The use of sand by-passing systems in the management of an urban beach. The case of Capbreton, France.

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Abstract:

The extension of the northern jetty of the port of Capbreton (France) in 1974 has resulted in significant accretion of the northern (updrift) beaches and strong erosion of the southern beaches (downdrift), with direct impacts on tourism and the stability of the coastal protection structures and sand dunes. This article describes the erosion issues, together with engineering options for preserving and protecting the coast with respect to future shoreline changes.

Contents

1. Introduction

Capbreton is situated on the sandy coast of Aquitaine about 45 km to the north of the Spanish border. This sandy coast stretches 240 km from the Gironde estuary in the north to Cap Saint Martin in the south. It is a wild, preserved coast bordered by artificially stabilised dunes (fig. 1).

Figure 1: Location of study area

For many reasons, Cap Breton is one of the most attractive towns along the Aquitaine coast, drawing thousands of tourists each year. First of all, the town is situated on the seafront, offering people direct, easy access to the beach and a unique view of the ocean (fig. 2). It also has a harbour offering more than 1000 places – the only harbour between the Arcachon basin in the north and the mouth of the River Adour in the south – connected to the ocean by the Boucarot channel. Lastly, a submarine canyon (the "Gouf de Capbreton") runs directly towards the town (fig. 3), creating very specific wave refraction conditions. The considerable attenuation resulting from this makes access to the harbour much easier for boats. The very high concentrations on either side of the harbour create waves that are ideal for surfing, which has earned a worldwide reputation for "spots" such as La Gravière, Le Nord and La Piste.

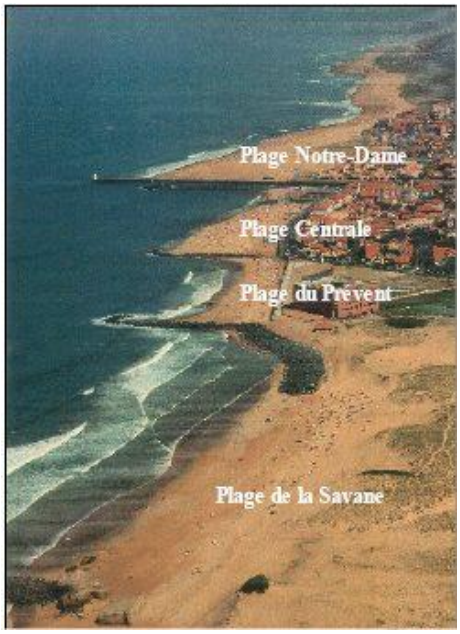

Figure 2: *Oblique view of Cap Breton*

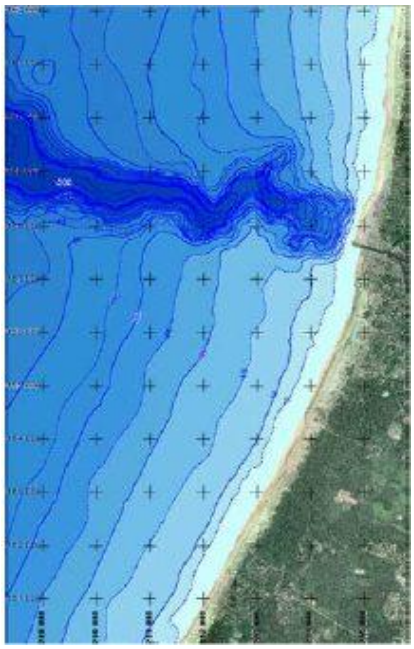

Figure 3: *Bathymetry in the area around Cap Breton, showing the submarine canyon ("Gulf de Cap Breton")*

2. History of coastal development work

The first structures to be built along the Cap Breton shore were started in 1864 with the aim of fixing the mouth of the Boucarot channel and protecting the town against coastline erosion. The first structures strictly intended to protect the shore were put up in 1952, when a sea wall was built along the seafront boulevard. Between 1954 and 1957, two groynes (the "Central" and "Préventorium") were built, followed by a third (the "Northern") in 1965. Between 1973 and 1974, the Northern jetty was lengthened with a curved section and a final groyne (the "Southern") was built close to the bunkers[1].

The storm of winter 1978-1979 destroyed the last 25 metres of the Northern jetty (fig 4) and badly damaged the seafront structures, which had to be reinforced in 1981[2]*. However, no repairs were made to the Northern jetty, which today remains as it was left after the storm. Further longitudinal protection was built in 1981 opposite the CERS (Centre Européen de Rééducation Sportive) and since then has been regularly consolidated with rockfill.*

Figure 4: *Storm of winter 1978/1979 -Destruction of the last 25 metres of the Northern jetty and landing stage*

3. Changes in Capbreton shore and present situation

Coastal erosion phenomena at Capbreton began long before the extension of the Northern jetty in 1974. In 1938, houses along the seafront were threatened with collapse (fig 5). In 1952 and 1954, winter storms caused significant damage to the installations on the upper beach (fig 6).

Figure 5: Buildings damaged by the 1938 storm.

Figure 6: 1954 storm. Collapse of the Préventorium

The extension of the Northern jetty in 1974, which was intended to ensure sufficient depths in the harbour access channel and protect the harbour basin against offshore wave disturbance, resulted in accretion of the northern "Notre Dame" beach and also accentuated the erosion observed to the south from the Estacade beach to the Océanides.

Notre-Dame beach is today saturated. Large quantities of sand bypass the roundhead and are deposited at the end of the channel or inside it under the action of tidal currents. The seafront beaches (Estacade, Central and Prévent), which are low and narrow, no longer provide protection against storms and are insufficient to accommodate visitors during the summer period.

The beaches further south (Savane, La Piste, Océanides, La Pointe) are still undergoing pronounced erosion, with the dunes suffering regular attack However, the retreat observed recently is tending to slow down in relation to that observed just after the Northern jetty was lengthened, owing to the progressive re-establishment of longshore drift (table1).

***Table 1**: Rates of retreat on the southern beaches at Capbreton*

	1974 - 2000	*1974 - 1985*	*1985 - 2000*
La Piste	*2.3 m/year*	*3.6 m/year*	*1.6 m/year*
Océanides	*1.5 m/year*	*2.3 m/year*	*1 m/year*
La Pointe	*1.2 m/year*	*1.5 m/year*	*0.9 m/year*

To remedy the situation, Capbreton has removed sand regularly since 1983 from Notre-Dame beach in order to consolidate the beaches south of the Boucarot channel and in particular the Central beach, which is very popular during the summer period. Between 1983 and 2002, 415,000 m^3 of sand was removed from Notre-Dame beach and 305,000 m^3 replaced on the southern beaches (the rest was dumped on land). In addition, the Boucarot channel has been dredged annually to maintain sufficient depths for boats to pass. Between 1983 and 2001, 180,000 m^3 of sand was taken out of the channel and permanently removed from the coastal dynamics (with the exception of 7000 m^3 in 1990).

4. Current situation and aims

The current situation along the Cap Breton shore is as follows:

- Deterioration in the harbour access conditions owing to the quantities of sand that bypass the roundhead of the Northern jetty and are deposited in the mouth of the channel.

- Unsuitable morphology of the seafront beaches (which are narrow and low-lying), for both tourist use during the summer season and protection during the winter.

- Coastal erosion to the south of the protective structures, that may endanger the built-up areas situated behind the dunes.

The aims are to find solutions to the above-mentioned malfunctions in order to improve the situation while minimising environmental impacts and taking into account the various socio-economic aspects involved (development of the harbour, tourism, leisure and sports activities on the beaches, such as surfing, swimming, fishing, etc.).

5. Methodology, numerical decision-aid tools and proposed solutions

The methodology defined to address these issues consists of three phases:

1. *Assessment of coastal changes*
2. *Mathematical modelling of changes in the coastline and effects on coastal risks*
3. *Investigation of coastal development solutions*

Mathematical modelling involved creating a model of wave propagation between offshore and the coast (SWAN), in order to understand the effect of the Gulf de Cap Breton and use a sedimentological model of changes in the coastline (GENESIS) (fig 7).

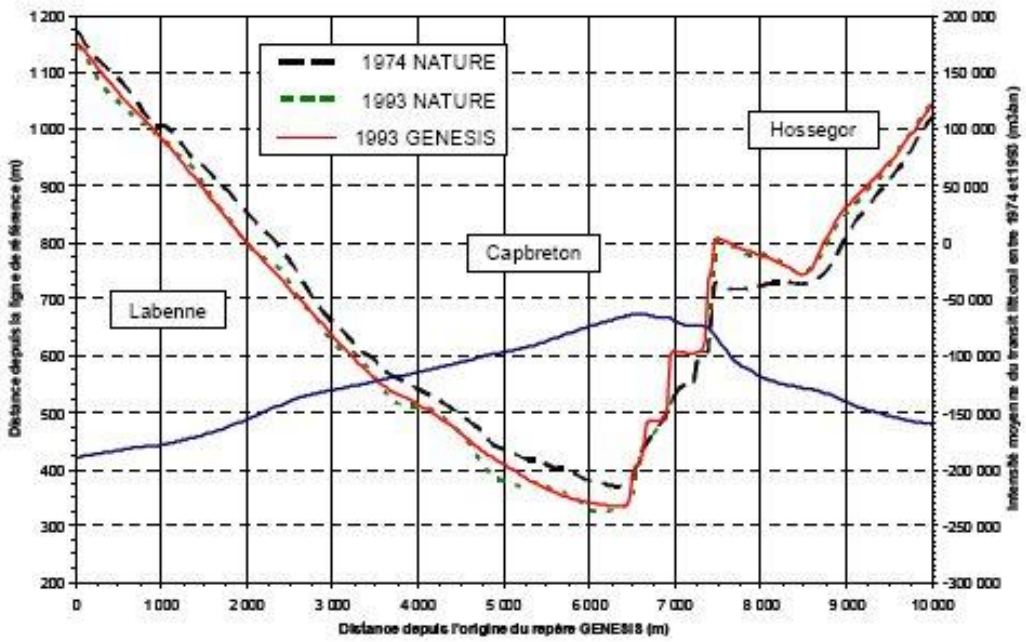

Figure 7: Results of calibrating the GENESIS model

The various tests performed on the sedimentological model showed that larger consolidation operations spread more judiciously along the Cap Breton coast accompanied by small-scale work on the existing structures would help to:

- *improve the seafront beaches to the south and,*
- *reduce the quantities of sand bypassing the roundhead of the Northern jetty.*

In the end, the complete solution adopted for protecting and developing the Cap Breton shore consisted of the following:

For the seafront beaches:

- *Lengthening the Central and Prévent groynes by 20 m and raising their crest levels.*
- *Possible creation of a new groyne on the Estacade beach.*
- *Nourishment using sand from Notre-Dame beach (40,000 m^3 initially and 15,000 m^3 for annual maintenance).*

For the beaches to the south of the CERS:

- *Protection of the base of the dune on Savane beach by using geotextile rolls.*
- *Nourishment to stabilise the coastline (50,000 m^3 per year from Notre-Dame beach).*

6. Beach response and changes in port exit conditions

The seafront beaches should widen by 10 m to 15 m (width of dry beach at +5.0 m CD). It is expected that the Savane beach will stabilise and that the retreat in the beaches situated further south will diminish (table 2).

Table.2: Retreat over 20 years in the various beaches immediately south of the CERS

	La Savane	*La Piste*	*Les Océanides*	*Treatment plant*
Current situation	*-12 m*	*-12 m to -15 m*	*-15 m to -17 m*	*-20 m*
Transfers of 50,000 m^3/year to Savane	*stability*	*-1 m to -10 m*	*-9 m to -16 m*	*-17 m to -18 m*

The port exit conditions should be improved in view of the fact that extraction carried out on Notre-Dame beach will be compensated by natural deposition of sediment from the north.

7. Sand transfer systems

At the present time, sand is transferred from Notre-Dame beach to the Central beach by lorry. These transfers cause problems for traffic, damage the roads and produce noise and smells. In addition, the development scenario chosen involves greater quantities being transferred, and this will increase the constraints connected with the use of lorries. Consequently, the introduction of a hydraulic sand transfer system was studied and compared with the existing methods based on the use of mechanical equipment (lorries, dragline).

The hydraulic sand transfer system imagined for the Capbreton shore consists of the following components:

- *a hydro-ejector that will be used to extract the sand from Notre-Dame beach (fig 8),*
- *a pump for taking clear water from the Boucarot channel, connected to the hydro-ejector,*
- *relay pumps placed to the rear to provide sufficient hydraulic power to supply the southern beaches (Savane, bunker),*
- *delivery pipes laid across the Boucarot channel,*
- *rigid pipes laid below the seafront at Capbreton with regularly spaced outlets,*
- *flexible pipes that can be connected to the outlets.*

A diagram of the hydraulic sand transfer system layout is given in figure 9.

Figure 8: Indian River hydro-ejector, Delaware, USA

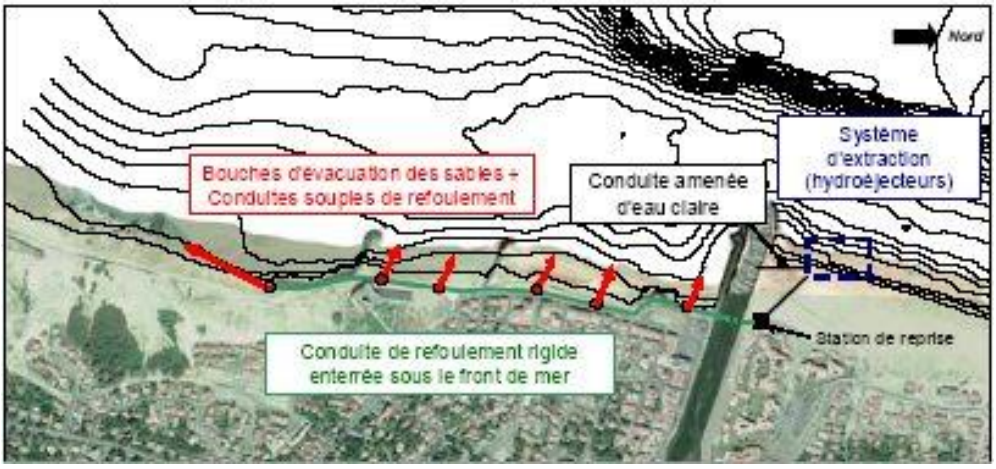

Figure 9: General layout of the hydraulic sand transfer system

The system is capable of transferring 180 m^3/h of sand on average, which corresponds to 12 - 15 weeks of operation for the chosen scenario (possibility of carrying out operations before the summer season).

The consolidated beach is levelled by loaders. The trenches excavated by the hydro-ejector on Notre-Dame beach are filled by natural sediment deposition resulting from longshore drift.

See also: *hydraulic sand by-pass, CFD, SWAN, GENESIS*

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