

Connectivity in the Scheldt Basin: The role of the river Scheldt in the Roman-era transport network¹

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Abstract: Historical-archaeological research has argued that waterways were the most efficient means of transporting goods. Nevertheless, little systematic research has been done on the use of waterways in northern Gaul. This study assesses the potential of the river Scheldt as a transport corridor. It starts with a general characterisation of the river basin and a reconstruction of the Roman-era transport network, arguing that the necessary investments in fluvial transport were made. Both the settlement pattern, the level of economic activity, and the epigraphical evidence displays a peak in riverine and maritime trade during the second and the beginning of the third century. The results of the GIS-based cost-distance and accessibility analysis reveal a well-connected region, strategically situated between northern France, the North Sea coast, and the Rhine frontier. Although seasonal rivers were essential in minimizing transport costs, the accessibility of sites primarily depended on access to the road network.

Introduction

Archaeological sources make it impossible to deny that rivers served as transport corridors in the past. However, the organisation and requirements for fluvial trade remain a complex subject. In the last decades, there has been a growing interest in transport routes, even more so since the wide-spread application of GIS-technologies.²

The role of inland waterways in the Roman transport economy of northern Gaul has received little scholarly attention. As a result, this paper studies the transport network of the Roman-era Scheldt basin,³

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2 See i.a.: de Bruin (2012); Carreras / de Soto (2013); Schäfer (2016); Verhagen et al. (2019).

3 In order to study the supra-regional role of the river Scheldt, the initial study area was expanded to include parts of the Meuse, Yser, Aa, and Somme basin.

with a focus on waterways. As a starting point, it works from the hypothesis of an integrated transport network, in which rivers, roads, and seaways link up to form a single system.⁴

This paper starts with a general description of the natural environment, which largely determines both the nature and extent of economic activities in a pre-industrial environment. Next, it integrates epigraphical evidence found around the mouth of the Scheldt, which indicates the existence of an extensive trade network at the end of the second and beginning of the third century.⁵ Additionally, we represent a reconstruction of the transport network of the Scheldt basin, containing roads, navigable river sections, relevant sites, and fluvial infrastructure. The last two are essential, since waterways, much like roads, required both maintenance and infrastructure to serve as efficient transport routes.

The concept of ‘connectivity,’ introduced by Horden and Purcell, has been put forward as one of the factors contributing to the performance of the Roman economy.⁶ This paper aims to apply this concept to the study of the transport network of the Scheldt basin by performing two types of spatial network analysis: cost-distance and accessibility.⁷ The value of these results are measured by discussing the distributional pattern of several archaeological proxies (e.g., limestone building blocks, local and imported pottery, and grain). By identifying general patterns of connectivity, this paper hopes to provide a useful jumping-off point for further research.

The physical environment

The headwaters of the Scheldt are situated in northern France, near Gouy-Le-Catêlet.⁸ From here the river flows 360 km north to end up in the North Sea in Zeeland (south-western Netherlands), receiving, among others, the Scarpe, Haine, Lys, and Rupel along the way.⁹ During its meandering journey, the Scheldt crosses several distinct landscapes (fig. 1): the fertile loamy soils in northern France and central Belgium (i.e., the loess area), the limestone massifs around Tournai, the less-fertile Pleistocene sandy soils of Flanders, and the peat landscape of the coastal areas.¹⁰

4 For the application of the idea of an integrated transport network: Laurence (1999); Horden / Purcell (2000); Laurence (2005); Adams (2007); Carreras / de Soto (2013); de Soto (2019). Within this paper, the term ‘system’ is used to describe the physical transport structures and not a set of ideas or rules. It is interchangeable with the term ‘network’. Not to be mistaken with the wider ‘system’ definition introduced by Flannery: “[...] which encompasses both cultural and non-cultural phenomena [...]” (Flannery [1967], p. 120).

5 All centuries mentioned in this paper are CE (Common Era/After Christ/Anno Domini).

6 Horden / Purcell (2000); Howgego (2009), p. 289; Horden and Purcell define ‘connectivity (of microregions)’ as: “[...] the various ways in which microregions cohere, both internally and also one with another – in aggregates that may range in size from small clusters to something approaching the entire Mediterranean.” (Horden / Purcell [2000], p. 123).

7 Cost distance analysis measures the cost of transporting 1000 kg of goods over 1 km (expressed in wheat), from one point to the rest of the network. Accessibility analysis displays the centrality value of every node in a weighted network. See: Carreras / de Soto (2013); de Soto (2019).

8 Sevrin (1990), p. 52; Suttor (2011), p. 852; Meire et al. (2015), p. 32.

9 Sevrin (1990); Antrop / Leroy (2001), p. 52; Meire et al. (2015), p. 35–37; Gelaude (2018), p. 251. Depending on the publication, the length of the river Scheldt is either 350, 355, or 360 km.

10 Sevrin (1990); Antrop / Leroy (2001), p. 53; De Clercq / van Dierendonck (2009), p. 35–39.

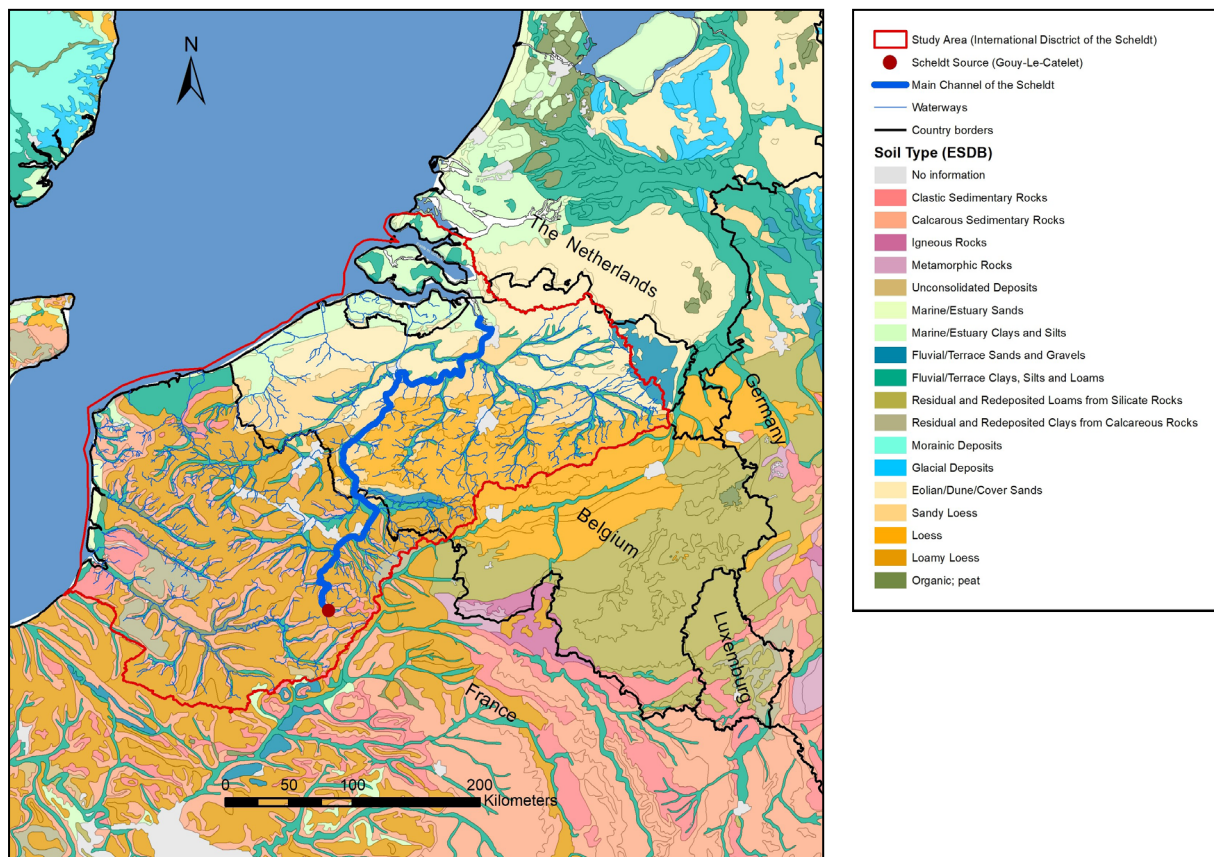


Fig. 1: Map showing the study area (which coincides with the 'International district of the Scheldt'), the present-day waterways, the main channel of the Scheldt and the soil association map (European Soil Association Map, derived from ESDB v2.0: The European Soil Database distribution version 2.0, European Commission and the European Soil Bureau Network, CD-ROM, created for the 'Civitas Tungrorum Project' by the Department of Archaeology, Ghent University – Van Thienen et al. 2019.). The Southern part of the study area (Northern France and Wallonia, Belgium) is characterised by fertile loess soil, while the northern part (present-day Flanders, Belgium) is covered by less-fertile sand or sandy loess. The areas around the North Sea coast and the Scheldt Estuary predominantly show clay and silt of either fluvial or marine origin.

In the Roman period, the currently cut-off Eastern Scheldt served as the river's mouth (fig. 2). This situation is different from the current one, in which the southern 'Western Scheldt' connects the river to the North Sea. In the first century, the Western Scheldt was a modest tidal inlet (possibly reaching as far as present-day Terneuzen).¹¹ Furthermore, the Roman-era coastline was situated several kilometres to the west in comparison to its present-day position.¹² From the third century onwards, the coastal areas of Northern France, Belgium, and Zeeland were subject to flooding as the late Roman period saw a general rise in sea levels.¹³

11 Vos / van Heeringen (1997), p. 50–79; De Clercq (2009), p. 139–72; De Clercq / van Dierendonck (2009), p. 36; Vos (2015), p. 82–94; For the historical development of the Western Scheldt see Vos (2015), p. 88–89.

12 De Clercq (2009), p. 150.

13 Vos / van Heeringen (1997), p. 34, 64–68; De Clercq / van Dierendonck (2009), p. 36–37, 66–67; Vos (2015), p. 65–66, and 75–76.

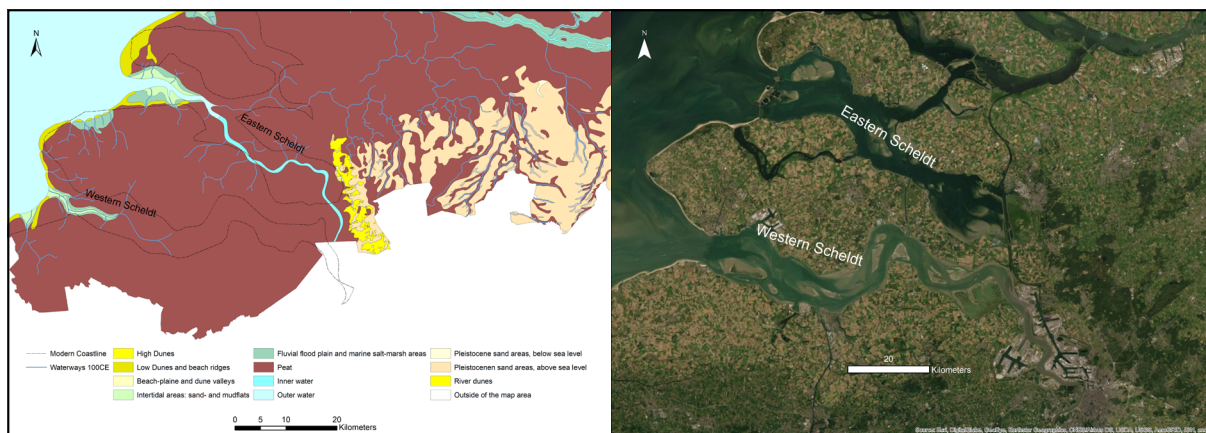


Fig. 2: (Left) The Scheldt estuary around 100 CE, showing the Eastern Scheldt and the predecessor of the Western Scheldt within the peat landscape. Based on: Vos, P., M. van der Meulen, H. Weerts and J. Bazelmans 2020: *Atlas of the Holocene Netherlands, landscape and habitation since the last ice age*, Amsterdam (Amsterdam University Press). **(Right)** The present-day estuary of the Scheldt with the peninsula 'Walcheren' (south-western Netherlands) between the Western Scheldt (at present a busy shipping route for the ports of Antwerp and North Sea Port) in the south and the Eastern Scheldt (presently a marine reserve) in the north.

Compared to other West European rivers, such as the Seine or Rhine, the Scheldt is a modest river. The Scheldt and its tributaries are rain-fed rivers, whose flow rate mainly depends on rainfall. The flow rate of the Upper Scheldt (from its source to Ghent) averages 70 m³/s but fluctuates between 5 and 140 m³/s. The flow rate of the Lys, the main tributary of the Scheldt, is even more varied (between 1 and 200 m³/s). These seasonal fluctuations, with periods of low and high water, impose limitations on riverine transportation.¹⁴ The remains of several Roman-era transport vessels at Pommeroeul indicate that they were constructed following these specific hydrological conditions (e.g., low draught, propulsion by i.a. poling, and fixed width-length ratio).¹⁵ The second- or third century barge of Pommeroeul is of a similar date and type to those found along the Rhine limes (i.e., the barges of De Meern,¹⁶ Woerden,¹⁷ and Zwammerdam¹⁸), but its dimensions (3 m by 18/20 m) place it in the smaller category.

14 Gelaude (2018), p. 42 and 251.

15 Suttor (2011), p. 851, 858–64, and 867. The remains of three vessels were found: two of which have been reconstructed and are now located in the 'Espace Gallo-Romain' (Ath, Belgium). The largest ship, the flat-bottomed barge, is 3 m in width, 18–20 m in length, and has a board height of 67 cm. The wood used in its construction was most likely felled between 197 and 217 CE (de Boe [1980]; de Boe [1978], p. 24–26; Thiébaux [2011], p. 229–31; Suttor [2011]). This relatively low board height indicates the low draught of the ship. The maximum capacity of the ship (analogues to De Meern 1 ship, *infra*), is considered to be between 1 and 14 ton (Jansma / Morel [2007], p. 155–56); a maximum capacity of 30 t, proposed by Suttor (2011), p. 859 seems exaggerated.

16 De Groot / Morel (2007); Jansma / Morel (2007); Aarts et al. (2012).

17 Haalebos et al. (1996).

18 Hazenberg / van der Heijden (2016).

The Transport Network

The Roman-era transport network consists of three modes: 1) sea transport, 2) riverine transport, and 3) land-based transport (i.e., animal-drawn cart). The transport network has been reconstructed based on existing and archaeological features. The characteristics of these modes and the issues concerning their reconstruction will briefly be outlined below.

First, the Roman-era coastline and the location of the North Sea were taken from the Barrington Atlas and adjusted based on archaeological and paleogeographical studies.¹⁹ Unfortunately, there exists a lack of the latter for the (southern) Belgian and French areas, making it impossible to assess the extent of the late-Roman inundations. Second, various human interventions (dam construction, dredging, and rectification of meanders) starting as early as the tenth century, have made it difficult to precisely reconstruct the flow pattern of the Scheldt during the Roman period.²⁰ Nonetheless, present-day riverine characteristics were taken to represent past waterways.²¹ Based on archaeological, cartographical, and historical data, potentially navigable river sections were selected.²² Third, the Roman road network, like the coastline, is derived from the Barrington Atlas. However, the exact location and course of several sections, most notably in the north of the study area (present-day Flanders, Belgium) are not well documented.²³ Therefore, the existing dataset was adjusted based on archaeological data and site locations, which have a higher degree of certainty.²⁴ The primary sections of the road network were constructed between 20 and 10 BCE and complemented in the second quarter of the first century. The most crucial section in the study area connects Boulogne-Sur-Mer to Cologne, via the capitals at Théroutanne, Arras, Cambrai, Bavay, and Tongeren.²⁵

Settlement Pattern

Besides physical corridors, settlements played an essential role in the transportation of goods, offering a variety of services (resting point, transshipment, and military protection) as well as being (intermediary) markets. The study area displays three general phases: early-, middle-, and late Roman.²⁶

19 Vos / van Heeringen (1997); De Clercq / van Dierendonck (2009), p. 34–40, 66–67; De Clercq (2009), p. 145–147; Vos (2015). The original shapefile come from the Ancient World Mapping Center (from now on called AWMC) (CC BY-NC 3.0 license) (http://awmc.unc.edu/awmc/map_data/shapefiles/physical_data/coastline/- Last modified 03-02-2014).

20 Sevrin (1990), p. 21, 43–44, and 46; Suttor (2011), p. 851–853; Personal correspondence Dr. Frank Gelaude.

21 Suttor states that the general characteristics of the Scheldt have not changed substantially (Suttor [2011], p. 851).

22 Shapefiles derived from European Environment Agency (EEA). © European environment agency (EEA), Copenhagen, 2012. Prod-ID: DAT-120-en Created 13 Jun 2012 - Published 13 Jun 2012 - Last modified 26 Apr 2018 (<https://www.eea.europa.eu/data-and-maps/data/european-catchments-and-rivers-network#tab-european-data>).

23 Shapefiles from AWMC (CC BY-NC 3.0 license) (http://awmc.unc.edu/awmc/map_data/shapefiles/ba_roads/- Last modified 02-06-2016). North-western part improved by Drs. Gerben Verbrugghe (Ghent University – Department of Archaeology). See Verbrugghe, et al. (2017).

24 The result is by no means a detailed reconstruction of the Roman-era road network but simply one that more closely resembles the past transport network.

25 Brulet (2008), p. 64–68.

26 The precise end- and start dates of this temporal classification is the subject of discussion. This paper adopts the following distinction: early Roman period (50 BCE–68/69 CE), middle Roman period (68/69 CE–286 CE), and late Roman period (286 CE–406 CE), in accordance with the chronological classification of De Clercq (2009).

The early Roman period sees the installation of capital settlements (*capita civitatum*): centres of the newly-formed administrative units (*civitates*),²⁷ but the settlement pattern reaches its peak during the middle Roman period. At this time, we see the installation of (semi-)permanent military structures, most likely to secure economic and political interests.²⁸ The most important of these was *Gesoriacum* (Boulogne-sur-Mer), which served as the seat of the *Classis Britannica*.²⁹ From the second half of the second century onward, two coastal *castella* protected the Scheldt estuary, one in Oostkapelle-Oranjeston and one near Walcheren-Roompot. Nonetheless, the region suffered from raids of northern bands such as the *Chauci*, who attacked the coastal regions of the Netherlands and Belgium between 172 and 174 CE, resulting in the installation of a coastal defence system at Aardenburg around 175 CE and later in Oudenburg.³⁰

The late Roman period shows a significant decrease in the number of sites, especially in the northern part of the study area. Moreover, the remaining civilian settlements grow smaller and show signs of fortification, as well as specialisation. This pattern is most visible along the above-mentioned road between Bavay and Cologne.³¹ These developments can be explained by, inter alia, the insurrection of both Postumus (260–280 CE) and Carausius (286–293 CE), and the Germanic incursions starting in the late third century, combined with a general deterioration of the political and economic structure.³² However, the end of the third century also signifies an administrative re-organization in which both provinces and *civitates* are reformed, and several *capita civitatum* relocate to the south; for instance, *Turnacum* (Tournai) replaces *Castellum Menapiorum* (Cassel) as the capital settlement of the north-western civitas in *Belgica Prima*.³³

The military infrastructure also goes through significant changes. The coastal *castella* around the mouth of the Scheldt disappear in the third century, although precise dating is not possible.³⁴ The *castellum* in Aardenburg is destroyed around 275 and is not rebuilt.³⁵ Boulogne-Sur-Mer no longer serves as the seat of the *Classis Britannica* but maintains a military role alongside several smaller coastal fortlets.³⁶ The remaining shore forts possibly acted as secure transshipment points, besides offering defence against barbarian piracy.³⁷ Around 325 CE the *castellum* at Oudenburg is reoccupied and re-fortified.³⁸

Despite having a large number of well-connected rivers and streams,³⁹ the study area displays a modest investment in riverine infrastructure (compared to the Rhine- or Rhône basin). Except for Boulogne-Sur-Mer, no major early-Roman ports exist. In the second century, riverine and coastal ports emerge *ex novo* or in the vicinity of pre-existing settlements (fig. 3): *Turnacum* (Tournai), Pommeroeul, and most likely also at *Ganuenta* (Colijnsplaat) and Domburg. Several sites suggest riverine activity (e.g., Kortrijk, Kerkhove, and Rumst), while others have evidence of modest riverine activity (e.g., Brussels

27 Brulet (2008), p. 81–110; De Clercq (2009), p. 173–96; Coquelet (2011), p. 12–13.

28 De Clercq / van Dierendonck (2009), p. 61–63.

29 Dhaeze (2011), p. 313–324.

30 De Clercq / van Dierendonck (2009), 62–64; Dhaeze (2009), p. 1231–1237.

31 Brulet (2008), p. 233–47.

32 Wightman (1985), p. 206–11; Brulet (2008), p. 229–36; De Clercq / van Dierendonck (2009), p. 64; Dhaeze (2009), p. 1238–1239.

33 Delmaire (2004); Brulet (2008), p. 53–54.

34 Dhaeze (2011), p. 285–86; De Clercq / van Dierendonck (2009), p. 62–63.

35 De Clercq (2009), p. 391–92; De Clercq / van Dierendonck (2009), p. 63; Dhaeze (2011), p. 209–212.

36 Vanhoutte (2007); De Clercq / van Dierendonck (2009), p. 66–67; Dhaeze (2011), p. 299–308

37 Morris (2010), p. 136–37.

38 De Clercq / van Dierendonck (2009), p. 66–67; Dhaeze (2011), p. 209–211, and 299–308.

39 Strab. geogr. 4,1,2.

and Ramegnies-Chin). During the late-Roman period, several of these riverine sites are abandoned. Only Tournai, Kortrijk, Boulogne-sur-Mer, and Etaples exhibit sufficient evidence of occupation (and riverine activity) throughout the late third and fourth century.

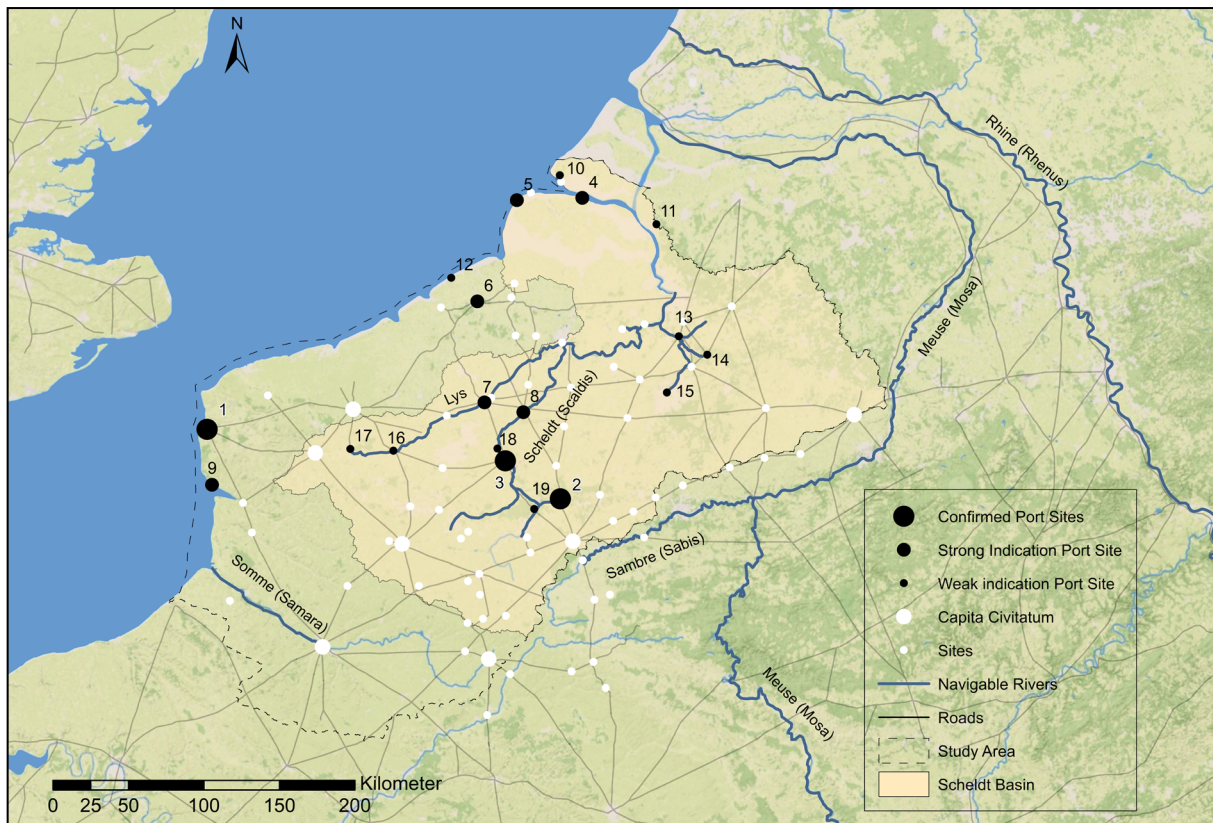


Fig. 3: The transport network in the middle Roman period showing navigable rivers, roads, and relevant sites in the study area. Archaeologically confirmed ports: 1) Boulogne-Sur-Mer, 2) Pommeroeul, and 3) Tournai. Sites with very strong indications of either a port or a harbour : 4) Colijnsplaat and 5) Domburg. Sites with strong indications of riverine transport infrastructure: 6) Bruges, 7) Kortrijk, 8) Kerkhove, 9) Etaples. Sites with either weak evidence of riverine transport infrastructure or evidence of a minor installation (i.e., quay): 10) Westenschouwen, 11) Bergen op Zoom, 12) Wenduine, 13) Rumst, 14) Rijmenam, 15) Brussels, 16) Estaires (La Gorgue), 17) Thiennes, 18) Ramegnies-Chin, 19) Escautpont.

Traders and Transporters

The Roman presence in Northern Gaul gave rise to a Gallo-Roman elite, who – by analogy with the *Civitas Treverorum* (Trier) or *Lugdunum* (Lyon) – was likely involved in (riverine) trade; although very little is known about their specific economic interests.⁴⁰ Furthermore, there is no evidence that indicates the existence of *collegia* (professional guild-like organisations) in the study area, despite these being a common feature in other areas of Gaul (e.g., around *Lugdunum*).⁴¹

40 Wightman (1985), p. 162; Schlippschuh (1987), p. 92, 161–63; Bérard (1999), p. 122–23; Dondin-Payre (1999), p. 206; Schmidts (2011), p. 46.

41 Verboven (2018), p. 233–234.

Hundreds of inscribed votive altar stones, dedicated to the goddess Nehalennia, have been found in the Scheldt estuary, specifically around Domburg and Colijnsplaat.⁴² The context of these stone monuments is unclear. They were most likely located around temples dedicated to the goddess Nehalennia, the patron of shippers,⁴³ at both Domburg and Colijnsplaat. The latter, which likely bore the name *Ganuenta*, was probably a port facility (or harbour) and trade centre connecting northern Gaul with Britain and the Rhine.⁴⁴ The stone monuments have been attributed to the last decades of the second century, extending into the first decades of the third century.⁴⁵ This is around the same time that the harbours at Goederee and Naaldwijk, between the mouths of the Meuse and Rhine, flourish.⁴⁶

Several dedicants, of whom we know the name, mention their origin, allowing us to produce an image of the trade network centred around *Ganuenta* (fig. 4).⁴⁷ Most of them came from the *Gallia Belgica* and *Germania Inferior*, more specifically: *Municipium Batavorum* (possibly one),⁴⁸ *Durnomagus* (one),⁴⁹ *Colonia Claudia Ara Agrippinensium* (four to eight),⁵⁰ *Civitas Treverorum* (four),⁵¹ *Civitas Tungrorum* (possibly seventeen),⁵² *Civitas Veliocassorum* (one),⁵³ *Civitas Sequanorum* (one),⁵⁴ *Civitas Rauracorum* (one).⁵⁵ Several dedicants also mention where (or with whom) they were conducting trade: one traded salt for Cologne (*negotiator salarius Coloniae Claudiae Arae Agrippinensium*),⁵⁶ four were active in Britain (*negotiatores Britannici*),⁵⁷ and one moved between Boulogne-Sur-Mer and Kent (*negotiator Cantianus et Geserecanus*).⁵⁸

The profession of several dedicants is also cited: on top of the above-mentioned *negotiatores britannici*, there are two who simply call themselves *negotiator*,⁵⁹ three specify trading in fish sauce (*negotiator allecarius*);⁶⁰ four in salt (*negotiator salarius*);⁶¹ and two possibly in wine.⁶² Not all of them

42 Stuart / Bogaers (2001); Stuart 2013.

43 Stuart / Bogaers (2001), p. 209.

44 Bogaers (1971); Vos / van Heeringen (1997), p. 65–65; Stuart / Bogaers (2001) B50; De Clercq / van Dierendonck 2009, p. 56; de Bruin (2012), p. 145; Verboven (2018), p. 230.

45 Stuart / Bogaers 2001, p. 40–41; Four monuments contain consular dates: 188 CE (A54), 193 CE (A33), 223 (A5), 227 (B37).

46 De Bruin (2012), p. 151–53.

47 Verboven (2018), p. 229–34.

48 Stuart / Bogaers (2001) B37 = B63 = C6 = C17.

49 Stuart / Bogaers 2001, B30.

50 Certainly from Cologne: Stuart / Bogaers (2001) A26 and A49; explicitly stating Cologne as residence: A1 and A54; most likely from Cologne: A3 (= Hondius-Crone [1955] 23 = 7) A5, and A7; most likely identical to inscriptions found in Cologne: A11 and B94. Possibly from Cologne family Hondius-Crone (1955) 4 = Stuart (2013) 21. See: Stuart / Bogaers (2001), p. 32–33, and 214; Stuart (2013), p. 78–80; and Verboven (2018), p. 231.

51 Stuart / Bogaers (2001) A1, B44, and B45.

52 Stuart / Bogaers (2001) B47, 48, 50, 51, 79–84, 106–11, and potentially B49.

53 Stuart / Bogaers (2001) A6.

54 Stuart / Bogaers (2001) A57.

55 Stuart / Bogaers (2001) A41.

56 Stuart / Bogaers (2001) A1; Verboven (2018), p. 231.

57 Stuart / Bogaers (2001) A3, A6, A11 = A37, and B10.

58 Stuart / Bogaers (2001) A9.

59 Stuart / Bogaers (2001) A53 and B14.

60 Stuart / Bogaers (2001) A34, A39, and B44.

61 Stuart / Bogaers (2001) A1, A26, A49, and B1.

62 Stuart / Bogaers (2001) A8 and A41.

are traders: one is a ‘representative’ (*agens rem adiutor*);⁶³ another is shipper (*nauta*);⁶⁴ and even a ship’s captain (*actor navis*) is mentioned.⁶⁵ Then there is Mercatorius Amibilis who dedicates a monument to his ships (*pro navibus*).⁶⁶ Some ask the goddess for ‘good enterprises’ (*ob meliores actus*),⁶⁷ while others ask her to keep their wares safe (*pro mercibus bene conservandis*)⁶⁸ or thank her for already having done so (*ob merces bene/recte conservatas*).⁶⁹

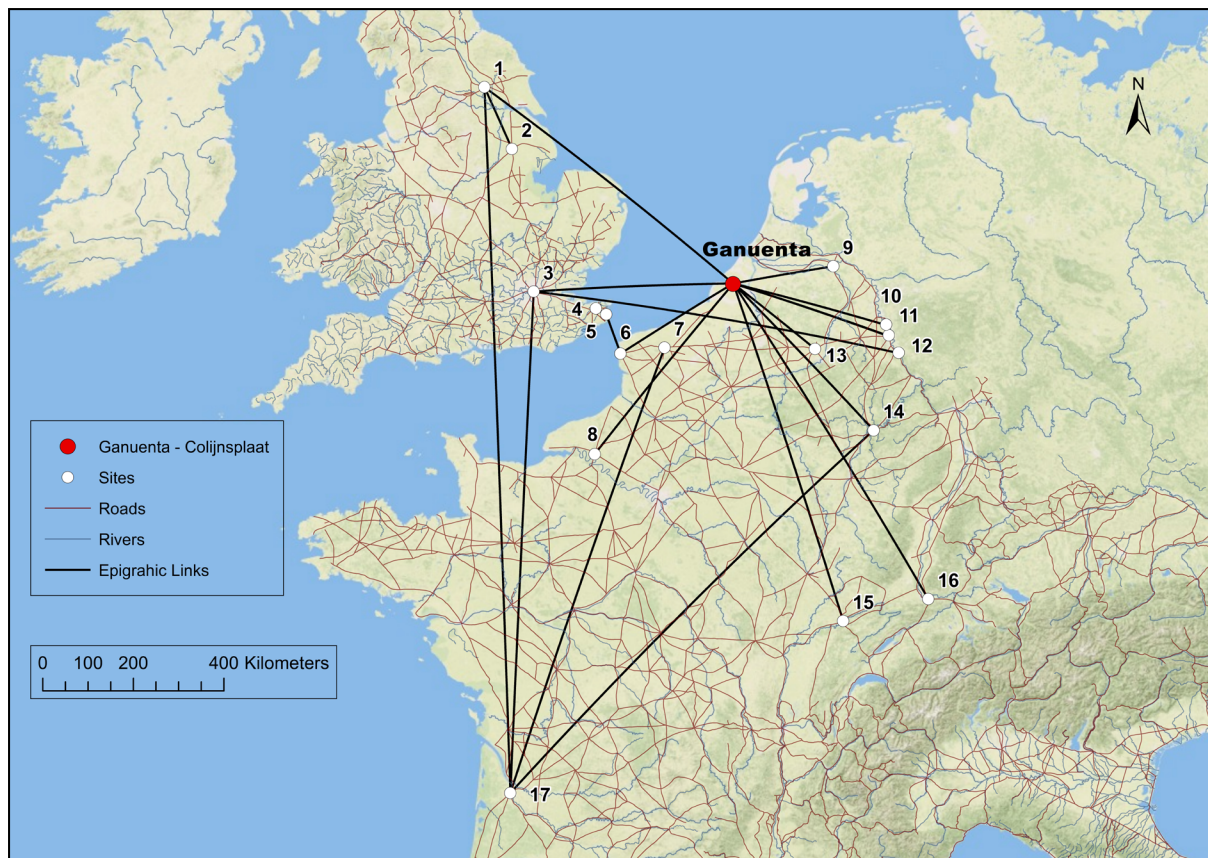


Fig. 4: Reconstruction of the network centred around Ganuenta, based on epigraphic evidence. Sites: 1) Eburacum (York), 2) Lindum (Lincoln), 3) Londinum (London), 4) Durovernum Cantiacorum (Kent), 5) Portus Dubris (Dover), 6) Gesoriacum (Boulogne-Sur-Mer), 7) Castellum Menapiorum (Cassel), 8) Rotomagus (Rouen), 9) Municipium Batavorum (Nijmegen), 10) Durnomagus (Dormagen), 11) Colonia Claudia Ara Agrippinensium (Cologne), 12) Bonna (Bonn), 13) Atuatuca Tungrorum (Tongeren), 14) Augusta Treverorum (Trier), 15) Vesontio (Besançon), 16) Augusta Rauracorum (Augst), 17) Burdigala (Bordeaux).⁷⁰

63 Stuart / Bogaers (2001) A29.

64 Stuart / Bogaers (2001) A57.

65 Stuart / Bogaers (2001) B38.

66 Stuart / Bogaers (2001) B2 and B4.

67 CIL XII, 8782; Verboven (2018), p. 233.

68 Stuart / Bogaers (2001) A62 and B3.

69 Stuart / Bogaers (2001) A3, A9, A42, B10, and B37.

70 The connection Eburacum – Ganuenta is presumed on the basis of Viducius Placidus, who is attested in both sites (Stuart / Bogaers [2001], A6; RIB 3, 3195); Also see M. Aurelius Lunaribus, Sevir Augustalis of Eboracum (York) and Lindum (Lincoln) and possible negotiator (AE 1922, 116); Bordeaux is connected with Britannia and Trier through L. Solimarius Secundinus, civis Treverus negotiator Britannicianus around 151–220 CE (CIL XIII, 634; ILA, Bordeaux 209; Krier[1981], p. 23–25); The Civitas Menapiorum is connected through Pompeia Menapia ca. 201–250 (CIL XIII, 624; ILA, Bordeaux 210).

The *Ganuenta* trade network connected northern Gaul with *Britannia* via the North Sea and accommodated the distribution of goods along the coast, both in a northern direction (to the mouths of the Meuse and Rhine) and in a southern direction (towards Boulogne-Sur-Mer or further inland). It extended between Besançon (eastern France) in the south and York (northern England) in the north, with Bordeaux as a southern extremity. The network most likely linked up to that of *Augusta Treverorum* (Trier) in the east. Trier, on the bank of the Moselle (the largest tributary of the Rhine), was not only the capital of the province *Gallia Belgica* but also served as a major centre of trade with an own trading elite.⁷¹

Spatial Network Analysis

This study has presented the physical environment, as well as the transport- and socio-economic network. It now turns to the study of connectivity.⁷² According to de Soto ‘connectivity’ and ‘accessibility’ can be seen as overlapping terms,⁷³ yet this study distinguishes between (general) ‘connectivity’ and ‘accessibility’ (i.e., the result of accessibility analysis). In order to study connectivity, two types of GIS-based spatial network analyses have been performed: cost-distance and accessibility analysis.⁷⁴ The former visualises the cost of transporting 1000 kg over 1 km (expressed in wheat) from one point to the rest of a predetermined multi-modal network.⁷⁵ The latter visualizes the accessibility of an entire region, by calculating the value of every junction (i.e., intersection) based on the cumulative value of the incoming edges (the sea, a road, or a waterway).⁷⁶ Behind these analyses lies the hypothesis that points with a higher degree of accessibility (or lower transport costs) display a higher amount of (transported) goods.⁷⁷ Both cost distance and accessibility analysis are based on set ratios between the different means of transport (table 1), following the methodology constructed by de Soto.⁷⁸ Sea transport is by far the most efficient (in terms of volume, speed, and cost), followed by downstream river transport, upstream river transport, and finally land-based transport. Cost distance analysis attributes transport costs (column 3) as a cumulative value per distance unit (km), while accessibility analysis utilises a constant edge value (column 4) per section. It is important to note that these (cost) values are not to be taken literally, since they may vary significantly depending on the local conditions (terrain, weather, relief), the transported goods, and the wider economic context (risk, supply vs. demand, etc.). Both accessibility and cost distance analysis merely demonstrate the potential of the transport network.⁷⁹

71 Wightman (1985), p. 56–58, 62, 150–53, 156–57, 162, 192; Krier (1981), p. 174–88; France (2004), p. 157–68; Verboven (2018), p. 231–232.

72 De Soto describes connectivity as: “[...] the capacity of the different urban settlements to allow the circulation of people and goods.” (de Soto [2019], p. 277). This definition is different from that of Horden and Purcell (2000), and focusses more on the role of settlements instead of the connection between (micro) regions.

73 De Soto (2019), p. 277.

74 De Soto 2010; Carreras / de Soto (2013); de Soto / Carreras (2014); Carreras et al. (2019); de Soto (2019); Overview of the application of network analysis in archaeology: Brughmans (2010); Computer-based analysis and reconstruction of transport routes: Verhagen et al. (2019), p. 217–329.

75 Mees (2011); Carreras / de Soto (2013), p. 120; Franconi / Green (2019); de Soto (2019), p. 280–82.

76 De Soto (2013); Herzog (2013); de Soto (2019).

77 Carreras / de Soto (2013), p. 120; Franconi / Green (2019), p. 70.

78 De Soto (2010); Carreras / de Soto (2013); de Soto / Carreras (2014); Carreras et al (2019); de Soto (2019).

79 Carreras / de Soto (2010); de Soto (2010a); de Soto (2010b); Carreras / de Soto (2013), p. 120; de Soto (2019), p. 276–83.

Transport mode	Ratio	Transport cost	Edge value
Sea	1	0,097 kg ton/km	4
Riverine transport (downstream)	3,1	0,33 kg ton/km	3
Riverine transport (upstream)	6,8	0,66 kg ton/km	3
Land-based transport	50,72	4,92 kg ton/km	1-2

Tab. 1: Transport modes with ratio, transport cost, and edge value and characteristics. After de Soto 2019, p. 283 table 13.3.

Cost distance analysis has been performed on four sites: the capital settlement *Bagacum* (Bavay), the port facility and late-Roman capital *Turnacum* (Tournai), the port-*vicus* Pommeroeul, and the port facility *Ganuenta* (Colijnsplaat). These sites have strong evidence for a role in the riverine network, while at the same time representing different locations (i.e., along the coast, along a river, at a crossroads).

First *Bagacum*, displays a central position within the network. Goods can be transported cost-efficiently to the valleys of the Scheldt, Meuse, Somme, and the North Sea coast (fig. 5). These results can be explained by *Bagacum*'s advantageous position on a junction of roads since it has no direct access to a river.⁸⁰ Nonetheless, it seems plausible that these favourable results can also be explained by connections to nearby rivers. The port-*vicus* of Pommeroeul (infra) for instance, was directly accessible by a 20 km-long road section. These results explain why *Bagacum* served as a political and economic centre for more than three centuries.⁸¹

Second, the port-*vicus* of Pommeroeul, located 20 km north of *Bagacum* on an extinct branch of the river Haine (an eastern tributary of the Scheldt),⁸² clearly displays a cost-efficient position (fig. 6). Compared to *Bagacum*, it displays lower transport costs for the Scheldt valley but slightly higher costs for the Meuse valley. These lower costs would logically bring about a north-western oriented distribution of goods from Pommeroeul. Consequently, Verboven and De Clercq note a high similarity in the (second- and) third-century coin assemblages of Pommeroeul and several sites to the north: Merendree, Aardenburg, and Oudenburg.⁸³

⁸⁰ Delmaire (2011).

⁸¹ Delmaire (2011); Coquelet (2011), p. 137–138.

⁸² De Boe (1978); de Boe (1980); Thiébaux (2011).

⁸³ Verboven / De Clercq (2017).

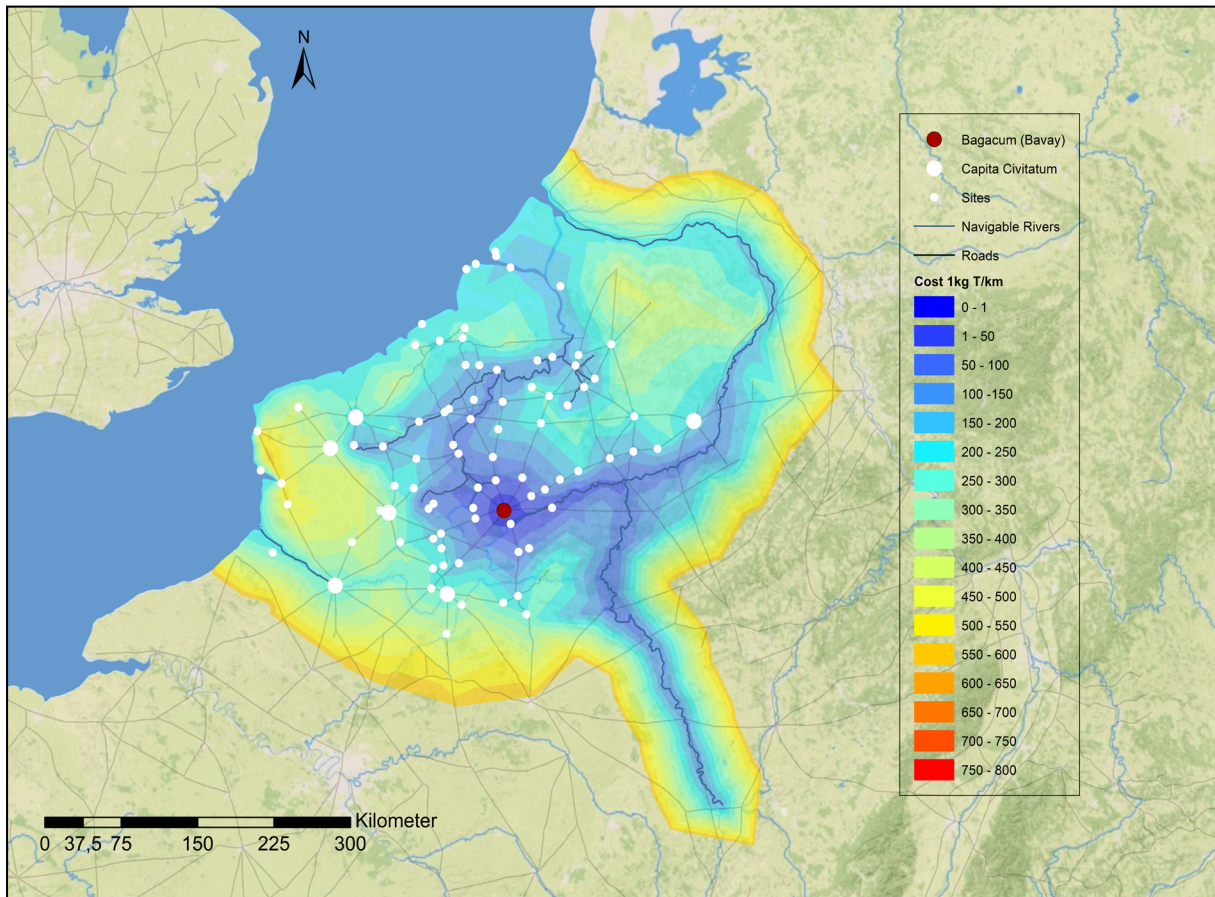


Fig. 5: Cost-distance analysis from Bagacum (Bavay) in the middle-Roman transport network.

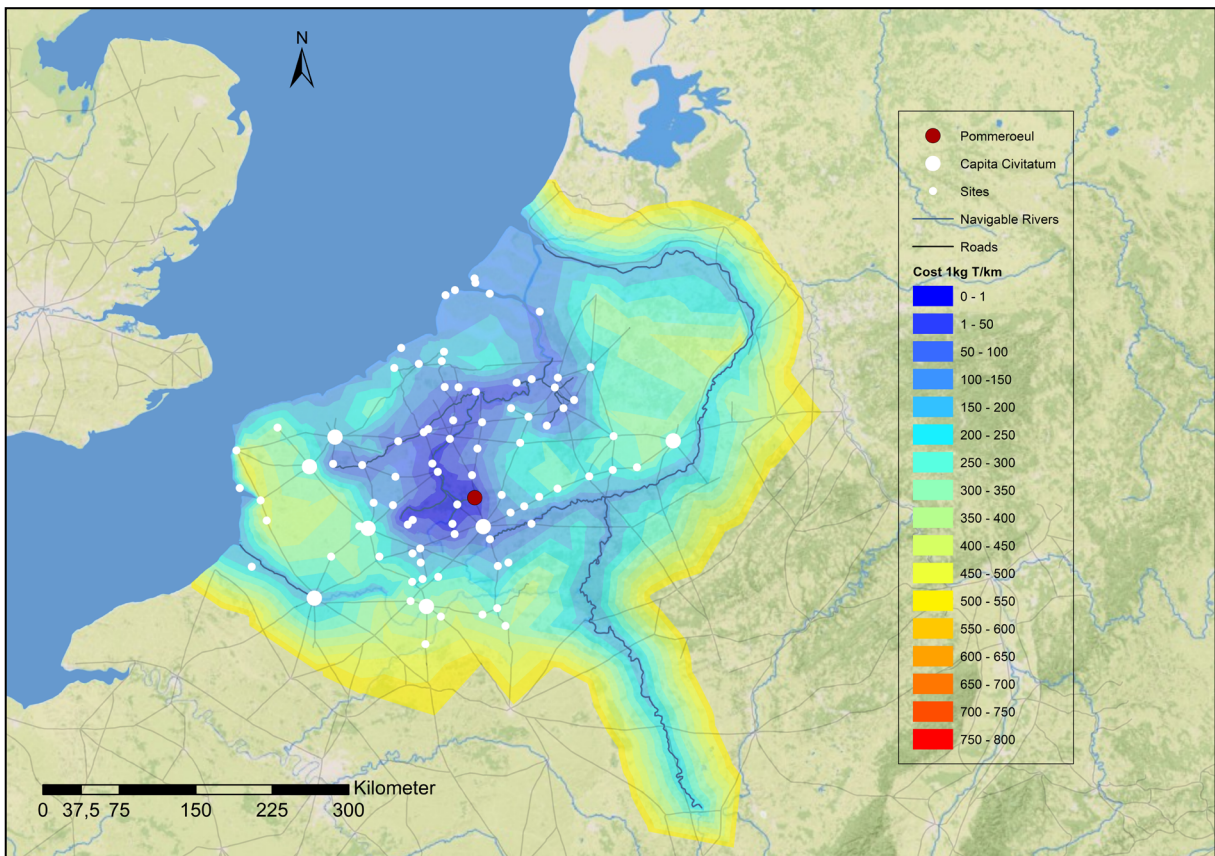


Fig. 6: Cost distance analysis from Pommeroeul in the middle-Roman transport network.

Third, *Ganuenta* shows low transportation costs for goods coming from the Scheldt valley, the North Sea coast and even the Somme (fig. 7). These results give further credence to its presumed role as an important junction in the (supra)-regional transport network geared towards cross-channel transport.⁸⁴ Furthermore, recent studies have shown the viability of an Atlantic sea route for goods travelling from Spain to the Rhine region.⁸⁵ It is not unthinkable that *Ganuenta* played a role in this large-scale transport network. The epigraphical evidence (supra) further confirms economic ties with both *Britannia* and *Germania*.⁸⁶ It is therefore likely that *Ganuenta* served as transshipment location, where goods transferred between riverine vessels (i.e., flat-bottomed barges) and keeled seagoing vessels.

Finally, *Turnacum* presents low transport costs for the Scheldt valley but relatively high costs for regions not connected by waterways (fig. 8). Until the third century, it served as a (modest) port-*vicus*, before being promoted to *caput civitatis* of the newly-formed *Civitas Turnacensium*.⁸⁷ This makes it the first and only capital settlement – within the study area – along a navigable inland river. It remains tentative why several administrative capitals, *Bagacum* and *Castellum Menapiorum* among them, were moved to pre-existing southern sites in the late Roman period. Socio-political, environmental and economic factors have all been proposed.⁸⁸ In the case of *Turnacum*, the reasons can be found in its direct access to the Scheldt (in a time when northern roads were possibly unsafe or neglected) and its vital role in the distribution of limestone (infra).⁸⁹ However, it could simply be related to the desire of the local administration to move their base of operations closer to home and away from the unfavourably positioned *Castellum Menapiorum*.⁹⁰

Accessibility analysis has been performed for both the middle and late Roman network, allowing a comparison between two distinct periods. Accessibility analysis can be performed in various ways; this study distinguishes between an approach based solely on junctions and one based on nodes (i.e., junctions and sites). Here the former is applied. In other words, accessibility was measured by only taking into account physical junctions (intersections of roads, roads and rivers, etc.), while ignoring sites (i.e., nodes). By eliminating sites in the research set up, these could later be used in the evaluation of the results without running the risk of falling into circular reasoning.

84 Wightman (1985), p. 155; Hassall (1978), p. 43; Trimpe Burger (1997), p. 47; Stuart / Bogaers (2001), p. 44–46; De Clercq / van Dierendonck (2008), p. 48; Morris (2010), p. 62, 75, and 109–10; de Bruin (2012), p. 145; Stuart (2013), p. 42.

85 Carreras / Morais (2012); Morillo et al (2016); Schäfer (2016).

86 De Clercq / van Dierendonck (2009), p. 56.

87 Not. Gall. 6, 7; Brulet (2008), p. 54, 374–379.

88 Delmaire (2004), p. 45–47.

89 Brulet (2008), p. 239.

90 Delmaire (2004), p. 45–47.

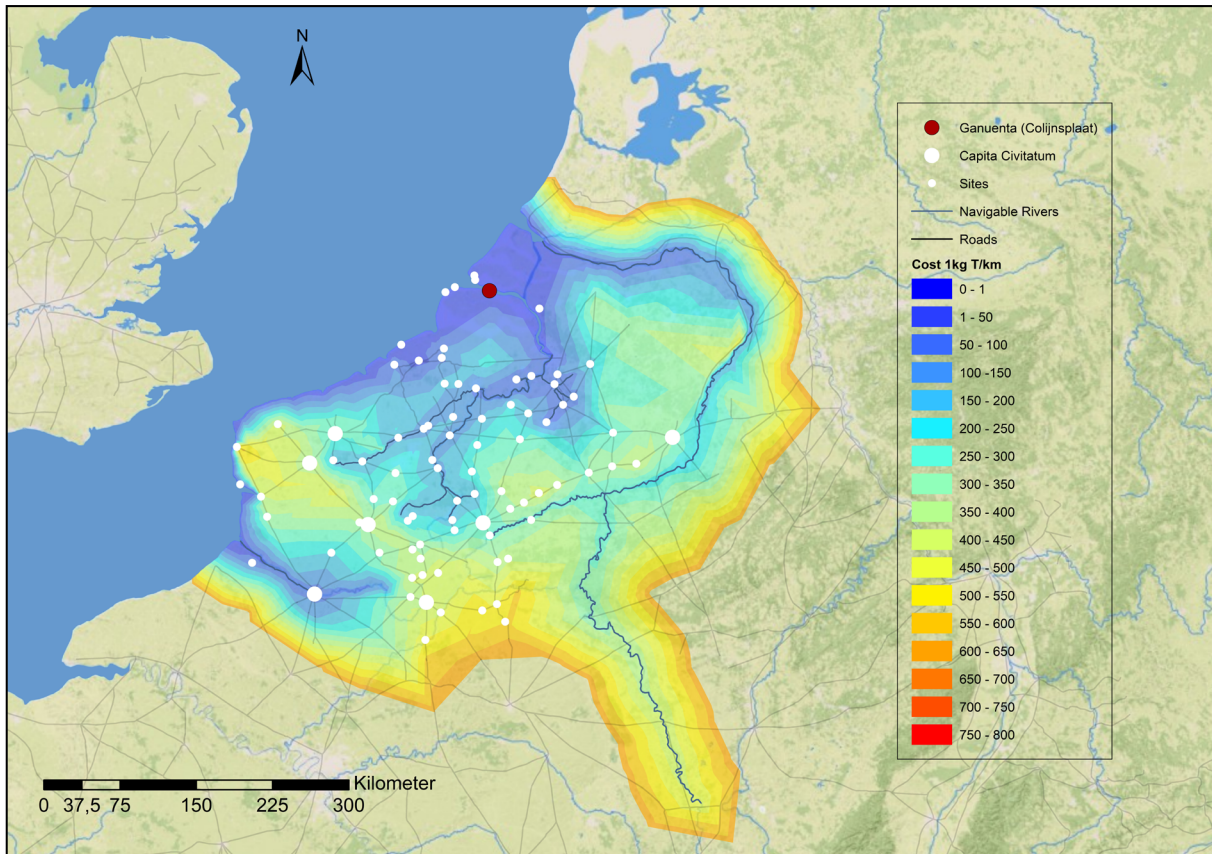


Fig. 7: Cost distance analysis to Ganuenta (Colijnsplaat) in the middle-Roman transport network.

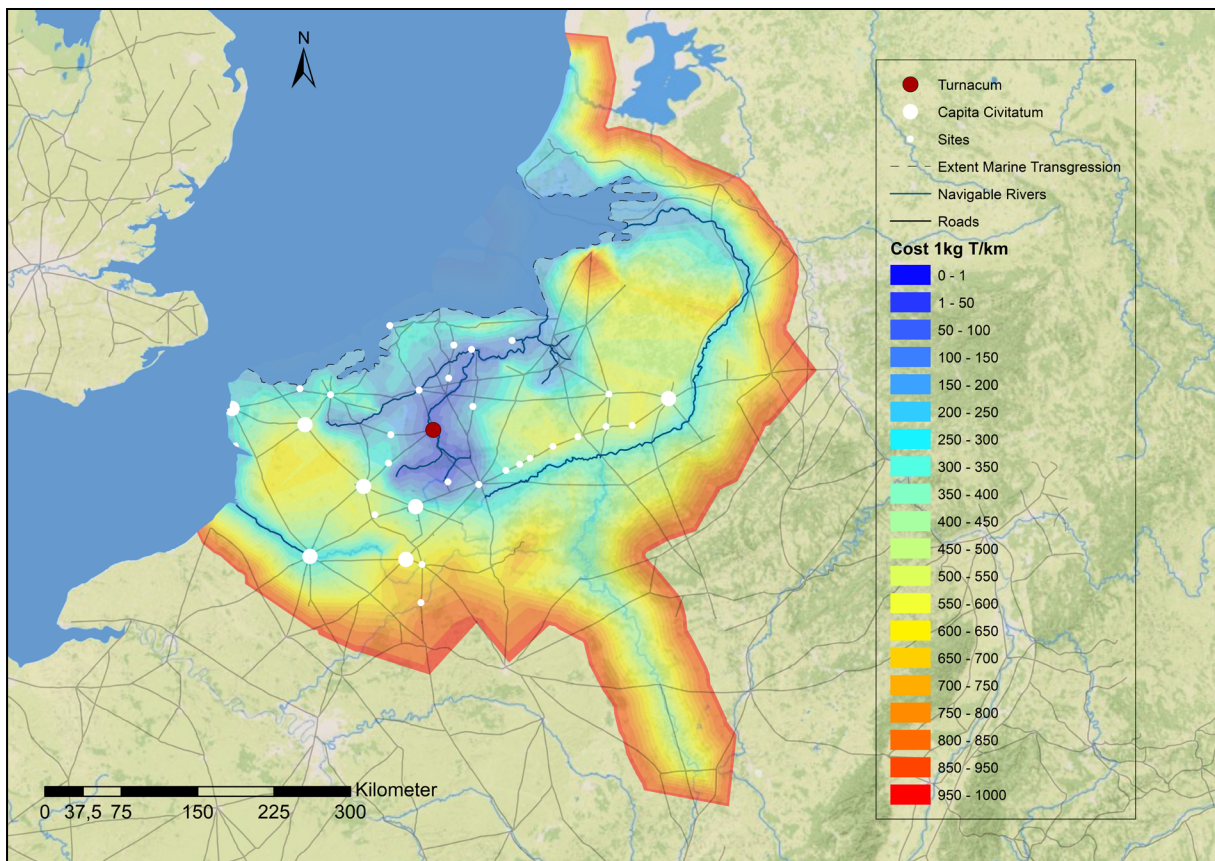


Fig. 8: Cost distance analysis from Turnacum (Tournai) in the late-Roman transport network.

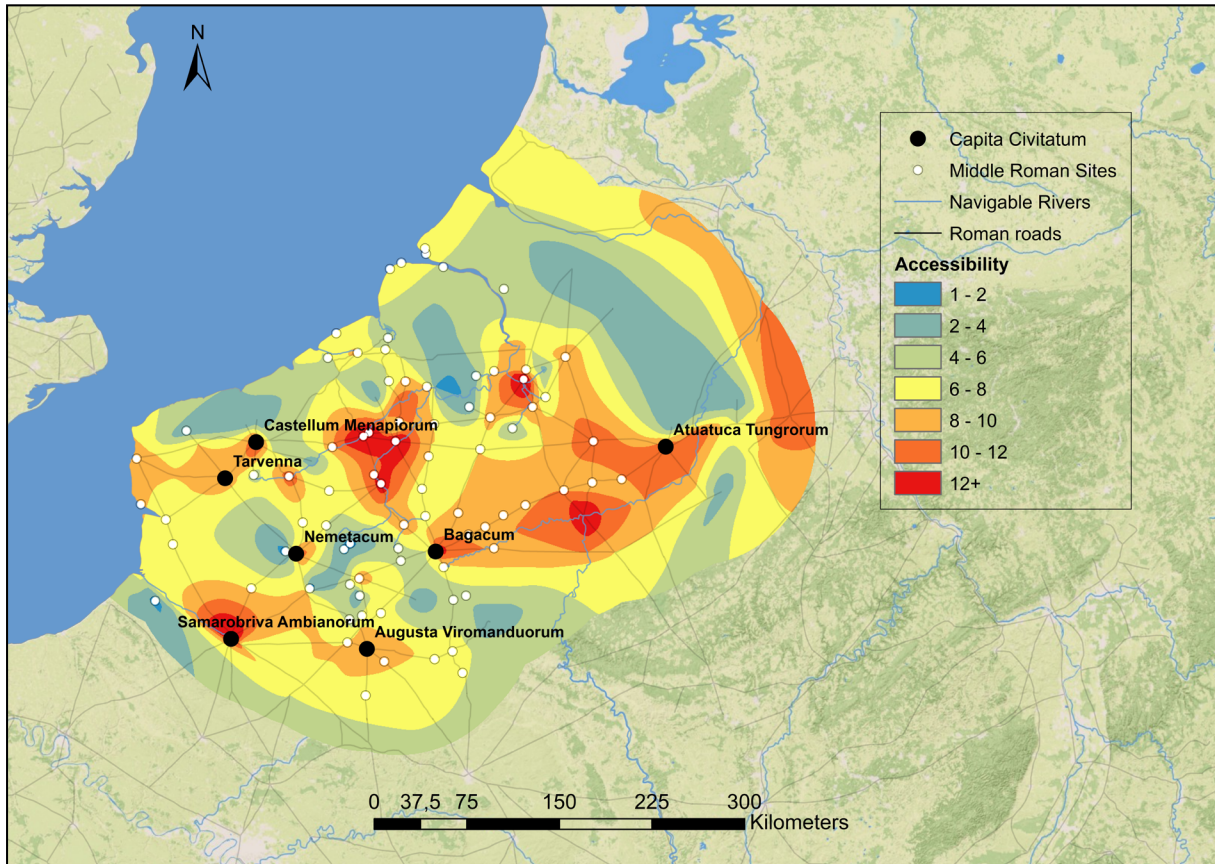


Fig. 9: Accessibility analysis of the middle-Roman transport network.

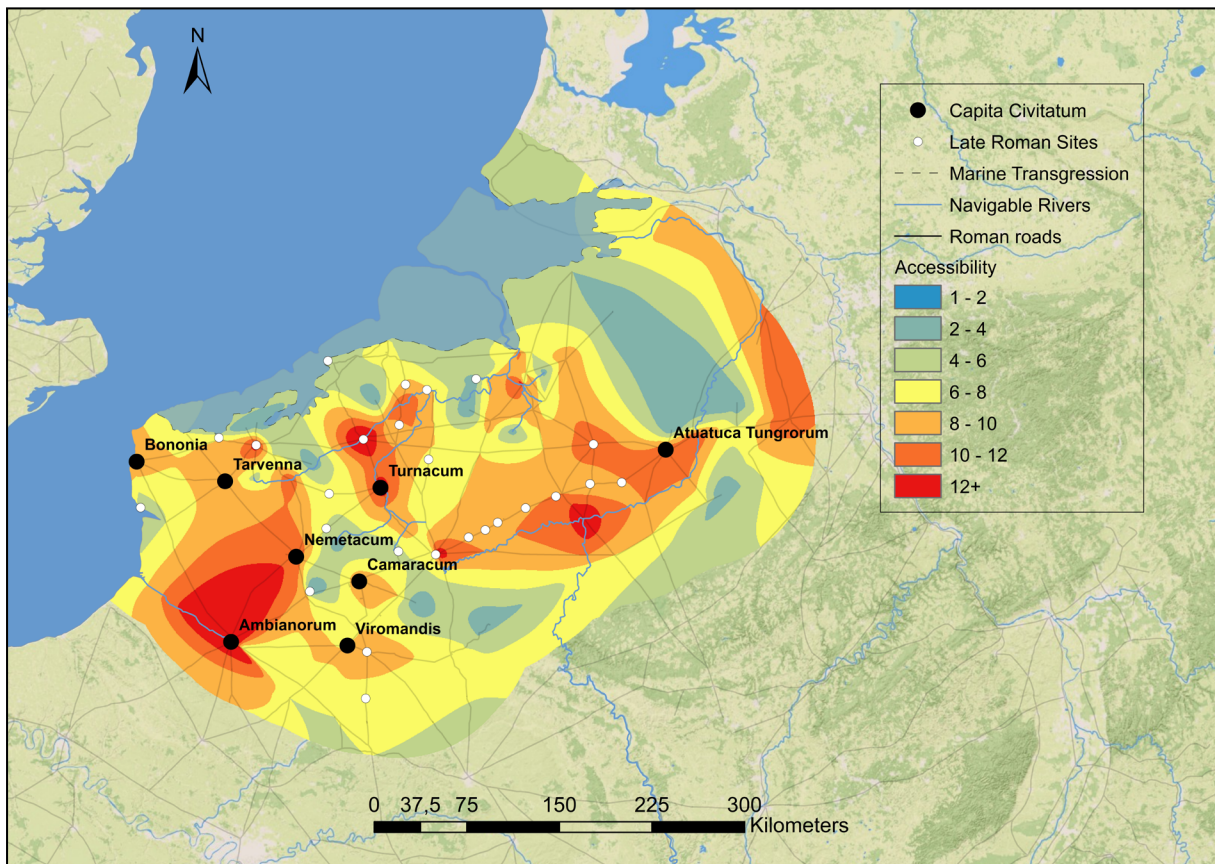


Fig. 10: Accessibility analysis of the late-Roman transport network.

The analysis of the middle Roman period (fig. 9) shows the highest accessibility values in the areas where a navigable river is intersected by several roads or at the confluence of several rivers and a road: i.e., the area around Amiens, the middle Scheldt valley, the confluence of the Dyle and Zenne near Rumst, and at the confluence of the Sambre (*Sabis*) and Meuse (*Mosa*). The exception to this rule is Bavay, which is only served by roads. High accessibility values are also found in areas where several roads converge (i.e., the areas around *Castellum Menapiorum*, *Tarvenna*, *Viromanduorum*, and *Atuatuca*). The study area is generally well-connected due to the extensive road network. However, areas with no evidence of either navigable rivers or road sections (i.e., the north-eastern part of the study area, several coastal and inland regions) remain relatively inaccessible. It is these areas which also contain the lowest number of sites. The highest values are surprisingly not found along the coast, where a possible lack (of evidence) of roads or navigable rivers distorts the results.⁹¹ Nonetheless, the southern coastal zone (Boulogne-Sur-Mer and Amiens) shows higher accessibility values compared to the northern part (Colijnsplaat and Domburg).

The network of the late Roman period (fig. 10) shows a slight decrease in general accessibility, related to rising sea levels, erasing both land- and water-routes. At the same time, there is an increase in accessibility in the southern part of the study area, which has a direct connection to the sea and a high amount of (cross)roads. In the northern part of the study area, the highest values are found around *Turnacum* and a little to the north (i.e., Kortrijk – *Cortoriacum*). The values in the eastern part of the study area (around *Atuatuca Tungrorum*) remain unchanged.

To conclude, access to (seasonally) navigable rivers lowered transport costs and improved accessibility. However, where cost distance analysis shows a reliance on rivers to improve transport costs, accessibility seems to be primarily determined by access to the road network. Access to waterways was beneficial but not paramount in the transport network of the Roman-era Scheldt basin. Therefore, rivers can be seen as cost-efficient south-north (downstream direction) transport corridors to the North Sea, complementing a road network geared towards connecting north-western Gaul (and the coast) to the Rhine in the east.

Transported Wares

The distribution of several material categories demonstrates the supra-regional role of the Scheldt basin. This section will discuss the distribution of various goods such as stone, ceramics, wood, and salt. These goods represent non-perishable bulk goods, consumer goods, and perishables.

First, Tournai limestone was most likely transported down the Scheldt between the second and fourth century. Tournai limestone was quarried in the area around *Turnacum* and was used to construct both the second-century *castellum* of Aardenburg as well as the fourth (last quarter of the third century) and fifth (second quarter of the fourth century) phases of the *castellum* in Oudenburg.⁹² Several arguments can be made to support a predominantly fluvial transport route for these stones: 1) it would have been inefficient to transport these large amounts of stone by carriage;⁹³ 2) both *castella* are located more than 100 km north of the quarry; 3) both had good connections to either the Scheldt or the North Sea; 4) the quarries themselves were located near the port of *Turnacum*.

91 It is possible that several tidal inlets, as well as the first sections of the Yser and Aa were at times navigable for certain ships, but there is currently very little evidence to support these theories. See De Clercq (2009), p. 255–256.

92 De Clercq / van Dierendonck (2009), p. 63–66; Vanhoutte (2007), p. 222, 230.

93 Regular (ox-drawn) wagons would have carried 1–2 tonnes (Russell [2013], p. 97–100).

Second, the construction of the *castellum* of Aardenburg used not only limestone but also volcanic tuff from the Middle Rhine region.⁹⁴ These, as well as basaltic lava querns and millstones with a similar origin, were common in the northern part of the study area.⁹⁵ The early distribution of stone products from the Middle Rhine area is linked to the military,⁹⁶ as demonstrated by, among others, the discovery of a basaltic quern in ‘De Meern 1’.⁹⁷ Stone goods from the Rhine area were transported downstream and further distributed south via the North Sea, possibly via Domburg and Colijnsplaat.⁹⁸

Third, another frequently attested stone type is Macquenoise sandstone from the area around Hirson (northern France) and Macquenoise (southern Belgium).⁹⁹ Much like basaltic lava stones they display a wide distribution (more than 100 km from the extraction point) throughout the entire Roman period, but they are predominantly attested in civilian settlements.¹⁰⁰ Despite the northern distribution, throughout the valley of the Scheldt, Picavet et al. conclude that they were mainly transported by road.¹⁰¹

Fourth, oak is also indicative of the supra-regional character of the Scheldt. Jansma et al. conclude, based on dendrochronological evidence, that the above-mentioned De Meern 1, as well as De Meern 4 and 6, were most likely constructed with oak trees from the Scheldt region.¹⁰² Furthermore, wood of a similar origin seems to be absent along the Lower Rhine limes. This combined evidence leads the authors to conclude that these ships navigated from the Scheldt to the Rhine through a combination of inland waterways and dug canals.¹⁰³

De Meern ships are not the only transport vessels with a link with to the Scheldt basin. The Woerden 1 barge was excavated near the Roman *castellum* at *Laur(i)um*, less than 15 km west of the Meern, together with its inventory and cargo. Similar to De Meern 1 and the barge of Pommeroeul, it is dated to the second century.¹⁰⁴ Among the inventory were five ceramic vessels, of which four originate from the Flemish coastal area. Moreover, plant remains resembling the original cargo, covered the wooden floor of the ship.¹⁰⁵ The analysis of these remains points to emmer wheat from the Loess area (Rhineland, central Belgium, and northern France, fig. 1).¹⁰⁶ The combination of several containers from Flanders, a rare occurrence in the Rhineland, and cargo from the Loess area leads Haalebos to conclude that the Woerden barge most likely transported grain from northern France down the Scheldt and up the Rhine to the limes *castella*.¹⁰⁷

Fifth, another commodity deriving from the Scheldt region is ‘Low Lands Ware I’ (LLWI), a pottery type found in high numbers between the first and third century. It was most likely produced around the area of Bergen op Zoom and displayed a water-based distribution along the Rhine, Meuse, Scheldt,

94 Trimpe Burger (1997), p. 29; De Clercq / van Dierendonck 2009, p. 63.

95 Reniere et al. (2016), p. 410; Reniere (2018), p. 383–89, 452.

96 Reniere (2018), p. 383–389.

97 Mangartz (2007), p. 246–254.

98 Reniere (2018), p. 389.

99 Picavet et al. (2018), p. 36–37.

100 Reniere et al. (2016), p. 412–13; Picavet et al. (2018), p. 37; Reniere (2018), p. 365–367, p. 388–389.

101 Picavet et al. (2018), p. 36–37.

102 Jansma et al. (2014); Wood used for the construction of De Meern 1 (Jansma et al. 2014) was felled around 145 CE, De Meern 4 around 100 CE (Jansma 2007), and De Meern 6 around 158 CE (Dallmeijer / Morel 2012).

103 Jansma et al. (2014), p. 484, 485, and 492–95; Jansma et al (2017).

104 The trees used to construct the Woerden 1 were most likely felled around 175 CE (Haalebos [1996], p. 482).

105 Haalebos et al (1996), p. 482, 485–487, and 502–509.

106 Pals / Hakbijl (1992), p. 294.

107 Haalebos et al. (1996), p. 490. Also see: de Bruin (2012).

North Sea coast, and the adjacent inland regions.¹⁰⁸ LLWI is furthermore found along the southeast coast of Britain, where the potential role of Colijnsplaat and Domburg again comes up.¹⁰⁹

Sixth, during the second and third century, the north-western part of the research area displays higher amounts of *terra sigillata* from the Rhine production centres (i.e., Trier and Rheinzabern) compared to the eastern part of the study area. This distribution is striking since the latter is closer to the production centres. According to De Clercq, this can be explained by the favourable position of the Scheldt basin facilitating efficient import from the Lower and Middle Rhine region.¹¹⁰

Finally, wool, salt, meat and fish products, and other perishables such as grain, were undoubtedly produced and transported throughout the study area.¹¹¹ Unfortunately, these products leave fewer archaeological traces. Salt was one of the leading export products of the North Sea area.¹¹² Besides the above-mentioned traders in salt, two first-century inscriptions from Rimini (Italy) honour L. Lepidius Proculus, *ex-centurio*, on behalf of the *salinatores* of the Menapii and the Morini.¹¹³ Another inscription from *Municipium Batavorum* (Nijmegen) mentions Marcus Liberius Victor, a grain trader (*negotiator frumentarius*) from the *civitas* of the Nervii.¹¹⁴ Menapian ham was on two occasions mentioned in Roman sources: in the first century by Martialis and in 301 on Diocletian's Price edict.¹¹⁵ The same source mentions wool from the Nervii, while the *Notitia Dignitatum Occidentis* mentions an official (*procurator gynaeccii Tornacensis*) responsible for a military textile *fabrica* located in *Turnacum*.¹¹⁶

Conclusion

This paper assessed the role of the river Scheldt in the Roman-era transport network. The combined data has shown that the Scheldt functioned as a transport corridor, in combination with the extensive road network and maritime trade routes.

The basin of the Scheldt is characterised by a diverse landscape, capable of supporting a variety of economic activities. It naturally holds a strategic position between northern Gaul, Britain, and the Rhine limes. The extensive river network depends on rainfall to maintain the necessary water level and flow rate, capable of supporting transport. These natural conditions imposed inescapable seasonal restrictions on riverine transport. Nonetheless, investments in riverine infrastructure (i.e., ports and quays) were made and the discovery of a second-century transport barge, further confirms the role of the Scheldt in transporting goods.

Epigraphic evidence reveals a supra-regional trade network at the end of the second century, connecting the Scheldt estuary to Britain, the Rhineland, and northern *Gaul*. The chronology of the *Ganuenta* network coincides with a phase of increased economic activity and riverine investments along the coast of

108 De Clercq / Degryse (2008), p. 455–57.

109 De Clercq / van Dierendonck (2009), p. 49.

110 De Clercq / van Dierendonck (2009), p. 49; Mees (2011).

111 For the northern part of the study area see: De Clercq / van Dierendonck (2009), p. 46–49.

112 De Clercq / van Dierendonck (2009), p. 51–52; De Clercq (2009), p. 471–478.

113 CIL XI, 390 and 391.

114 CIL XIII, 8725.

115 Mart. XIII, 54; Edict. Dioclet. XIX, 44.

116 Edict. Dioclet. XIX, 44; Not. Dig. Occ. XI, 47.

Germania Inferior starting in 150 CE. Furthermore, several barges found along the Rhine limes show a strong link with the Scheldt basin.

In northern Gaul, both the settlement pattern and the amount of transported goods reach a peak between the end of the first and early third century. Yet, towards the end of the third century, the number of sites declines and an increased military presence is noted. The amount of transported goods also decreases, but (long-distance) transport still occurs as the network remains in use and the first riverine port, *Turnacum*, is promoted to *caput civitatum*.

Cost distance analysis has revealed that rivers are essential for lowering transport cost, but accessibility depends on a connection to the road network. Rivers in the Scheldt basin, therefore, constituted cost-effective (seasonal) south-north corridors, which complimented a road network geared towards connecting the western coastal areas to the eastern Rhineland. The existence of a dense road network, navigable rivers, and several maritime connections, resulted in a high degree of connectivity in the Scheldt basin, with slight differences between the northern and southern part. During the late Roman period, the north-western part of the study area is subject to flooding, resulting in a more divergent connectivity pattern, due to the loss of both water- and land routes.

Abbreviations

- AE: Année Epigraphique
- CIL: Corpus Inscriptionum Latinarum
- ILA: Inscriptions latines d'Aquitaine
- RIB: Roman Inscriptions of Britain

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