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# The Zwin: From Golden Inlet to Nature Reserve

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## ABSTRACT

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Artists of the XVII Provinces contributed considerably to cartography. For instance, Peter Pourbus, a Bruges painter, is the author of maps of Zeeland and of the Zwin Region, an area that Emperor Charles V (1500–1577) was anxious to protect against a seaborne enemy invasion. The coastal areas of Flanders and Zeeland were repeatedly covered, in prehistoric, protohistoric, and historic times, by the North Sea waters. The storm of the 13th century broke through continental barriers, opening a channel whose draught allowed ships to sail up to such towns as Sluis, Damme, and Hoek, sites that became, for several centuries, outer harbors of Bruges. The trade thus generated is at the origin of Bruges's wealth, leading to the Zwin inlet being nicknamed the "Golden Inlet." Sadly, silting set in and occlusion of the inlet progressed inexorably. This benefited Antwerp, which took up the declining trade of Bruges. The richest city of northwestern Europe yielded thus to a sister city that would be, for several centuries, the largest city of the world. The Zwin inlet is today just a natural swimming pool. And at high tide a rivulet of water allows some canoes to maneuver. On the other hand, the region became a world-celebrated bird and plant natural refuge. Yet Bruges, like the phoenix reemerged from ashes, is again a ranking port, thanks to sea canals linking it to the sea and an artificial harbor (Zeebrugge) some 20 km south of the Zwin inlet's mouth, in full expansion. On the shoreline, erosion and sedimentation have brought about new modifications, some of which impact faunal presence, while others might trigger a political "tempest in a teapot."

**ADDITIONAL INDEX WORDS:** Coastal erosion, coastal wetland, coastal barrier, inlet closure, coastal wildlife refuge.

The contributions to cartography of artists born and/or working in the XVII Provinces have been somewhat overlooked. A relatively recent United Nations Educational, Scientific, and Cultural Organization (UNESCO) publication (*Contributions of Dutch Cartography*) has, to some extent, remedied the situation. Yet the designation Dutch is misleading, as map making has been an endeavor of Flemings as well, with such *figures de proue* as Geeraert De Cremer (or De Kremer), more commonly known as Gerardus Mercator (1512–1594) and Abraham Ortelius (or Ortelius) (1527–1598), genitors of the *Theatrum Orbis Terrarum* (published in Antwerp in 1570 by Gilles Coppens Van Dienst).<sup>1</sup> With Bruges once the wealthiest city and harbor of the Western world, and Antwerp once the largest city in the entire world, numerous were the outlets for geographical products. Both cities were at one time or another centers of map making.

It is less common to find a cartographer who was also a painter of talent who led a dynasty of famed painters.<sup>2</sup> Pierre (or Pieter) Pourbus<sup>3</sup> was born in Gouda (Northern Lowlands) but worked mostly in the Southern Lowlands. His date of birth has been reported variously as 1501, 1510, and 1523; he died in

1584.<sup>4</sup> He spent no less than 30 years in cartographic activities, making maps with what may be labeled minutiae, using "modern" methods. He worked especially for the Sire of Moerkerke de Watervliet (a town near Damme), who was involved in legal disputes with the Free of Bruges (in French le Franc de Bruges; in Flemish het Vrije van Brugge). The Sire had also been at the origin of an exodus of impoverished Flemings to the Azores, which were designated thereafter for a long period of time as the Flemish Islands.<sup>5,6</sup> The Sire of Moerkerke, a town in North Central Flanders, urged Isabelle, duchess of Burgundy, who ruled Flanders, to inquire whether her brother Alphonso V, king of Portugal (1438–1481), would devolve the Azores to her. She followed up on the suggestion and the king granted her request. Then de Moerkerke got some 2000 colonists together, representing all trades, in Bruges's agglomeration [Het Vrije van Brugge], Furnes [Veurne Ambacht], while Duchess Isabelle provided all the possible labor equipment and house furnish-

<sup>4</sup> Pierre Pourbus and Antoine de Smet, 1947. A note on the cartographic work of Pierre Pourbus, painter of Bruges. *Imago Mundi* 4, 2, 33–36.

<sup>5</sup> Cf. Mining the sea for energy (by this author), ms in press.

<sup>6</sup> The de Watervliet family has modern descendants. The author of the present paper was a coprisoner, with Jean [Veranneman] de Watervliet; both were imprisoned by the German Nazi occupation powers for Resistance activities in 1943–44 (World War II) in the same Number 94 cell [St. Gilles Prison–Brussels] as the heroic Arnaud Fraiteur, who was executed, and were very fortunate to survive. See also for relations between Flanders and Portugal A. De Doncker and J. Loos, 2009, *Kust- & Zeegids 2009*. Mechelen, W. Ibens.

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<sup>1</sup> Asbroek, J.J.W., 1946. Mercator, Ortelius et la cartographie flamande au 16<sup>e</sup> siècle. *Bull. Soc. Roy. Géogr. Anvers*, 74, 40–62.

<sup>2</sup> Frans Le jeune, Frans II le jeune.

<sup>3</sup> There are at least six different spellings of his family name, depending on the language used.



Figure 1. The Medieval Zwin on a Pieter Pourbus attributed map that shows, *i.a.* sites of Cadzand and Sluys (Sluis). Courtesy of Jacques De Groote, Zwin Researcher.

ings. Men, women, and equipment went to the “Birds” Islands. It took two centuries for Portuguese to displace the Flemish vernacular and the Flandrian culture. Foyal Island had actually been called New Flanders, and Pieter van den Broeck called the islands “The Flemish Islands.”

Pourbus was thorough in his cartographic work. He collected information from surveyors, pilots, and fishermen; climbed church and belfry towers to have the best vantage positions for his measurements; and crossed the Zwin by boat to reach Cadzand Island. He had been retained by Emperor Charles V to survey and map the Zwin Region. Charles V wanted to assess the possibility of enemy ships sailing up the Zwin inlet and threatening Bruges. Thus, Pourbus provides information on the depth of the coastal sea and of the Zwin on his mostly 1:12,000 scale maps. Though the original maps have long disappeared, excellent reproductions and facsimiles exist that provide detailed information on the 16th century Zwin region. The map here reproduced dates from 1561–1571 (Fig. 1).

### THE GOLDEN INLET

The Zwin that today straddles the Belgium (Flanders)–Dutch (Zeeland) international border is perhaps the world’s

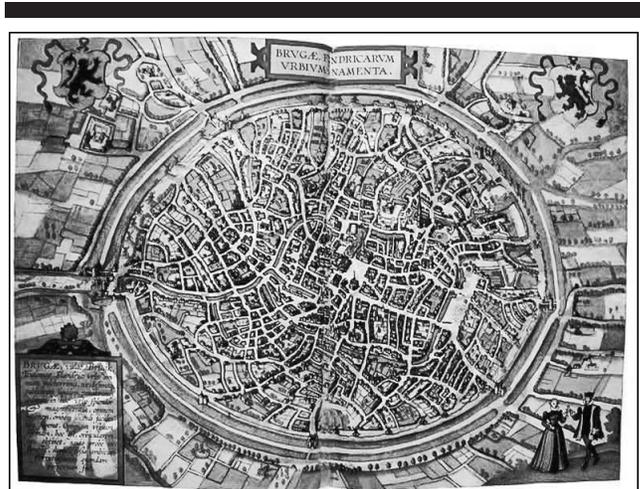


Figure 2. Medieval city of Bruges.

most famous marine tidal inlet, at least from an economic viewpoint. It brought wealth to Bruges (Belgium), Damme (Belgium), and Sluis (The Netherlands) to such an extent that the city of Bruges was nicknamed the Venice of the North, and not, as so often believed, because a network of canals crisscrosses it. It is the inlet that made Bruges the most important city, during several centuries, of Western Europe (Fig. 2). Nor for that matter is there an etymological kinship between the name of the city (Bruggeà) and the Flemish word for bridges (bruggen). The name is rather of Nordic origin and means a location where goods are transferred.

The development of Bruges, which is located some 15 km from the contemporary coastline, was most closely linked to the evolution and modification of the North Sea coastal geomorphology. Bruges owed its 13th to 16th century wealth to the Zwin, an inlet that connected it directly to the North Sea.

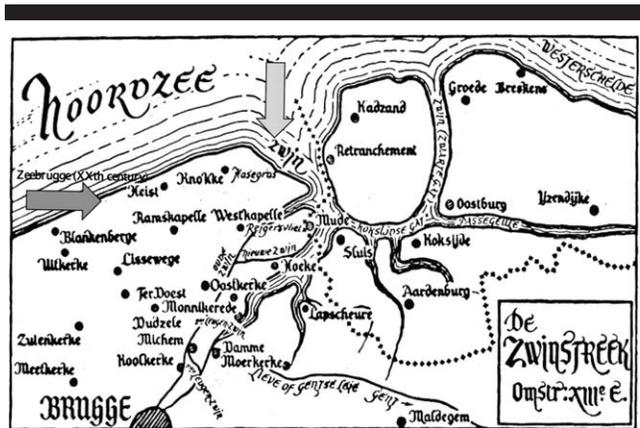


Figure 3. Map of the 13th century Flanders coast with arrows showing the Zwin area and the contemporary location of Zeebrugge harbor. The ... boundary is the contemporary borderline between Belgium and The Netherlands.

Occasionally referred to as a tidal inlet—even a stream (*Webster's Geographical Dictionary*, 1960 edition)—the Zwin is actually a tidal channel, characterized of course by bidirectional tidal flow and *ipso facto* bidirectional sediment transport. When the ebb transport fell below that of the flood tide, trouble developed for Bruges. The Zwin does not link barrier lagoons, or an impounded estuary with the North Sea, but it drained intertidal flats and tidal creeks.<sup>7</sup>

After the 13th century transgressions (to the historical-geologists the Dunkerquian III B), the Zwin started silting up. During that century, farther up north—in today's Netherlands—freshwater Lake Flevo got connected with the North Sea and became the Zuiderzee. Since then floods were often caused by humans: 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 in World War II, but the idea was scuttled because thousands of refugees fleeing the advancing Germans were clogging the roads, and many of them would have drowned.

### Birth of a City

In 1134 a storm of exceptional strength wrought havoc on the Flanders' coast and opened, east of Knokke,<sup>8</sup> between a spot known as Lekkerbek and contemporary Cadzand-Bad (now 2 km inside the Netherlands border), the Zwin [inlet] that reached all the way to near Bruges, some 15 km 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 the fishermen settlements or even in the case of Damme further up the Zwin channel. If Damme is often mentioned as a foreport of Bruges, the home town of famed Flemish poet Van Maerlant claims the label of being a port on its own. Facts are that Damme was an important fortified city and that it was a transfer point for goods from ships of a certain draught to flat bottom ships for the final stretch of the voyage to Bruges itself.<sup>9</sup>

The Zwin Region<sup>10</sup> in the 13th century, as pictured on an old map (Fig. 3), 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 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.

<sup>7</sup> Bruun, P. and Gerritsen, F., 1959. Natural by-passing of sand at coastal inlets. *J. Waterways, Harbors Division Proceedings. American Society of Civil Engineers* WW4, 2301, 75–107; *id.*, Stability of coastal inlets. In: *Proceedings of the 7th Conference on Coastal Engineering* (Berkeley, California) 23, 366–417; *id.*, *Stability of Coastal Inlets*. Amsterdam, Elsevier-North Holland. 123 pp.

<sup>8</sup> Knokke :older spellings Knocke, Cnocke, Cnokke.

<sup>9</sup> Gysseling, M. and Verhulst, A. (eds.), 1969. *Nederzettingenamen en nederzettingsgeschiedenis in de Nederlanden, Noord-Frankrijk en Noord-West Duitsland*. Amsterdam, Elsevier; Van Werveke, H., 1965. De oudste burchten aan de Vlaamse en Zeeuwse kust. *Mededelingen Koninklijke Academie van België, Klasse. Letteren*, 27, 1.

<sup>10</sup> Zwin is also spelled Zwyn, and even Zwijn. Kadzand is currently spelled Cadzand and Hoeke is spelled Hoek.

### Occlusion of the Zwin

By the end of the 13th century, silting of the Zwin set in. It progressed in the 16th century. The toll sounded for [the ports of] Damme and Bruges at the time, and Antwerp took up their trade. Bruges (Brugge) plunged into economic doldrums<sup>11</sup> (Fig. 2). While Antwerp became the third, fourth, or ninth harbor of the world—depending on scale chosen and on who makes the assessments—Bruges, like the phoenix, rose from its ashes and resurrected as a major port; it is today thanks to sea canals, a fishing harbor, a passenger and freight terminal, a pleasure craft haven, and a naval facility. It is in full expansion.

### The 20th Century Zwin: The Zwin as Natural Refuge

The North Sea coast of Flanders, *sensu largo*, suffered a major flood in 1921. Then, the Zwin broke through, once again, in 1953 (the year of the 20th century's great flood), and reached the outskirts of Damme. The waters receded after a short while.<sup>12</sup> 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.<sup>13</sup> Thus, centuries ago several villages were engulfed along the Flanders coast: Scarphout, Ter Streep [off Mariakerke near Ostend], and 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*).<sup>14</sup> 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. The works have entrained serious consequences upstream of the Scheldt River, a still unresolved problem.

The territory of the Natural Reserve lies mostly in Belgium, where it is part of the municipality of Knokke-Heist (roughly 1.25 ha) and property of the private Compagnie du Zoute;<sup>15</sup> in The Netherlands, it belongs to the municipality of Cadzand (formerly spelled Kadzand), which still has a tiny harbor and covers approximately one third of a hectare. The Zwin has been

<sup>11</sup> Rodenbach, G., several editions prior to 1970. *Brugghe, die dode [Bruges la Morte]*. various publishers. Derville, A., 1980. *Le marais de St Omer. Revue du Nord* 73–95.

<sup>12</sup> Plasschaert, R., 1988. *De fysisch-geografische evolutie van het open Zwin*. Gent, Rijksuniversiteit Gent. Faculteit Wetenschappen. [Dissertation for the licenciate in geography]; Verhulst, A. 1964. *Het landschap in Vlaanderen in historisch perspectief*. Brussels, Gemeentekrediet.

<sup>13</sup> Verhulst, A. and Gottschalk, M.K.E., 1978. Transgressies en occupatiegeschiedenis in de kustgebieden van Nederland en België. In: Verhulst, A. and Gottschalk, M.K.E. (eds.), *Proceedings Colloquium* (Ghent, 5–7 Sept. 1978).

<sup>14</sup> Verhulst, A., 1995. *Landschap en landbouw in middeleeuws Vlaanderen*. Antwerpen, De Nederlandse Boekhandel. 128 pp.; Voet, L.; Verhulst, A., and Sarfatij, H., 1990. *Ontstaan en vroegste geschiedenis van de middeleeuwse steden in de Zuidelijke Nederlanden.—La genèse et les premiers siècles des villes médiévales dans les Pays-Bas méridionaux*. Bruxelles/Brussel, Crédit Communal-Gemeentekrediet. 576 pp.; Heyvaert, J. and Decler, M., 2003. *Atlantide sur Escaut. Tempo Verde* 6, Nov., 67–75.

<sup>15</sup> At one time there were two parallel channels, one carrying fresh water (Flemish *zoete*), the other salty or brackish water (Flemish *zout[e]*). The name stuck, though the meaning has been lost.

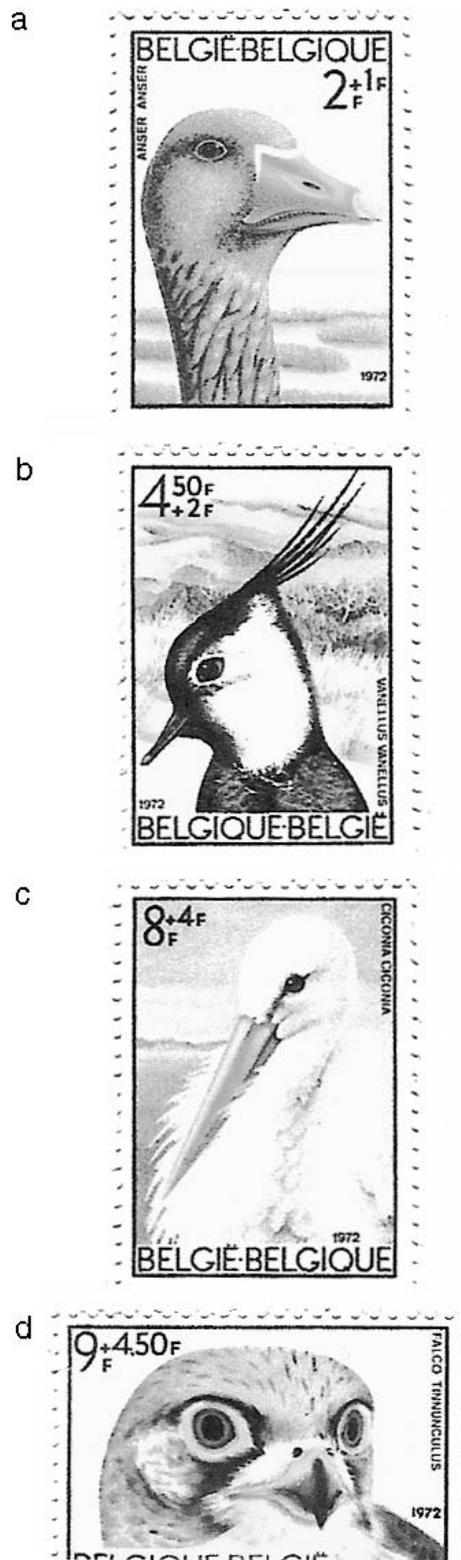


Figure 4. Belgian Postal Administration issue of special series of semipostal stamps showing birds that have made their home in the contemporary Zwin Natural Refuge. Birds of the Zwin (a) *Anser anser*, (b) *Vanellus vanellus*, (c) *Ciconia ciconia*, (d) *Falco tinnunculus*.



Figure 5. White stork, a rare inhabitant of the Zwin Bird Reserve, now sometimes a permanent resident.

preserved jointly by Belgium and The Netherlands, and as a nature reserve it is a protected ornithology and plants park (Figs. 4, 5, 6). Public works have been undertaken, sporadically during the last decades, by various authorities, to prevent—or at least control—further silting and to preserve this unique environment. The reserve is paired with the Marquenterre Reserve sited on the Somme River Bay (Fig. 6).

Whatever remains of the Zwin, as waterway, and the adjoining *slikke* and *schorre*, the area has acquired a worldwide reputation as an uncompromising ornithological refuge (Fig. 7). More than that, the center has contributed significantly to the rescue of species on the way to disappearance. Among the major successes are the cinder-colored goose, the crested lapwing, the white stork, and the rattling falcon (Fig. 4).

Once common in Western Europe, the cinder-colored goose (*Anser anser*) was all but wiped out by man and found in the first half of the 20th century only in Iceland and on the rim of Eastern Europe (Fig. 4a). Researchers at the Zwin succeeded in reacclimatizing the bird in the Reserve, where during the last half century over a thousand individuals were born and thrive. The Center has donated some of these palmipeds to centers in The Netherlands, France, Germany, and elsewhere in order to bring the species back to all of Western Europe. The largest of all geese, it is the ancestor of the domestic goose.



Figure 6. Sea Lavender (*Limonium vulgare*). Rare species with Zwin as habitat.

The crested lapwing (*Vanellus vanellus*; Fr.: vanneau huppé), a Limicolae, inhabits coastal inlets, wetlands, meadows, and polders (Fig. 4b). A law forbidding spring hunting in Belgium has enticed this lapwing to extend its territory eastward to the confines of northeastern France, Germany, and Luxembourg. Soon after the law passed, more than 5000 couples were counted, and the number has easily doubled since the count 25 years ago. This migratory bird spends winters in Southern Europe and North Africa.

The White Stork (*Ciconia ciconia*) disappeared from Belgium by the end of the 19th century (Figs. 4c, 5). Common in Eastern Europe and North Africa, the stork left the other European regions. The Zwin Center attempted to reacclimate these legally protected birds and received support in this undertaking from the World Wildlife Fund in 1962. Young individuals from Portugal and Morocco turned sedentary in the Zwin region, while seven nests were already regularly "reoccupied" in 1972; the number has increased and the territory expanded.

The crested falcon (*Falco tinnunculus*; Fr.: faucon crécerelle) that feeds mostly on small rodents ran afoul of popular opinion, as a result of beliefs that held that birds of prey, whether diurnal or nocturnal, were harmful. To the contrary, they play an important role in maintaining a healthy natural balance (Fig. 4d). Protected in nearly all European countries, they are



Figure 7. Zwin and Sincfal.

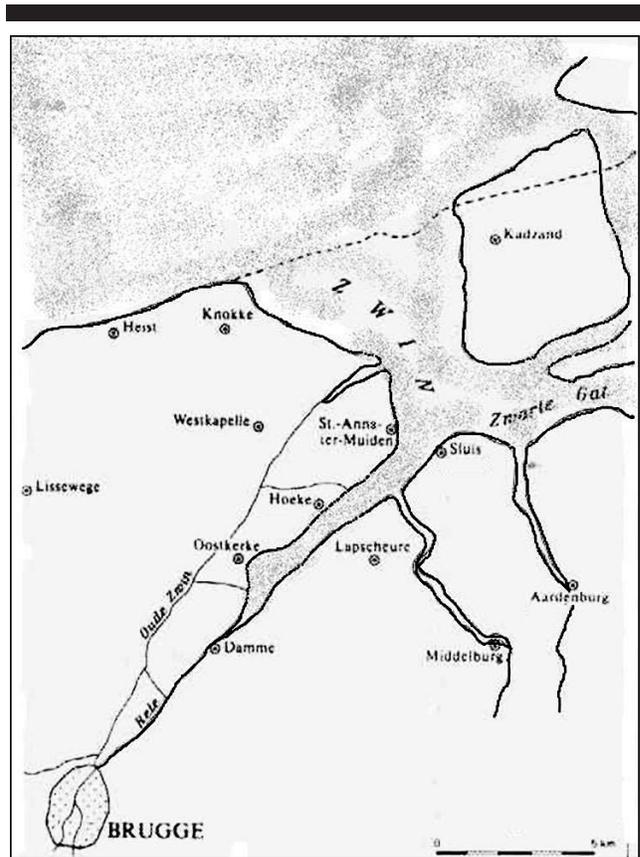


Figure 8. Sincfal in pre-13th century.

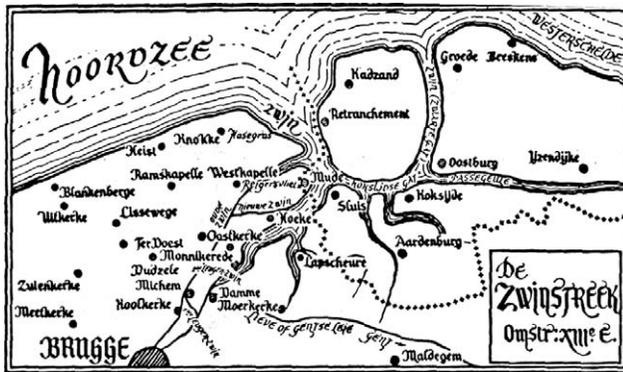


Figure 9. Map showing Zwin and its diverticules in the 13th century after the “great storm”; Damme, Sluis, Cadzand, and Bruges (Brugge) are shown.

often victim of poisoning by overuse of pesticides in agriculture. Survival of the species is monitored by the Zwin Center.

All four birds were the subject of a special philatelic series published by the Belgian Postal System on December 18, 1972. The surcharge carried by these stamps benefited the Zwin Refuge (Figs. 4–6).

### Developments in In-Shore Marine Coast Geomorphology

Along the Belgian coast, erosion seems to be caused by marine currents striking from east to west; beaches are under direct attack, and sand is carried a.o. to a sand bank located at about a seventh of a nautical mile (0.265 km) from the beach itself. The Paardenmarkt Bank is split in two by the Appenzak Channel or Appenzak Deep. Incoming tides bring in sand, but in smaller quantities than sand carried away by outgoing tides, deposited for the most part in the Appenzak. The deep has been gradually filling up, resulting in unexpected consequences (Fig. 5).

### Capricious Flemish Coast

The coast and offshore area of Belgium have undergone numerous changes during the Anthropocene. The events involving the Zwin Inlet are but one. Channels have been filled in, such as the Sincfal; towns have been “swallowed up” by the North Sea, such as Harendyke and Walraverside; but there have also been “readjustments” at relatively short distance from today’s coastline on the continental shelf. The Sincfal was made up during the Middle Ages of river estuaries, schorres, sandbanks, and islands—*Wulpen* (which gradually disappeared between 1377 and 1513), *Koezand* (totally disappeared by 1570), *Zuidzande*, *Cadzand* (now a small coastal harbor and resort), and *Schoneveld*—spread out where the mouth of the *Westerscheldt* is located today (Figs. 8, 9). Originally an inlet, the *Westerscheldt* became an estuary between the ninth and twelfth centuries. The Sincfal is sometimes referred to as the early link between the coast and Bruges.

Peat layers and the retrieval of coins and artifacts, *inter alia*, witness that the area has undergone several very recent sea-



Figure 10. Location map: Belgian Coast, Zwin Inlet, and Scheldt and Yser rivers estuaries. Scale: Distance De Panne [near border with France] to Zwin [on border with Netherlands] is 67 km. Town names translated to English: Brugge = Bruges; Vlissingen = Flushing; Dunkerque = Dunkirk.

level changes. The peat layers continue under the present sea surface for quite a distance and reappear near the English coast.

Storm floods periodically affected the Rhine,<sup>16</sup> Meuse, and Scheldt estuaries, with effects on the coastal land of Flandrian Zeeland. Dunes protect only the western sides of the islands, while the inlets and outlets on the coastline are protected artificially by dikes. Dune development seems to be contemporary with the implantation of human built sea defenses (12th–13th century). The hard structure approach has not yielded only benefits. Larger inlets and outlets have been closed by dams, as part of the Dutch Delta Plan, implemented after the disastrous and murderous storm and flood of 1953.

Coastal barriers and dunes lined the coast during the Holocene; indeed, young tidal and lagoonal deposits are overlain by younger dunes, which occasionally top older dunes, and barriers were destroyed when, after the Gallo-Roman historical period, the shoreline migrated seaward and the peat deposits were either eroded or covered by tidal flat sedimentary deposits.

On the Atlantic coast of France, north of Cap Blanc-Nez, the Holocene transgression wiped out the Pleistocene beaches, except at Sangatte on the Straits of Dover. Wide tidal flats emerge at low tides on the oceanic coasts. Facing the Flanders and Picardy coasts, the southeastern English coast has been subject to severe erosion.

The Belgian coast of West Flanders has nearly all of these characteristics (Fig. 10). A gently sloping fine sand beach abuts a string of dunes of varying width and moderate height ( $\pm 20$  m), beyond which spreads a coastal plain, from 5 to 10 km wide, with sandy creeks and clay pits; the plain’s landward limit corresponds to the farthest extension of the Holocene transgression. 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. In sum, the layering in the coastal region consists of a superposition of the Upper Clay (labeled Polder Upper Clay Layer); Coquina marine sand with a.o. the cockle, *Cardium edule*;<sup>17</sup> marine clay also containing *Cardium*; a peat layer

<sup>16</sup> Rhine (*Rijn*, Rhin, Rhein); Meuse (*Maas*); Flandrian Zeeland (*Zeeuws Vlaanderen*, *Flandre Zélandaise*).

<sup>17</sup> Still present on the beaches today though channel shifts are responsible for grave thanatocoenoses.

containing evidence of modern flora (trees such as birch, hazelnut, oak, and poplar); marine sand that includes in its top layer roots from trees that lived in the overlying peat layer; and sands with *Corbicula fluminalis*. 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.

The coast in its western expansion is a region of several pans or pannes, called moërs across the French border. The geological–geographical term panne has even been used as the name (in Flemish De Panne, in French La Panne) of a community that has been fused with Adinkerke, once the last Belgian rail-station that connected with the French National Railroad Network. *Sensu stricto* pans are usually shallow, salty, or brackish lakes. Saltiness depends in this area upon the rate of precipitation, runoff, and evaporation. On the Belgian coast no rivers discharge in the pans, though the Aa River crisscrosses the area on the French side. Pans, or pannes, are ephemeral and become part of the coast. The border city of La Panne<sup>18</sup> has developed in an area of numerous dried-up pans. The lands of the Westhoek and of the Zwin on the Oosthoek<sup>19</sup> have been set aside as a Natural Reserve. The reserve is paired with the Bay of the Somme [river] reserve of Marquenterre.

Manmade polders predominate in the eastern expanse of the Belgian coastal zone (Oosthoek); polders are found in the Flandrian North Sea coastal zones of France and Belgium and of course in Zeeland (Netherlands' province). The first “real” polders date back to the 11th or 12th century.<sup>20</sup> Mud flats, a type of pan perhaps, which often form in front of polder dikes, constitute an enticement at further polder incorporation. However, polderization and concomitant reclamation are today often looked askance at because dikes appear to favor coastal erosion and, in a reversal of approach, 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 (Westhoek) and on the French side of the frontier, has shown encouraging signs of abatement.

The Zwin, at the extreme limit of Belgian territory, was the foundation for the wealth of medieval Bruges. In Flemish and Dutch, a zwin is a waterway located at or near the coast and allowing seawater to circulate, sometimes thereby creating islands; it is not—as erroneously sometimes designated—a river (e.g., *Webster's Geographical Dictionary*). The name has been given to such a waterway to an inlet that Sluis (in French, *l'Écluse*), Damme, and particularly Brugge (in French and

English, Bruges). Today, mostly silted, it is a “natural” swimming pond and navigable for one-man canoes. The overall contemporary picture is that of a stagnating inlet with sand starvation along the Dutch coast and widening of the Belgian beach updrift. The Zwin inlet functions as a sedimentary trap, with its typical ebb-delta features displaced shoreward. Since 1952 maintenance of the area has consisted mainly in keeping the channels free and relocating the inlet channel when it had migrated too far eastward. In 2006 a multidisciplinary study was started to investigate the optimal and most sustainable way of preserving the Zwin nature reserve as a tidal inlet (Figs. 11, 12).

Beach erosion, a generalized phenomenon all along the Belgian coast, and to some extent prolonged along the Zeeland (Netherlands' province), threatened the lucrative coast tourism even in the late 1800s. Warnings of field observers were pooh-poohed by ill-informed high-ranking government officials, yet they proved accurate and appropriate, beaches shrank, and eventually fields of groins were placed on and in front of the beaches. Yet in most areas the shoreline kept on migrating landward, to such an extent that beaches were entirely covered by the sea at high tide, as for instance in Heist, while in other locations—e.g., Knokke—only a few square meters of dry sand remained available for tourists to squeeze on. The major geomorphological agent is the tide, but the anthropic factor plays a major role.<sup>21</sup>

The case of Knokke, the last large—and highly fashionable—resort before the Zwin and the Dutch border (province of Flandrian Zeeland, *Zeeuws[ch] Vlaanderen*), is rather unique, at least unusual. An ocean deep, the Appenzak, is located relatively close to shore; outgoing tides used to carry beach sand away and deposit them in the Appenzak, turning it into a kind of Danaides' barrel.<sup>22</sup> At that time—the early eighties—further extension of the nearby harbor of Zeebrugge was decided upon, and disposal of the tons of sand removed for the purpose had to be planned. Thus, the decision was made to use that sand for a massive beach-nourishment project at Knokke.<sup>23</sup> At the time it was the largest such undertaking in the world. Though sand kept on being “lost” to the Appenzak (an English translation would be Apples' Sack) Deep, the beach maintained itself, in part due to periodic addition of new supplies of sand.

Not far from the Appenzak a sandbank known as the Paardenmarkt Bank (translation into English would give the Horse Market Bank!) began to expand while the Appenzak Deep filled. This uninterrupted process took on such magnitude that 20 years later the bank emerged—and still does—at low tide, expanded shoreward, and became accessible on foot, somewhat comparable, on a miniature scale, to the Mont Saint Michel

<sup>18</sup> La Panne (*De Panne*).

<sup>19</sup> 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., and Morcos, S., 2004. Since when coastal protection? In: *Proceedings of the 6th International Congress on the History of Oceanography—Bridging the Millennium*. Paris, UNESCO Press and Qingdao, China Ocean Press.)

<sup>20</sup> The Zwin “Inlet” is actually a tidal channel, characterized of course by bidirectional tidal flow and *ipso facto* bidirectional sediment transport. The Zwin does not nor did it link barrier lagoons, or an impounded estuary with the North Sea, but it drained intertidal flats and tidal creeks. Now an ornithological reserve, it was, in medieval times, navigable to Bruges, a city it brought wealth, power, and fame.

<sup>21</sup> Charlier, R.H. et al., 2003. History of coastal protection. In: Morcos, S., et al. *Proceedings of the 6th International Congress on the History of Oceanography*. UNESCO-Paris and 1st InstOceanography-Qingdao-PRC.

<sup>22</sup> Characters from Greek mythology, referring to a bottomless barrel.

<sup>23</sup> Charlier, R.H. and De Meyer, C.F., 1998. *Coastal Erosion and Management*. Heidelberg, Springer Verlag [Lecture Notes in Earth Science series].



Figure 11. Zwin Reserve. Photos: upper, M.-C. Chaineux; lower, Regional Tourism Office.

situation on the French Brittany–Normandy coast.<sup>24</sup> An anecdotal consequence ensued: the bank and the “land” being linked, some local ultranationalists claim link and bank now are part of the “regional” territory of Flanders and are no longer under [Belgian] federal jurisdiction. Fantasy Island perhaps? A new political tempest in a teapot?

The bank probably owes its name to an elevated point of the engulfed island of Wulpen once located in the sea outlet of the Zwin, where no less than four villages stood in the 12th century. Horses were traded there. However the original Paardenmarkt gradually sank to below 10 m depth. The name was “reused,” transferred, to the contemporary bank, offshore of Knokke-Heist and at less than 4 m below low-tide level.<sup>25</sup> The area has acquired an unenviable reputation as the resting

<sup>24</sup> A permanent causeway was built linking the dry land with the Mont Saint Michel. A decision was made, after undesired consequences caused by the structure, to demolish the causeway and restore the *status quo ante*.

<sup>25</sup> See Charlier, R.H., 1955. Belgian coastal erosion. *The Professional Geographer*, 7, 2, 10–12.

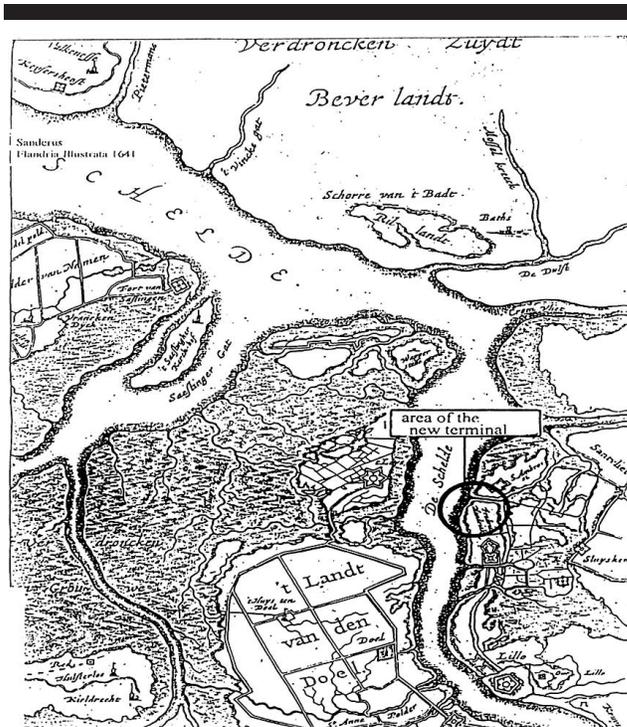


Figure 12. Antwerp about 16th century, with superposed new facilities under construction (2004).

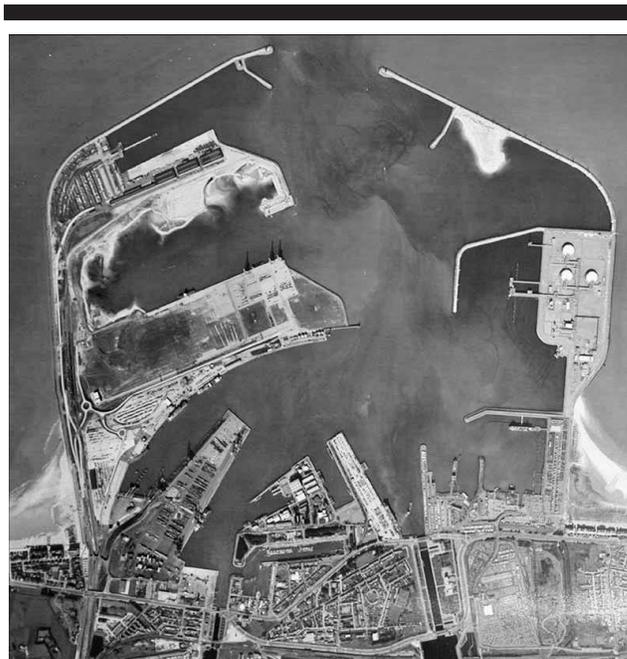


Figure 13. View of the port of Zeebrugge after completion of extension works, about 2000. Photo HAECON Inc. (1999).



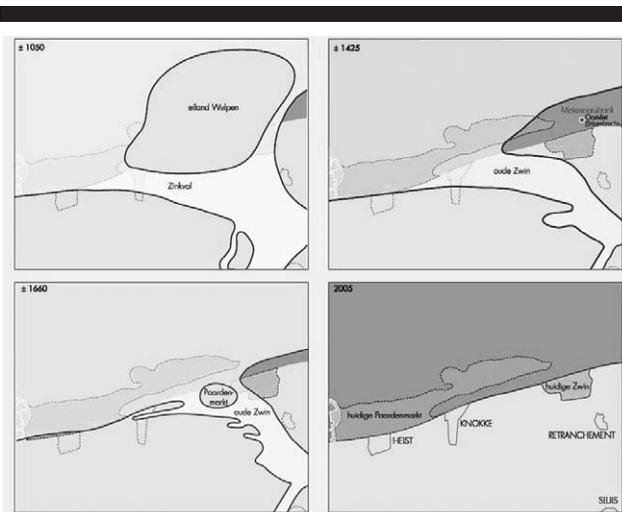


Figure 17. Evolution of Zwin estuary over last ten centuries. Credit: Flemish Institute for the Sea and related organizations. Translations: eiland = island; Zinkval = Sincfal; oude Zwin = old Zwin; huidige = contemporary.

On the other hand, the artificial part of Zeebrugge (occasionally spelled in French and English Zeebruges, meaning Bruges-on-the-sea), which expanded ever since its creation 100 years ago, is polyvalent and is a member of the cohort of North Sea ports<sup>27</sup> (Figs. 13–14). The Zwin Area is permanently under study and the inlet under constant observation (Figs. 15, 16).

### Epilogue or Prologue?

To close this paper on the celebrated North Sea inlet the author faces a dilemma: is he writing an epilogue closing with a nostalgic thought about the shining Bruges of times bygone, and its rebirth as part of an important port complex, coupled to a Zwin area transformed in a nature lovers and ecologists tourism spot or is it a prologue as the area is slated for a major face-lifting and coastal protection works. He tends to opt for the prologue.

In the close-by years to come great transformations are to take place related to coastal protection and to reversion to natural conditions. Once beyond the glamour of Knokke and the adorable nestled villas of Het Zoute (“the salt area”), the wide dike and promenade lined with expensive structures narrows, and a walk-and-bicycle path heads for the Zeeland border: this pathway with its protective half-a-meter high wall—in fact a berm—is the international dike. All it has of international is its name as it ends inside Belgium at the edge of the Zwin. The Zwin lost its commercial significance as

<sup>27</sup> Cf. Charlier, R.H., 2005. Tale of two inlets. In: *Proceedings of the 2nd International Congress of Coastal Geomorphology*. Höfn, Iceland. pp. 38–46; Charlier, R.H., 2004. The ports of Bruges. In: *Proceedings of the 2nd International Congress on Seas and Oceans*, Szeszyn, Poland, Book of Abstracts. pp. 32–41; Charlier, R.H., Chaineux, M.-C., 1999. From riches to rags and back to riches. In: *Proceedings of the 1st International Congress on Seas and Oceans*, Szescin, Poland. Vol. 2, 20–34.

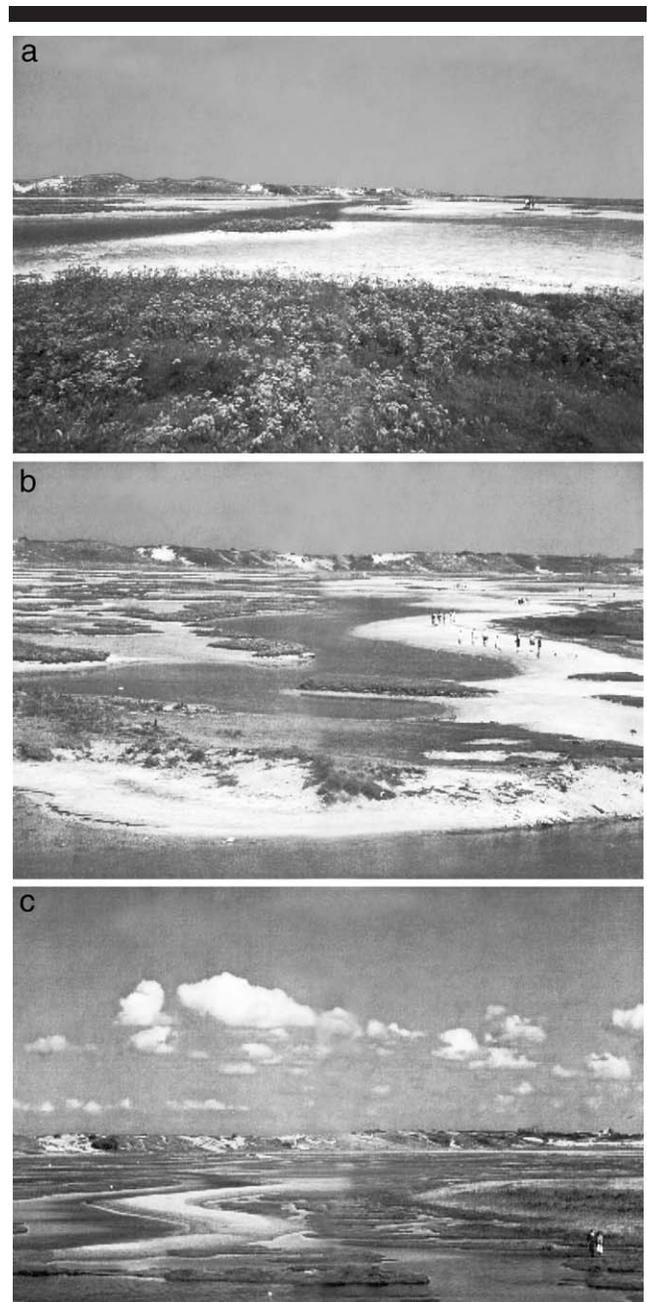


Figure 18. Views of the contemporary natural refuge (Photos M.-C. Chaineux and Regional Tourist Office). (a) Rising tide, (b) low tide, (c) midpoint of tide.

sedimentation made it too shallow to allow even Renaissance vessels to navigate it to Damme. But sedimentation continuing inexorably the bed heightening process is causing major coastal modification problems. (Figure 17). Hence the international dike will be dismantled; a brand new dike will be constructed but a good distance further inland—in the Zwin plain—, no longer along the beach (Figure 18). Slikke and schorre will expand. This will bring about the reversion to “natural condition” of at least 120 ha. Involved are thus removal of a

dike, construction of new one, extension of the “nature park”, building of a new visitors center.

The siltation processes weakened the tides dynamics and endangered fauna and flora survival. Dredging is planned: back to a deeper Zwin of yore. What is wanted is a situation allowing sea water to enter and exit from the Zwin exutory. The sea water will find its own channels of penetration in an area that will be humid. Plans remind of the approach initiated some years ago at the other end of the Belgian coast, the Westhoek, where the toes of the dikes were not repaired and water is allowed to flow inland.

Miradors will be erected in surrounding dikes and dunes, both on Belgian and Dutch territory, and a “platform” will allow an

all but 360° circular view. Even the Royal villa is due to yield space for the new “nature education eco-tourism Zwin”. According to local authorities the existing natural reserve is to be turned into a crown-jewel of a diadem of nature-experiencing.

### ACKNOWLEDGMENT

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### □ RÉSUMÉ □

Des artistes originaires des XVII Provinces ont largement contribué à la cartographie. Parmi eux le peintre Pierre Pourbus a dressé, e.a., des cartes de la Zélande et de la région du Zwin, aire que l'empereur Charles-Quint voulait protéger contre toute invasion ennemie venant de la mer. Les régions côtières de la Flandre et de la Zélande ont été sporadiquement envahies par la Mer du Nord au cours des périodes proto-, pré- et historiques. L'invasion du 13<sup>e</sup> siècle ouvrit une telle brèche et d'une telle profondeur qu'un chenal, baptisé le Chenal d'Or, fut créé reliant Bruges et la mer; des bateaux purent pénétrer jusqu'à Hoek, Damme et L'Ecluse, qui devinrent les avant-ports de Bruges. Hélas, l'enlèvement graduel du chenal ruina le commerce mondial brugeois, qui périclita au profit d'Anvers et donc la ville la plus riche de l'Europe du nord-ouest s'effaça devant la ville qui fut pour une longue période la plus grande ville du monde. Quant au Zwin il se réduisit à un chenal étroit faisant office aujourd'hui de piscine naturelle et de voie pour canoës. Mais, d'autre part il devint un refuge ornitho-, phytologique de réputation. Bruges, elle-même, renaquit de sa somnolence séculaire, devint un centre touristique de renommée et grâce à des travaux gigantesques ayant créé un port artificiel sur la côte, à une vingtaine de km du Zwin, a regagné une place primordiale en tant que port polyvalent. Sur la côte les jeux d'érosion et de sédimentation ont engendré des modifications géomorphologiques qui ont entraîné des conséquences faunales et même peut-être une tempête politique dans un verre d'eau.

### □ SAMENVATTING □

Kunstenaars afkomstig uit de XVII Provincies hebben merkkelijk toegedragen tot de cartographie. De vermaarde kunstschilder Pieter Pourbus is o.a. de auteur van kaarten van Zeeland en van de Zwinstreek, een gebied dat Keizer Karel wou vrijwaren van een van de zee komende vijandelijke inval. The kuststreken van Vlaanderen (B) en Zeeland (NL) zijn herhaaldelijk het toneel geweest van Noordzee doorbraken gedurende de proto-, voor- en historische periodes. De overstromingen van de 13e eeuw openden zulke geul, die de bijnaam kreeg van Gouden Geul, dat schepen plotselings de oorden Sluis, Hoek en Damme konden bereiken, en die dan ook de rol van voor-havens van Brugge opnamen. Brugge was verbonden met de zee en handel bloeide in de streek. Alas, de geul verslakte gelijdelijk, de economische activiteit daalde ten voordeel van Antwerpen: de rijkste stad van noordwest Europa moest het opgeven aan die voor een langere tijd de grootste stad ter wereld werd. Het Zwin vernauwde tot een smal “kanaal” dat heden een natuurlijke zwemkom geworden is en biedt een kort ritje, bij hoge tij, aan kano's. Tevens, echter, groeide het uit tot een wereldbepaald beschermd centrum voor planten en vogels. Brugge ontwaakte wederom en dankzij gigantische werken ondernomen op een twintigtal km ten zuiden van Het Zwin, werd het verbonden met een artificiële haven, op de kust gelegen en is opnieuw een polyvalente haven. Op de kust zelve zorgden erosie en sedimentatie voor veranderingen die leidden tot modificatie van de dierenbezetting en misschien ook wel tot een politieke storm in een glas water.