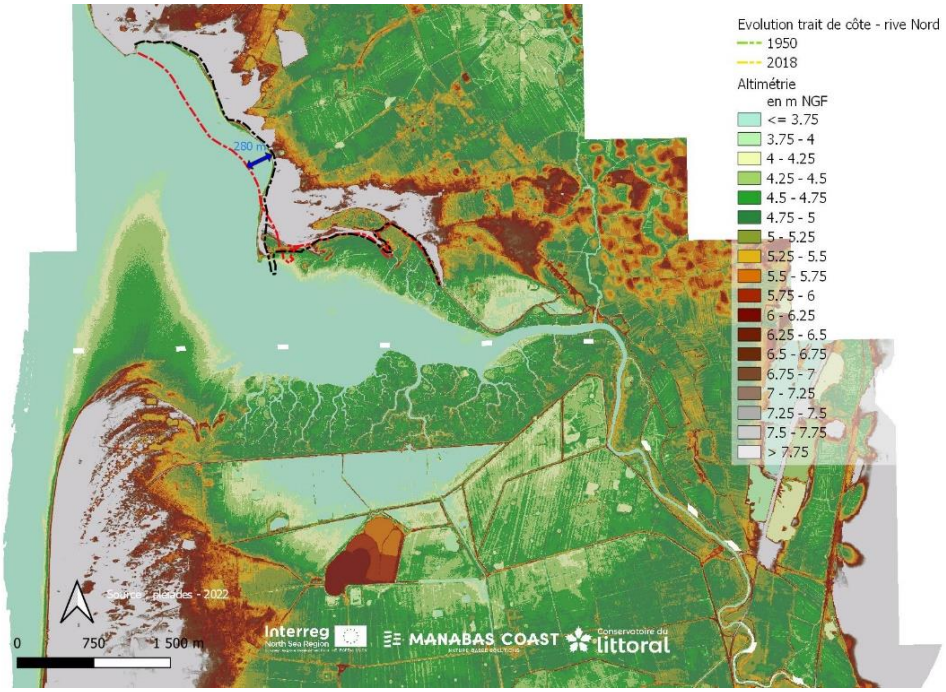
Water level during storms

Return period	m NGF
10 years	6.10
20 years	6.20
50 years	6.30
100 years	6.50

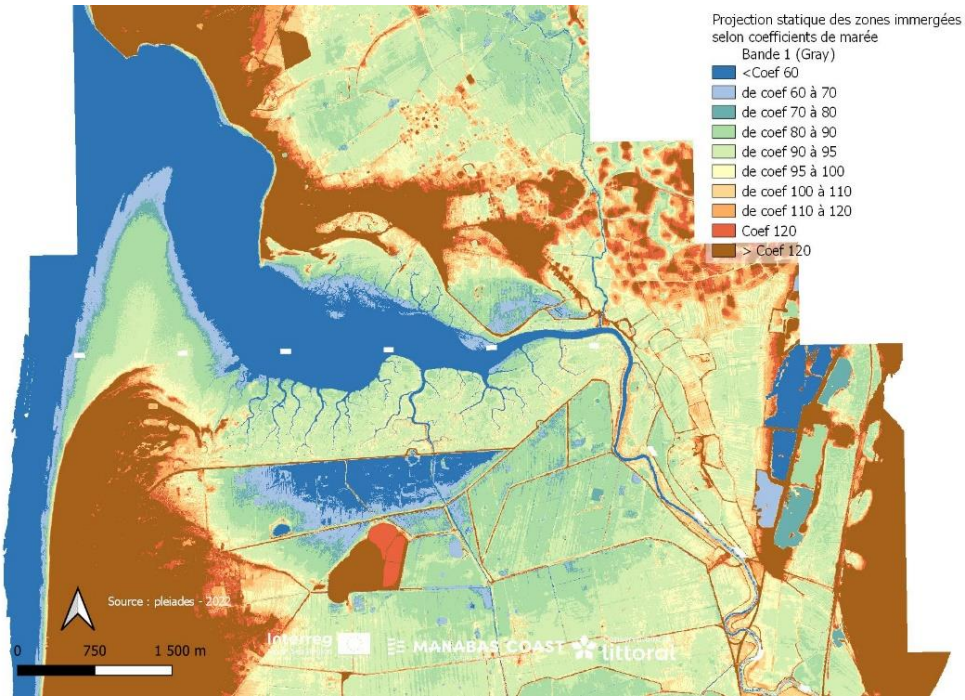
Current minimum, maximum and mean high water (in m NGF) according to tidal range for 2015 at Berck Plage - Fort-Mahon.

	Coefficient de marée	Moyenne des pleines mers (PM)	Maximale des PM	Minimale des PM
	36	2.79	2.87	2.71
	40	2.96	3.03	2.89
Morte-eau moyenne	45	3.26	3.39	3.16
	50	3.41	3.51	3.25
	55	3.63	3.72	3.54
	60	3.87	4.04	3.68
	65	4.04	4.17	3.84
Marée moyenne	70	4.18	4.28	4.07
	75	4.49	4.63	4.4
	80	4.61	4.81	4.41
	85	4.86	4.96	4.72
	90	4.96	5.08	4.83
Vive-eau moyenne	95	5.12	5.27	4.98
	100	5.34	5.34	5.34
	105	5.43	5.45	5.42
	110	5.58	5.62	5.53
	115	5.73	5.77	5.68
« Vive-eau exceptionnelle »	119	5.84	5.84	5.84

Altimetry in m NGF



Limit of submersion extension as a function of tidal coefficient.



3. Which current NBS solutions are already present (it ca be a non-engineered original landscape)

- **Lancieux :**
  - Current natural land area protected: 215 ha (60% of the authorized intervention perimeter of the Conservatoire du littoral)
  - Since 1999, restauration of dune
  - 45 ha reconected in 2021 and created of realignment dike in 2023
  - Evacuate a house and imagine a new vocation
  - Close a road to traffic
  - Changes in farming practices towards an agricultural model that maintains natural wetland areas and is more resilient to saline intrusion (2012: acquisition of 17.5 ha of cultivated land (corn) - 2014: Restoration of a wet meadow and management by extensive sheep grazing)
  - 2019 : Development of lancieux's urban planning document to anticipate the relocation of human issues and adapt buildings, redevelop of campsite, and set up land reserves to offer new pedestrian alternatives to the coastal path, taking account of rising sea levels
  - 2021 : Renaturation of a 9-hectare vacation village development in a vulnerable zone
- **Orne :**
  - Current natural land area protected: 480 ha (60% of the authorized intervention perimeter of the Conservatoire du littoral)
  - 2 sites of 8ha and 16 ha reconnected in 2020 (lowering the ground of a dredging sludge disposal area) and 2022 (regulation tidal exchange)
- **Authie :**
  - Current natural land area protected: 654 ha (40% of the authorized intervention perimeter of the Conservatoire du littoral)
  - Wooden hydraulic spur laying, sand refill (300 000 m3), flexible management of the dune and creation of a buffer zone for the expansion of maritime floods (14ha) with realignment dike - Creation of a 2nd ranck dyke (1,2 km) with curves integrating into the environment and supporting new paths adapted to different types of users (pedestrian, equestrian, bike and agricultural)
  - 50 ha of dunes as natural elements related to the containment system to anchor the dyke and continuity of the coastal and equestrian path (2km) and relocation of the parking
  - Reorganize the uses set back from the future dike
    - 2018 : removal of the concrete path in the middle of the salt meadows, with prior relocation of the parking lots in the future protected area
    - 2019 : creation of a belvedere and new walking path in the wooded area of the dune
    - 2021: redevelopment of port’s parking and restoration of saltmarshes on the site

4. Describe how study pilot is monitored.

- **<u>Lancieux (breach on dike):</u>**
  - Aerial drone surveys:
    - blue-green-red (red edge) and near-infrared mapping; photogrammetry; digital surface model
    - Lasergrammetry;
    - The Normalized Difference Vegetation Index (IVND) is constructed from bands capturing red and near-infrared electromagnetic waves. It highlights the difference between the visible red band and the near infrared band. This index is sensitive to the vigor and quantity of vegetation.
    - 3D reconstruction of the breach, channel and site
  - Observation of vegetation by permanent quadrats, sampling and identification of fauna (arthropods), analysis of seed bank by sampling and cultivation; analysis of changes in salinity and topography.
  - Landscape monitoring
- **<u>Orne (regulation tidal exchange - terrain francois) :</u>**
  - Hydrodynamic monitoring (turbidity, suspended matter, current speed and water level)
  - Sedimentology monitoring (monitoring of sediment deposition by quadrats - particle size, density, water content, salinity, OM, pH, Re-dox; deposition/erosion)
  - Topographical and land use monitoring (elevation, channel extension, lidar drone identical to lancieux)
  - Site vegetation monitoring (disappearance of grassland, shrubland, surface area of schorre habitats created, evolution of rosselière, state of conservation)
  - Monitoring of benthic invertebrate (taxa, abundance, biomass)
  - Monitoring of fish use (species richness, composition, dominance)
  - Monitoring of use by birds (diversity, richness)
  - Monitoring of salinity (in residential wells near Terrains François, at 4 drinking water catchment points)
  - Landscape monitoring
- **<u>Authie :</u>**
  - Lidar monitoring of sand recharging in Bois des Sapins

5. Describe the sediment dynamics: Macro or micro sediment budget, conceptually or detailed volumetric monitoring. Include any dredging

Sediment transports will be derived from the data sets, mainly from aeolian transport on beach and dunes.
Filling in estuaries.

6. Long term trends. These could be chronic erosion, long-term subsidence or trends in mean sea level.

Based on case studies of depoldering and on the literature, certain trends can be identified. After each reopening to the sea, different phenomena occur in terms of sediment dynamics, hydrology and plant recolonisation.

a) Conditions required for depoldering
   i) Sediment dynamics and hydrology
      - The environment must be low in energy and sheltered from waves (Nottage & Robertson, 2005),
      - If the sediment budget is low, sedimentation within the polder is likely to be at the expense of adjacent marshes (Goeldner-Gianella, 2013).
   ii) Ecology
      - The presence of tidal channels is fundamental for the establishment of vegetation,
      - For species to recolonise well in the polder, it is essential to have a well-developed salt meadow nearby, which acts as a "seed bank" (Goeldner-Gianella, 2013),
      - The altitude of the polder is fundamental as it determines the frequency and duration of immersion, which is essential for the proper functioning of the maritime marsh ecosystem (Esteves, 2014),
      - Plant recolonisation is better if the schorre develops between the height of the PMME and the height of the PMVE (Esteves, 2014).

b) Outlook for the evolution of the return of water
   i) Sediment dynamics and hydrology

After the polder was reopened to the sea, morphological adjustments took place in the first few years (Esteves & Williams, 2015):

- The submerged zone undergoes rapid sedimentation (French, 2001),
- Initially, erosion processes outside the polder and at the height of the breaches may occur. The increase in submerged surface area causes a local increase in the volume of water exchanged during a tidal cycle. This increase in water flow results in local erosion (Goeldner-Gianella, 2013),
- The tidal channels are expected to move upstream as a result of the advancement of their terminal sections within the polder (Goeldner-Gianella, 2013),
- There are many uncertainties linked to hydrology and sediment movements (French, 2001).

   ii) Ecology

- Depoldering with a sluice system can hinder the entry of seeds by sea and slow down the recolonisation of the polder by plants (Goeldner-Gianella, 2013),
- If there is polluted agricultural land in the polder, depoldering can have an impact on the quality of the environment, particularly water quality (Goeldner-Gianella, 2013).
- If depoldering is carried out by breaching, the breaching must be of a size adapted to the desired volume of incoming water and in a suitable position, preferably at the level of the old tidal channels (French, 2001).

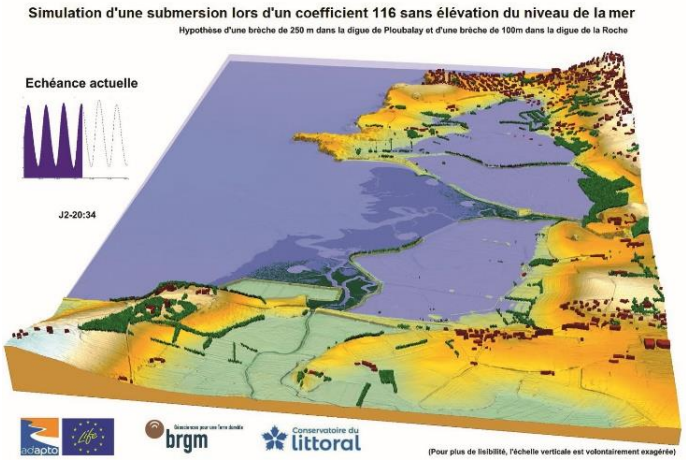
7. Describe the current coastal protection being used in the study pilot.

- **Lancieux :** dyke
- **Orne :** dyke
- **Authie :** dyke

8. Describe the current risk of flooding and erosion.

- **Lancieux :** 210 ha of polders (potential dyke failure due to overtopping, external erosion, internal erosion, landslide; overtopping without failure)
- **Orne :** 5,800 ha in a flood zone (potential dyke failure due to overtopping, external erosion, internal erosion, landslide; overtopping without failure)
- **Authie :** 5,000 ha in a flood zone (potential dyke failure due to overtopping, external erosion, internal erosion, landslide; overtopping without failure)

Exemple of dynamic simulation of flooding in the event of a breach in the dykes



9. Which human activities impact your coastal system?

   Lancieux: coastal path
   Orne : cycle path (100,000 passages/year)
   Authie : hunting and horses

10. Describe important culture and historical aspects in the study pilot

- **Lancieux :**

When the dyke was breached and Ploubalay reclaimed land was flooded, local operators showed greater interest in participating for the future of Lancieux. Collaborative workshops were organised on this point with representatives of the different users: hunters, farmers, golf course and camp site owners, hiking and horse riding associations, and a sailing school. Participants were provided with information on the history and transformation of the site, and the inherent risks, at this meeting. At a later session in the field, participants gave their opinions on the various development decisions reached for the site. What would be the consequences for the activities, usages and landscape of the site if the main dyke was raised, if the entire site was flooded, or if an intermediate dyke was added? Finally, at a third workshop, the various options under consideration were detailed in the field based on a multi-criteria analysis, to qualify and integrate usages in the project.
Politicians and farmers were already aware of the risks inherent in a dyke failure for the Ploubalay reclaimed land. Bilateral exchanges were organised to compare their visions of the plans to allow the site to behave as nature intended. Once the dyke failed, politicians or technicians at the site for each high tide provided an opportunity to discuss the transformation of the landscape occurring under their very eyes with local inhabitants. Local inhabitants started taking photographs to record the metamorphosis. Finally, local anecdotes relating to bay history were collected and narrated at an exhibition with cartoon-style illustrations and redevelopment.
The reconnection of the Ploubalay reclaimed land to the ocean has attracted the attention of other regions. Many visits have been organised to discuss the approach to flexible coastline management with local politicians.

- **Orne :**

It is essential to take the perceptions of users and local inhabitants into consideration to determine their ability to adapt to and accept the transformation of the site. A study was carried out to determine the perception of local populations targeting 187 users of the Cagny marsh. According to this study, local inhabitants are attached to the wildness of the site, as well as to using the area for leisure: walks, cycling, gathering... Around 60% of respondents were not aware of the dyke failure in 2011. Users mentioned a range of reactions to the potential flooding of the site: some are concerned, particularly in terms of the safety of nearby inhabitants, while others consider that “nature should lead the way”. Most respondents (72%) indicated that a dyke failure would not affect their behaviour, although many locals also mentioned that they would prefer for hiking and cycling to still be authorised. In terms of management strategies, most respondents would prefer to “work with the

ocean and adapt the region as necessary" (85%) and thus approve that the Cagny marsh be partially opened to the ocean in a controlled manner (53%).
The results of this survey were presented in cartoon form. The cartoon focuses on specific topics to highlight the main lines of regional policy to mitigate climate change by adapting the landscape.

- **Authie :**

The project study included an analysis of local perceptions of Baie d'Authie and found that people were strongly attached to it. The natural and wild appearance of the area, the site as a whole, the landscape, biodiversity and plants were all frequently mentioned, as well as the dune environment.
Site users are aware of the risk of coastal flooding, particularly towards the south. Over half of those surveyed (55%) considered that the main risk involved the dyke at the back of the bay failing, which is indeed the most probable current scenario according to existing studies. When faced with these risks, 60% of those surveyed mainly trust nature-based solutions; this outcome is encouraging for regional decision-makers promoting this type of approach. Almost all those surveyed (88%) agreed that "working with the ocean and adapting the region as necessary" was the preferable solution to sea level rise and the more intense storms expected on the coast. Nonetheless, 58% of the local users living near to the area in question are not entirely convinced by the plan to move the dyke landwards, they feel attached to the dyke and fear both expropriation and the high cost of the works. Finally, the analysis of the perception of local populations identified the main expectations of site users in terms of the dyke system. Local inhabitants would prefer easy access for both pedestrians and cyclists, and the use of environmentally friendly materials. Dyke plans were adapted on the basis of these criteria.

b. Description of the governance context

Please briefly describe those areas that are relevant for your pilot:

11. Who are the landowners of the land?

The Conservatoire du Littoral is only competent to act on its own property, so the work it carries out as part of the MANABAS programme can only be based on its own property. However, as a player in regional planning, it is able to apply its expertise to a wider area than just the properties for which it is responsible.
In short, the area concerned by the work in question is the submersible zone, with the Conservatoire du littoral as the main player in natural areas, and in areas with socio-economic issues outside natural areas, the owners, those responsible for these issues and the local authorities.

12. What are the main land uses in the pilot area (ie agriculture, nature reserve, infrastructure),

As mentioned in the previous point, the land concerned by the study is a natural area, which may be used for ecological management purposes (such as farming, for example).

13. What are the current laws and regulations that govern the use of nature-based solutions in the pilot (i.e Natura 2000, planning)?

Loi littoral (1986, specific law on the development of the French coastline), Natura 2000, local planning rules (town planning documents), loi MAPTAM (2014, law on protection against flooding), classified or listed sites, etc. Climate & Resilience Act (2020 on combating climate change and strengthening resilience to its effects)

14. What is the current status of using nature-based solutions in your pilot area (ie to what extent are they mainstreamed into existing policy?)

The Cdl works to ensure that these solutions are incorporated into local authorities integrated coastline management strategies.

15. What are the current goal conflicts (ie protecting cultural vs natural areas, or protecting private land vs municipal-owned land, or agricultural uses vs nature preservation?) How are these dealt with?

The main obstacle to progress in the work in progress is the resistance to change shown by all the local players. It is difficult to convince minds that are not accustomed to the broad notions of the changes underway.
It is VERY difficult to get them to accept the inevitability of future and current changes, the ineffectiveness of permanent solutions, the real efficiency of NBS and the need to address the issue of spatial reorganisation.

16. How are the stakeholders identified and involved

The landscape approach brought together all the public players with an interest in adapting to climate change:
For exemple in Orne :

- the region for strategies on the scale of coherent hydro-sedimentary areas
- The Department of Calvados, the CPIE Vallée de l'Orne (cyclepath ; sensitive natural areas, etc.);
- The City of Caen, the Caen la mer Urban Community, the Normandie Cabourg Pays d'Auge Community of Communes and the communes of estuary (town planning documents, urban development, GEMAPI: management of aquatic environments and flood prevention);
- Normandy ports (port development master plan) ;

- State services (Risk Prevention Plan ; water agency).

To Lancieux project, the consultation workshops brought together representatives of various users (business, agriculture, leisure, tourism, hiking, etc.).

17. Briefly describe the socio-economic development in the area.

Territories are affected in different ways by socio-economic issues, which are themselves more or less sensitive to and tolerant of adaptation:

- **Lancieux :** There are not many issues, but these include residential areas below sea level, main communications routes and established economic uses (camping, golf, etc.).
- **Orne:** Number of visitors/year: 500,000 – farming, bicycle path, industrial-port zone, city of 100 000 inhabitants
- **Authie :** tourism (number of visitors/year: 450,000) – farming, hunting

18. What do you experience as the main barriers to mainstreaming NbS in your pilot?

In Lancieux bay, the parties involved in this project were able to witness the ocean reclaiming the land and the success of the decision, in controlled circumstances. 40 ha of salt marsh with its inherent ecological role were restored, bringing social acceptance of the transformation of this landscape and creating a buffer zone to absorb coastal flooding, encouraging flexible coastline management. This project was led by the local authorities, not by the Conservatoire du littoral. This project required much more than simply planning to construct a dyke. The project planted the seed, which grew, and now politicians and local populations are gaining momentum and planning for the future of the region and preparing for rising sea levels.

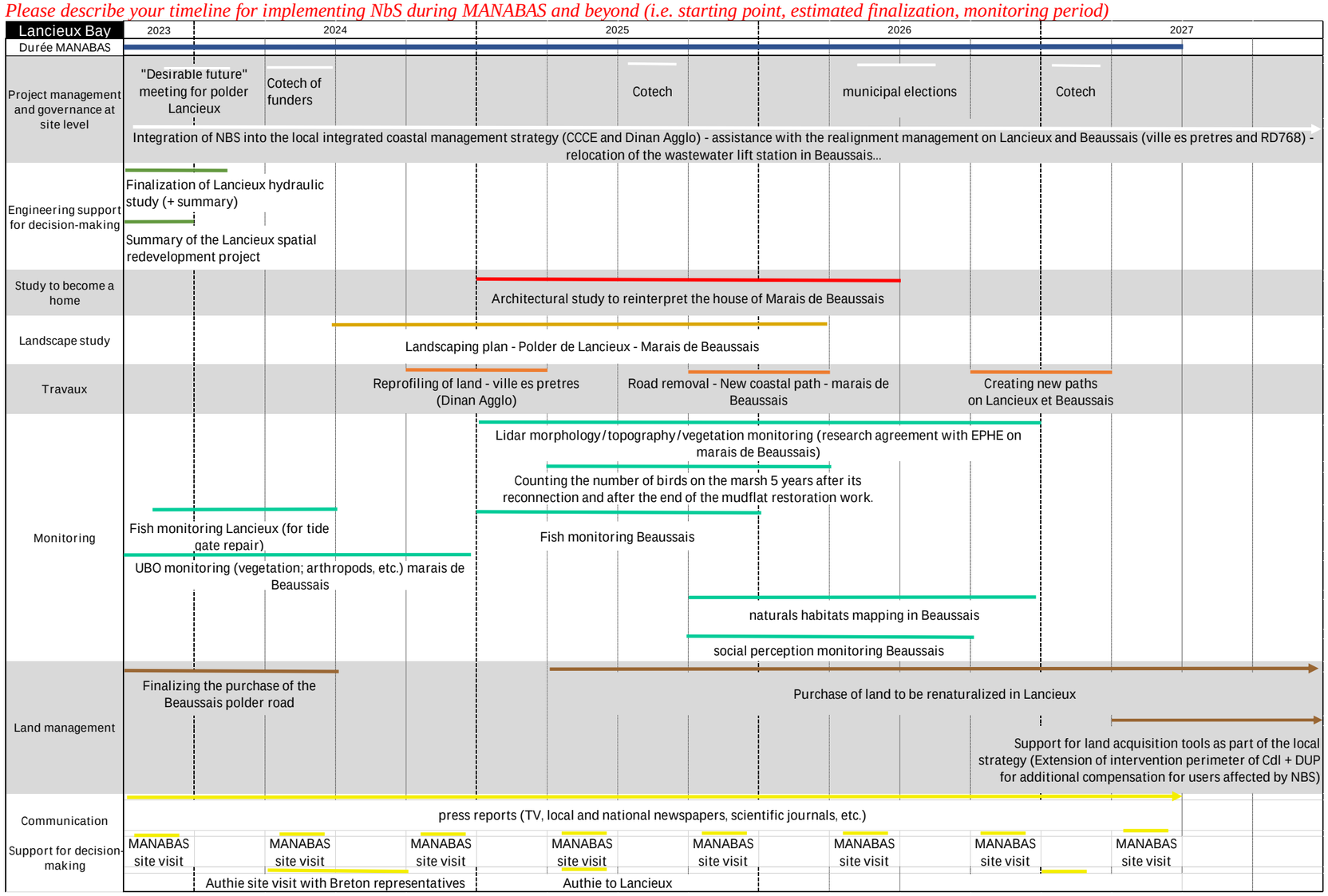
In Orne Estuary, converging public policies are one of the keys to taking action now. Il's nécessary to reveal the complementary nature of the different operators working towards a shared target: improve the resilience of natural spaces in a context of climate change. User behaviour must be analysed in detail to understand the emotional attachment to the site felt by local inhabitants and propose alternative solutions to improve the lifestyle of inhabitants while allowing coastal ecosystems to return to their natural state. For many people, reconnecting these areas to the ocean implies the loss of the current site, the loss of a familiar view, the loss of a routine. However, change can be beneficial. We will obtain something new, such as salt marshes, which will create a friendlier environment for many species that the general public is less familiar with. Once the works connecting the reclaimed land to the ocean have been completed, it may not look great, but we need to give the plants and wildlife time to find their feet.

Baie d'Authie illustrates the difficulties faced when attempting to combine long-term visions with emergency actions. The developments required to manage coastal hazards must be decided as part of a collective process. We must look beyond the protective role

of a dyke and design a dyke system able to fit in with the daily needs of all users. By appreciating this natural landscape and evaluating the ecological potential of intermediate floodplains, we can plan for the future with peace of mind. Flexible coastline management is thus considered as a potential source of solutions against a backdrop of regional challenges and the progressive transition to a greater appreciation of the natural environment. The idea is not simply to prevent sea level from rising. We must plan ahead for changes to the natural environment and farming operations due to increasing temperatures and more saline downlap.

c. Implementation scheme

Please describe your timeline for implementing NbS during MANABAS and beyond (i.e. starting point, estimated finalization, monitoring period)



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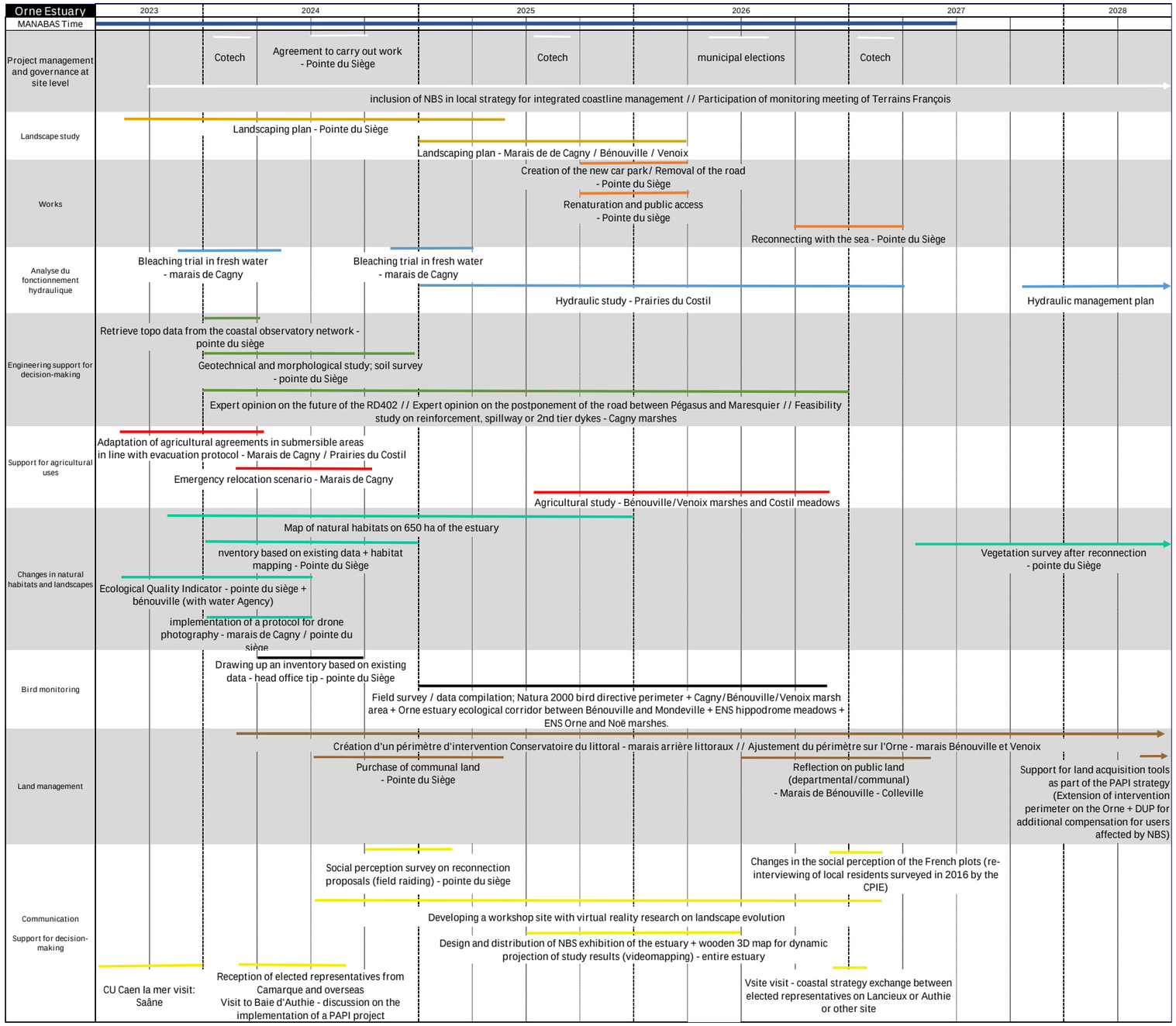

Authie Bay	2023	2024	2025	2026	2027
MANABAS Time					
Project management and governance at site level	Cotech of funders	Financial agreements	Cotech	municipal elections	Cotech
Engineering support for decision-making		Monitoring sedimentology at the bottom of the bay - assessing suspended matter to anticipate accretion in reconnected areas; soil sampling Current hydrodynamic modelling and proposed development and release scenarios (breaching, levelling, creation of tidal channels, etc.).			
Support for agricultural uses / Creation of new sectors		Agricultural study: Diagnosis of existing farms / Agricultural support for buffer zone renaturation / Meetings with farmers / Search for compensation solutions Study the profitability and implementation of a saltwort harvesting industry at the head of the bay on the south shore / Support for the structuring of sustainable and economically viable seaside agriculture			
Landscape study			Landscaping plan - Polder de l'enclos - Coude du bout du monde		
Works			Restoration of meadows before reconnection to the sea - Polder de l'enclos Accompanying works - Polder de la Mollière		
Aerial shots	implementation of a protocol for drone photography				
Land management		Finalisation of purchase of land on the north shore (dike buffer zone + enclos polder)	Purchase of land to be renatured in the south bank buffer zone (fresh or brackish water)	Support for land acquisition tools as part of the PAPI strategy (extension of the intervention perimeter or DUP for additional compensation for users affected by NBS)	
Communication	press reports (TV, local and national newspapers, scientific journals, etc.)				
	MANABAS site visit	MANABAS site visit	MANABAS site visit	MANABAS site visit	MANABAS site visit	MANABAS site visit	MANABAS site visit	MANABAS site visit
Support for decision-making		Site visit - Baie de l'aiguillon (voluntary depoldering 2021 PAPI post xynthia - Life baie de l'aiguillon)	Visit to the Bay of Lancieux (depoldering by breccia 2021) and the Orne estuary (2 voluntary depolderings by tidal regulation works 2022).		Site visit - Saâne Valley (maritime character restoration work)	
	Reception for elected representatives - discussion on the implementation of a PAPI Caen la Mer and marine reconnection / / elected representatives from Lancieux					

Part 2: Enabler Assessment

Please consider the barriers identified in Part 1B (question #18). The enablers below are meant to be ways to overcome these barriers. However, these enablers are not set in stone and will be further developed, augmented and /or changed during the MANABAS Coast project. There may be other enablers that are more important in certain pilots or for mainstreaming NBS. We will explore these during our project. In this assessment we want to get an initial idea of how these proposed enablers by EcoShape play out in your pilot and for mainstreaming NBS on a large scale.

Enabler 1: Technology and system knowledge

- Which types of technology or systems knowledge are important in your pilot? (i.e. Sediment cell, salt marsh protection, salt marsh dynamics, sand nourishment, enhanced dune development)

Monitoring changes in landscapes, biodiversity (ecological quality indicator), ecological functions and ecosystem services.

- Are there any knowledge and technology gaps in your pilot that need to be addressed ? Please briefly describe.

There is still a systematic lack of popularization tools to help all stakeholders (local decision-makers, local residents, socio-economic players, etc.) quickly and firmly grasp these complex concepts.

Enabler 2: Multistakeholder approach

- Who are the main stakeholders in your pilot?

Local authorities, government departments, environmental education organizations, etc. But also local residents and socio-economic players.

- How will you engage your stakeholders in the project?

Through information meetings, the aim is to help them understand the issues involved in adaptation, and the role of natural spaces. But also that they take up the issue and build their own local solution, adapted to the area in question.
To get them out of the "hard protection" reflex, which won't work in the long run.

Enabler 3: Management, monitoring, and maintenance

- What routines does your pilot have in place for management, monitoring and maintenance of the NbS?

participation in local integrated coastline management meetings by local decision-makers to incorporate NBS, implementation of scientific monitoring partnerships, propose Cdl land for NBS implementation

- How do you measure the success of your pilot? Do you have any indicators for successful mainstreaming of NbS?

Social acceptance of the role played by natural areas.
Through a tool for monitoring qualitative and quantitative changes in biodiversity in areas reclaimed from the sea.

Enabler 4: Institutional embedding

- How do current institutional arrangements already facilitate mainstreaming of NbS? Please describe and mention the key institutions

State departments are discovering both the concept of NBS and its implementation. We are therefore working with these departments so that they can then take the experience outside the areas for which the Conservatoire du Littoral is responsible...

- How committed is your organization to mainstreaming NbS within MANABAS Coast and after the project ends?

After the success of the adapto program (2015-2022), the Conservatory is listened to and expected to provide on this expertise. We will therefore be closely followed by the stake-holders involved at the end of the MANABAS program.

Enabler 5: Business Case

- Do you face problems with funding in your pilot? Please briefly describe, including the general sources of funding.

For the time being, the Conservatoire du littoral's studies and work are financed solely from its own funds. This limits its action in the long term. The contribution of European

programs (Life, Interreg) enables us to maintain a team of specialists to support the project.
Partnerships are being finalized to finance additional studies to support the MANABAS program.

- How will your pilot and/or continued mainstreaming be funded after the MANABAS Coast project?

Outside the Conservatoire's grounds, it will be up to the collectivities to finance (tools resulting from the 2014 MAPTAM law). For Conservatoire properties, the funding will come from the Conservatoire's own funds.

Enabler 6: Capacity building

- What types of capacity building would your pilot need in order to facilitate mainstreaming of NbS?

Territorial coordination

Enabler ranking

To what extent are the above enablers important for mainstreaming NbS in your region? Please rank (1 is least important, 10 is most important)

Enabler 1: Technology and system knowledge
1 2 3 4 5 **6** 7 8 9 10
Enabler 2: Multistakeholder approach
1 2 3 4 5 6 7 8 9 **10**
Enabler 3: Management, monitoring and maintenance
1 2 3 4 5 6 **7** 8 9 10
Enabler 4: Institutional Capacity
1 2 3 4 5 6 7 8 9 **10**
Enabler 5: Business case
1 2 3 **4** 5 6 7 8 9 10
Enabler 6: Capacity Building
1 2 3 4 5 6 7 8 **9** 10

Suggestion for additional enablers

Nothing

Are there any aspects of mainstreaming enablers from your pilot that you can already suggest? If so please briefly state these:

Part 3 MANABAS mainstreaming framework (inspired by earlier work e.g. ISBAM)

Within MANABAS Coast we are working on a framework that helps in mainstreaming NBS. To develop this framework, we need information on the pilots as well as the ambitions and goals of the different organizations involved. We build on work already done in the past such as the ISBAM approach, which was developed in the Interreg BwN project (see also the brochure in the appendix for a further explanation or online). Just like the enablers, the MANABAS mainstreaming framework is still a work in progress.

As a starting point for the MANABAS framework, 3 leading principles from ISBAM are evaluated. We would like to know if these principles can also be applied across the entire northwest Europe coasts and how they can be improved.

Three leading principles have been identified that are deemed important to enable mainstreaming of NBS:

MANABAS Coast principle 1: "Act at a landscape (system) scale, including both the natural and socio-economic system/context"

- Do you identify with this principle?

Yes, completely.

- Is this principle applied (to a certain degree) within your pilot? And within your organization? If yes, how?

Sometimes, but not often enough, we need to multiply this.

- In managing your assets, how are the system-wide effects and benefits taken into account?

- On a scale from 1 (room for improvement) to 10 (superb), do you think your organization adheres to this principle? Why?
  1 2 3 4 5 6 7 8 9 **10**

MANABAS Coast principle 2: "Integrate management of multiple assets and functions within the landscape system context"

- Do you identify with this principle?

Yes

- Are relevant organisations/institutions efficiently cooperating to jointly address system-wide challenges? If yes, which challenges and how?

We didn't work on NBS in terms of risk, but in terms of landscape evolution. Because users are very attached to them. Development of landscape studies and landscaping plans to show the beauty of landscape transformation.

- If you see room for improvement in the integrated management of multiple landscape assets, what would be the necessary steps to take according to you? Briefly state

Landscape is the best gateway to a peaceful, non-confrontational exchange. It creates consensus.

- On a scale from 1 (room for improvement) to 10 (superb) how much is this principle applicable to your organization?
  1 2 3 4 5 6 7 8 9 **10**

MANABAS Coast principle 3: "Embrace and leverage upon the natural dynamics of the system"

- Is this principle applicable to your situation/organization?

Yes

- What are the main natural processes that should be considered? Are these well-known with all the stakeholders?

Dune migration and coastal squeeze

- How are using natural processes incorporated in the management practices within your organisation?

By defining land acquisition intervention zones and imagining the future of these sites.

- On a scale from 1 (room for improvement) to 10 (superb) how much is this principle applicable to your organization?

1 2 3 4 5 6 7 8 **9** 10

Additional MANABAS Coast mainstreaming questions:

- In your view, what is essential in the mindset or way of working of people (policy makers, managers, professionals, general audience) to promote mainstreaming of NBS? Do stakeholders need more information on mainstreaming?

Mutli-partnership and project-mode working across all local authority competencies

- What other leading principle(s) would you suggest?
- How can we make these principles more applicable to the context of pilots?
- **Finally: What does mainstreaming mean for your pilot? Please briefly describe.**

Moving from a pilot site demonstration to widespread use for a sustainable perspective for a coastal strip development strategy integrating ecosystems.

The flexible management of coastal strips is based on the premise that a coastline is a dynamic interface, not just a fixed shoreline. A new type of engineering – combining disciplines as varied as geomorphology, civil engineering, ecology, landscaping and project management – is emerging to give this field substance. This new engineering field focuses on protecting, restoring and managing coastal environments with functional roles, including mitigating the impact of coastal hazards and acting as a vector for numerous ecosystem services. This engineering still needs consolidating and would benefit from a significant improvement in the status of existing higher education options for it to fully develop.

These management solutions can be adapted to the various coastal typologies and risks under consideration. Leaving coastal strips with a certain width enables natural systems to operate with a combination of different kinds of complementary solutions, for example, flexible management areas interfacing directly with the sea combined with fixed secondary

structures. Research is needed to better describe how these natural systems work and how they interact with protection systems, but conclusive examples already exist.