D-Day climate change

Translation of the exhibition in English
The D-Day climate change exhibition displays the main results of a participatory research, which took place between 2021 and 2024, within the programme “Les futurs des mondes du littoral et de la mer” (The Future of the Coasts and the Seas) funded by the Fondation de France. It has been carried out by a research team from the universities of Caen, Le Mans, Nantes and Nîmes, by associating the laboratories ESO, LETG, IDEES and Chrome. The subject is the future of the memory sites along the Landing Beaches. This is a topical question in this time as we commemorate the D-Day 80th anniversary, as the project of list the Landing Beaches on the Unesco World Heritage is on the agenda, but also in the time of other participatory steps in local territories in Normandy, ‘Notre littoral pour demain’, and the development of an adaptation coastal policy by the Région Normandie and local authorities.

Different types of research have been conducted: 100 individual in-depth interviews, a questionnaire with 568 respondents, photographic reports. This exhibition aims to highlight the contributions of the participatory workshops, carried out with twelve citizen groups, between 2021 and 2023, with the original step to have local groups with inhabitants, as well as remote people, from France, Europe, United States, Canada, with whom the workshops held online.

Timeline of the project:

2019: preparatory works with the stakeholders in memory tourism and coastal planning
2020: application to the programme The Future of Coasts and Seas funded by the Fondation de France
2021: one hundred in-depth interviews
2021-2023: twelve participatory workshops with three meetings per workshop
2022-2023: questionnaire with 568 respondents
2023-2024: valorisation and dissemination of the results
2024: analysis of school practices
D-Day climate change

Board 2

Scientific information and forecast data in terms of sea-level rise

Upper left:
Changes in sea level in millimetres per decade in Cherbourg and Le Havre between 1981 and 2020

Upper right:
Sea level rise forecast in centimetres according to the IPCC between 2000 and 2100

Lower left:
Three types of coastal landscapes, three ways to grasp the coastline

Choose the right line for the shore is essential in order to measure the change of the coastline. Three situations exist:

- In cliff sectors: the chosen line is the top of the cliff
- In non-urbanized low coasts: the chosen line is the vegetation line between the beach and the dune
- In urbanized low coasts: the chosen line is the limit of highest tides along the artificial protection structure

Lower right:
Understand the maps of the sea-level rise and potential flooding on lower coasts

Along the Landing Beaches, lower coasts are made of beaches, dunes, and marshlands. Marshlands have low altitudes, most of the time less than the high waters of spring tides. By mapping the water level of the marshlands, we get a surface area of potential flooding. This does not mean that these marshlands would be flooded, as long as there is not any breach between the sea and the marshlands. By representing an increase of water level, due to, on the one hand, the effects of climate change (blue dashed line), and, on the other hand, to temporary storm surge tides (due to lower atmospheric pressions), the result is an amplification of the potentially flooded area.
D-Day climate change
Board 3

Participatory groups and geographical sectors studied in workshops

“Quescussion” is a participatory method, which is to request the participants’ questions regarding the expected topic in the subsequent steps. More than a hundred questions have been asked at the beginning of the workshops. This is eleven main questions which summarize them. During the exhibition, you will be able to reflect on the answers that boards can bring you. At the end of the exhibition, a board will present some major answers regarding the objectives of the study.

Question 1: Have the Landing Beaches already changed since 1944?
Question 2: What will be the future of the Landing Beaches facing the effects of climate change?
Question 3: What will happen to the existing memory places along the Landing Beaches?
Question 4: Will there be Utah Beach 2 as there is Lascaux 2?
Question 5: How to respect and perpetuate the duty of memory along the Landing Beaches?
Question 6: What sustainable and well-balanced tourism in the Landing Beaches territories?
Question 7: How will memory tourism be recomposed along the Landing Beaches?
Question 8: What is the future of permanent housing along the Landing Beaches?
Question 9: How to involve citizens in the duty of memory along the Landing Beaches?
Question 10: What role do public authorities play in protecting memory places along the Landing Beaches?
Question 11: How to continue to educate and pass on the History of the Landing and the Second World War to the youngest?
D-Day climate change

Board 4

Utah Beach: from past to future

Figure 1: Evolution of the coastline on the Utah Beach memory area between 1947 and 2019

The coastline has been increasing to the South of Utah Beach between 1947 and 2019. As we go to the North, the coastline has been decreasing facing the sea.

Figure 2: Evolution of the distance, in meters, between memory places and the coastline, between 1950 and today

After being degraded in the 1950s following the Landing, the dune has formed again in the second part of the 20th century. For twenty years, the distance is stable between the Utah Beach Museum and the coastline, as between the US Navy Monument and the coastline. To the North, the distance between the Utah Beach American Memorial and the coastline has been decreasing. To the South, the distance between the B-26 hangar and the coastline has been increasing.

Figure 3: The Utah Beach coastal area with a centennial storm in 2044

The hazard of centennial storm in 2044 leads to a risk of potential flooding in the marshland inland, but on surfaces almost similar to the actual risk.

Figure 4: The top of the beach in Utah Beach, may 2024

A sand reloading has been done opposite the Utah Beach Museum in 2022. Two years later, the layer of sand at the top of the beach has been eroding.
Utah Beach: participatory future scenario


Utah Beach in 2044: stability of the coast thanks to the natural reinforcement of the dune and the beach

“We have to preserve, for the protection of the environment, visitors have to avoid to walk on the dune, in the aim that it continues to be protected, as it serves to protect the coast. It’s time, it must be protected now.”

“I would add wooden piles on the beach. At every high tide, the sand can settle. From year to year, it would accumulate the sand behind the piles. I would wish that all along the coast.”

“Natural solutions can exist around Utah Beach. It can preserve the natural aspect of the site, while limiting the erosion concerning the houses as the museum.”

Utah Beach in 2100: move the museum

“I think that it would have had as many visits. It will be a bit different, as memory places will no longer be on the original site, but inland, and I will do a virtual visit of the site as it was, and I will do historical reconstructions. Something to sensibilize people, although the museum would have been moved. If the waters rise so high, it is moved to higher ground.

Utah Beach in 2100: development of an islet to preserve the museum on-the-spot in 2100

This perspective is not possible according to the actual public rules in terms of the protection of natural coastal areas.

“We have to plan spill areas. As for an island, as in the Mont Saint-Michel, we leave water flows around, and we build a causeway which allows to absorb the water, which avoids to damage the surrounding too much.
D-Day climate change
Board 6

Pointe du Hoc: from past to future

**Figure 1: Evolution of the coastline between 1947 and 2019**

Between 1947 and 2016, the cliffs have been eroding several meters longer. The top of the cliff is stabilized in 2010 thanks to consolidation works with concrete injection in the rock.

**Figure 2: Rocky spur at the pointe du Hoc site, may 2022**

Following the marine erosion, for the 20th century, a rocky spur has dissociated from the land. On May 5, 2022, the eastern flank of the spur, regularly attacked with north-east swell, collapsed.

**Figure 3: Pointe du Hoc in 2044**

The cliff erosion will be continuing. From 2024, the memory site will have been moved inland, with the moving of the monument in tribute to the American Rangers, which had been erected there in 1984.

**Figure 4: Pointe du Hoc in 2100**

The further erosion can also lead to the formation of a more indented cliff than today. On the tip of the coast, a new rocky headland could form, surrounded by the sea.
Pointe of Hoc: participatory future scenario


Pointe of Hoc in 2044: creation of a new visitor trail back from the cliff

“The trail has to go through some strategic places, as shooting direction post. I will develop a trail A and a trail B, according to attendance, to limit the frequenting.”

Pointe of Hoc in 2100: closing of the ancient trail and retreat of the observation platforms

“Every close access to the tip of the coast and the cliff must be forbidden.”

“In 2100, pointe of hoc will no longer exist. I mean the original and symbolic pointe.”
D-Day climate change

Board 8

Omaha Beach: from past to future

**Figure 1: Evolution of the coastline in Omaha Beach between 1947 and 2019**

Omaha Beach is divided into two main areas: the coastline in Vierville-sur-Mer and Saint-Laurent-sur-Mer, with a diked low coast which is stable and dotted with monuments and steles, and, on the other hand, the dune at the bottom of the hill where the American cemetery of Colleville-sur-Mer is located.

**Figure 2: Les Braves Monument, Saint-Laurent-sur-Mer**

This sculpture symbolizes hope, freedom, and fraternity. Its establishment on the occasion of the 60th anniversary of the Landing in 2004 should have been temporary. However, it has thereafter been remained on-the-spot, revealing the memory involvement on Omaha Beach.

**Figure 3: Omaha Beach coastal area in 2100 with a centennial storm**

The coastline would not move a lot, but the flooding due to a centennial storm would become very important, due to a springboard effect with the higher sea-level. Thus, the sea would flood all the lower areas inland.
Omaha Beach: participatory future scenario


Omaha Beach in 2044: preserve the dyke, and the dune opposite Colleville-sur-Mer

“From 2050, build walls, walls, as in cartoons.”

Omaha Beach in 2100: retreat of housing and memory places on the plateau

“The sculpture ‘Les Braves’ will have feet in water.”

“We will arrive to the Charles Norman Shay monument by boat”.

“I imagine that the planning rules will change under the popular pression, and we will accept to build at the top of the cliff to move people from the lower area to the top of the cliff.”
Main insights from the in-depth interviews and the questionnaire

**Upper left Map: Different stakes according to the geographical origin of the interviewees**

**French people (out of Normandy):**
- Fears: erosion of the coastline
- Hopes: give more means for the preservation of the coastline

**American people: preserve the sacred beaches**
- Fears: the shortening of the beach
- Hopes: preserve the access to the beach to continue the memory itinerary

**European people: preserve the remains**
- Fears: disappearance of the remains due to the sea, the rain, the wind...
- Hopes: developments on the sea: artificial islands, buildings on stilts, visits with diving

**Norman people who do not live along the coast**
- Fears: Engulfing, submersion of the coastal area
- Hopes: move some remains and monuments inland

**Landing Beaches’ local inhabitants**
- Fears: reinforcement of marine and weather hazards
- Hopes: the museums and monuments matter more than the original locations of the beaches

**Lower left Chart: How will the memory sites be in 2044? The citizens’ perceptions**
- Will have partly disappeared
- Will have entirely disappeared
- Will have been moved
- Will be like today
Main insights from the in-depth interviews and the questionnaire

Upper right Table: How would you want that the memory of the Landing Beaches continues to be passed?

- By continuing to go to the Landing Beaches themselves
- By visiting the authentic heritage of the Landing and the Liberation inland
- By participating to commemorations
- By valuing the sea as a heritage of the Landing
- By developing international meetings and exchanges
- By using more the museums
- By participating to reenactments
- By developing one or several discovery centres inland
- By using only virtual resources
- By stopping to establish new memory places

Lower right Map: Perception of the Landing Beaches memory places in 2044: The perception of moving

Share of respondents (%)

Number of respondents
D-Day climate change

Board 11

The answers to the participants’ questions (1/2)

Question 1: Have the Landing Beaches already changed since 1944?
Yes, some sections have been eroding facing the sea, but, on the contrary, others have been increasing thanks to the accumulation of sediments. On the other hand, the dunes, marshlands and cliffs are more protected now than before.

Question 2: What will be the future of the Landing Beaches facing the effects of climate change?
In terms of the sea-level rise, the forecasts lead us to distinguish two times: firstly, a moderate rise until the middle of the 21th century, and secondly, an increase of the rise. Until 2050, storms are the main risk for the Landing Beaches and some memory places. Later on, the risk will be due to the combination of the sea-level rise and the storms.

Question 3: What will happen to the existing memory places along the Landing Beaches?
In the past, some actions to preserve memory places occurred, like the artificial reinforcement of the cliff at pointe of Hoc. But actual choices consider the probable effects of the sea-level rise on the coast, and plan the adaptation of the coastal area, in needed with a moving of memory places inland, without preserving them on-the-spot. In case of a threatening sea, none memory place would be worth to be preserved on-the-spot.

Question 4: Will there be Utah Beach 2 as there is Lascaux 2?
Lascaux 2 is a reconstitution of a famous prehistoric site in the South of France, without being able to go on the original site. The preservation of the Utah Beach Museum on-the-spot is not envisioned in the future, due to the threaten of the sea-level rise. However, its new location after moving inland will not prevent visitors to go to the coast, where monuments and a memory trail will be still present.

Question 5: How to respect and perpetuate the duty of memory along the Landing Beaches?
The respondents have highlighted that the continuation of memory is not sure in a long-term future. But the expected inscription of the Landing Beaches on the list of the Unesco World Heritage will allow us to continue the duty of memory. In local territories, public authorities will still care the memory assets which they are in charge of. The future of the private museums will depend on private initiatives.

Question 6: What sustainable and well-balanced tourism in the Landing Beaches territories?
There are several tourisms along the Landing Beaches: memory, seaside, sport, etc. The rules of coastal planning allow them to be protected. The new choices of sustainable tourism are about soft mobilities, with new cycling routes, even though they do not meet the majority of the touristic demand and offer along the Landing Beaches.
D-Day climate change

Board 11

The answers to the participants’ questions (2/2)

Question 7: How will memory tourism be recomposed along the Landing Beaches?

With the adaptation of coasts to the effects of climate change, but also with the changes in tourism, changes in memory visits are expected. In the short and medium term, memory trails more inland are envisioned. In the short term, a more temporary occupation of the coastal area is planned, with less accommodations and museums in areas at risk, but a more developed organization of memory trails.

Question 8: What is the future of permanent housing along the Landing Beaches?

In the short term, the demand is still high regarding the housing along the Landing Beaches, with a high cost to buy a house or an apartment due to the coastal value of housing. People who wish to become owners do not perceive the risks due to the sea-level rise in the lower urbanized coastal areas. In parallel, the recent quarters of the middle and working classes are already located inland and thus are out of this risk.

Question 9: How to involve citizens in the duty of memory along the Landing Beaches?

The duty of memory happens mainly during the commemorations in June, and during the other months of the beautiful season, with tourists and school groups. The involvement of citizens has to be done more thanks to meetings (local, national and international), thanks to the consideration of the History of the civil people in the Landing and the Liberation, and thanks to a better recognition of citizen actions for caring the memory assets and the renew of twinning activities.

Question 10: What role do public authorities play in protecting memory places along the Landing Beaches?

The memory places along the Landing Beaches is ensured thanks to the protection of the coast. The sites of the Conservatoire du littoral allow some memory places to be protected. Several museums and monuments are owned and managed by local authorities. National, European and international supports exist for the development of renowned places as the recent British memorial in Ver-sur-Mer. At least, the project of inscription of the Landing Beaches on the list of the Unesco World Heritage is supported by the Région Normandie.

Question 11: How to continue to educate and pass on the History of the Landing and the Second World War to the youngest?

On-the-spot visits with a concrete dimension are hoped, in a context in which the veterans will no longer be able to bring their testimonials. The youngest do not point out more a demand of virtual visits, but wish to still visit the Landing Beaches. People wish the association of the visit at the original remains with the use of virtual tools. For example, the Museum of Arromanches includes a virtual presentation of the harbour as it was during the Landing. In terms of school trips, logical pedagogical trails will have to associate visits of authentic sites and museums to make sense.
Arromanches-les-Bains: participatory future scenario


Arromanches-les-Bains in 2044: retreat of the urbanized area to the plateau

“We have to stop building all types of houses and buildings close to the coast.”

“The museum is too close to the sea. It should have been built at the top of the cliff.”

“The workers’ memory must be protected. It is more important than preserving the site itself.”

Arromanches-les-Bains in 2100: reorganization of the urbanized and memory space behind the top of the cliff

“The visitors are those who have the memory of Landing in their families. Will it be the case in 2100?”

“We could reclaim some elements from the artificial harbour to display them elsewhere.”

“We have to stop to build along the coast, and to build behind the top of the cliff.”
D-Day climate change
Board 13

Arromanches-les-Bains: from past to future

Figure 1: Evolution of the coastline from Arromanches to Asnelles, between 1947 and 2019
Apart from the cliffs West from Arromanches, the coastline is generally stable along this coast. Some stability is due to dykes along the urbanized areas of Arromanches, Saint-Côme-de-Fresné and Asnelles.

Figure 2: The risk of cliff erosion in Arromanches
Overlooking the artificial harbour with concrete caissons damaged by the sea, the top of the cliff in Arromanches is reported at risk for the visitors.”

Figure 3: The coastal area from Arromanches to Asnelles with a centennial storm in 2044
In 2044, the risks will come again from stormy episodes, with threatened areas in the coastal plain in Saint-ôme-de-Fresné, Asnelles and Meuvaines.”
D-Day climate change
Courseulles-sur-Mer: from past to future
Board 14

**Figure 1: Evolution of the coastline in Courseulles-sur-Mer between 1947 and 2019**

The Juno Beach site has been increasing for the last decades. The process is due to the deposit of sediments West from the harbour dykes."

**Figure 2: Evolution of the distance, in meters, between memory places and the coastline, between 1950 and today**

In the non-urbanized Juno Beach area, the distance between the Juno Beach Centre and the coastline has been increasing. On the contrary, it has been decreasing opposite the Lorraine Cross. As for the Monument ‘Signal’ in Graye-sur-Mer, it has been erected in 1954 at the top of the beach in a breach; however, the dunes surrounding this breach have been increasing."

**Figure 3: Courseulles coastal area in 2044 with a centennial storm**

The Juno Beach dune continues to enlarge. But an important risk of flooding exists in the marshland. The mouth of the Seulles induces a direct communication between the sea and the coastal plain. The sea-level rise has a low aggravating effect until 2044."

**Figure 4: Juno Park**

After being occupied by a campsite, the Juno Beach dune has been protected and developed for memory purpose. The Juno Beach Centre has been open since 2003. Its surroundings have been digged up of the sand to reveal German remains, and the outdoors are developed with a memory space: the Juno Park."
D-Day climate change

Board 15

Courseulles-sur-Mer: participatory future scenarios


Courseulles in 2044: preservation of the coast and memory trail inland

“The Juno Park will be accessible in 2044 as it is today. So I do not see the usefulness for reenactors.”

“In my opinion, the visits inland can be a good option. We could follow the way that the Canadian troops did after landing.”

Courseulles in 2044: preserving the coast and moving memory assets

“The Juno Beach Centre won’t be flooded. But if the rest of the surroundings are flooded, how will people be able to access it? One should build a bridge, or something like that. We should anticipate and not wait for the last minute.”

“I would move the De Gaulle stele, which would be more or less flooded. On the other side, the Churchill tank, the monument ‘Signal’ and the Lorraine Cross would be moved as well.”

Courseulles in 2100: the Juno Park will become a peninsula

If everything becomes engulfed, guided visits by boat or kayak can exist. If the access becomes difficult, small boats could go around the peninsula. We do not need a big polluting boat. On the contrary, we need soft mobilities to try to reach the museum, because, otherwise, the issue would be just reinforced.”

Courseulles in 2100: gathering of the memory assets in the Juno Park peninsula

“You have to gather all in the dune, the peninsula, and then you have to organize a shuttle, by boat, to enable everybody to reach it.”

“The Juno Beach Centre would be isolated on a small peninsula, it would prevent us, more or less, to reach it.”
Figure 1: Evolution of the coastline in Bernières-sur-Mer between 1947 and 2016
The coastline is urbanized and diked, and has been stable between 1947 and 2016, apart from a very localized retreat at the steles of tribute to Canadian troops.

Figure 2: Tourist information board belonging to the memory trail Remem’Bernières
Two memory trails are proposed in Bernières-sur-Mer, with information boards. This one is opposite the ground of a temporary military Canadian cemetery. A web-based application now supports this development.

Figure 3: Bernières-sur-Mer coastal area in 2044 with a centennial storm
The urbanized lower areas are most at risk in case of storm by 2044. The diked shoreline is more elevated and would remain protected.

Figure 4: The monument Signal in Bernières-sur-Mer
In 1950, the monument ‘Signal’ in Bernières was the first erected of the series of similar monuments along the Landing Beaches. They were the first markers of the Landing, and today remain well visible within the memory landscape.
Bernières-sur-Mer: participatory future scenarios


Bernières in 2044: preservation of the coast and retreat of memory assets

“In 2044, it will be the time for the last mass access to some sites, before accesses reserved for some groups. It is the beginning of deterioration. We are aware of this deterioration, and we will limit the access. The first flooding will happen inland.”

Bernières in 2044: retreat of the urbanized area and development of a draining system

“If the breaches are inevitable, perhaps we can create them by ourselves, as controlled breaches, to lead water where we want it to go to. Some choices can be made to avoid risks, like create artificial marshland to collect water.”

Bernières in 2100: retreat of the urbanized area and development of a new coastline

“One will have to move the Canadian House elsewhere, in a protected area, but with new conditions: virtual tools, and the possibility to reach the coast dry feet. Because, at its actual location, it will disappear.”

Bernières in 2100: reorganization of the urbanized area with a lido

“We must reinforce the sea walls, and preserve a water level in the marshland. There will be gates to let water in. In case of heavy storms, these gates would be closed, to protect the area behind. It is water management.”

“In a hundred years, we won’t make people believe that Canadian soldiers landed in the actual core of the village. The idea that the coastline would have retreated inland must be eliminated. We have to do all our best, in our power, to preserve the coastline along with these coastal memory places.”
D-Day climate change

Sword Beach: from past to future

Board 18

**Figure 1: Evolution of the Sword Beach coastline between 1947 and 2010**

Sword Beach is partly diked. Between 1947 and 2010, two parts have been distinguished according to the evolution of the coastline: a part with erosion in Hermanville-sur-Mer, and a part with accretion in Colleville-Montgomery and Ouistreham.

**Figure 2: The vegetation at the top of the beach, Sword Beach**

At the end of spring, herbs grow at the top of the beach, revealing the possibility of rooting and fixing the sand.

**Figure 3: The Sword Beach coastal area with the future scenario 8.5 (IPCC) plus a centennial storm in 2050 and 2100**

The risk of centennial storm leads us to envision the extension of flooding areas in the short and medium term (2050). Regarding this risk of flooding, the locations of memory assets would be raised and preserved. However, this map reveals the perspectives of changing land cover.

**Figure 4: Unveiling of a Norwegian monument in Hermanville-sur-Mer**

On the occasion of the ceremony on 6th June 2022, the monument in tribute to Norwegian troops is unveiled at the Place du Courbet in Hermanville-sur-Mer.
D-Day climate change

Board 19

Sword Beach: participatory future scenarios


Sword Beach in 2044: preservation of the coast and new visits

“We can add virtual visits: in Riva Bella, close to the casino, where there is a wide stretch of beach. Some monuments have been erected there a few years ago, in 2019, where the international ceremony had previously taken place in 2014. In this area, there are not dykes or wooden piles.”

Sword Beach in 2044: retreat of memory assets inland

“The dykes of this area will be, either preserved, or even raised, because it is done now, and it will be like that until 2044.”

“The statue of the piper Bill Millin could be moved inland, because this story can be told elsewhere. But it is not needed that it is too remote either.”

Sword Beach in 2100: reorganization of the urbanized area and the memory assets far from the coastline

“In 2100, if the sea-level rise is more important, or as important as we have said, we will realize that we can no longer continue to constantly struggle.”

“We must think about public safety, as there will be more risks in the marshlands. Thus, we should move the main road, which is now close to the coastline, inland.”

“The museums collections would be moved inland, but the buildings could remain on-the-spot, as they are more robust and can resist. In this way, people will be able to visit the buildings and the collections will be protected elsewhere.”

Sword Beach in 2100: reinforcement of coastal preservation and retreat of memory assets

“The dykes will be higher in the future. We will move the monuments, which risk to be swept away by the water. We realize that the West part in Hermanville would be at risk in 2100. We can anticipate. The monuments are very close to the sea, so it would be a good option to move them inland.”
With the expected sea-level rise, the coastal landscapes along the Landing Beaches will be changing: retreat of cliffs, retreat of dunes along some coasts, more sand and water on roads. The participants of the research D-Day climate change have suggested a number of scenarios of the future, regarding the memory places and memory trails, which are in large part compatible with the rules of coastal planning. Concerning the memory assets which will have to be moved inland, the stake is to identify available plots. Memory practices along the Landing Beaches are perceived as extending more in the coastal area in the future: redevelopment of the most at-risk places close to the coast, extension of memory trails associating the coast and inland, soft mobilities along the coast, uses of the coastline and the sea thanks to beautiful weather. Beyond some retreat of memory assets, the change of the coast with the effects of climate change goes hand in hand with the perspectives of memory development along the Landing Beaches. It is expected that this development is strengthened by the Unesco World Heritage listing.