Journal of Coastal Research	SI	42	425–447	West Palm Beach, Florida	Spring 2005

Grandeur, Decadence and Renaissance

Roger H. Charlier

Free University of Brussels
[V.U.B.] Belgium

ABSTRACT

CHARLIER, R.H., 2005. Grandeur, decadence and renaissance. *Journal of Coastal Research,* SI(42), 425–447. West Palm Beach (Florida). ISSN 0749-0208.

Rise, fall and resurrection make up the life story of Bruges, a city that glittered in Northern Europe with as much panache as Venice did in the Mediterranean World. The fate of Bruges hung however on a thin thread: the navigability of the Zwin, a tidal channel that was navigable as far as Damme, where goods were transboarded to flat bottom boats for the remaining few kilometers to Bruges. But the Flanders' coast was the scene of several transgressions and if man managed fairly well to keep waters out of his settlements, there was nothing he could do—dredging not being a technique known at the time—to keep the Zwin waterway open for navigation. The size of ships and their draught did not help things either. And thus the splendid city slid gradually but inexorably in a commercial and political torpor. Its commerce and political power waned and its rival Antwerp became the largest city of the Western world and one of its largest ports. But the phoenix rose out of its ashes and with the creation of a harbor on the coast Bruges has regained an envied position not only as a prime touristic center, at a stone's throw of the coastal resorts, but also as a deep water port endowed with all the modern infrastructures.

ADDITIONAL INDEX WORDS: *Damme, tidal channel/inlet, transgression, Zeebrugge, Zwin.*

INTRODUCTION

This is a story about a tidal inlet and its harbors; it is also a story about grandeur and decadence, and about the resurgence of a harbor like a Phoenix reborn out of its ashes. Tidal inlets result from geological events—such as the Bay of San Francisco and fjords in America and Europe, hydrological conditions—such as the Scheldt (in Dutch/Flemish *Schelde,* in French *Escaut,* in Latin *Scaldis*), Meuse (Dutch/Flemish *Maas*) and Amazon rivers, or drifts—such as inlets resulting from wave action, break-through, cross-bay barrier (e.g. Den Helder, Netherlands; Oregon outlet NC; East Rockaway NY). Perhaps most inlets originate from drifts. The durability of drift-originating inlets is limited as the sediments currents deposit, and they will eventually fill them up, unless they are dredged regularly. Their stability has been studied a.o. by Bruun (1997).[1]

The Zwin's Branches and Migrations

Several old inlets of the North Sea still exist, but very often their configuration and location have changed. Indeed, the history of an inlet illustrates a continuous geometry change. Conditions of flow, wave climate and littoral drift are continuously changing, hence an inlet's site and aspect.

The Zwin tidal inlet, today marking the border between Belgium and The Netherlands made the glory and wealth of harbors that developed along its inland protrusion. Its routing has varied and the [main] channel moved several times. A Belgian-Dutch border marker on the Zwin's contemporary embankment bears the tongue-in-cheek inscription relating that "I have been felled several times and moved as the channel shifted, but was re-erected each time". This refers evidently to the post-1830 years when the border was traced by a joint commission.

A XIIIth century era map of the Zwin Region (Figure 1) shows a network of arms, including that of the Old Zwin (Oude Zwin), Eerste and Tweede Leuge Zwin (First and Second Fake Zwyn), Nieuwe Zwin (New Zwyn) and the Zwarte Gat Zwin (Black Hole Zwyn) which opened rather close to the end (arm) of the Western Scheldt River, each a witnesses of the frequent and wide main channel migrations. Before turning westwards, opposite Sluis (French name *L'Ecluse*) towards Hoeke, Damme and Bruges (Flemish name *Brugge*), a branch of the Zwin turned eastwards forming the Koksijdse Gat (English term Deep), which near Oostburg continued northwards by the Zwarte Gat Zwin and eastwards by the Passegeme.

The widest of the two "Zwin" inlets was the one west of and near Kadzand (Cadzand); at one time the channel swung westwards towards Westkapelle (Oude Zwin) and continued southwards passing Michem and Koolkerke to reach Bruges. The width of the XIIIth century inlet's main channel narrowed considerably after reaching Damme where the draught apparently also diminished. Still other branches split from the main channel; one branch after passing the town of Hoeke, pushed inland beyond Lapscheure, another beyond Sluis and passed near Aardenburg, and still another headed southeastwards before reaching Koksijde (not to be confused with its homonym near the current French-Belgian border).

Both Bruges (Brugge in Flemish) and Damme owe their development during the Middle Ages to the inlet and became important sea ports located within a 15 to 20 km range from the coast (and the inlet's most westerly opening). If Bruges' renown has survived the centuries, Damme, though less

04-0302 received and accepted 28 July 2004.

[1] Bruun, P., 1992, *The stability of tidal outlets*: Amsterdam, Elsevier.

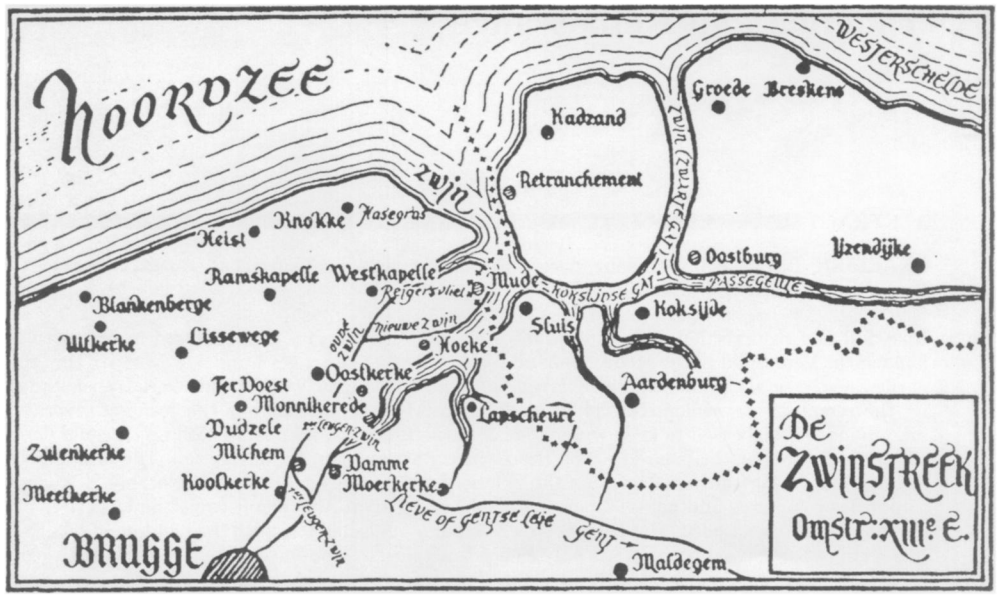

Figure 1. Thirteenth century map of the Zwin region.

known, was also a wealthy and important city due to its transshipment function: Indeed the draft of many ships did not allow them to pursue their journey on the Zwin to Bruges itself; goods were thus commonly transferred, in Damme, to flat-bottomed river boats.

Silting of the Zwin led to the decline of both Damme and Bruges, to the benefit of Ghent (in Flemish *Gent,* in French *Gand*), Ypres (in Flemish *leper*) near the IJzer River (in French and English *Yser*) and Antwerp, the western world's largest city during the Renaissance.[2]

Antwerp, in turn, lived through many years of decline, with short respites during the Napoleonic era (1796–1814) and during the period when Northern and Southern Netherlands were united (1815–1830) as a result of the Congress of Vienna's redrawing of the map of Europe (1815); it was commercially strangled as the Scheldt River was closed off by the [Northern] Netherlanders or heavy access rights were levied by them. Only in 1857 were the Dutch rights bought off through the deal negotiated by Baron Lambermont.

Damme is today a high point of tourism and the center of the legendary Tyl [Tijl, Till] Uilenspiegel land, symbol of local resistance against the XVIth–XVIIth centuries Spanish rule (cf. p.ex. Charles De Coster's epic [*"Les aventures mémorables de Tyl Uilenspiegel*[3] *et de Lamme Goedzak . . ."*], Marguerite Yourcenar's novel (*"L'Oeuvre au Noir"*)—and Delvaux' masterpiece film based thereupon—*"L'OEuvre au Noir"* (an alchemist's formula) and Richard Strauß' (1864–1959) *Till* symphonic poem. Bruges, after a long slumber [*cf.* Georges Rodenbach's *"Bruges, la morte"*), took on a new life as harbor when a sea-canal linked it anew to the North Sea some 15 km west of the present-day Zwin Inlet (Zeebruges; Zeebrugge in Flemish)), as a tourism center (cf. St John's Hospital, Memling Museum, Dolfinarium, Belfry, Holy Blood Pageant and Procession, Tomb of Mary of Burgundy, etc.) and as an international academic center (Collège de l'Europe—College of Europe).

And the main protagonist? The Zwin is still a tidal outlet, still located at a bare two kilometers from Cadzand-Bad, but runs up inland for a mere two or three kilometers, navigable at high tide at best for canoes and kayaks, but part of a natural preserve that is a refuge for birds, many migratory, several sea dwellers (Figure 2 and 3), "twinned" with Marquenterre, the Bay of the Somme Natural Park.

The Shifting Shoreline

Montreuil-sur-mer is no longer on the sea, and Champlain (1570/7–1635) would have a serious problem attempting to sail for North America, even in rowing boats, from his home port of Brouage where silting set in during the seventeenth century. Some islands are now well inside the landmass. The Atlantic coast of France and the North Sea coasts of France, Belgium, and The Netherlands have undergone substantial changes during the «historical period». In the mid-sixties a seldom occurring tide was experienced near St Malo, on the coast of Brittany, and the water pulled back for miles uncovering scores of ships sunk during World War II but also several Gallic settlements that were once engulfed.

Ours is a tale that centers on a city that has known major vicissitudes due to such coastline variations. Coastline chang-

[2] Antwerp was granted municipal rights in 1291, became a hanseatic city in 1315 and was the commercial and financial capital of Europe during the 16th century; it was Fugger, an Antwerp banker who loaned emperor Charles V money and advised him. As all international cities of importance, Antwerp has a name in several languages: Anvers in French, Amberes in Spanish, An versa in Italian, Antwerpen in Dutch/Flemish, Scandinavian languages and German.

[3] Also spelled Ulenspiegel and Eulenspiegel.

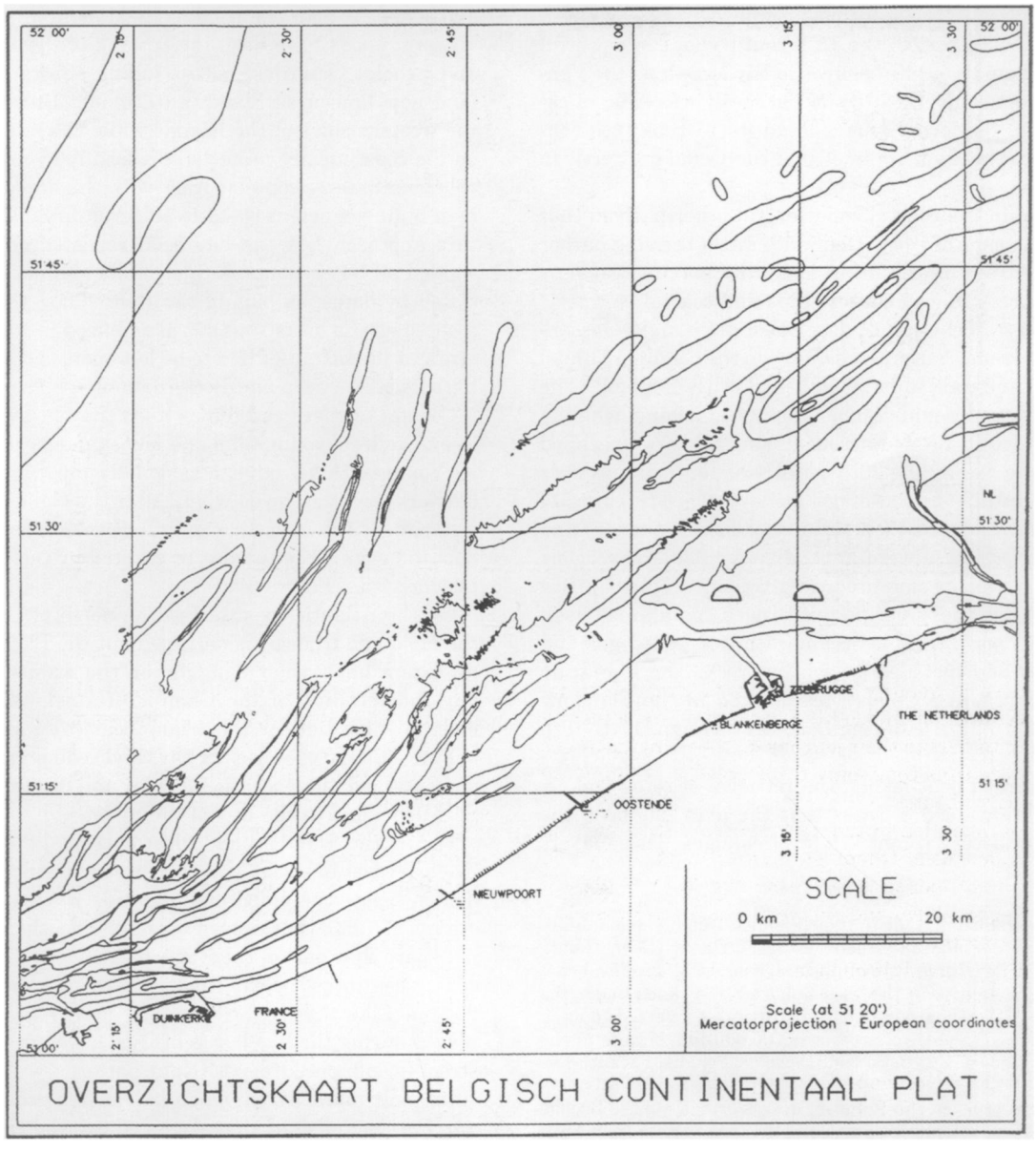

Figure 2. Map of the Belgian Continental Platform.

es, and, ipso facto, sea-level change in tropical areas are a matter of utmost urgency for small islands and archipelago countries, which may well drown. Proof the alarm signal sent in mid-February 2004 by Vanuatu, a Pacific Ocean country consisting of nine atolls—ready to sue Australia because the Commonwealth will not adhere to the Kyoto Protocol; where will the 11,500 inhabitants go if their country disappears under the waters? The country had already sent out a S.O.S. ten years ago. What if the dire predictions made for Charleston SC come to pass?

The impact of historical geology events, whether in tropical or in mesothermal environments, upon history may provide food for thought.

Setting the Stage

Of the four large cities that made the glory of medieval Flanders, and dominated the lucrative cloth industry—Bruges, Ghent, Ypres, Lille—Bruges, though located at some 15km from the contemporary coastline, has had its fate the most closely linked to the evolution and modification of the North Sea coast geomorphology. Both Bruges and Ghent were at one time important harbors. Ghent, on the confluent of the Scheldt and Lys rivers, is established on several former islands connected by bridges and linked by canals to Bruges and Terneuzen (Netherlands), the latter a sea-vessels water-

way[4]. Bruges, connected today by canals to Ostend and Zeebruges, was perhaps the wealthiest medieval city of Northern Europe. The residence, in the 15th century, of the powerful dukes of Burgundy, it has been variously known as the Venice of the North and the City of Bridges[5], was later nicknamed Bruges-la-Morte. Bruges owed its 13th to 16th century wealth to the Zwin, an inlet that connected it directly to the North Sea.

There were in the coastal zone several other harbors that lived their moment of glory: Dixmude[6] was a thriving harbor on the Yser River[7] until silting made the port increasingly difficult of access to ever larger ships and coastal Newport[8] took over the traffic. Ostend[9] developed into a major passenger harbor, a trade that tapered off when the Channel Tunnel was opened and rail links established with England. The coastal fringe traditional economy had been fishing, whaling and later agriculture.[10] Numerous fishing harbors[11] declined or ended trade during the 20th century as tourism took over in the 20th century as the major money earner (Figures 4a and b). Whaling was by then but a very distant memory and some fishing practices were kept alive for folkloric reasons rather than as an income producing trade[12] (Figure 5). But Zeebrugge, today the major port of Bruges, maintained itself as a fisheries port while it became a major passenger and goods harbor and includes a yachting dock. The Flandrian ports of Dunkirk and Calais[13] are located in the Flanders' area annexed to France during Louis XIV's reign (17th–18th centuries).

The presence of peat layers, the retrieval of coins and artifacts, *inter alia,* bear witness that the area has been the scene of several very recent sea level changes. These layers continue under the present sea surface for quite a distance and reappear near the English coast.

Storm floods have been the scourge of the Rhine[14], Meuse and Scheldt estuaries, not excluding effects on the coastal land now known as Flandrian Zeeland. Dunes protect only the western sides of the islands while the inlets and outlets on the coastline are protected artificially by dikes; dunes development seems contemporary with the implantation of human built sea defenses (12th–13th century). The hard structure approach has—as has been repeated *ad libitum*—not yielded all but benefits. Larger inlets and outlets have been closed by dams, as part of the Delta Plan, that was implemented after a disastrous storm and flood in 1953. The southernmost fluvial outlet had to be left open, access to the world harbors of Antwerp and Rotterdam oblige.[15]

Coastal barriers and dunes lined the coast during the Holocene; indeed, young tidal and lagoonal deposits are overlain by Younger Dunes, that occasionally top Older Dunes, and barriers were destroyed when, after the Gallo-Roman historical period, the shoreline migrated seawards and the peat deposits were either eroded or covered by tidal flat sedimentary deposits (Figure 6).

On the Atlantic coast of France, north of Cap Blanc-Nez, the Holocene transgression wiped out the Pleistocene beaches, except however at Sangatte on the Straits of Dover—today the terminal of the Channel Tunnel. Wide tidal flats emerge at low tides on the oceanic coasts (Figure 6), sheltered behind spits, in estuaries or bays and sedimented by the tidal currents and the exceptional tidal amplitudes, *e.g.* at Mont St. Michel and in the Bay of the Somme.

Facing the Flanders and Picardy coasts, the southeastern English coast has been subject to severe erosion. Roman London is below contemporary high-tide sea-level. The megastorms of 1953, that caused over 2000 deaths, and 1978, did not spare that part of the English coast, nor did those of preceding centuries.[16] Near Holderness cliffs retreated by some 200 m. Like across the Channel, groins and breakwaters placed during the two last centuries have, as anywhere else, strongly influenced depositional patterns with negative results. Salt marshes, in which halophytes grow (*e.g. Salicornia, Puccinellia, et al.*), criss-crossed by tidal creeks, have developed in spit-protected areas and along estuaries and so did a few barrier islands. Erosion is unequal along the coast but agricultural land and even towns[17] have been lost way back in the 14th century (Dunwich, a port in Suffolk) but also in the twentieth century and the example of Selsey Bill is usually given for rapid recess: 116m from 1955 to 1975.

---

[4] Alternative name(s), italic in their Flemish/Dutch version: Flanders (*Vlaanderen,* Flandre), Bruges (*Brugge),* Ghent (*Gent,* Gand), Ypres (*Ieper*), Lille (*Rijsel,* Rijssel, Lisle, L'lsle). Lille, medieval capital of Flanders, is now in the area annexed by France under the reign of Louis XIV (1638, king 1643–1415) and is referred to as *la métropole du Nord.* Ypres counted over 200,000 inhabitants in the Middle Ages. Zwin or Zwyn. Scheldt (*Schelde,* Scaldis, Escaut); Lys (*Leie*).

[5] Brug [plural bruggen], in Flemish, means bridge, thence Brugge is a "city of bridges". Some authors claim the name comes from *bryggia,* meaning unloading facility.

[6] Dixmude (*Diksmuide,* Dixmuide).

[7] Yser (*Uzer*).

[8] Newport (*Nieuwpoort,* Nieuport).

[9] Ostend (*Oostende,* Ostende).

[10] cf. Charlier, R.H., 2004, Cetaceans of Belgium, in Morcos, S.; Charlier, R.H. *et al.* (eds), *Proc. 6th Int. Cong. Hist. Oceanog. «Oceans bridging the Millennium»*: Paris, UNESCO [in press, chapter 41].

[11] Ardenne d', J., 1888, *Guide descriptif illustré de la côte de Flandre et des plages de la Mer du Nord*: Bruxellles, L'Auteur pp. 99 et suiv.; Bertholeyns, E., 1911, *La cote beige de la Panne à Knokke:* Bruxelles, L'Auteur; De Vos, X., 1967, *Le tourisme dans l'economié régionale du littoral beige*: Louvain, Université Catholique de Louvain [These] pp. 9–53; Haulot, A., Van Hove, N. *et al.,* 1977, Coastal belt tourism, economic development and environmental impact: *Int. J. Enu. St.* 10, 161–172; Opdedrinck, J., 1965, *Knokke-sur-Mer. History and recollections*: Knokke, The Author's Imprint; Van Bladel, G., 1937, *Le littoral bege de la Mer du Nord*: Bruxelles, Ligue Maritime Beige [87 pp.].

[12] Charlier, R.H. see fn. 10.

[13] Dunkirk (*Duinkerke,* Dunkerque, Dunquerque); Calais (Kales).

[14] Rhine (*Rijn,* Rhin, Rhein); Meuse (*Maas*); Flandrian Zeeland (*Zeeuws Vlaanderen,* Flandre Zélandaise).

[15] Antwerp lies on the Scheldt, Rotterdam on the New Meuse (*Nieuwe Maas*).

[16] Steers, J.A., *et al.,* 1979, The storm surge of 11 January 1978 on the east coast of England: *Geog. J.* 145, 192–205; Valentin, H., 1971, Land loss at Holderness 1852–1952: *Appl. Coast. Geomorph.* [ed. by J.A. Steers] 116–137.

[17] Sheppard, T., 1912, *The lost towns of the Yorkshire coast and other chapters pertaining to the geography of the district*: London, A. Brown & Sons [xviii + 328pp.].

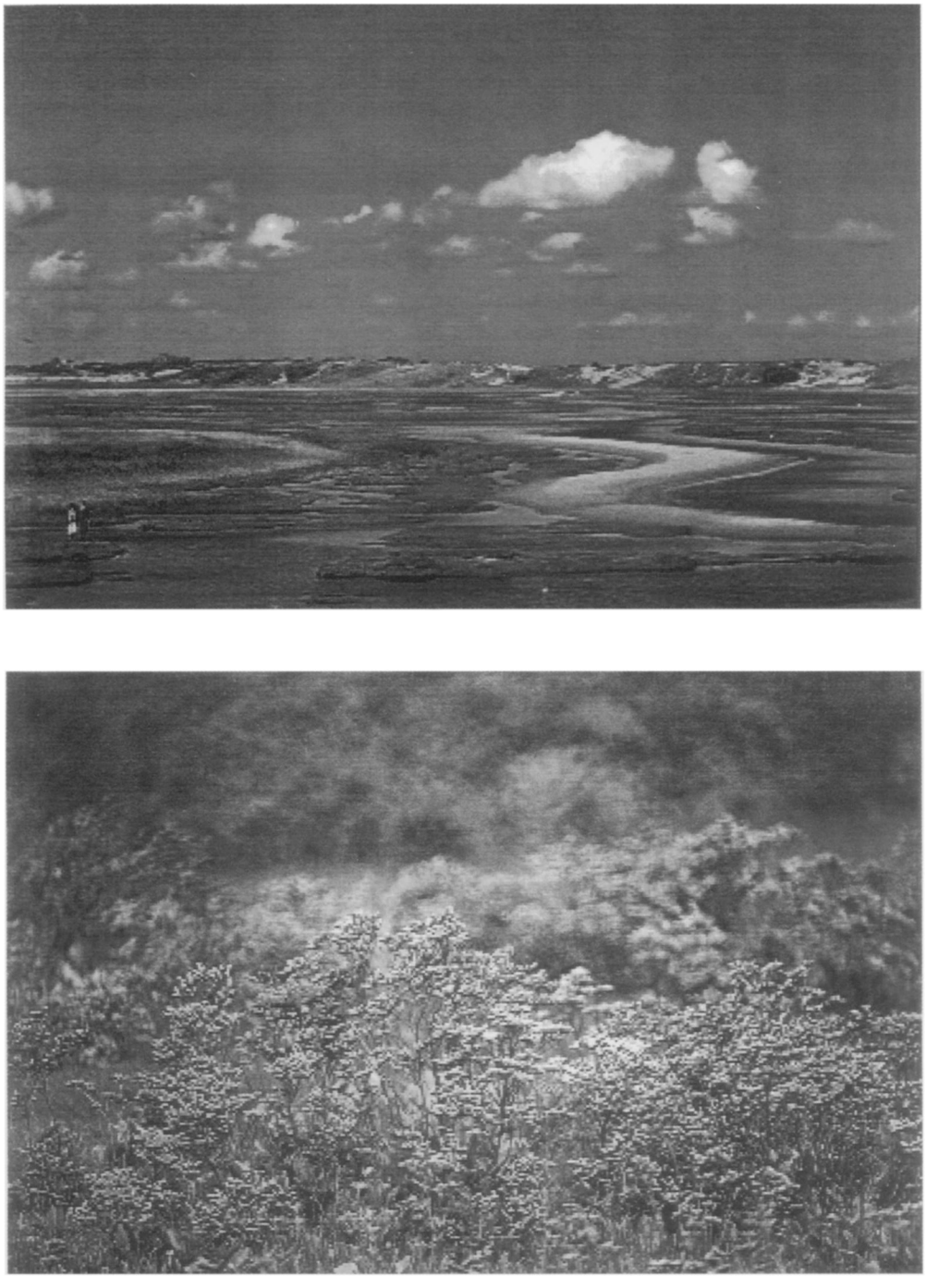

Figure 3 (top). Vegetation of the contemporary Zwin region (low tide). Figure 3 (bottom). Vegetation of the beach general area about the Zwin.

The Scene for a City

The Belgian coast of West Flanders partakes of about all of the characteristics of the regions touched upon above. A gently sloping fine sand beach abuts to a string of dunes of varying width and moderate height (± 20m), beyond which spreads a coastal plain, from 5 to 10 km wide, with sandy creeks and clay pits; the plain's land-ward limit corresponds to the furthest extension of the Holocene transgression (Figure 6). Clay pits are often ornithological refuges and those near De Panne and Heist are now protected areas. The Quaternary deposits are a succession of marine and continental deposits. Summarized, the layering in the coastal region consists of a superimposition of the Upper Clay (labeled Polder Upper Clay Layer), Coquina marine sand with a.o. a lamel-

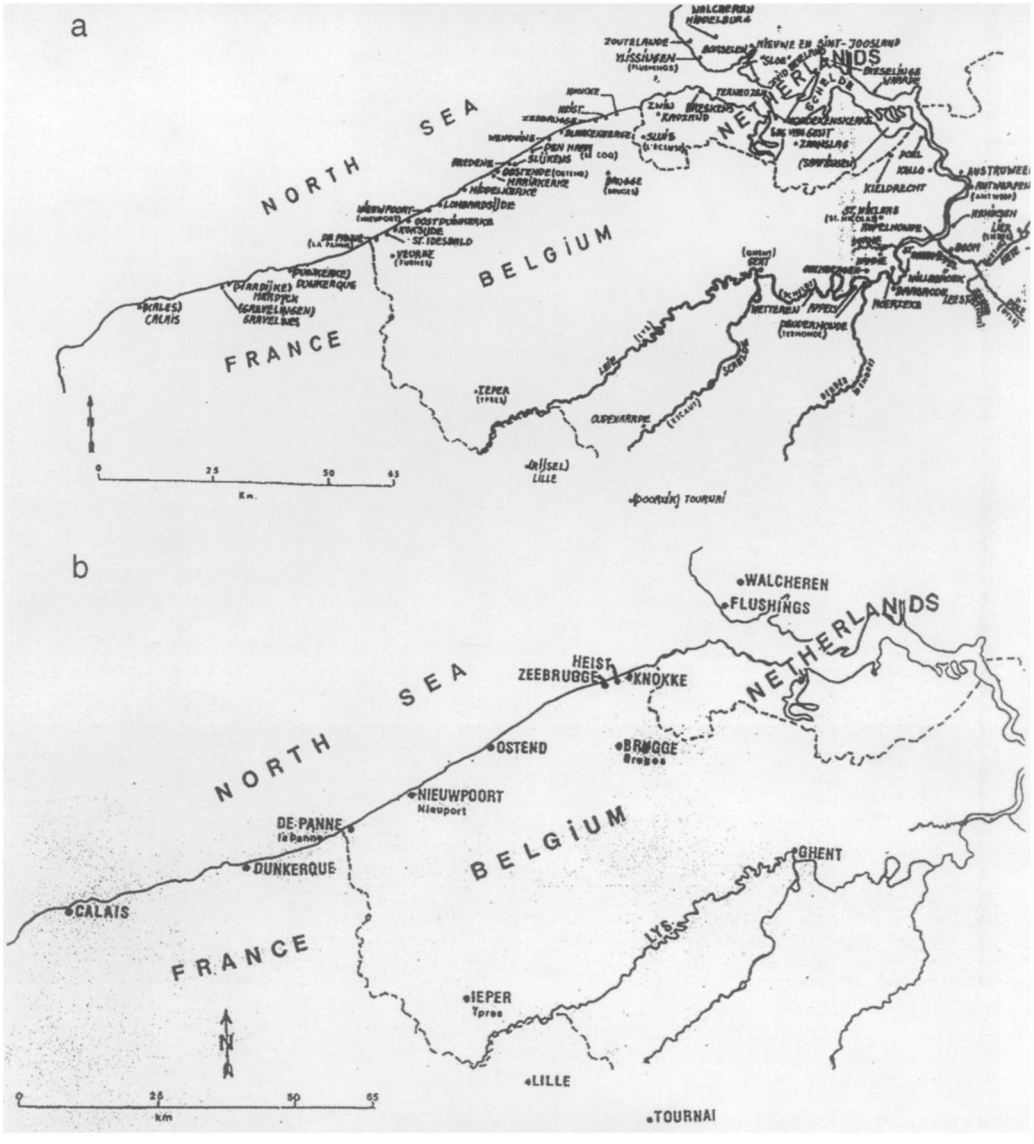

Figure 4a. Map of the Belgian North Sea coast with indication of sites where cetaceans have been sighted in recent times. Whaling ended with the 19th century. Figure 4b. Location map of major towns.

libranchiata the cockle, Cardium edule[18], Marine clay also containing Cardium, a peat layer containing evidence of modern flora—trees such as birch, hazelnut, oak and poplar—Marine sands with in its upper part roots from trees that lived in the overlying peat layer, and sands with *Corbicula fluminalis,* an organism still living in the Nile River estuary. The sea level is, in spots, at the base of the Lower Polder Clay, in others at that of the upper limit of the peat layer, from which Roman coins and cut silex, dating from the Neolithic Period, have been retrieved.

[18] Still present on the beaches today though channel shifts are responsible for grave thanatocoenoses. The mollusk is extremely abundant in sub-tropical areas such as the Sinai and Israel.

The coast in its western expansion is a region of several pans or pannes, called rather moërs on the French side of the Franco-Belgian border. *Sensu stricto* they are, usually shallow, salty or brackish lakes. Saltiness depends in this area upon the rate of precipitation, runoff and evaporation. The latter factor plays a greater role in subtropical and tropical pans; the presence or absence of underground springs, and whether the morphology is karstic plays a role there. Nowhere of course are there pans in the French or Belgian coastal zone that like in South Africa dry up during the tropical warm (dry season) and leave salt flats. Some additional factors are the pan's bottom permeability and its insulation from the sea. On the Belgian coast no rivers discharge in the pans, though the Aa River crisscrosses the area on the French

Figure 5. Painting of horseback fisherman in National Fisheries Museum at Oostduin-kerke (Photo R. Charlier).

side. Pans are ephemeral and become part of the coast. The border city of La Panne[19] has developed in an area of numerous dried up pans. The lands of the Westhoek have been set aside as a Natural Reserve.

Polderland

Polders predominate in the eastern expanse of the Belgian coastal zone (Oosthoek). This is, of course, a man-made *paysage,* that took over from a marshy area. The original meaning of the Dutch/Flemish term «polder» is earthen wall—the «primitive» dike that protected reclaimed land[20]; the term has also meant silted-up land, and, by extension, it designates land reclaimed upon the sea, or even inland water.[21] The concept of polders is usually associated with the achievements of the Dutch, but lakes, swamps and even river valleys were drained and «reclaimed» in subtropical and tropical areas in ancient Greece and Italy and more recently in Africa (Lake Chad); there are polders in the Flandrian North Sea coastal zones of France and Belgium and of course Zeeland.

The first «real» polders date back to the eleventh or twelfth century.[22] Mud flats, a type of pan perhaps, often form in front of polder dikes, and they constitute an enticement at further polder incorporation. However, in the area of our concern, polderization/reclamation is today often looked askance at because dikes appear to favor coastal erosion and, in a reversal of philosophy, tidal waters are allowed to regain access to old channels, dike toes are not repaired and erosion in experiments conducted in the La Panne area and on the French side of the frontier have shown encouraging signs of

[19] La Panne (*De Panne*). A new approach to counter erosion has been not to repair the hard coastal defenses and to let the tides run up ancient channels (see Charlier, R.H., Chaineux; M-C. & Morcos, S., 2004, Since when coastal protection?: *Proc. 6th Int. Cong. Hist. Oc.—Bridging the Millennium* [in press] Chapter 43).

[20] Charlier, R.H., Chaineux, M-C.P. & Morcos, S., 2004, Panorama of coastal protection: *J. Coast. Res.* [in press].

[21] Wagret, P., 1968, *Polderlands*: London, Methuen & Co [228 pp.].

[22] cf. fnn. 20 and 21.

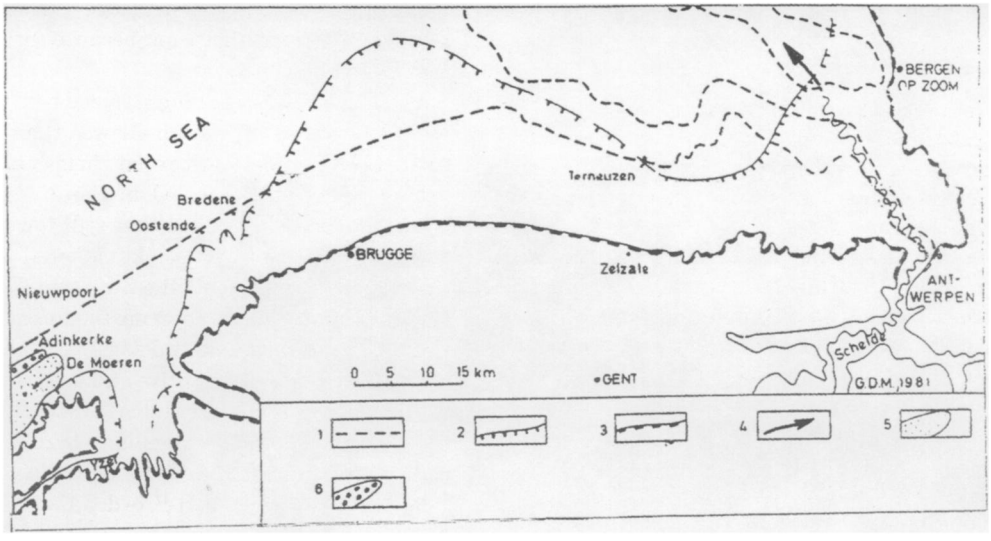

Figure 6. Map showing Holocene transgressions (from De Moor, *op. cit.*).

abatement.[19] Close to the Oosthoek, the Zwin, whether inlet or channel, has also been set aside as a Natural Reserve and ornithological sanctuary, where wild geese are common visitors.

Though referred to frequently as a tidal inlet—even a stream (*Webster Geographical Dictionary,* 1960 edition)—the Zwin is actually a tidal channel, characterized of course by bi-directional tidal flow and *ipso facto* bi-directional sediment transport. When the ebb transport fell below that of the flood tide, trouble developed for Bruges. The Zwin does not nor did it link barrier lagoons, or an impounded estuary with the North Sea, but it drained inter-tidal flats and tidal creeks.[23]

Based on some finds mentioned earlier, the area that became Flanders was already inhabited during the Neolithic. Knowledge about the tribes that occupied what are today the Dutch, Belgian and Northern France territories is rather parcimonious. The coastal region was an area of forests and marshes, which incidentally turned out to be excellent terrain to harass the Roman invader. The Menapii and Morini proved to be serious enemies: Julius Caesar himself (100–44 BC) wrote (57 BC) in his books relating the campaign of Gaul (*De Bello Gallico*) that «of all the people of Gaul, the Belgae are the bravest». And, unable to subdue the Menapii found that the best solution was to make them «free allies of the Roman people». The landscape evolved into a maze of small channels that drained the wet, marshy coastal lands at low tide, filling them up as the next high tide.

The entire coastal plain was flooded—outside the Scheldt estuary—and transformed into an offshore barrier protected inter-tidal flat from the 3rd to the 8th century AD. To the geologists this corresponds to the Dunkerquian II transgressions. The bar, which still bears the contemporary dune belt, led to formation of a barrier islands complex.[24] Man reclaimed the silted former flats and built artificial protection structures which kept the waters out during the 11th century transgressions that flooded the areas from Dixmude and Newport (Yser estuary) to the Zwin tidal channel. Settlement of the area and development of agriculture have been commonly ascribed at the establishment of abbeys, many by Cistercians monks, in the coastal fringe and down the coastal plain (*i.a.* Westvleteren, Ter Duinen, Ter Doest); this view has been challenged in a 2003 doctoral thesis defended at the Free University of Brussels (Vrije Universiteit Brussel [Belgium]) crediting instead a great deal of human development to the counts of Flanders and lay settlers.

After the 13th century transgressions (to the historical-geologists the Dunkerquian III B) the Zwin started silting up. During that century, further up north—in today's Netherlands—freshwater Lake Flevo got connected with the North Sea and became the Zuiderzee. Since then floods were often man-provoked: the dune belt was broken in the 16th century for the siege of Ostend, so were the dikes in the Zwin areas, and centuries later the Yser River locks were opened to stem the German Army's advance in World War I (1914). An action that had been considered to be repeated in World War II, but the idea was scuttled as thousands of refugees fleeing the

[23] Bruun, P. and Gerritsen, F., 1959, Natural by-passing of sand at coastal inlets: *J. Waterways, Harbors, Div. Proc. Am. Soc. Civ. Eng.* WW4, 2301, 75–107; *id.,* Stability of coastal inlets: *Proc. 7th Conf. Coast. Engng (Berkeley CA)* 23, 366–417; *id., Stability of coastal inlets*: Amsterdam, Elsevier-North Holland [123 pp.].

[24] De Moor, G., 1979, Recent beach erosion along the Belgian North Sea coast: *Soc. Geol. Belg. Ann.* 88, 143–157; Paepe, R. and Baeteman, C, 1979, The Belgian coastal plain during the Quaternary: *Act. Univ. Ups. Symp. Univ. Ups. Ann. G. Cel. 2,* 143–146; Tavernier, R. and Moorman, F., 1954, Les changements du niveau de la mer dans la plaine maritime flamande pendant FHolocène: *Geol. & Mijnb.* New Ser. 16, 201–206.

advancing Germans clogged roads and many of them would have drown.

Birth of a City and Rise of Another

In 1134 a storm of exceptional strength ran havoc on the Flanders' coast and opened, east of Knokke,[25] between a spot known as Lekkerbek and contemporary Cadzand-Bad (now 2km inside The Netherlands border), the Zwin [inlet] that reached all the way to near Bruges, some 15km inland. That city, which was on the lookout for an outlet to the sea, immediately built a transversal dike at the end of the Zwin channel. Alongside the dike or *dam* sprouted a fishermen settlement.[26] Damme was born and after a glorious period as the fore-port of Bruges went on, much smaller, to attain notoriety as the hometown of Flemish poet Jacob Van Maerlant, and of immortal hero Tyl Uilenspiegel, champion of liberty, whose legend inspired an opera to Richard Strauss (1864–1959) and a saga to Charles de Coster (1827–1879).[27]

The Zwin Region[28] in the 13th century, as pictured on an old map (Figure 1), had Kadzand on an island surrounded by the sea, the Zwin and the Coxyde Deep *(Koksijdsche Gat),* a lateral arm of the Zwin. The widest channel, apparently a new one, proceeded to Hoeke, thence to Damme. According to the map, the Zwin had previously followed a closer to the sea channel—here named the Old Zwin (*Oude Zwin*)—that had reached Bruges via Westkapelle. Five channels are shown branching off the new Zwin route.

Contrary to other areas of the North Sea coast (contemporary France and Netherlands), no effort was apparently made in the region to harness the energy of the tides on coast, rivers or channels to generate mechanical power. Such mills did function in Dunkirk, in Zeeland and far up the Scheldt River (Rupelmonde). The tide mills of Zeeland~and those further up North—are said to have been used in the drying up process of the polders (de Waart).[29]

The origin of Bruges is however not connected with sea or waterway, but rather to the building of a castle by the counts of Flanders in the 9th century; a settlement may have existed before then. It became a major hanseatic town in the 13th century (Figure 7). Sometimes siding with the count of Flanders, sometimes opposing him, the city always shrugged off the overlords French kings' attempts to subdue it, the bloody *matines brugeoises* of 1302 being only one of these uprisings. The kings of France had an unpleasant habit of burning down Flemish towns; Philippe-Auguste burned down Lille and Damme; to no avail however, because the inhabitants rebuilt rapidly their cities.

The Brugeois (*Bruggelingen*) sided with England's king Edward III (1284–1327) which allowed them to pursue their lucrative cloth trade and earned them many advantages and fishing rights still enforced in the 20th century by British courts![30] The belfry tower that still towers above the Main Market Place (Gro[o]te Markt) allowed observers to signal the arrival of ships down the Zwin and to sell the loads even before docking. The city became the financial and commercial hub of Northern Europe and a brilliant cultural center, birthplace of the Flemish primitive and mysticism schools of painting, home to the brothers Hubert (1366–1426) and Jan (1390–1441) van Eyck, Hans Memling (1425–1495), Pourbus and others, and symbol of a thirst for liberty personified by national heroes such as Jan Breydel and Pieter De Coninck. It has regained great cultural luster and got its turn as Cultural Capital of Europe in the 21st century.

If floods brought wealth and fame to Damme and Bruges, they resulted in the Scheldt estuary area to considerable loss of land; the Drowned Land of Saeftingen is perhaps the most spectacular example.[31]

North Sea Shorelines Modifications—The Zwin

The coast of Southeast England has been, throughout historical times, repeatedly invaded by the North Sea and some storms have left indelible scars with the loss, to the sea, of several towns. The same scenario developed on the other side of the Channel and Dover Straits. The coastal lands of today's Northern France, Flanders and Flandrian Zeeland, then all part of the County of Flanders, were, in the 10–11th centuries, a landscape of a maze of small channels draining the wet, marshy, coastal lands at low tide and filling up at high tide.[32] Land reclamation was undertaken since the 10th–11th centuries in the coastal regions.

Philippe d'Alsace (11657–1191) [Filip van Elsas], count of Flanders, granted in 1180 city status to Damme. A link between Bruges and Damme was established and the latter became the point where goods which ships brought, were transferred to flat bottom boats for further transport to Bruges. Damme, on The Zwin, got warehousing rights on Bordeaux

[25] Knokke is also spelled Knocke, Cnocke, Cnokke.

[26] Gysseling, M. & Verhulst, A. (eds), 1969, *Nederzettingsnamen en nederzettingsgeschiedenis in de Nederlanden, Noord-Frankrijk en Noord-West Duitsland*; Amsterdam, Elsevier; Van Werveke, H., 1965, De oudste burchten aan de Vlaamse and Zeeuwse kust: *Med. Kon. Acad. Belg. Kl. Letteren* 27, 1.

[27] The personage is however of German origin.

[28] Zwin is also spelled Zwyn, and even Zwjn as on Fig. 1; Kadzand is currently spelled Cadzand and Hoeke is spelled Hoek.

[29] Charlier, R.H. & Menanteau, L., 2001, The saga of tide mills: *Renew. Sustain. Energy Rev.* 3, 1, 1–33; Charlier, R.H., Menanteau, L. & Chaineux, M-C. P., 2004, The rise and fall of the tide mill, in Morocs, S., Charlier, R.H. *et al., Proc. 6th Int. Cong. Hist. Oceanog.:* Paris, UNESCO [in press, chapter 39]; personal communication of the late Dr Jacob de Waart, president at that time of the[Dutch] Molonogical Society and scientific collaborator at the Research Laboratories at Zeist (prov. of Utrecht, The Netherlands).

[30] Roovere, A. de, 1531, *Excellente Kroniek van Vlaanderen*: Antwerpen, Willem Vorsterman [Catalog Nr 46, Biblioth. Royale de Belgique); Wavrin, J[ean] de, 1475, *Chroniques d'Angleterre depuis les temps fabuleux jusqu'en 1472*: Bruxelles, Manuscrit depose à la Bibliothèque Royale de Belgique Albert Ier.

[31] In Dutch, *Het Verdronken Land van Saaftingen,* also spelled Saeftingen. See: Heyvaert, J. and Decleer, M., 2003, Atlantide sur Escaut: *Tempo Verde* 6, Nov., 67–75.

[32] Burggraeve, G. and Declier, no date (estimated 1999–2000), *Het Zwin: Leven tussen land en zee*: Brugge; Marc Van De Wiele pp. 8–32, *cf.* Also Van Belle, fh. 44.

Figure 7. Old map of the city of Bruges.

wines and herring, a wealth-producing privilege.[33] The Zwin brought such riches to Bruges that the city became known, in the Middle Ages, as the "Venice of the North", less perhaps because of the canals that cut it up, than due to its economic, financial and political clout, even, to some extent, its military might and the international alliances it entered in. A ruler's spouse making her *Joyeuse Entree* (in Flemish *Blijde Inkomst*), meaning Joyous Entry[34] into Bruges observing women along her parade route quipped: "Your Lordship, I thought I would be the only queen here. I am surrounded by them". She was referring to the rich clothing and costly jewelry worn by Flemish women lining the cortege's route.

A Dikes' Landscape

The area between Bruges and the North Sea was crisscrossed in the 13th century by dikes protecting settlements and also a polders landscape[35]. Some of these dikes still exist[36]; others have become roads, even streets, keeping the dikes' names or providing toponymic reminders such as Count John's Ditch (*GraafJan Gracht*), *dijkgraaf weg*[37] and Kronkeldijkhoek (Oostkerke).

Constructing dikes was, naturally, a very hard backbreaking undertaking in medieval times, and very serious business. Hundreds of workers were put to the task of breaking up the hard ground with hand spades, filling baskets with the loosened material and carrying it on man's back to the dike site, either to construct it or to repair it. And frequently the elevation, often *levee* to the French,[38] was a single meter high. Dikes were a protection for the *polders* crisscrossed by a network of natural and man-made creeks or against the invading sea. In 1213 Philip of Alsace (1136/1140–1191), then count of Flanders, issued an edict that whoever caused damage or destroyed dikes would have his right hand cut off and all his possessions confiscated. Vandalism and mischief, or storms, were not the only threats against dikes: rats were a real plague and their underground paths not infrequently would transform the dikes' lower part in a gruyère-cheese like pattern of holes, thereby weakening them to the point of great vulnerability. The animals bear a large responsibility in the giving way of the dikes and the gigantic flood damage occurring with the great storm of 1483.

Not only rats, but also rabbits sapped dikes with their underground conduits. Only after numerous floods had taken place due to weakened dikes, did Jeanne (15th century), countess of Flanders, allow her subjects to enter her grounds and dikes to organize anti-rabbits posses. Even today muskrats, who multiplied in the polders during the 20th century, are a matter of serious and continuous concerns for (polder) dike protection.

Philip was quite anxious to develop Flanders' coastal region, from Breskens to Dunkirk (*Dunkerque* in French and *Duinkerke* in Flemish), probably even to Calais, and then some. There were no real cities, so he created several, thence Nieuwpoort (Newport in English, *Nieuport* in French), on the mouth of the IJzer (Yser) River became an important harbortown. The Zwin became the center of an important region and polder with cities such as Sluis (*L'Ecluse*) near other sea inlets as for instance that of Sijssele.

Polders, and accompanying protective dikes, had been created as well along the Scheldt River (Dutch: *Schelde*; French: *Escaut*; Latin: *Scaldis*) even as far inland—more than 60 km—as north of budding Antwerp[39] (Figure 8).

Occlusion of the Zwin

Philippe-Auguste, king of France, put Damme to the torch in 1218. But as of 1225 a flurry of construction in Damme included building of a church, new "*halles*" [Flemish: hallen; covered market] were erected in 1241, and, in 1249, St John's (St Jan) Hospital was built. Alas, already fifty years later, by the end of the 13th century, silting of the Zwin set in, though

---

[33] The Joyous Entry (*Blijde Inkomst*) was the city's "welcome" to a new ruler, and the occasion of extensive official and popular festivities as well as the presentation of gifts to the sovereign. The custom of the Joyous Entry has survived until the present and the successor to the Belgian throne gets this "welcome", upon his marriage; in the major cities of Belgium. Bruges was a city of the County of Flanders, a virtually autonomous territory whose count was vassal to the King of France. Bruges itself enjoyed considerable self-government privileges and did not hesitate, in the 14th century, to ally itself with the King of England, Edward III (1312–1377) whose country was a large purchaser of Flemish cloth. As a result Flemish fishermen gained the right of unharmed unhampered fishing rights in English waters, even winning reconfirmation of these in British courts in the nineteenth-fifties. The second born son of a King of the Belgians gets the title of Count of Flanders.

[34] Pannier, N., De datering van de Duinkerke-III-B transgressie en het dijksysteem ten noorden van Brugge: *Handel. Maatsch. Geschied. en Oudheidk. Gent* New Series 24, 113–126; Verhulst, A. & Gottschalk, M.K.E., 1978, Transgressies en occupatiegeschiedenis in de kustgebieden van Nederland en België. In Verhulst, A. & Gottschalk, M.K.E. (eds), *Proceedings Colloquium* (Ghent, 5–7 Sept. 1978); Verhulst, A. and Gottschalk, M.K.E., 1980; Transgressions and the history of settlement in the coastal areas of Holland and Belgium: *Proc. Colloq. 5–7/9/1978, Rijksuniversiteit Gent*; Verhulst, A., Middeleeuwse inpolderingen en bedijkingnen van het Zwin: *Tijdsch. Belg. Vereen. Aardrijk. Stud.* 28, 21–54 ; Verhulst, A. 1964, *Het landschap in Vlaanderen in historisch perspectief.* Brussel, Gemeentekrediet.

[35] Charlier, R.H., Bruun, P., Chaineux, M-C. & Morcos, S., 2004, Since when coastal protection: *Proc. 6th Int. Cong. Hist. Ocean,* [in press, Chapter 44].

[36] The *dijkgraaf* (literally the "count of the dikes", actually master of the dikes) was a position of top responsibility, in Flanders, Zeeland, Holland, as keeper of the security; safety and maintenance of the dikes. Dikes were taken up in penal and civil legislation and whoever was found guilty of damaging (or perhaps neglecting upkeep on them) was subject to severe punishment, cutting off the right hand and heavy fines.

[37] Charlier, R.H., 1947, *Historische und ekonomische Stadtgeographie von Antwerpen*: Erlangen, Friedrich-Alexander Universität; Philo. Fak., Doktorarbeit; Leenders, K., De Antwerpse polders in de middeleeuwen. Ontginning, bedijkingen en overstromingen: *Tijdschr. u.d. Belg. Veren.* v. *Aardrijk. Stud.* 54, 43–77; Mijs, J., 1973, De landschapsgeschiedenis van de Scheldepolders ten Noorden van Antwerpen: *Tijdschr: Belg. Veren. Aardrijk. Stud.* 42, 39–124.

[38] *cf.* The *levees* along the Mississippi in the USA, particularly in Louisiana. The word has become a standard geological term.

[39] Charlier, R.H., 1947, *Historische und ekonomische Stadtgeographie von Antwerpen*: Erlangen, Friedrich-Alexander Universität, Phil. Fak., Doktorarbeit; Leenders, K., 1985, De Antwerpse polders in de middeleeuwen. Ontginning, bedijkingnen, overstromingen: *Tijdschr. u.d. Belg. Veren. Aardrijk. Stud.* 54, 43–77; Mijs, M., 1973, De lanschapsgeschiedenis van de Scheldepolders ten Noorden van Antwerpen: *Tijdschr, u.d. Belg. Veren. Aardrk. Stud.* 42, 39–124.

Figure 8. Dikes and polders of the Zwin Region at various tide stages (Photo Charlier & Chaineux 2004).

Damme remained for many years an important center: Charles the Bold (1432–1477), Duke of Burgundy and Count of Flanders, wed Margaret of York in Damme in 1468.[40] The city was virtually destroyed by the Gueux [Flemish: *Geuzen*] during the period spanning 1578 through 1584 and the area suffered most in 1566.[41] The decline, and "demise", of Bruges followed as it suffered from the decline of the cloth industry, and silting progressed in the 16th century (Figure 9). The toll sounded for Damme and Bruges at the time, while Antwerp, on the deep water Scheldt River, 87km inland from its mouth, took up their trade. Bruges earned the nickname of "the dead city" and plunged into economic doldrums.[42]

Silting occurs of course in other sites of the North Sea: in 400 years time, the Somme River Bay shrank from 400 km^2 to 70 km^2. At equinoctial tides the sea retreats some 14km from the shoreline. Much of the loss of the Bay is to be attributed to man who preferred salt pastures (*prés-salés*) and roads. Natural silting began some 7000 years ago, but since the 12th century settlers constructed *polders* (called here *renclôtures*) with the last one dating from 1976, and laid out derivation channels. Commercial and fishing harbors have disappeared.[43] Somewhat further up north, "rings of water" or, better, *wateringen* (French: *wateringues*) have contributed to the creation of dried-up marshes, polders and *mollières,* which gave the Gravelines (in Flemish *Grevelingen*) region and the outlet of the Aa River a landscape reminiscent of the Zwin area before the 13th century.[44,45]

[40] Braeckeler, K., 1975, *Burgund im Spiegel seiner Kultur*: Neuß, Burgund und daß Reich, Neuß; Kirk, J., 1863, *History of Charles the Bold*: London; Lettenhove, K. de, 1869, *Relation du mariage du due Charles de Bourgogne et de Marguerite d'York, communiquée par le baron Kervin de Lettenhove*: British Library, Cott. Nero C-IX, Bruxelles, Commission Royale d'Histoire [de Belgique] 3e série, 1869; Mertens, J., 1982, Landschap en geografie in het Zuiden (1300–1480). In *Algemene Geschiedenis der Nederlanden,* Vol. II: Haarlem pp. 40–47.

[41] Name taken by the insurgents against Philip II (1527–1598) King (1556–1598) of Spain in the Lowlands (The Nineteen Provinces). They wanted to be freed of Spanish yoke, opposed the Inquisition, championed liberty of religion and local rule. History holds that Margaret of Austria (1522–1586), his half-sister, Regent of The Lowlands, frightened by the insurgents, was told by her councilor: "Fear not, Madam, these are only Gueux [beggars]" ("*Ne craignez rien, Madame, ce ne sont que des gueux*").

Gueux (from Old Dutch *guit*; modern Flemish *geuzen*) actually means beggar. The revolt led to the sentencing and subsequent decapitation of two Belgian noblemen, the counts of Egmont (1522–1568) and of Homes (1518–1568), on the orders of Philip II, King of Spain's Spanish overlord of the Netherlands, Ferdinand Alvarez of Toledo, duke of Alba (1508–1582), still celebrated as national heroes, and the independence, from Spain, of the northern provinces of the Lowlands. The beggar's bag was adopted by the insurgents as their symbol, remained henceforth so throughout history and is, since its founding, part of the coat of arms of the [Flemish] Free University of Brussels (V.U.B.), Belgium.

[42] Rodenbach, G., 1892, various editions prior to 1970, *Brugghe, die dode* [*Bruges la Morte*]: various publishers.

[43] Derville, A., 1980, Le marais de St Omer: *Revue du Nord* 73–95.

[44] Buffler, D. & Dufour, J-P., 2001, La France des estuaires: *Le Monde* July 21, 2001, 9; Verhulst, A., 1990, *Précis d'histoire rurale de Belgique*: Bruxelles, Presses de l'Universite libre de Bruxelles. 224 pp.

[45] Voet, L., 1943, Vlaanderen in de vroege middeleeuwen: *Wetenschappelijke Tijdingen* 8, col. 121–129.

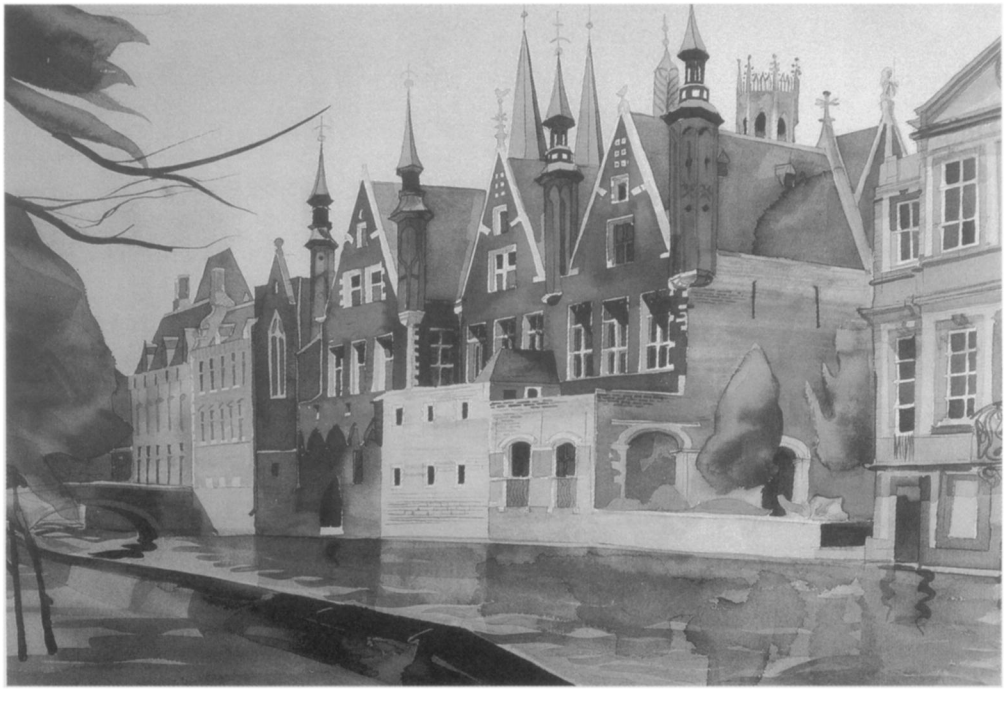

Figure 9. Original drawing representing Renaissance Bruges with houses still in use (Nuernberg School of Architecture, University of Nuernberg, Bavaria).

Becoming the capital of the province of West Flanders in an independent Belgium in 1830, following secession from the Kingdom of The Netherlands, did not much to restore its luster. It eventually profited from the birth of popular tourism in the 20th century and became a pole of universal attraction for the "Holy Blood" procession, its historical buildings, medieval pageants and canals.[46]

A Short-Lived Ray of Hope

The city lived through a short revival when Napoleon I (1769–1821), who ruled over the French annexed "Belgian" provinces, and whose brother Louis had been made King (1806–1810) of Holland, initiated the digging of a canal to link Bruges with the Scheldt River and thereby giving Bruges, and Damme, a "new" access to the sea.[47] The waterway reached Hoeke. When William I of Orange-Nassau (1772–1843), King of The Netherlands (1813–1840),[48] was selected by the Congress of Vienna (1814–1815) to succeed Napoleon as ruler of the "Belgian" provinces (1815–1830) annexed to The Netherlands (1815–1840), he ordered the pursuit of the digging and the canal reached Sluis (L'Ecluse). It never went further because the Belgians revolted in 1830 against Dutch rule and Sluis became part of Dutch territory, as did the lower part of The Scheldt River. It was Scaldisian Ghent that eventually got "a short-cut" that linked it, directly, with the Scheldt Delta in The Netherlands, when a sea canal was dug from that city to Terneuzen in The Netherlands on the Scheldt.[49]

Other small agriculture and fishing settlements—e.g. Cnokke (modern spelling Knokke)—sprouted, much later, beyond the dunes belt along the coast, in the polder-lands near the Zwin.[50] On the Dutch side of the contemporary Belgian-Dutch border, the towns of Cadzand and Retranchement are similar agricultural polder villages, though Retranchement owes its origin to forts built there as a protection against the Spaniards who ruled the "Belgian" provinces ("Southern Netherlands"); Cadzand extended gradually to the shore where a fishing village (today Cadzand-Bad), now a shore-resort, nestled behind the sea dunes; at less than a mile from the Zwin's entrance.

Bruges and the 20th Century Zwin

The North Sea coast of Flanders, *sensu largo*; suffered a major flood in 1921. Then, the Zwin broke through, once again, the year of the 20th century's great flood (1953) and reached the outskirts of Damme. The waters receded after a short while.[51] The inlet's entrance fills today, at high tide, flooding its sea outlet and a short distance inland. Breaches inland by the sea have occasionally taken major dimensions.[52] Thus centuries ago several villages were engulfed along the Flanders coast: Scarphout, Ter Streep [off Mariakerke near Ostend], Harendijke [off Wenduine], besides part of the island of Walcheren and the region of Saeftingen (The Netherlands). The latter is referred to as the Drowned Land of Saeftingen (*Verdronken Land van Saeftingen*).[53] (Figures 10, 11). The major storm of 1953 is at the origin of the gigantic Delta works undertaken by The Netherlands; these involved even cutting off one of the arms of the Scheldt River delta. These works have entrained serious consequences upstream the Scheldt River, a still unresolved problem, notwithstanding the lofty admiration for an otherwise truly impressive engineering feat.

But flooding may not be a thing of the past. According to a *Manifesto,* released in late February 2004, signed by sixty American scientists, the dikes and protection works undertaken in The Netherlands will not suffice to protect the land beyond and the sea will break through between 2006 and 2013, unless measures proposed by the Kyoto Protocol are enforced. The document charges the current American administration with falsification of reports to hide the actual situation (*cf.* Gordon Orsian of the National Academy of Sciences and the University of Washington, quoted in *La Libre Belgique* Feb. 20th 2004). True, on February 16th 2004 a pres-

[46] The "Holy Blood" procession is a recollection of the Crusades in which then Count of Flanders, Philip of Alsace participated; it is still organized in May; currently (second half of the 20th century to present) Bruges' canals are the site of the Feast of the Canals (*Reien Feesteri*). Reien means actually "the braulier of the Reie" [river].

[47] When the French Revolution broke out, the "Belgian" provinces, except for the Bishopric-Principality of Liège, were possessions of Austria. They wrought a short-lived independence (1791–1792), were recaptured by Austria and subsequently invaded by the French (Republic) who eventually annexed them. They stayed under French rule until Napoleon I's defeat at Waterloo, nearby Brussels, by a coalition of mainly British, Prussians and Austrians.

[48] After the Battle of Leipzig (1813) between France and the anti-Napoleon coalition, the coalition created a Kingdom of The Netherlands out of the former northern "Lowlands Provinces" and offered the crown to William (of Orange-Nassau). After Louis Bonaparte had stepped down as King of The Netherlands (1810), Napoleon I had annexed the territory to the Empire of the French. The southern part of the Lowland Provinces had been ceded "unconditionally and irreversibly" by the Austrians to the French Republic (1795).

[49] van Belle, J., 2000–2003, *Het bizarre verhaal van een gouden doodskist*: Maldegem, Het Zwin (vols I, II, III, IIIb); uitgegeven met de hulp van de Vlaamse Gemeenschap); Anoniem, 1985, *2000 jaar Zwinstreek*: Knokke, Mappemundi; Verhulst, A., 1995, *Landschap en landbouw*: Brussel, Gemeentekrediet (ISBN 90-5066-149-1).

[50] Coomaert, M., 1974 *Knokke en het Zwin: de geschiedenis, de topografie en de toponimie van Knokke met een studie over het Zwindelta*: Tielt, Lannoo.

[51] Plasschaert, R., 1988, *Defysisch-geografische evolutie van het open Zwin*: Gent, Rijksuniversiteit Gent. Faculteit Wetenschappen. [Dissertation for the degree of licenciate in geography]; Verhulst, A. 1964, *Het landschap in Vlaanderen in historisch perspectief*: Brussel, Gemeentekrediet.

[52] Verhulst, A. & Gottschalk, M.K.E., 1978, Transgressies en occupatiegeschiedenis in de kustgebieden van Nederland en Belgie. In Verhulst, A. & Gottschalk, M.K.E. (eds), *Proceedings Colloquium* (Ghent, 5–7 Sept. 1978).

[53] Verhulst, A., 1966, *Histoire du paysage rural de l'epoque romaine au 18e siecle*: Bruxelles, La Renaissance du Livre. 158 pp.; Verhulst, A., 1995, *Landschap en landbouw in middeleeuws Vlaanderen*: Antwerpen, De Nederlandse Boekhandel 128 pp.; Verhulst, A., 1964, *Het landschap in Vlaanderen*: Brussel, Gemeentekrediet; Voet, L., 1943, Vlaanderen in de vroege middeleeuwen: Wetenschappelijk Tijdingen 8, col. 121–129; Voet, L., Verhulst, A. & Sarfatij, H., 1990, Ontstaan en vroegste geschiedenis van de middeleeuwse steden in de Zuidelijke Nederlanden.—La enese et les premiers siecles des villes medievales dans les Pays-Bas meridionaux: Bruxelles/Brussel, Credit Communal-Gemeentekrediet. 576 pp.; Heyvaert, J. and Decker, M., 2003, Atlantide sur Escaut: Tempo Verde 6, Nov., 67–75.

Figure 10. Vegetation of the Drowned Land of Saeftingen area (after Photo M. Decleer).

idential advisor, on the Columbia Broadcasting System's program *Meet the Press,* stated that enforcing the Protocol is unconceivable because of its consequences for the country's [USA] economy.

The Drowned Land of Saefthingen

The region of Saefthingen [also spelled Saafthingen or still Saaftingen] was regularly subject to major floods due to exceptional tides between 1350 and 1600, and inhabitants were accustomed to rebuilding their houses and the towns after each catastrophe. Around 1600 another storm inundated the lands and they became irremediably "the lost land of Saefthingen," an expanse of 3500 ha "buried" under the waters of the Scheldt River and of the North Sea. In the mid 13th century the village, whose economy was mainly animal husbandry, located in the center of the land, was a site where cloth production, salt raking and turf "mining" were typical occupations providing a decent livelihood. The Hundred Years War (1337–1453) killed off the cloth trade that had rivalled that of Bruges [Brugge], Ghent [Gent, Gand] and Ypres [Ieper] (Figures 8, 10).

Twice a day, at the whim of semi-diurnal tides with a mean range of 4.5 m, the very top layer of the submerged land reappears and could be used as grazing pastures for cattle and sheep, as in the *pré-salés* areas of Normandy and Brittany. But the risk of drowning is ever present with a tidal current that progresses at a speed of some 7.2 km/h. Waters spread throughout the marsh by way of innumerable rivulets and mini-channels dwarfed by three main channels—often named *gat*—Hondegat, Speelmansgat and IJskelder. Muddy areas—slikke—are covered at each tide while the schorre (often designated in French by the term *lais*) gets drowned only with lunar high tides.

The major geomorphological agent is the tide, but the anthropic factor has played a role. Dikes were intentionally pierced by the Gueux in an effort to stem the progress of the Spanish armies towards beleaguered Antwerp, a Protestant stronghold.[54] An environment in which plants have a difficult time to survive, it is an accretion site as such plants as salicorn, the immortal (a Composancaea), the statice (a Plombaginacaea), *Elymus athenicus* and *Aster maritimus* fix the mud and rain water washes gradually off the salt. A Foundation manages the nature reserve that straddles the Belgian-Dutch border and which has become a sheltered area for birds, many of which are migratory birds.

[54] A period masterly described in and used as a setting by Marguerite Yourcenar's novel and subsequent Delvaux motion picture, *L'oeuvre au noir* (Prix Fémina 1968), centering on the personnage of Zenon, a physician, and life under the Inquisition.

Figure 11. Other view of the Drowned Land of Saeftingen with Scheldt River on the far background (Photo M. Decleer in *Tempo Verde*).

Phoenix Rising out of its Ashes

in 1908, Leopold II (1835–1909), king of the Belgians (1865–1909), keen on development of the coastal strip, inaugurated a coastal harbor on the North Sea coast, some 15 km north of Bruges and approximately 12 km east of the Zwin (Figure 8). It was named Zeebrugge (literally Sea-Bruges, spelled in English or in French occasionally Zeebruges) and made it part of the municipality of Bruges. Canals were dug and sea-locks constructed for a derivation canal and eventually a sea-canal linked Bruges and Zeebrugge. During the last decades of the 20th century, Zeebrugge-port was considerably expanded and became, as ferry and container terminal, a major port of Belgium and of the North Sea coast, bringing back riches to Bruges and its area (Figure 12). Zeebrugge came under consideration during the three last decades of the 1900s as a site for a methane harbor (STATOIL) and a NATO military hardware and munitions port.[55] Pipelines, possibly crossing of the Heist Clay Pits Natural Reserve—reputed for its ornithological wealth—and closeness to heavily populated sites smothered such plans. Nevertheless, riches had turned to rags and the rags had turned back into riches.

The province of West Flanders, which includes the contemporary Zwin area, is the second largest producer of rugs in the world, furnishes Libya most of its animal fodder, is of capital economic importance for the United States because of its flax production, and more. It is an economic heavyweight. Bruges, its capital, is itself a major tourist attraction pole; Zeebrugge, probably contrary to expectations, developed as a seaside resort in addition to its function as seaport. The sea-dike jetting into the sea interferes with the long-shore transport of sand and has thus contributed to the creation of a far wider than the original beach, free of erosion effects. On the other side of the harbor—on the territory of the fused municipal entity of Knokke-Heist—sand starvation resulted in the practical disappearance at high tide, of beaches in Heist, Duinbergen, Albert-Plage (in Flemish *Albert-Strand*), Knokke and Zoute.

These beaches were "resurrected" when the large quantities of sand dredged during the construction, then expansion of Zeebrugge harbor were transferred to them in a major—the world's largest at the time—beach artificial nourishment scheme.[56,57]

[55] Charlier, R.H., 2001, Coastal environment—Hazardous goods and their environmental impact: *Int. J. Env. St.* 58, 3, 271–286.

[56] Charlier, R.H. & De Meyer, C.P., 2000, *Coastal erosion: Response and management*: Berlin, Heidelberg, New York *et al*, Springer Verlag pp. 222–284.

[57] De Moor, Erosie aan de belgische kust: *De Aardrijkskunde* Nieuwe Serie 4, 279–294; Charlier, R.H., Decroo, D. and De Meyer, C.F., 1989, Beach protection and *in situ* restoration: *Int. J. Env. St.* 33, 4, 167–191.

Figure 12. Port of Zeebrugge (Photo Charlier & Chaineux, from an air photo taken by HAECON).

The Contemporary Scene

Bruges, through its shore sited extension harbor Zeebrugge, is at present part of a cohort of nine Belgian and Dutch "seaports" established in the confines of the Rhine-Scheldt "delta" (Figures 12 and 13). These ports however vary considerably in size, importance, traffic intensity and significance. On the Belgian side, Nieuwpoort, Ostend, Bruges-Zeebruges (Brugge-Zeebrugge), and the river ports of Ghent (*Gent, Gand*) and Antwerp (*Antwerpen, Anvers*) (Figure 14). Nieuwpoort (in French *Nieuport*) is virtually somnolent, though still a fishing and pleasure craft harbor. Ostend has suffered some loss of prominence, particularly as a passengers and cars transfer point, since the opening of the *Eurotunnel* and the creation of the *Eurostar* rail service.[58] On the Dutch side there are two seaports, Flushings (Vlissingen; Flessingue) and Terneuzen in Zeeland, and three river ports, Rotterdam, Moerdijk and Dordrecht.[59]

Rotterdam and Antwerp, in the middle of the "delta", are respectively the first and the second largest harbors in Europe, the first and the third harbors in the world. These ports handle about 500 million metric tons, and provide employment to a quarter million people.[60]

Development plans for Zeebrugge are formulated and if approved by the proper instances will involve constructions through 2010 (Figure 15).

As for The Zwin, the inlet and the surrounding area have been preserved jointly by Belgium and The Netherlands and as a nature reserve: they are a protected ornithology and plants park (Figures 16 and 17). The preserve is associated with the French (Picardy) Natural Reserve of Marquenterre, in the Bay of the Somme. Sailing ships have been replaced by swimmers and the shores "colonized" by the tourists of Cadzand-Bad, about two km away (Figure 4b). The Flanders coast has been virtually spared the disastrous green tides which have affected the beaches in Brittany (Figures 18, 19 and 20). All is however not that rosy on the Belgian ecological coastal region horizon. The government got a backhand slap from the European Commission for failure to respect the European "Birds" Directive pertaining to the Special Protected Areas (SPAs) as it applies to wild birds in Flanders and may be subject to fines if it does not comply.

Zeebrugge

The «new port» of Bruges had been barely inaugurated (1908) by Leopold II, King of the Belgians, that World War I broke out and the German Army, notwithstanding a dogged resistance at its progress, rapidly reached the east coast of Belgium (1914). The occupying power decided to use Zeebrugge as a submarine base. The plan was foiled when the British frigate *HMS Vindictive* scuttled herself at the entrance of the navigation channel. A similar operation, somewhat less successful was undertaken offshore Ostend, the two Belgian ports occupied by the Germans that were beyond the reach of the Allied guns lining the Yser River mouth.

Those Tempting Offshore Sandbanks

Large sandbanks parallel the Belgian coast, channels and banks form the Flemish Banks. They constitute a tempting setting for the siting of artificial islands on which waste processing facilities, airports, fresh water or power plants, stilt bridges, «floating» cities could possibly be placed here, and even four locations were suggested to build a «peninsula» off

[58] Blankenberge and Heist, though ports located on the sea, are not considered here because they are, at best, fishing and yachting harbors.

[59] Amsterdam, a river port, is not considered by specialists as a Rhine-Scheldt Delta port. It is located on the IJsselmeer and linked with the river Meuse (Maas).

[60] Data from the Dutch Statistical Office.

Figure 13. Two views of the port of Zeebrugge (Port Authority of Zeebrugge).

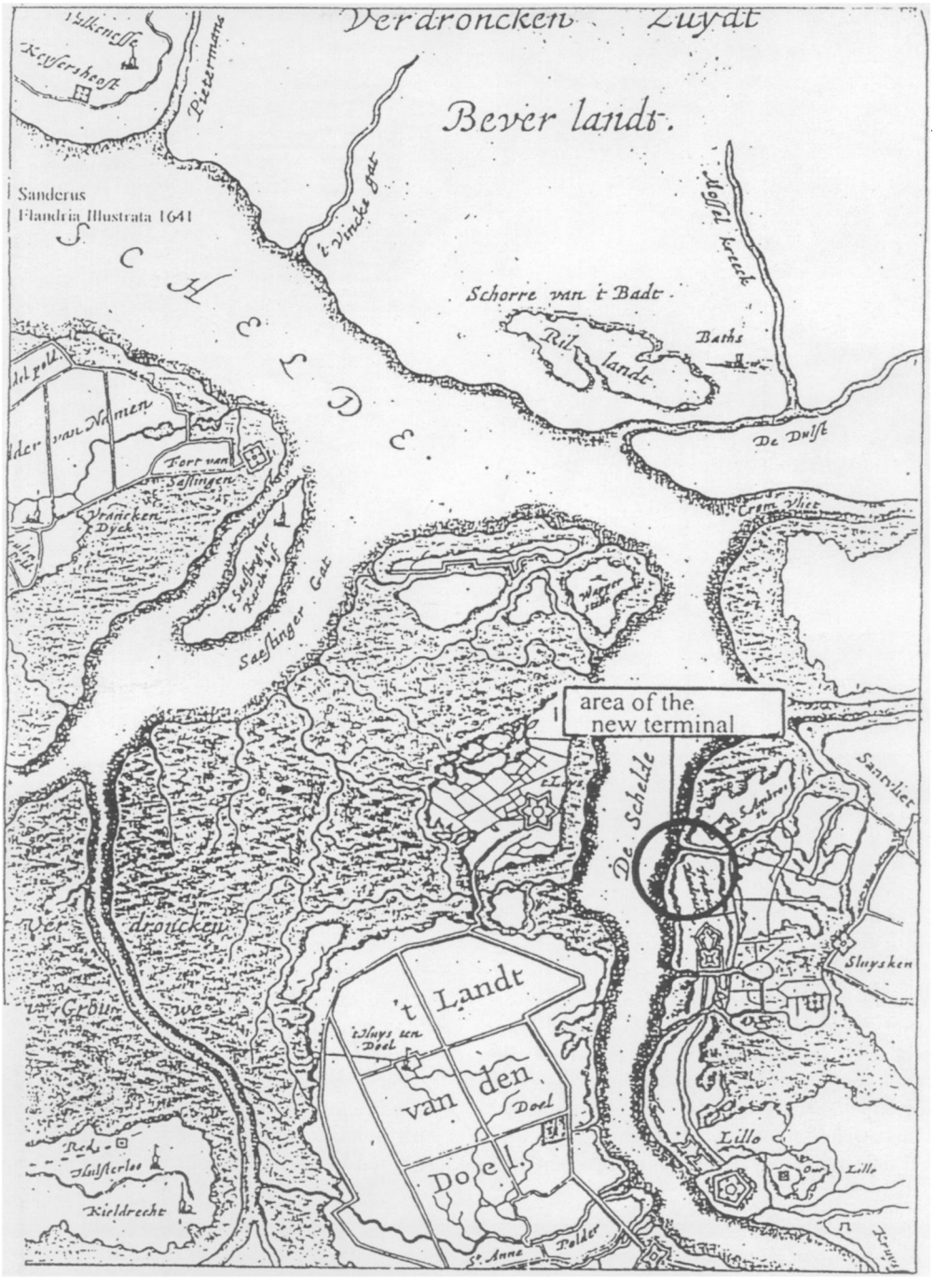

Figure 14. Map of contemporary Port of Antwerp extension overlaid on a map (see fn. 64).

Ostend on which to put a new casino.[61] Environmentalists and aesthetics specialists vigorously opposed these plans which came to naught. So did a plan to install an ocean wave power system to reduce silting in Zeebrugge harbor, and another to install a N.A.T.O.[62] military equipment and ammunition port; nor was the STATOIL[63] plan to site a gas pipeline implemented.[64] In several cases the proximity of human settlements (less than 10km) and of the budding seaside resort

[61] Charlier, R.H. & De Meyer C.P., 1992, An environmental purpose artificial island purpose offshore Belgium: *Int. J. Env. St.* 40, 249–265.

[62] NATO = North Atlantic Treaty Organization.
[63] STATOIL = [Norwegian] State Oil Company.
[64] See fn 11.

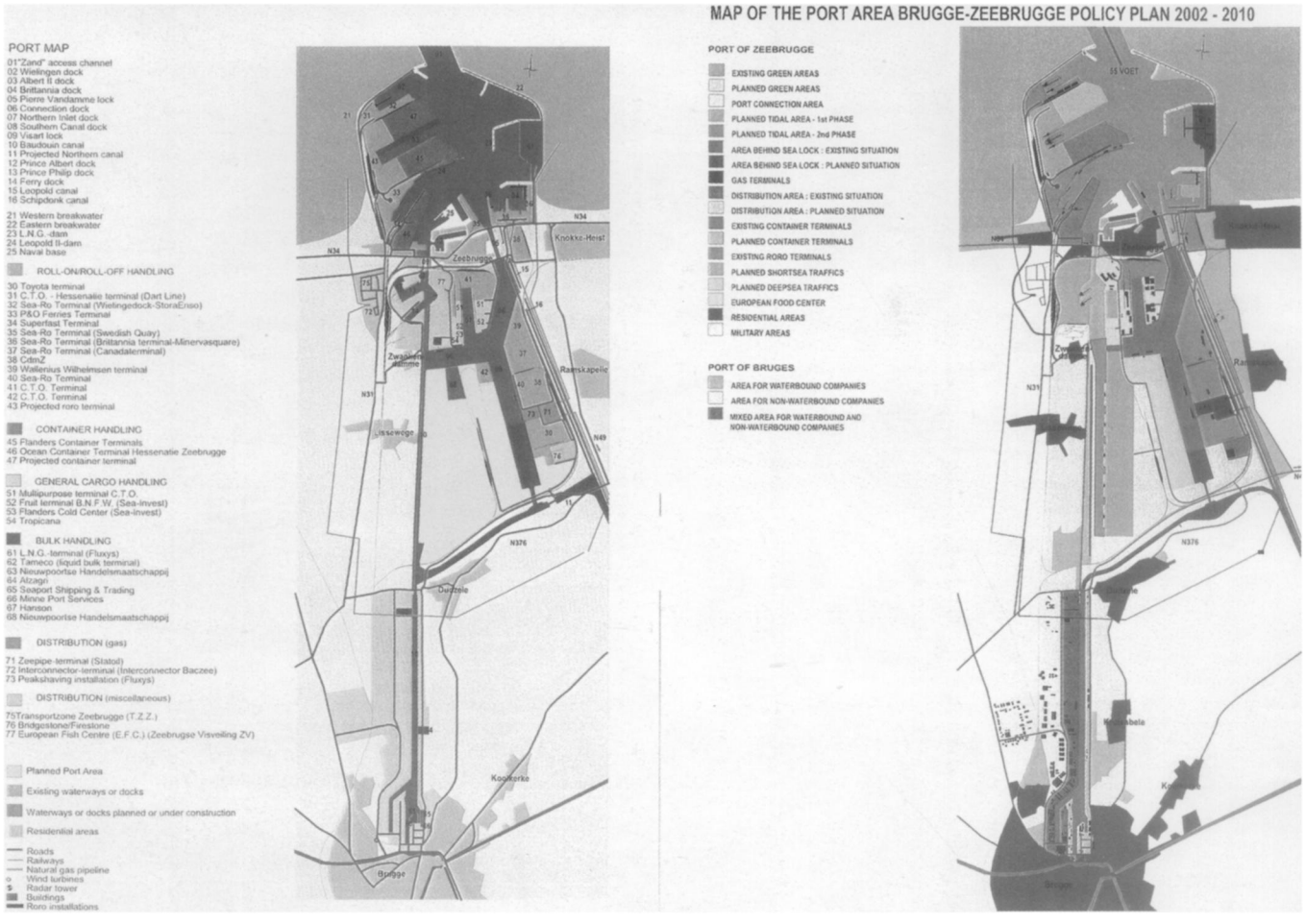

Figure 15. Expansion plans of the port of Zeebrugge (Port Authority of Zeebrugge).

were determining considerations, even though other factors militated in favor of the proposals. Zeebrugge, on the other hand, is the site of a growing Marine Winds Farm—on the moles—a Belgian Navy base and a yachting harbor.

The offshore region consists of a tidal channel system; the banks' surface is smooth and made up of fine sand. The banks situated further from shore are narrower and steeper than the in-shore ones. Ripple-marks occur and run perpendicular to current direction. Further from the coast the presence of sand is restricted, but in-shore banks lie in a sand-rich area where waves and currents counter ripple-marks formation (Figure 18). Closest to shore banks are wide, flat and linked. Little shape modification occurs here and transport is very limited though sediments, originating from Northern France

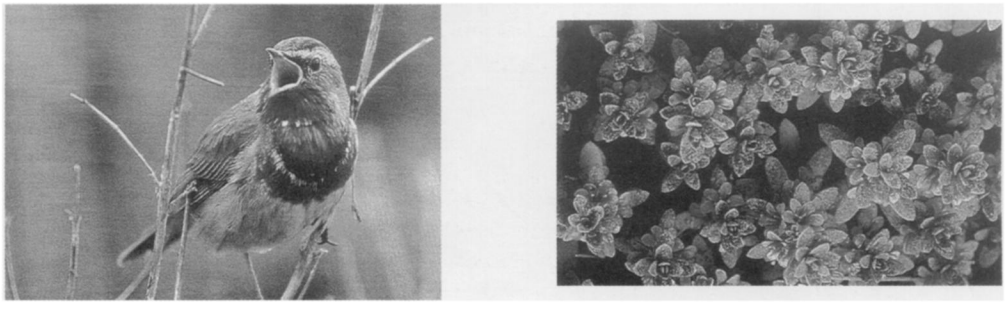

Figure 16. Pictures from the contemporary Zwin Natural Reserve.

Figure 17. Polder flower.

rivers and eroded Tertiary deposits are moved in the banks' area. Under calm weather conditions these sediments, made up commonly of sand, shells and shell pieces—a 15% calcareous content is average—are deposited in the banks' area channels, but more often, because of wave influence on the bottom, they remain in suspension. The surface deposits of the channels are principally gravel and shell. Possible sand tapping sources exist near the Westdiep, Smal Bank, Westhinder Bank and Outer Ruitingen. Of course, the Thames River estuary is suitable for sand extraction. Some deeps, like the Appelzak which had been the end of the course for sediments and thus contributed to intense beach erosion are closing up (Figure 19).

Sites eyed for implant of nuclear power plants were the Wandelaar and Smal I and II banks. They are at 7km offshore in waters ranging from 3 to 6m in depth, with stable banks and passes, and nearby exploitable sand deposits. The Trapegeer, at 3.5km from shore in waters 2 to 4m deep, located within the Belgian territorial waters and outside the shipping lanes, was also considered. Iperian clay layers—from 120 to 180m thick—make up the upper part of the Tertiary overridden by Quaternary deposits. Occasionally one to ten centimeters of Holocene clay are present. The banks area is generally stable, though locally, for instance in the Trapegeer, there is a trend to material migration; now seaward then landward, in contrast with the stabler Smal I Bank. But removal of sand near the Trapegeer would provide an entrance pass to the Westdiep.

Islands off the Belgian coast might have entailed some environmental problems: an important shore evolution is to be foreseen over the next forty years; erosional problems off Coxyde (Koksijde) would entail artificial nourishment of beaches involving some 40,000m^3 of sand every five years. An island off Zeebrugge was also under study: a waste processing plant and linked heat production facility would be of great use for both Great Britain and Belgium.

Meanwhile another port expansion of 282 ha has been authorized by the European Commission. It cuts into areas protected by the European Birds and Habitats Directive and involves compensatory moves elsewhere but about which little information has been released. The region has respectively

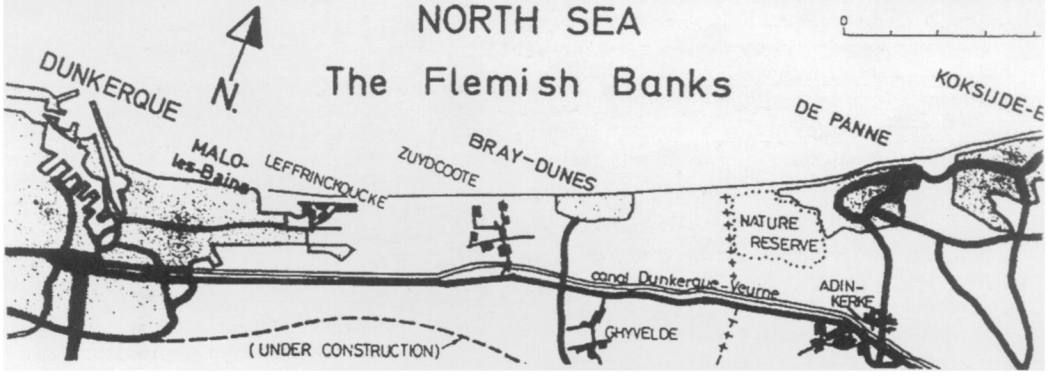

Figure 18. Map of the Flemish Banks.

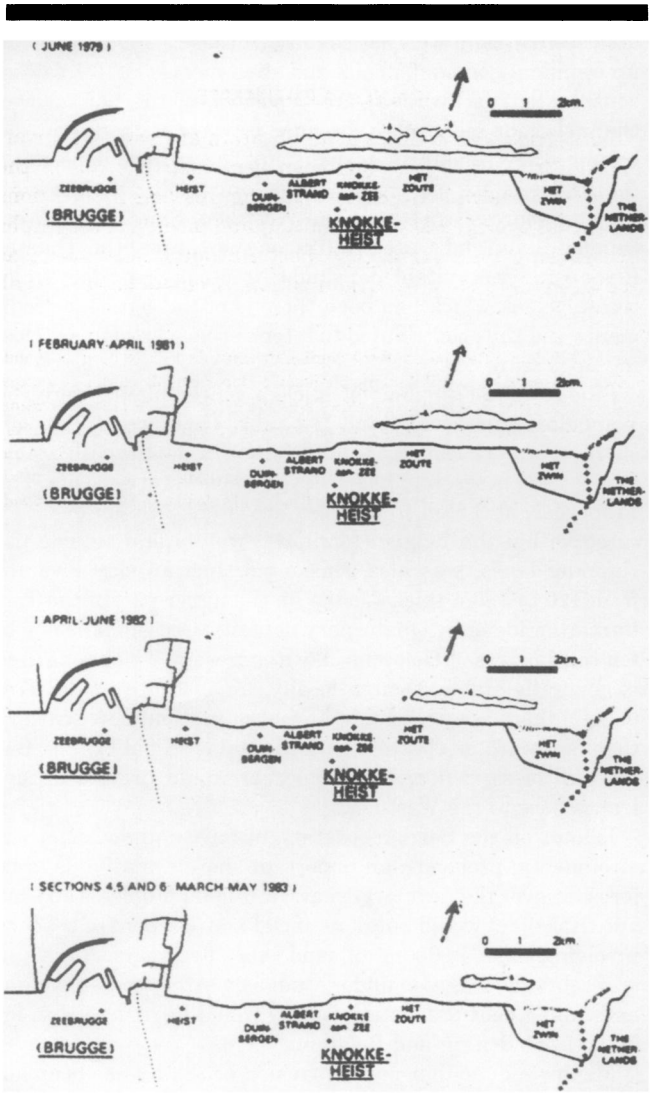

Figure 19. The Appelzak Gully offshore Belgian Coast.

102,000 ha and 98,000 ha of protected area under the Habitats Directive and the Birds Directive.

The Changed Landscape and Way-of-Life

In less than a hundred years, the Belgian coast, including Zeebrugge, changed from a string of rather indolent fishermen villages, nestled between dunes and polders very close to the coastline, into mainly a succession of originally fashionable «watering places» and, later on, of resort towns, themselves then challenged for coastal zone use by industry and port development. Zeebrugge is the most evident example of the latter development, but it is also an example that under given circumstances accommodation can be worked out. The economic value of tourism was successively enhanced by the laying of a narrow gauge railway—eventually electrified—paralleling the coast (1912), then in the mid-twentieth century by such social advances as paid annual leave, and, later, by the appearance of facilities affordable to the masses when once only the economic elite could envision holidays at the shore.[65]

Ownership of private cars, faster trains, cheaper fares have also contributed to the access to the shore and one-day tourism, quite popular, brings even more visitors who, however, frequently, do not bolster the local economy as often the day-tourist bring along his food and drinks. Theme parks that have sprouted in several places do draw, however, day-visitors. Population explosion has abated, yet, over a 110-year span (1860–1970) the Belgian population grew by 160%, but such increase is perhaps «modest» when compared to a 281% increase for the coastal fringe, and 979% for Knokke, the place closest to the Zwin. Zeebrugge has perhaps known the slowest growth but it has, over the last decades, made considerable strides forward, adding thereby to the economic renaissance of Bruges.

Equally amazing is the expansion of built-up areas that grew by 130% in a half-century (1919–1968) country wide, but by 225% along the coast (and not free of environmental damage). Development led to the gradual disappearance of elegant «villas» that lined the boardwalks of the shore resorts—and, to a more mitigated extent, that had been built inland; their place and that of some former luxury hotels, was taken up by multiple-storied apartment buildings—frequently condominiums. The hotels had become unable to draw any longer the well-heeled clientele, now attracted to tropical paradises, easily reachable, and generally affordable with low-cost airfares and package-deals. Dunes and woods have paid a heavy toll to this invasion of concrete while protective legislation has often been violated.

From a modest harbor with a single mole a little less than a kilometer in length, Zeebrugge has become a major port with several jetties. The original mole is mainly responsible for the development of a wide strand as it deviates long-shore currents. An ambitious further extension project spans the years 2002 to 2010 (Figure 15).

The end of the twentieth century extension of the harbor provided the opportunity to undertake the largest beach nourishment program in the world (at the time, of course) and to restore the sand starved strands of neighboring Heist, Duinbergen, Albert-Plage [Albert-Strand] and Knokke. Beach erosion was far less evident beyond Knokke and further east towards the Zwin.[66] The sand that was removed to enlarge

[65] De Moor, G., 1979, Premiers effets du rehaussement artificiel d'une plage sableuse le long de la cote beige, in, Guilcher, A. (ed.), *Les cotes atlantiques d'Europe, evolution, amenagement, protection* vol. 9: Brest, Centre National pour l'Exploitation des Oceans pp. 97–114; De Moor, G., 1980, Erosie aan de Belgische kust: *De Aardrijkskunde* New Ser. 4, 279–94; Roovers, P.P., Kerkaert, P., *et al.,* Beach protection as part of the harbour extension at Zeebrugge, Belgium: *Proc. 25th Int. Navig. Cong.* 2, 5, 755–769; Kerkaert, P., Roovers, P.P. *et al.,* 1985, Artificial beach renourishment on the Belgian coast: *J. Waterways, Ports, Coast. & Ocean Engng* Jan., 777–790; Verschaeve, J.E.L., 1961, La defense et le maintien des plages beiges entre Zeebrugge et la frontiere neerlandaise: *Bull. Techn. Assoc. Ingen. issus de l'Univ. Cath. de Louvain* 89, 1, 19–29.

[66] Charlier, R.H., De Meyer, C.P. & Decroo, D., 1989, «Soft» beach protection and restoration in Borgese, E.M., Ginsburg, N. and Morgan, J.R. (eds), 1989, *Ocean Yearbook 8,* Chicago, University of Chicago Press pp. 289–328.

the harbor and to keep the navigation channels open was used in this huge artificial nourishment undertaking. Furthermore, the gradual occlusion of the Appelzak Deep [Diep] closed a sediment Danaides barrel and helped stabilize to some extent the otherwise starved beaches (Figure 19).

The link today between Bruges and the Zwin is far more tenuous than it was in medieval times, as Zeebrugge has provided the city with a port that offers pleasure craft shelter, passenger terminals, roll-on roll-off facilities, and complete modern harbor infrastructures. But the memories linger on and it is the tourism value that is now focused upon in the «Zwin Streek».

ACKNOWLEDGMENT

Dr Patrick Vanouplines head librarian at the Free University of Brussels (VUB), has been very instrumental in the search for relevant literature. The figures and illustrations are copies of originals by the author, and include photographs by Misjel, Achim Seitz, The Port Authority of Zeebrugge, West Flanders Tourism Organization, Archives atlases, et al.

☐ RESUME ☐

L'ascencion, le déclin puis la renaissance de Bruges constituent la vie d'une ville dont l'éclat dans l'Europe du Nord équivalait celui de Venise dans le monde Méditerraneen. Son destin toutefois ne tenait qu'à un fil arachnéen: la navigabilité du Zwin, un chenal á marees, navigable jusqu'a Damme où des bateaux à coque plate prenaient le relais pour amener les marchandises, et passagers, jusqu'à la capitale des ducs de Bourgogne. La côte flamande est le site de plusieurs transgressions marines et si l'homme parvenait tant et mal à se proteger par des digues contre les inondations, il restait sans pouvoir—les drageurs n'étant pas encore connus—contre l'ensablement. La dimension des navires et leur tirant-d'eau n'aidaient guère non plus. Et done la merveilleuse cité sombra graduellement dans une léthargie commerciale et politique. Sa rivale, Anvers, devint la plus grande ville du monde occidental et l'un de ses plus grands ports. Mais le phoenix brugeois resurgit de ses cendres et suite à la creation d'un port sur la côte même, Bruges a résumé un rôle international, combinant tourisme, ville d'eau et port d'eau profonde doté des infrastructures modernes.