1. INTRODUCTION

And so, having enjoyed favourable winds, they crossed the sea and touched at a landing site not far from the castle of Bruges. The […] town is inhabited by Flemish settlers, and enjoys very great fame for the number of its merchants and for its affluence in all things upon which mankind places the greatest value 1.

As the 11th-century *Encomium Emmae Reginae* describes, Bruges became a leading European cultural and economic centre during the Middle Ages. The specific position it held within transcontiental and maritime trade route networks played a crucial role in this development. Lying inland, a navigable connection to the sea was not self-evident for Bruges. In order to attain and retain such connections, natural creeks were connected with man-made canals, dams and sluices, creating a port system that was named *totum pro parte* after its main waterway: the *Zwin* 2. At the borders of the main creek, a series of *Zwin* cities developed, including *Damme*, *Monnikerede*, *Hoeke*, *Mude* and *Sluis*. These cities functioned as a network of outports, which shaped the region into a linear suburban extension of Bruges. The land that was cut across by this port system simultaneously evolved from natural mudflats and saltmarshes into an embanked agricultural landscape. To make these wetlands arable and liveable, a vast network of dikes and ditches were constructed, which resulted in seemingly opposed interests: on the one hand, searching a navigable way to the sea, and, on the other, protecting the land against flooding. Both incentives stimulated innovative hydrological engineering and had a far-reaching impact on the coastal landscape.

In spite of this hydraulic *tour de force*, the silting up of creeks and canals turned out to be geomorphologically inevitable, and ultimately Bruges lost its vital connection to the sea 3. The subsequent commercial downturn of the port functions of Bruges in the 16th century proved that outports, such as *Monnikerede* and *Hoeke*, were not viable without the port network in which they were founded 4, which
Fig. 1. — Abstract map of the Zwin region with indication of the dikes (A–E), hydrological features (a–i), and toponyms: (A) Internationale Dijk, (B) Kalveketedijk, (C) Brolozendijk, (D) Krinkeldijk, (E) Romboutswervedijk; (a) Damse Vaart, (b) Leugenzwin, (c) Municareda, (d) Nieuw Zwin/Hoekevaart, (e) Open Zwin, (f) Oud Zwin, (g) Reie, (h) Verse Vaart, (i) Zwin inlet. As the course of some waterways is overlapping, their mutual relation is explained by the symbol ‘<’. For example ‘h<f’ means that the younger Verse Vaart (h) is dug into the former bed of the older Oud Zwin (f).
resulted in their eventual desertion. Although multiple economic stimuli were the driving force behind landscape transformations in the medieval period, it would be post-medieval military policies that marked the landscape in the subsequent centuries. Today, the large-scale inundation resulting from intentionally breaching dikes during the Eighty Years’ War, the line of defensive works built by Louis XIV and the Napoleonic canal between Bruges and Sluis remain the most visible landscape features.

Conflicting views and intense discussions over the development of the medieval port system has resulted in a controversy which we denominate as the Zwin debate. For more than a century (1871-2014), this controversy was chiefly pursued by historians and soil scientists, who used written sources, historic maps and soil maps. Apart from traditional prospection research5, archaeological input was virtually non-existent. However, the last decade has seen spectacular advancements in landscape archaeology with the development and application of innovative, non-invasive prospection techniques, such as aerial photography, LiDAR and geophysics. Moreover, recent research in areas surrounding the Zwin have revolutionized the understanding of the morphology and evolution of such transformed wetlands6. These studies have also insisted on reinvigorated parallel research on a regional scale, although the application and integration of new techniques and studies have not yet been fully established with respect to the Zwin debate. An integration of traditional and innovative interdisciplinary research will not only grant more insight into the geomorphology of the eastern corner of the Belgian coastal plain, but also clarify early medieval commercial expansion of the region. In addition, such an approach has potential for detecting the exact location, layout and quality of preservation of deserted Zwin cities. This valuable information may also provide a solid basis for further use in heritage management, environmental planning and public archaeology initiatives.

The aim of this paper is to critically review previous attempts to characterize and understand the Zwin area; focussing on influential published works that have centred round and shaped the Zwin debate. It will offer a platform for renewed research into one of Europe’s leading yet little-known medieval port networks. In the first section, we will offer an overview of nearly 150 years of research, divided into four characteristic phases. The second section focusses on two landscape components, which, in our opinion, are crucial for a relative dating and geomorphology of the area: the Oud Zwin and the Krinkeldijk. The topography of these linear features will guide us through this unique historical land- and seascape. Finally we will show how the integration of new data and techniques will contribute to a better understanding of the Zwin area (fig. 1).

2. THE ZWIN DEBATE: TRENDS IN RESEARCH

Louis Gilliodts-Van Severen indirectly opened the Zwin debate in 1871 by studying and publishing the inventories of Bruges’ archive. In the same year, the occlusion of the tidal Zwin inlet was finalized with the construction of the Internationale Dijk7, reclaiming the new Willem-Leopoldpolder on its landward side and leaving an area of mudflats and saltmarshes at its seaward side. This untouched mouth of the Zwin has been protected as a nature reserve since 19528. Due to progressive silting of the tidal inlet, the ZTAR LIFE + project has been launched in order enlarge the tidal area and give the water, mudflats and wildfowl more space9, which, in 2014, coincides with the start of the current study.

Historiographically, the 142 years of research between 1871 and 2014 created a debate that pits historians against soil scientists, academics against amateurs, urban versus rural approaches, and regional versus international perspectives. Moreover, geomorphologically, after a millennium of embanking, the tide has turned with this first « unembankment » in the Zwin area.

2.1. The Zwin debate begins (1871-1945)

In addition to archival work, Gilliodts-Van Severen was the first to study Bruges’ connection to the sea10. Although he focussed on the 16th-century situation rather than including earlier phases, his work resulted in the opening up of archives and set the tone for subsequent research. Unfortunately, due to some geographical misinterpretations, his work also caused long-lasting confusion concerning the names of some canals. A second contributor worth mentioning is the priest and local historian Opdedrink. He studied the archives of Damme, inspiring future local historians and laying down the foundations for amateur histori-
ography of the Zwin region. The first author venturing into the origins of the Flemish coast was Edouard Jonckheere. Although his descriptions of the geomorphology of the Zwin inlet are vague, one of his reconstruction maps clearly suggests a large coastal inlet reaching Bruges in the 4th century. A few years later, Jonckheere also made an attempt to describe the pattern of dikes and waterways. Raoul Blanchard’s study of the Flemish coastal plain and the evolution of the Zwin area built on Gilliodts-Van Severen’s data. Hence, Blanchard did not manage to correctly situate the canals in time or place either, which is clear from his reconstruction maps. More importantly, was his general view on the geomorphology of the coastal plain. He considered the Zwin as a large 5th-century inlet which reached Bruges and gradually silted up, without any natural catastrophes. Next, Rudolf Häpke paid more attention to historical geopolitical and economic questions, leaving geomorphology aside.

After these rather general contributions and the interruption of WWI, it was not until the 1930s that the brothers Antoine and Jos De Smet thoroughly studied the history of the Zwin and its ports. Antoine De Smet, who is regarded as one of Belgium’s founders of historical cartography, was the first to relate written evidence to cartographic sources and pre-cadastral documents. As a consequence, he was able to offer a more structured and detailed topographical description of the waterways, whereas his predecessors remained rather vague and unsure. He also succeeded in unravelling the confusion about hydronyms, such as the Verse Vaart, Oud Zwin and Nieuw Zwin. As for the geomorphology of the region, he used Blanchard’s model of the silted-up inlet, but adjusted it by arguing that, during the process of sedimentation, not one – the proper Zwin – but several waterways remained open in between accreted islands. In particular, the Oud Zwin was now attributed more importance. For the first time it was regarded as a proper, navigable and natural waterway. Apart from this influential contribution, both Antoine and Jos De Smet frequently published more popular papers, through which an interest in the history of the Zwin became more widespread amongst a less specialised audience.

The last two contributions to this first phase of the Zwin-related research conformed to Blanchard’s point of view, but approached the subject from a more regional perspective. Both authors started with a geological introduction but diverged later, with Maurits Waterschoot focussing on dikes, embankments and water boards, and Jozef De Langhe concentrating on the evolution of the eastern coastal plain. In fact, these two works did not present new information but were aimed at synthesizing the existing data and translating it into a comprehensible narrative for a broad and Dutch-speaking public. As non-professional historians they are forerunners of a trend that would return after the dust of World War II had settled.

All in all, in its initial phase, the Zwin debate was opened by the dissolution of historical and geological data. It was overall assumed that a large inlet gradually silted up during the Middle Ages. This was considered to be a natural process in which no drastic changes occurred and in which human actions had little or no influence.

2.2. Stepping up the academic input: two colloquia (1945-1978)

In the decade following WWII, a new and crucial research phase arose through close academic cooperation between historians and soil scientists. The historian-soil scientist duo, Jan Dhondt and René Tavernier, converged on their growing interests in the genesis of the coastal plain. Dhondt’s interest developed from his studies of the County of Flanders, while Tavernier analysed the quaternary deposits of the coastal plain and revolutionized perceptions of its development. In summary, he adopted the interpretation of the Asise de Dunquerque being a transgression deposit and subdivided it into a series of individual transgressions. In doing so he ruled out Blanchard’s model of a gradually reducing inlet and replaced it with a model in which three successive phases of marine transgression radically reshaped the landscape.

Through the mediations of both men, the ideas of another, younger, duo – historical geographer Adriaan
Verhulst and soil scientist Jean Ameryckx – were brought together in a 1958 colloquium. At that time, Verhulst was preparing a study of the formation of water boards in the coastal plain. Ameryckx was working in the national subsoil programme, focusing on the coastal area and was supervised by Tavernier. In the programme of soil mapping, Tavernier’s tripartite division was applied, albeit sometimes reluctantly. The 1958 colloquium was thus aimed at integrating new pedological and geomorphological insights with historical sources, and eventually resulted in the construction of the Dunkerque Transgression Model. This model had a profound and lasting influence on the general interpretation of human-landscape interactions throughout time in the coastal plains of the Low Countries. In this first multidisciplinary model, three subsequent marine strata of clay were correlated to both an oscillating sea-level and the presence or absence of archaeological finds, toponyms and historical records. As a con-

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26. Soens explains water boards as « local organisations that since the 13th century were responsible for the construction and maintenance of dikes, waterways and discharge sluices in the Flemish coastal plain. » (Soens 2006, p. 35.)
27. A MERYCKX 1953; MOORMANN, AMERYCKX 1950.
sequence, it was argued that the transgressive periods introduced uninhabitable environmental conditions, and were interrupted by periods of marine regression in which the coastal plain was again occupied. On three out of the four items addressed by the colloquium, a tentative agreement was reached. The fourth item, the connection of Bruges with the sea between the 9th and the 11th centuries remained unsettled.

One of the most notable contributions to the Zwin debate resulting from the intensified research was pinpointing the creation of the tidal Zwin inlet to AD 1134, and relating it to transgression III-B. Verhulst attributed the cause of this marine transgression to a single storm surge, and in doing so unwarly laid the foundations of the next colloquium, which occurred some 20 years later. In subsequent years, both Verhulst and Ameryckx wrote many papers detailing their new findings, successfully synthesising the results into a new paradigm. First and foremost, Verhulst substantiated the transgressions and regressions with historical data. Furthermore, he reconstructed the reclamation and embankment of the Zwin area from the 13th century onwards. Ameryckx integrated this supportive historical data into the geomorphological transgression model of the Belgian coastal plain. Through their combined output, the comprehensible Dunkerque Transgression Model became established quickly and was accepted easily.

The model served as a practical steppingstone for further research. From the 1960s onwards, local historical societies increased in popularity and became involved in the debates surrounding the genesis of the Zwin region. Examples include Sint-Guthaag, founded by self-trained amateur historian, René De Keyser. In reaction to and in dialogue with Verhulst, De Keyser wrote several articles discussing the hydrological network northeast of Bruges. Although his writings were not considered to be of a high academic standard, he introduced several new elements that were incorporated into the debate and still hold. Two of his major contributions were the subdivision of the Oud Zwin into several parts with different chronologies, and suggesting that the Budansflit was a possible predecessor of the tidal Zwin inlet of 1134.

Another prolific writer based in Sint-Guthaag was Maurits Coornaert, whose most notable contribution to the debate was his well-structured summary of both De Keyser’s often chaotic theories and Astaes’ research on the waterways north of Bruges.

Academic contributions initially came from research promoted by Verhulst. Nicole Pannier, for example, studied both the network of dikes north of Bruges and the Dunkerque III-B transgression. Remarkably, she sided with De Keyser’s dating of the Krinkeldijk and location of the Budansflit, whilst questioning the arguments of Verhulst. Moreover, just like Elisabeth Gottschalk in that period, she started focusing on the frequency of storm surges, which demonstrated a first incongruence with the transgression-based paradigm. In addition, Cornelis Dekker’s historical-geographical research in South-Beveland put even more pressure on the Dunkerque model. The rigid framework of transgressions and regressions was further contradicted by new Roman and medieval archaeological research in the Belgian coastal plain. In order to efficiently confront these new data, Verhulst and Gottschalk organized a further colloquium during which the Dunkerque Transgression Model was disentangled as a model that was both constructed by circular reasoning and theoretically invalid. From a pedological point of view, the transgressions turned out to be indistinguishable from one another, and historical and climatological data now suggested storm surges as the motor of landscape transformation. However, the geomorphological concept of flooding and retreating water volumes remained.

As a consequence, the more straightforward transgression model continued to be applied in both academic and popular literature, providing a convenient shorthand for explaining apparent gaps in knowledge regarding (pre-)historic human occupation of the coastal plain.

In short, the second phase of the Zwin debate was marked by two important colloquia in which interdisciplinary cooperation between historians, soil scientists, geographers, climatologists, toponymists and archaeologists led to new understandings of how the Belgian coastal plain developed. The driving force of
the geomorphological processes was first attributed to an alternation of transgressions and regressions, but was later correlated with a more irregular pattern of storm surges. Not only was there a rapprochement of academics from different domains, but amateur researchers also joined the debate.

2.3. The slow death of the Dunkerque model (1978-2010)

However much the first colloquium had induced an immediate intensification of research, the second colloquium did not. The old Dunkerque Transgression Model was only half-heartedly abolished, leaving both historians and soil scientists rather empty-handed. It took several years before a new generation of researchers would gather enough data to reopen the debate. Marc Ryckaert – another pupil of Verhulst – did so from a historical-geographical point of view, which he had already begun at the colloquium by thoroughly synthesising preceding historical-geographical research on the Belgian coastal plain. He critically applied the colloquium’s outcomes to the genesis of the tidal inlet, and clearly analysed the silting up of the Zwin in the late medieval period. Jean-Pierre Sosson and Brigitte Fossion offered more economic-historical approaches, employing urban network theory in their analyses of the Zwin region’s urban network. From a geological stance, new extensive research into the Holocene evolution of the coastal plain was conducted after nearly 30 years of inactivity. A study of the western coastal plain by Cecile Baeteman was followed by a study of the eastern coastal plain by Frank Mostaert. Based on new field data, both geologists further disproved the rigid transgression and regression model, and gradually constructed a new geomorphological framework. At the time, Belgian archaeologists were influenced by the new trend of Landesaufnahme, which resulted in extensive field-walking combined with archival research. The first thorough archaeological prospection in the Zwin region using this approach was conducted by Bieke Hillewaert. In addition to university-based non-invasive research, first rescue and later preventive archaeology increasingly provided new insights from large infrastructure projects north of Bruges.

Although these datasets were gradually redefining Holocene development of the coastal plain, they were not adopted into popular and much-read historical literature. Furthermore, the sequence of well-known transgressions and regressions continued to be used as a reference. The comprehensibility of the Dunkerque model and the lack of easy alternatives hampered the integration of new datasets and the forging of new paradigms.

Interdisciplinary projects in the central Belgian coastal plain attempted once more to deconstruct the Dunkerque model by successfully integrating environmental and landscape data. A new comprehensive geomorphological model for the genesis of the coastal plain in the Low Countries was finally proposed by both Peter Vos and Robert Van Heeringen, and Baeteman. Briefly, this new paradigm refuted the view that environmental conditions synchronically changed throughout the entire coastal plain over the last 2,000 years. Any type of coastal landscape (e.g. dunes, mudflats, salt marshes, tidal streams, peat bogs) could be present simultaneously, and at relatively close proximities. The mechanism of coastal transformations cannot simply be attributed to sea-level fluctuations driving transgressions and regressions, rather it is the interplay between palaeotopography, a decelerating relative sea-level (RSL) rise, sediment supply, tidal channels and accommodation space that generally forms the coastal landscape. Furthermore, historical research has exposed the anthropogenic agency in this process, particularly with regard to accommodation space. Reclaiming wetlands and building dikes limited the available space for tidal channels in between the dikes, while draining polders and extracting peat made the land behind the dikes subside and therefore vulnerable to flooding.

The third phase of the debate can be characterized by an older generation’s persistence of the Dunkerque model on the one hand, and a younger generation working across traditional disciplinary boundaries to integrate new datasets on the other. The new generation of geologists, historians and archaeologists,
working from ideas established at the 1978 colloquium, finally ruled out the transgression and regression model, and gradually replaced it with a new paradigm.

2.4. 2010-2014: a new model, new questions and new research

In order to invigorate and perpetuate this new paradigm, a third colloquium, « Landscapes or Seascapes? The history of the coastal environment on the North Sea area reconsidered », was organized in 2010 and published in 2013. Having a more international scope, it reproduced not only an overview of the work in the Belgian coastal plain, but also included contributions which engaged with the surrounding North Sea area. Notably, the evolution of embankments in adjoining coastal areas seems to differ from the model still applied in the Zwin area and suggests the need for re-evaluation. The last paragraph of Erik Thoen’s epilogue argued that « regional differences still deserve to be underpinned with more in-depth research. […] Therefore, much real inter and trans disciplinary research is still very necessary », and served as one of the incentives to initiate the Zwin Project.

Recent research into the Zwin region has proved productive. Raakvlak, the intermunicipal service of Bruges and its surroundings, has published the seminal work, *On the Interface of two Landscapes*, which foregrounds the art archaeological, landscape and historical-geographical research of the region for the period prior to AD 1127. Recent historical research has resulted in equally ground-breaking approaches on the genesis and occupation of the broader North Sea area, and specifically Bruges and its surroundings, demonstrate the necessity of revitalizing and innovating somewhat obsolete research in the Zwin area.

In order to demonstrate the above constructed historiographical analysis, it seems appropriate to elaborate on some more specific topographical features.

Recent archaeological excavations in the adjoining coastal plains continue to provide more proof of a continuous, permanent and varied human occupation, and demonstrate how differing coastal landscapes were inhabited in both Roman and medieval periods. In the Zwin region, on-going archaeological research has revealed new prehistoric and Roman sites.

A rather incongruous tailpiece to this overview is the two articles published by geologist Roger Charlier. Rather than furthering the debate, his work potentially serves to undo many recent advances. First and foremost, Charlier consistently refers to outdated research. He incorrectly situates the breakthrough of the Zwin inlet in the 13th century and persistently makes use of the now-disproved transgression and regression model. Furthermore, he relies on an inaccurate, and unreferenced, reconstruction map taken from a popular account of the Zwin area, and subsequently uses it to describe the 13th-century hydrography, thereby regarding the Oud Zwin as one of five coexisting tidal branches without further specification. However much progress has been made in coastal research during the last decades, the articles of Charlier confirm that the Zwin debate is in need of modernization and deserves re-examination. Moreover, recent integrated and interdisciplinary approaches on the genesis and occupation of the broader North Sea area, and specifically Bruges and its surroundings, demonstrate the necessity of revitalizing and innovating somewhat obsolete research in the Zwin area.

3. TO THE TEST: LINEAR LANDSCAPE COMPONENTS AS A GUIDELINE

In order to demonstrate the above constructed historiographical analysis, it seems appropriate to elaborate on some more specific topographical features.
that are closely related to the region’s geomorphology. The landscape stretching between Bruges’ city walls and the present-day nature reserve (fig. 1) is cut diagonally by two features: the Oud Zwin and the Krinkeldijk. Both features link up the hydrological phenomena of the coastal landscape and the anthropogenic adaptation to it. They represent the seemingly opposing human objectives of maintaining a navigable way to the sea and protecting arable and inhabitable land from that same sea. Digging the canal (Oud Zwin) and dike (Krinkeldijk) were conditional for Bruges to become the main commercial metropolis of the medieval North Sea area. Moreover, as both axes transect the study area, they incorporate crucial information on the relative chronology and geomorphology of the Zwin region, and are therefore worth a closer look (fig. 3).

3.1. The Oud Zwin

The Oud Zwin is a waterway that ran from Bruges northeast to the coast (fig. 1f and fig. 3f). Initial studies gave barely any attention to the existence, let alone the function, of the Oud Zwin. Gilliodts-Van Severen argued that the digging of the Verse Vaart – which he mistook for the connection between Bruges and Damme – decreased the use of the Oud Zwin. However much Blanchard does not mention the Oud Zwin, the course of the Verse Vaart on his 13th-century reconstruction map and the course of the Nieuw Gedelf on his 16th-century reconstruction map both show an analogy with the most south-western part of the Oud Zwin, thus creating confusion concerning these different canals. Jonckheere recognized the Oud Zwin as a canal between Bruges and Schapenburg, but also got tangled in the renaming and re-digging of the different tidal branches and canals. Nevertheless, based on its rectilinear dikes as well as on the different geomorphological zones it intersects, he was the first to argue that the Oud Zwin was an artificial canal. Whereas Jonckheere was mainly confining himself to a descriptive analysis of cartographical sources, De Smet successfully integrated historical cartography with written sources. Furthermore, he challenged Jonckheere’s hypothesis of the Oud Zwin being a human-made canal, and reasoned for it to be a natural waterway. The first to focus specifically on the Oud Zwin itself was De Langhe. He specifically considered the short section of this waterway, flowing northeast from the sluice at Schapenburg, following the successive embankments from the 13th-century onwards (see fig. 2f and 3f). At first he categorically argues that the longer and older part of the waterway, stretching between Bruges and Schapenburg, was a manmade canalisation of a tidal branch. However, the existence of this preceding natural creek is a hypothesis he is less convinced of in his more general overview of the Flemish coastal plain. Ameryckx resolutely stated that his soil cores affirmed the artificial origins of the Oud Zwin, however, he was unable to substantiate the argument with new data. Instead, he resorted to adopting Jonckheere’s arguments; that the canals have a rectilinear course and that they intersect multiple landscapes (fig. 3f and fig. 4f). Within the framework of the transgression and regression model, he dated the construction of the canal as subsequent to the construction of the dike belt. Consequently, its primary function would have been the drainage of the protected land. Verhulst at first concurred, but later adopted a middle course by considering the Oud Zwin as an artificial chain of natural creeks. Moreover, he dated canalisation prior to the construction of the dike belt and the alleged storm surge of 1134.

80. — Also Oude(e) Zwi(n) or Oude Zwijne Vaert
81. — Also Versche Vaart or Zoeve vaart. This canal was dug in different phases between 1557 and 1566 in order to replace the silted and un navigable remnant of the Zwin inlet (fig. 1h) (Ryckaert, Vandewalle 1982, p. 61-62.).
82. — Gilliodts-Van Severen, Gaillard 1871, p. 470.
84. — Just like the Verse Vaart, the hydronym Nieuw Gedelf was probably re-used for whenever a new canal was dug. In this case, we can identify it as the Verse Vaart. Further, it was also used to denominate a canal that bypassed Damme in the 14th century or the Konstal van Oostburg from the early 16th century (Ryckaert, Vandewalle 1982, p. 58-59.).
85. — This toponym is generally referred to as the place where the Oud Zwin discharged its water through a sluice in the dike belt. The sluice itself is sometimes referred to as Kwintenssluis. Beyond the dike belt, the discharged watercourse was named Reigaartsvliet. Whereas we will use Schapenburg to locate the end of the Oud Zwin, also Reigaartsvliet and Kwintenssluis can be found throughout literature to situate to same point.
86. — Jonckheere 1912, p. 18-25.
87. — De Smet 1933, p. 1027-1028.
89. — De Langhe 1935a, p. 121.
90. — De Langhe 1939, p. 110.
91. — Further reading on this particular discussion in De Smet 1933, p. 1033 and Ameryckx 1954a, p. 84.
92. — We use « dike belt » to denote a series of dikes that are often referred to as Evendijk (B). Adopting a certain terminology, however, includes in this case the adoption of a related morphogenesis. Since this morphogenesis is still a matter of discussion, we use general term « dike belt » to refer to the series of dikes, running from Heist over Schapenburg to Damme. However, different sections of this belt have different names. Between Heist and Schapenburg, we consider the Kalveketedij (1B). Between Schapenburg and Hoekse we consider the Bloetdloze of Brolozendijk (fig. 1C), between Hoekse and Monkereide we consider the Krinkeldijk (fig. 1D), and between the Verbrand Fort and Damme we consider the Rombootsvervedijk (fig. 1E). For the spatial reconstruction of the dikes, we’ve primarily used Verhulst 1995 and the Anon 2003.
Fig. 3. — Central part of the research area on the DEM Flanders. For legend details see figure 1.
Notwithstanding the disagreement concerning its date and function, the Oud Zwin was at that moment generally accepted to be a bipartite waterway. The first part stretched from Bruges, over Koolkerke and Eienbroeke to its sluice at Schapenburg. From here the second part was prolonged/left open in the subsequent embankments as far as the Graaffjansdijk. De Keyser challenged this interpretation by subdividing the first part of the Oud Zwin in a series of canalisations. He initially distinguished two subsections96 and concluded that five different phases of construction had occurred97. The argument that was decisive for his further discourse was the localisation of the Pylyserdam near Pereboom98, whereas De Smet and Ameryckx considered the Pylyserdam to be located near the sluice at Schapenburg99. De Keyser suggested that the initial course of the Oud Zwin turned east-southeast at Pereboom, after which it followed the course of the Municareda100 (fig. 1c and fig. 3c) that discharged into the Budansflit (infra)101. The part of the Oud Zwin between Pereboom and the dike belt would have been dug in two subsequent phases102. In a reply to these and other propositions put forward by De Keyser, Verhulst fiercely refuted his arguments and stated that a course running over Municareda-Budansflit was totally unfounded103. After this first intervention, Verhulst did not reply to De Keyser’s adapted hypotheses, nor did he touch upon it in his later articles104. Coornaert appreciated De Keyser’s idea of a phased construction and managed to phrase his argument more coherently105. Hillewaert supported De Keyser’s idea of a compartmentalized Oud Zwin too, and provided new evidence that supported parts of his thesis. Based on the soil map and oblique aerial photographs, Hillewaert argued that the Oud Zwin between Eienbroeke and Schapenbrug cuts a systematic pattern of reclaimed peat bog (see fig. 4). Consequently, the canal postdates these structures, which probably date to the second half of the 12th century106.

Ryckaert seemed to concur with Verhulst. Without discussing the issue in depth, he generally considered the Oud Zwin as a navigable drainage canal that stretched from Bruges to the dike belt107. However, in Landscape and Agriculture in Medieval Flanders108, Verhulst suddenly endorses the idea that the Oud Zwin initially discharged its water near Monnikerede, into a predecessor of the Zwin inlet109. Remarkably, he does not mention the Oud Zwin in his subsequent and last articles on the Zwin area110 and the coast111.

Historical-geographer Willy Wintein, relied on

96. — DE KEYSER 1960a; DE KEYSER 1960b.
98. — DE KEYSER 1960b, p. 11.
100. — Or Monnikerede, which could be translated as « waterway of the monks ».
102. — DE KEYSER 1962, p. 50-54.
103. — VERHULST 1962.
104. — VERHULST 1966.
105. — COORNAERT 1968.
108. — This was in fact a revision of VERHULST 1966.
110. — VERHULST 2000b. A second remarkable fact is that he often refers to Coornaert (1968), whereas he could and should refer to his own work.
111. — VERHULST 2000a.
Verhulst’s last insights to describe the course of the Oud Zwin but focused on the fact that the first step towards an north-eastern connection of Bruges with a tidal creek was to cut through a sandy ridge near Kooikerke. He dates the canalisation of the Oud Zwin to between 6th and 11th centuries. A view which was confirmed by Hillewaert.

3.2. Krinkeldijk-Romboutswervedijk

The Krinkeldijk and Romboutswervedijk are two dike segments that once bordered the left bank of the Zwin inlet (fig. 1D-E and fig. 3D-E). Initial authors paid little attention to the different dike segments or their chronologies, and considered them as a continuous and simultaneously built dike belt, protecting Bruges’ northeastern foreshore. As a consequence, the dike segment between Damme and Hoeke was only discussed when it was integrated within the relative chronology of the Dunkerque Transgression Model. Ameryckx argued that the complete dike belt was built in reaction to the IIIA-transgression (10th century), in the relative calm regressive period before transgression IIIB (11th-12th century). His soil samples proved that presumed IIIB-deposits stopped at the seaward side of this dike belt. In the 1958 colloquium, historians tried to put a more exact date on the transgressions and started to relate the dikes and sediment deposition with historical sources. Although Ameryckx’s argumentation remained the same, the construction of the dike complex was now correlated with the start of, and therefore built in reaction to, transgression IIIB, which was now dated at 1100.

One year later, Verhulst tried to deliver a new synthesis and substantiated the debate with more historical data. He introduced several new ideas regarding the different parts of the dike belt. Firstly, he argued that the dike segment between Heist and Hoeke, which might have had some fragmentary predecessors, was most likely enclosed immediately at the offset of the IIIB-transgression. In the perpendicular turn at Hoeke he finds evidence to postulate that the segment between Hoeke and Damme was only erected after the more powerful IIIB-transgression had broken through. His second argument revolves around the meandering course, and name, of this dike segment (fig. 5).

De Keyser argued that the dike between Hoeke and Damme was already erected at the time the IIIB-floods began. Drawing upon the process of relief inversion that made land between Hoeke, Damme and Dudzele settle, he argues that the land was all the more vulnerable to flooding. Moreover, he assumed that the large tidal creek in the direction of Damme had a predecessor in the aforementioned Budans slit. This argument could be used to explain the winding course of the Krinkel- and Romboutswervedijk, and agreed with his deviating hypothesis of the Oud Zwin. Pannier adopted De Keyser’s view in her licentiaat (Master’s) dissertation, which was supervised by Verhulst and Ameryckx. Moreover, she added that in the absence of the preceding Budans slit, the dike builders would not have turned at Hoeke, but would just as well have continued heading southeast towards higher ground such as De Hoorn (fig. 1). Parallel with the discussion on the Oud Zwin, Verhulst in 1995 reluctantly agreed that the Krinkel- and Romboutswervedijk bordered a small tidal inlet which preceded the 1134 enlargement. In the same paragraph however, he inconsistently holds on to a course of the Brolozendijk that in 1100 stopped near Hoeke. Verhulst only curiously touches upon this topic in his subsequent articles. Wintein again supported De Keyser and proposed the presence of a continuous ringdike reaching further southwest than Damme that was raised before 1100. Later, Wintein made a sudden reversal by suggesting the dike segment coming from Westkapelle did not turn southwest near Hoeke, but continued its path further east-northeast. The storm surge of 1134 subsequently made the dike burst and created the inlet towards Damme, whereupon the Krinkel- and Romboutswervedijk were erected. The reason why and the sources upon which he relied to make this U-turn are not clear, since such a hypothesis...
was not previously suggested. Finally, Hillewaert proposed a compromise between both Verhulst and De Keyser, in which small local dikes were united to form a continuous defensive dike that protected the hinterland. The remaining tidal channels were later boarded with lengthy dikes. The example given for this second phase comprises the Krinkel- and Romboutswervedijk that possibly boarded the Budansflit, which is once more suggested as the possible predecessor of the Zwin inlet126.

4. CONCLUSIONS

Over nearly 150 years the processes and actors involved in the creation, commercial heyday and silting of the Zwin region have been extensively discussed in what we denote as the Zwin debate. The multiple perspectives offered by a variety of trained amateurs and scholars have been at times conflicting. Since 1871, the mind-sets, methodologies and approaches applied to the Zwin region have dramatically changed, and the availability of new kinds of data has had significant impact on the outcomes of research. Based on these parameters, we have distinguished four trends in the Zwin debate.

In the first phase (1871-1945), the research was based on historical and geological data. As information on the earliest phases of the inlet was non-existent, research primarily focused on the later stages of silting. The overall assumption was that there was a large inlet that gradually silted up due to natural processes. The second phase (1945-1978), saw the rapprochement between scholars of different scholarly domains, who met at two influential colloquia. The post-war recording of the Belgian soil map brought new insights concerning the evolution of the coastal plain and intensified the Zwin debate. The alternation of transgressions and regressions was seen as the driving force of geomorphological processes until the irregular pattern of storm surges was attributed more importance. Only since the third phase

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126. — HILLEWAERT 2011, p. 115.
(1978-2010), was human agency recognized in the geomorphology of the Zwin. The Dunkerque model was slowly replaced by a new paradigm based on the integration of new pedological and archaeological data. Since 2010 intensified research interest can be observed in the broader North Sea area and the Belgian coastal plain.

To demonstrate how these trends in research dealt with specific landscape components, we discussed two linear features that stretch through the Zwin area: the Oud Zwin and the Krinkeldijk. This detailed study of both the Oud Zwin and the Krinkeldijk has shown that research in the Zwin area is outdated and has not kept up with trends in the surrounding regions. For both features, the debate has become preoccupied with reinterpreting the same limited set of historical maps, texts and pedological data. Although the outdated geomorphological framework in which these topographical features are interpreted has been disregarded, received notions of these features, and by extension the broader eastern Belgian coastal plain, still persist. This is problematic as the landscape is being primarily interpreted through the same limited set of historical sources rather than taking advantage of potential new data sources.

Landscape-archaeological research has recently demonstrated the potential gain from non-invasive prospection techniques. Although available for many years, traditional remote sensing techniques, such as the analysis of oblique, orthogonal and historical aerial photographs or LiDAR-data, has been so far underused. The added value of these techniques is particularly to be found in macro-scale analysis, providing insight into the overall landscape geomorphology (fig. 3 and fig. 4). The application of techniques such as geophysical survey, DGPS-mapped fieldwalking and UAV-mounted-3D-photogrammetry, can deliver new and highly detailed datasets, which when incorporated within a site-based strategy can provide high-definition images on a micro-scale. The interdisciplinary integration and confrontation of traditional and new techniques will deliver much-needed multi-scaled datasets, resulting in a better understanding of the evolution of the Zwin area.

Keywords: Geomorphology, Archaeological Prospection, Bruges, Medieval Port, Zwin, Coastal landscape.

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