

CASE STUDY

COASTAL DUNE MANAGEMENT ON A SHORELINE SUBJECT TO STRONG HUMAN PRESSURE: THE DUNKIRK AREA, NORTHERN FRANCE

LOCATION:

East Dunkirk, Nord Pas-de-Calais, France

TOPIC:

Beach morphology and evolution

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EXECUTIVE SUMMARY

The extreme northern coast of France from Dunkirk to the Belgian border is bounded by coastal dunes that have been massively transformed by urban and port development. The only stretch of preserved dune barrier, less than 8 km long, is located east of the port of Dunkirk. The foredune ridge was seriously damaged at the beginning of the 20th century by urban development and almost completely destroyed during World War II. In the 1980s, the foredune, 10 to 20 m high, was affected by breaches and blowouts, and by erosional scarps cut during storm events. The dunes are presently in a state of meso-scale (decadal) stability. This stability is attributed in part to human intervention. In the early 1990s, active restoration was carried out by the Departmental Authority of the North (Conseil Général du Nord) in charge of the management of these coastal dunes. These measures have resulted in incipient foredune development along accreting sectors. The restoration practices have significantly encouraged foredune stability and incipient foredune development.

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1 – INTRODUCTION

Coastal dunes act as sand reservoirs, which may supply sediment to adjacent beaches (Psuty, 1988), and therefore can delay coastal retreat and protect low-lying backshore areas against marine invasion. This is particularly the case along the southwestern coast of the North Sea where a large proportion of the coastal plain consists of densely populated reclaimed land. The extreme northern coastline of France, bordered by the Southern North Sea has been massively transformed by urban and port development and the only stretch of preserved dune barrier, less than 8 km long, is located east of the port of Dunkirk (Fig. 1). Along this coastline, coastal dunes are not only a protective natural barrier against marine invasion, but also are a much appreciated recreational area and a “natural” landscape of biological and geomorphological interests. This case study presents coastal dune evolution along this coastline, with particular attention to management practices that resulted in the recent (last decade) stabilisation of this shoreline characterized by erosion since at least the beginning of the 20th century.

2 – GENERAL DESCRIPTION OF THE AREA

Along this coastline the beach is subject to a macro-tidal range that increases from 3.5 m during mean neap conditions to 5.6 m during mean spring conditions. At low tide, the beach is 400 to 500 m wide and has a very gentle gradient (0.01). The beach consists of fine homogeneous well-sorted sands and is characterised by irregular ridge and runnel morphology. These ridge and runnel beaches are associated with extensive coastal dune fields. The development of these dunes has been related to massive sediment supplies from a sand-rich nearshore zone consisting of tidal banks, the Flemish Banks (Anthony, 2000). From Dunkirk to the Belgium border, a coastal dune field, known as Dewulf, Marchand and Perroquet dunes (Fig.1), is interrupted by the coastal resorts of Zuydcoote and Bray-Dunes (Fig. 1). The beach is backed by an established foredune ridge 15 m to 150 m wide and 10 m to 20 m high. This coastline is dominantly exposed to offshore to shore parallel winds from a south to southwesterly window. Northerly onshore winds, the most important in terms of potential dune accretion, are less frequent, but they occur in winter and can induce storm surges responsible for upper beach/dune erosion.

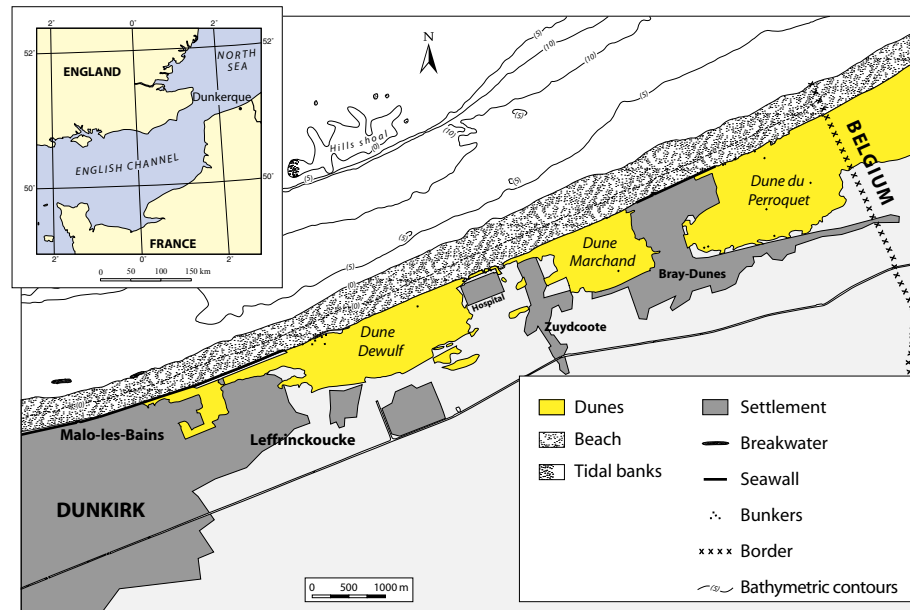


Figure 1. Location map

3 - COASTAL DUNE EVOLUTION PRIOR TO MANAGEMENT

The very high population density of the « Département du Nord » has resulted in strong human pressure on these coastal environments. East of Dunkirk, the shoreline evolution during the 20th century is dominated by coastal retreat. This evolution is related to both human pressure and natural erosional processes under storm conditions. The foredune was seriously damaged at the beginning of the 20th century by urban development. The extension of the seawall, east of Malo-les-Bains (Fig. 1) around 1906, resulted in the destruction of the adjacent foredune and the formation of active parabolic dunes, migrating eastward in response to the dominant westerly winds. From 1894 to 1939 the erosion rate was estimated at up to 2.5 m/y east of Bray-Dunes (Fauchois, 1998). Coastal dunes were also badly damaged during World War II. On the upper beach, as well as on the foredune ridge, several German bunkers and an anti-gunfire defense wall illustrate the strong impact of these buildings on the shoreline morphology. From 1947 to 1977 erosion still prevailed along the eastern and western part of the study area while in the central part, foredune development occurred. From 1971 to 1994, erosion rates were of the order of 1.7 to 2.9 m/y in the western part of the Dune Marchand (Fig. 1) while in the western part of the dune Dewulf the mean retreat rate was less than 1m/y. Along the Dune du Perroquet close to the Belgian border, stability prevailed (Clabaut *et al.*, 2000). In these fairly stable sectors, the foredune was progressively rebuilt and stabilized by vegetation. In the 1980s, the foredune was affected by breaches and blowouts, mainly due to human disturbance, and by erosional scarping during storms. Erosion was related to storm intensity and frequency. Over the

last few decades shoreline retreat was counterbalanced by sand accumulation at the top of the dune crest and on the backslope, resulting in a widening of the foredune. The refilling of dune blowouts and the development of a vegetation cover suggest a relatively balanced sand budget.

4 - COASTAL DUNE REHABILITATION THROUGH EFFICIENT MANAGEMENT PRACTICES

The foredune is presently in a state of meso-scale (decadal) stability (Ruz *et al.*, 2005). This stability is attributed in part to human intervention. In the early 1990s, measures to combat degradation of the dunes and reduce the threat of marine erosion were implemented by the Departmental Authority of the North (Conseil Général du Nord) in charge of the management of these coastal dunes. Wooden and brushwood fences were erected in order to encourage sand accumulation in the most sensitive areas. Wooden fences were erected across major blowouts and bare sand patches were fenced off and plants artificially introduced. Attempts have also been made to improve the effectiveness of the frontal dunes as sea defences by encouraging artificial accumulation of blown sand along parts of the backshore. Access to the public was restricted and panels showing information aimed at increasing people's understanding of the area were put up at the entrance of the pathways. In order to promote the recovery of natural habitats, these rehabilitation measures have involved, since 1994, manual collection of detritus and debris accumulating at the high tide lines at the Perroquet and Marchand dunes (Lemoine *et al.*, 1999). These measures have resulted in incipient foredune development along accreting sectors (Fig. 2).



(a) Source: Conseil Général du Nord



(b) Source : M-H Ruz

Figure 2. Coastal dunes evolution east of Bray-Dunes (a) Prior to 1994 mechanical cleaning on the upper beach did not allow sand accumulation (b) Development of incipient foredunes favoured by manual cleaning

Collaborative work involving beach and foredune surveys carried by the *Coastal Geomorphology and Shoreline Management Unit* and the Conseil Général du Nord over the past years has enabled better insight into beach and foredune sediment dynamics. Aeolian sand transport measurements enable quantification of sand exchanges within the dune front in a coastal sector where brushwood barriers

and sand fences were erected and where marram was planted in order to favour the formation of a protective incipient foredune. This study permitted a detailed quantification, through differential contour maps, of aeolian sand volume trapped by brushwood barriers and sand fences. An accumulation of about 1.75 m was recorded between September 1999 and May 2001 on the developing incipient foredune, demonstrating the efficiency of these management structures (Vanhée *et al.*, 2001). Sand transfer from the upper beach to the backshore through aeolian processes has resulted in sand accumulation that put the dune toe out of reach of the highest tides. Furthermore, the absence of major storm events since the early 1990s reinforced this natural accumulation trend.

Near the Belgian border, east of Bray-Dunes (Fig. 1), accumulation in the backshore zone has prevailed since at least 1995 (Clabaut *et al.*, 2000) and is emphasized by incipient foredune development. This coastal sector, less than 150 m long, is of particular interest as recent shoreline evolution can be studied along a “managed” sector. This sector was subject to sand deflation and the dune was an irregular assemblage of poorly vegetated hummocks (Fig. 3a). Erection of wooden fences and marram planting were completed and from 1998 to 2004 an “artificial” foredune developed along this sector, well behind the uppermost water levels (Fig. 3b). Such an evolution shows that along a coastal sector with a positive sediment budget, deployment of dune rehabilitation structures is very efficient.



(a) Source: Conseil Général du Nord



(b) Source: Conseil Général du Nord

Figure 3. Recent evolution of a “managed” sector at the Belgian border between 1998 and 2001 (a) erection of wooden fences on poorly vegetated chaotic dunes in June 1998 (b) development of an “artificial” foredune in September 2001.

CONCLUSION

The restoration practices mentioned above have significantly encouraged foredune stability and incipient foredune development. Nevertheless, a context of net sediment supply from foreshore to dune has certainly been a factor in enhancing shoreline stability and dune development. Reactivation of coastal retreat can occur at any time, after a stormy winter, for instance. The evolution of the coastline east of Dunkirk therefore still needs to be carefully observed through detailed monitoring and cautious management.

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