50. BELGIUM

The coast of Belgium is about 65 km long and forms part of the sandy and rectilinear Southern North Sea coastline that stretches from Cap Blanc Nez (France) in the west to the Schelde estuary (Netherlands) in the east. From the border with France at De Panne to Wenduine the coast's orientation is N 55° E. More to the east it runs east-northeast. The tide is semidiurnal. The mean tidal amplitude reaches 4 m with a slight decrease from west to east.

The coastal zone comprises three main units: a very gently sloping and fine sandy beach; a dune

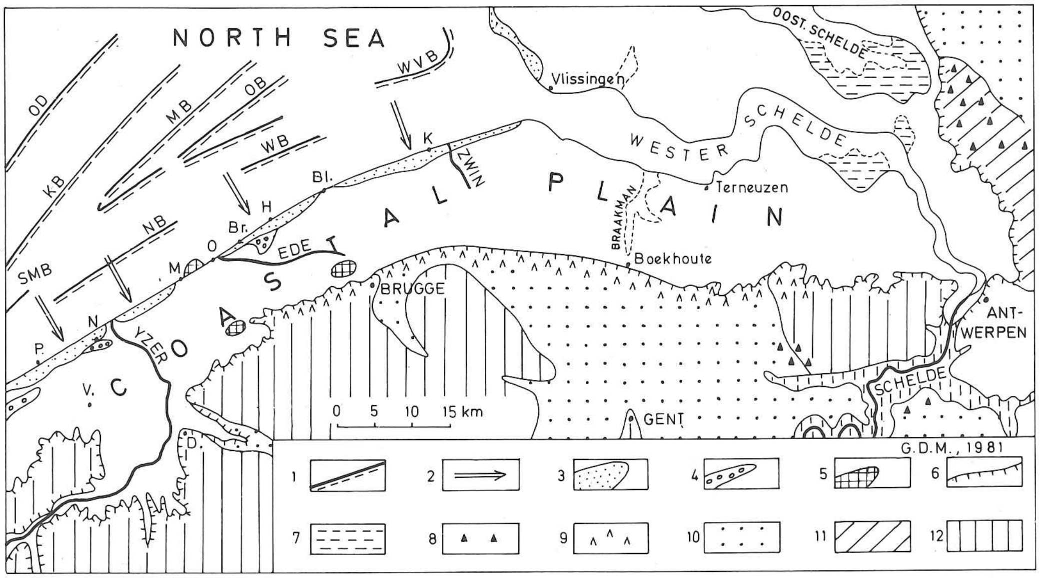

Figure 50-1. The Belgian Coastal Plain and Schelde Estuary. 1. Sublittoral banks; 2. 1960–1980 erosive mega-protruberances; 3. Younger dunes; 4. Older dunes; 5. Outcropping subboreal peat; 6. Limit of the reclaimed Holocene intertidal deposits; 7. Present-day active intertidal flats; 8. Tardiglacial eolian cover sand ridge; 9. Holocene river dunes; 10. Weichselian fluvioperiglacial sands (mainly of the Flemish Valley infillings); 11. Uplands in Lower Pleistocene deposits; 12. Uplands in Tertiary sands and clays. Bl = Blankenberge; Br = Bredene; H = De Haan; M = Middelkerke; O = Oostende; P = De Panne; V = Veurne. KB = Kwinte bank; OD = Oostdyck; WB = Wenduine bank; MB = Middelkerke bank; OB = Oostende bank; WVB = Walvis bank; NB = Nieuwpoort bank; SMB = Smal bank.

ridge generally of less than 20 m height, whose width varies from a few kilometers (at De Panne and east of Knokke) to less than a hundred meters and which is the site of numerous seaside resorts; and more landward, a coastal plain extending over a width of 5–10+ km, backed by a slightly uprising land developed in Pleistocene and Tertiary deposits. This coastal plain lies at a mean level of about 2 m above low-tide sea level, but shows a distinct microrelief of low sandy ridges (inversed sandy creeks) and clayey depressions. It corresponds to reclaimed Holocene intertidal flats, and its landward limit consists of the maximal landward extension of the whole of the Holocene marine transgression. The present-day elevation and micro-relief are mainly due to differential settling induced by the reclamation and draining.

Seaward, the foreshore continues in a broad and shallow sublittoral zone. The −5 m isobath runs at about 1500 m in front of the low water mark.

Farther offshore lies a field of banks and channels forming the Flemish banks. An inner row runs parallel to the coastline; an outer one lies obliquely to the shore.

The geologic substratum of the coastal plain and of the coastline consists of Upper Pleistocene deposits resting on Tertiary formations at a level of 25–35 m below mean sealevel. The Quaternary deposits comprise an alternation of marine and continental sediments: marine Eemian formations, fluviatile and eolian deposits dating from the last glaciation, mid-Holocene (Flandrian maximum) marine deposits covered by surface peat (mainly Subboreal), and finally the sediments of the Dunkerquian transgressions and of the intermediate regressive phases, such as the older dune deposits.

In a few places (Middelkerke), the shore consists of a wave-cut platform in the Subboreal peats, proving a local retreat of the subatlantic coastline over at least a few kilometers. In a few other places (Klemskerke), the subatlantic dune belt is backed by older dunes, proving local accretion.

From a tectonic point of view, the Belgian coast presents a remarkable stability, at least since the last interglacial. The stratigraphic top of the Eemian intertidal flats has been found at about the same elevation as the Subboreal.

The evolution of the coastal plain during the Dunkerquian transgressions can be considered according to the work of R. Tavernier and his various collaborators (1947, 1954, 1970). During

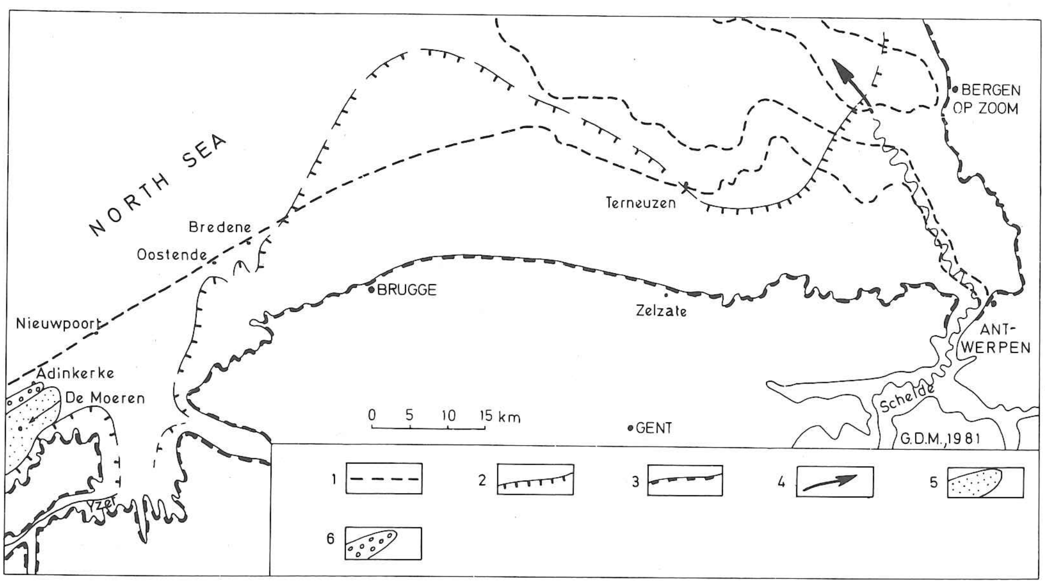

Figure 50-2. The Mid-Holocene Calais Transgression in the Belgian coastal plain and the Schelde estuary. 1. Present-day coastline; 2. Limit of the Calais transgression intertidal deposits (Calais coastline); 3. Limit of the Holocene intertidal deposits; 4. Former course of the Schelde; 5. Present-day outcrop of Calais deposits after post D-II removal of the Subboreal peat; 6. Remnant of the Calais island barrier with older dunes.

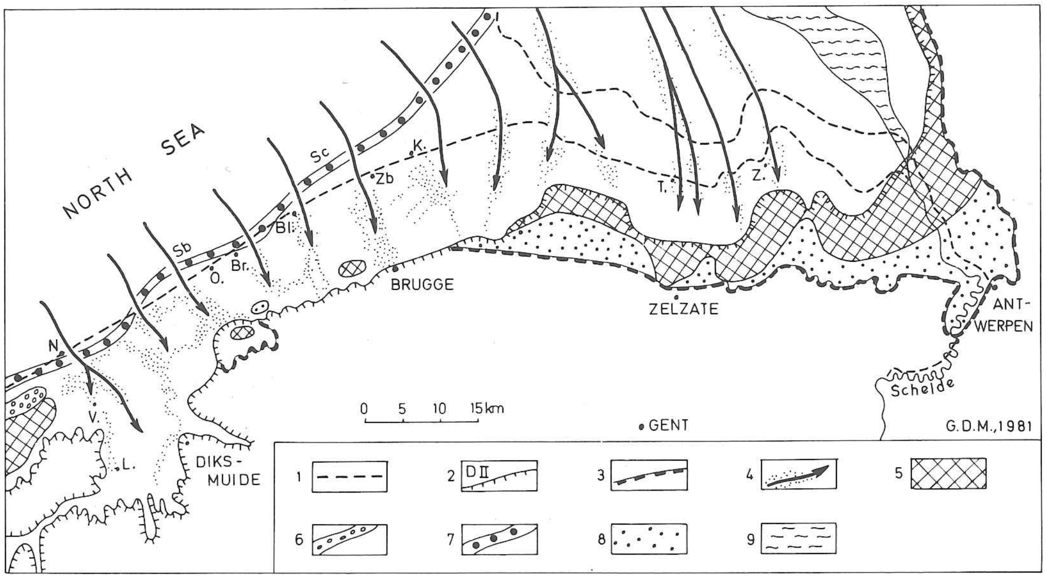

Figure 50-3. The Dunkerque II transgression in the Belgian coastal plain and the Schelde estuary. 1. Present-day coastline; 2. Limit of DII (3–8°C) transgression intertidal deposits (=DII coastline); 3. Limit of Holocene intertidal deposits; 4. Main beach barrier breaching and intertidal channel with sandy levee and channel deposits; 5. Outcropping surface peat (mainly Subboreal); 6. Older dunes (mid-Holocene); 7. Pre-DII beach barrier; 8. Not drowned Weichselian and tardiglacial sands outcropping within the Coastal Plain. Z = Zaamslag; Zb = Zeebrugge; V = Veurne; T = Terneuzen; Sc = Scarphout; Sb = Stroombank; O = Oostende; N = Nieuwpoort; L = Lo; K = Knokke; Br = Bredene; Bl = Blankenberge.

the Dunkerquian II transgressions (3rd to 8th centuries) the whole coastal plain, outside the Schelde estuary, was inundated and became an intertidal flat situated at the back of an important offshore bar. This bar later developed into a barrier island complex, banked against remnants of former Holocene coastlines, and still bears the present-day dune belt.

Soon after the inundation silting enabled man gradually to reclaim the flats. Later on three main dikes were constructed to save the western *oudland* and the central *oudland* from inundation by the eleventh century transgressions. Meanwhile the rest of the coastal plain was inundated again, especially going out from the Yser estuary (north of Diksmuide) and from the Zwin estuary (northeast of Bruges [Brugge]). New dikes were built to reclaim these *middellands.* Because of reclamation and draining, differential settling between the lower-lying sandy creeks, where the peaty subsoil had been cut, and the more elevated clay sedimentation flats, with peat subsoil, provoked inversion of that microrelief.

Since the thirteenth century transgressions (Dunkerquian IIIB) the western Schelde estuary developed very quickly, with an intertidal flat zone extending up to 20 km south of its southern bank and reaching Antwerp (Antwerpen), situated 65 km inland. Meanwhile, however, the important Zwin estuary was greatly silted up, cutting off the medieval harbor of Bruges from its outlet to the sea. These younger intertidal flats were gradually entirely reclaimed by a dense network of dikes during the following centuries.

These Dunkerquian II and III transgressions were, in fact, much more important than the older Dunkerquian I and Flandrian (Calais deposits). Their limits were much more restricted and the present-day extension of the Calais deposits shows that, because of the higher position of the pre-Holocene substratum, part of the coastal plain east of Ostend had only a very restricted Mid-Holocene inundation. To the west the Calais deposits are much more important and Holocene deposits there reach a thickness of 20 m. Nevertheless all marine Holocene sequences show a

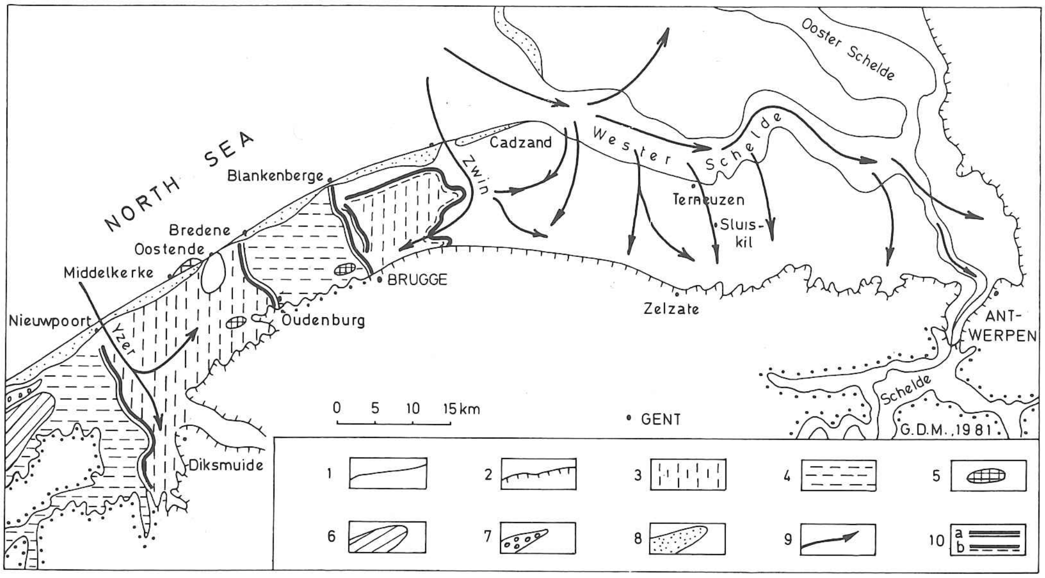

Figure 50-4. The Dunkerque III transgression in the Belgian coastal plain and the Schelde estuary. 1. Present-day coastline; 2. Limit of Dunkerque III transgression intertidal deposits; 3. Outcropping Dunkerque IIIA intertidal deposits (11°C); 4. Outcropping Dunkerque II intertidal deposits; 5. Outcropping Subboreal peat; 6. Outcropping intertidal Calais deposits; 7. Remnant of Calais island barrier; 8. Younger dunes (post Dunkerque II); 9. Main breacher and intertidal channels; 10. Chief dikes (a) post Dunkerque II (b) post Dunkerque IIIA (11–12°C).

juxtaposition and succession of subtidal, intertidal, and supratidal facies. There have also been interruptions by lagoonal deposition, especially during the formation of the surface peat.

Since the eleventh century transgressions the Belgian coastline has mainly been only disturbed by planned inundations provoked by artificial breaking of either the dune belt (Ostend, sixteenth century) or the dikes (Zwin, sixteenth century; Yser, First World War, 1914).

Today large parts of the Belgian coastline are characterized by defense structures such as groins and sea walls. Artificial nourishment has been carried out in several places.

The present-day open, macrotidal, sandy beach foreshore presents a succession of runnels and ridges. It shows lateral variations of slope, width, and sand grain size. The transversal beach slope tends to increase eastward, while its width decreases (Table 50-1), although the tidal amplitude decreases.

In a similar way, grain size distinctly increases from the west to the east, as shown by Table 50-2, which gives results of only three of the many stations studied by G. De Moor (1980) along the Belgian coast during the period 1977–1979.

This table also illustrates the difference between the lower foreshore, with finer sands, and the upper part of the foreshore. The coarseness of the beach sand increases from west to east on the lower as well as on the upper foreshore. The poor sorting of the easternmost station (Zwin) is partly due to artificial beach nourishment carried out in 1955–1957 and in 1977–1978 at a short distance (1 km) to the west of the sampling station.

During the last few decades several sections have been subject to more or less strong erosion resulting in a lowering of the beach and a retreat of the dune front, while adjacent sections remained nearly unchanged or even had some accretion (De Moor 1979*a*, *b*, 1980). Such sections extend over several kilometers and their evolution is known to have continued over several decades. Today such erosional sections are situated at Knokke-Heist, Bredene-De Haan, Lombardzijde, and De Panne. These sections are considered to be erosional mega-protruberances characterized by a chronological cyclicity and a spatial repetitivity

Table 50-1. Beach Morphometry along the Belgian Coast

Station (km)	*Locality*	*Date*	*Overall slope (%)*	*Width (m)*
3	De Panne	8/9/78	1.3	510
12	Oostduinkerke	8/9/78	1.5	480
38	Klemskerke	8/5/78	2.0	340
42	Wenduine	8/28/78	2.1	310
65	Knokke-Zwin	8/24/78	2.4	200

Table 50-2. Variation of the Beach Sand Grain Size along the Belgian Coast

		Percentage at		
Foreshore section	*Grain size grade (mμ)*	*De Panne (west)*	*Klemskerke*	*Zwin (east)*
High	125–180	30–40	10–20	5–10
	180–250	35–45	50–60	30–35
	250–300	5–30	15–25	30–50
Low	125–180	60–65	15–30	15–30
	180–250	20–30	50–55	30–60
	250–300	0–10	10–20	5–65

that both have been proved. They are mainly attributed to cyclic changes in the bottom morphology and in the current pattern within the sublittoral zone which affects the impact of the tidal currents as well as the energy level of the waves striking the beaches.

The following literature is recommended for further reading in connection with this review: Charlier and Auzel (1961), Codde and De Keyser 1967), Macar (1935), Ozer (1976), and Paepe and Baeteman (1979).

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A. OZER

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Plate 50-1. Klemskerke (1978). Runnel and ridge beach morphology. Beach longitudinal wind mega-ripples upon the ridges (photo by G. De Moor).

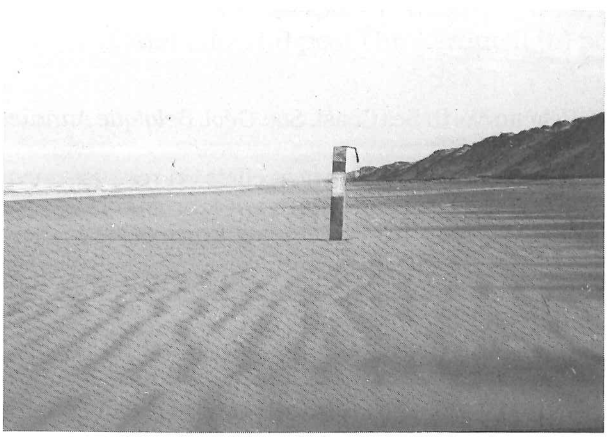

Plate 50-2. Klemskerke (1978). Effects of erosive megaprotuberance. Beach pole 38, situated about 45 m in front of the dune foot and spring high-water line. In 1960 it stood about 20 m from the spring high-water line and near the dune foot. The flattened high beach shows typical beach transversal backwash ripples, due to rapid seaward transport of eroded dune sands over the lowered beach (photo by G. De Moor).

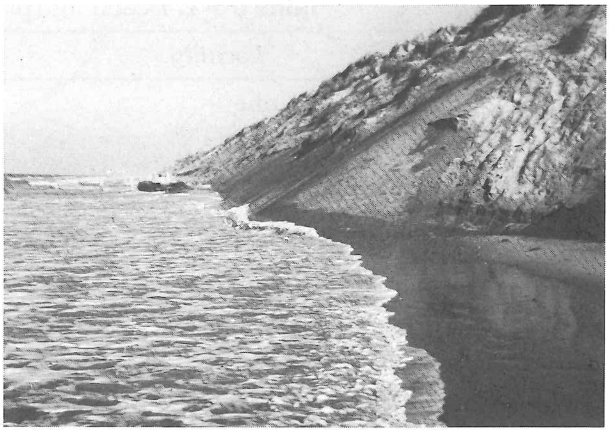

Plate 50-3. Klemskerke (1978). Effects of erosive megaprotuberance. Concrete dike built in 1910 against past sand waves, afterward completely covered by dune accretion and progression and since 1978 exhumed from underneath the dunes by the present-day retreat of the dune foot due to the repeated erosive action of sand waves (photo by G. De Moor).

Plate 50-4. De Panne (1980). French-Belgian border. World War II blockhouses left on the present-day forebeach after dune retreat due to the local strike of an erosive mega-protruberance (photo by G. De Moor).