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Cover image: embankments at the Danube waterfront of Regensburg "Donaumarkt" made of re-used Roman material, probably Carolingian (S. Codreanu-Windauer, BLfD 2014).

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Inland waterways and commerce in medieval England

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Over the last three decades the extent of inland navigation in medieval England and Wales has been investigated and debated by scholars working largely from administrative sources, with significant contributions made also in the fields of archaeology and place-name studies. This paper examines the material collected, proposed a new digital data-base that charts the known extent of river and canal navigation before the arrival of Black Death in 1348, and discusses the reach of water transport and communications in the economic landscape of England through spatial analysis of the distribution of settlements and commercial sites.
Keywods: medieval England, inland navigation, rivers, economic history, GIS

Negli ultimi trent'anni l'entità della navigazione interna medievale in Inghilterra e Galles è stata analizzata e dibattuta da studi basati soprattutto su fonti amministrative, ma con significativi contributi provenienti dalle discipline dell'archeologia e della toponomastica. Questo articolo esamina i materiali raccolti, proponendo un database digitale che registra lo stato conosciuto della navigazione su fiumi e canali prima dell'arrivo della Morte Nera nel 1348, e discute la capacità di trasporto e delle comunicazioni nel paesaggio economico inglese attraverso analisi spaziali della distribuzione di insediamenti e siti commerciali.
Parole chiave: *Inghilterra medievale, navigazione interna, fiumi, storia economica, GIS*

This paper reassesses and updates materials brought forward on the use of medieval rivers and canals for travel and transportation, discusses the creation of a new Geographic Information System (GIS) database on inland navigation, and contextualises the data through spatial analysis of its relationship with medieval vill, market and fair locations. While inland navigation in Wales would be covered by the digital resource, owing

to differences in the character and availability of the evidence discussion on economic data will concentrate on England. It is widely accepted that inland navigation and the transport advantages it provided played a key role in fostering commerce during the Middle Ages. But what is missing from the current scholarship is an attempt to pin down some numbers to its reach with reference to settlements at a national scale. This overview therefore seeks to place navigable rivers and channels in the human landscape of the English Central Middle Ages.

The first large-scale survey of navigable inland waterways in England and Wales during the Middle Ages was James Edwards' PhD thesis *The Transport System of Medieval England and Wales - A Geographical Synthesis* (Edwards 1987). There had previously been regional studies of restricted scale, such as those conducted on the Fenland waterways (e.g. Fowler 1933, 1933; Astbury 1957; Darby 1974, pp. 93-118), but Edwards provided the first comprehensive examination of a set of primary sources on a national scale. His major evidence were an exhaustive line-by-line review of the Calendars of State Rolls from 1219 to 1441, including the Charter, Patent, Close, Fine, Liberate, Chancery and Memoranda Rolls, along with Chancery Warrants and Inquisitions Miscellaneous. Together with his dissertation supervisor B.P. Hindle, Edwards published a summation of his results in the *Journal of Historical Geography* in an article arguing that medieval waterway transport was much more extensive than had previously been supposed, was well integrated with the overland road network, and played a vital role in directing urban and commercial growth (Edwards, Hindle 1991).

This conclusion was criticised by John Langdon, who pointed out that much of the material collected by Edwards did not concern river navigation directly, but rather consisted of commissions to investigate obstructed waterways (Langdon 1993). This material can be interpreted as evidence of desire to potentially open waterways for navigation, but not as direct evidence of navigation taking place. Drawing on royal purveyance accounts from 1294-1348, which document the acquisition of goods (mostly grain) for the king's military and household expenditures, Langdon argued that the effective reach of the water transport network was more restricted — roughly half of that proposed by Edwards and Hindle. The character of his sources lent Langdon's conclusion persuasive power, for the accounts provide a geographically comprehensive picture of large-scale bulk transport outside the north-west. A short reply by Edwards and Hindle dismissed Langdon's argument by naming a few clear instances of navigation beyond the purveyance account routes, but did not address the critique about the limitations of their source material (Edwards, Hindle 1993).

There the matter might have lain if not for an intervention by Evan Jones, which reassessed the evidence from the perspective of long-term transformations in the waterway network of southern England (Jones 2000). Assenting that crown commission reports of river obstruction could not be taken as positive evidence of river navigation, and that a large section of Edwards' references were therefore rendered inadmissible, Jones reinforced the point that if examined on a case-by-case basis the State Rolls nevertheless did contain direct evidence of river traffic on sections of waterways not mentioned in Langdon's purveyance accounts. Jones' thesis was that much of the discrepancy between Edwards' and Langdon's sources was due to their differing chronological spans, and that when combined they indicated a considerable diminution in the reach of inland navigation from the late 13th century onwards. Jones attributed this development to the increase in obstructions arising from other economic uses of rivers (e.g. construction of fishing weirs and mills) enhanced by demographic shifts that reduced the demand for long-distance bulk transportation.

Advances in scholarship have since deepened our understanding of the use of medieval inland waterways, with a particularly important collection of papers on topics such as human modifications of waterways, relative volumes of cargo transport, inland ports and several regional studies edited by John Blair some ten years ago (Blair 2007). With the exception of Ann Cole's contribution on the field of place-name studies (Cole 2007), discussed below, the broad picture on the extent of river navigation established in the 1990s has nevertheless prevailed. This material will now be surveyed, plotted using GIS tools and discussed in the context of the pattern of medieval settlements and commercial sites in England.

1. Mapping inland navigation in England and Wales before 1348

The earliest written sources surveyed here come from the 11th century, although owing to the great increase in the volume of records by the English royal administration the majority are dated to the 13th and the 14th centuries. The formal chronological end-point for the survey was set at 1348, although references in written sources to the beginning of the 15th century have been accepted on a case-by-case basis, if judged that they reflected an older continuity of river navigation. The impact of the Black Death undoubtedly altered the demographic and economic context of inland navigation. This is not to argue that the plague would have instantaneously or even necessarily fundamentally trans-

formed its overall scope, but rather to acknowledge that long-term changes to navigation in the Later Middle Ages cannot be satisfactorily examined in the confines of this study. The archaeology consists primarily of evidence of canalisation, wharves and cargo-carrying boats dated approximately between the 11th and 14th centuries.

Methodologies used for spatial analysis of historical and archaeological research have established their potential to create new information on the past (Bevan 2010). To facilitate analysis and dissemination of knowledge of inland navigation the data (fig. 1) has been compiled into an electronic resource, with the intention to turn it into a database available online, prospectively entitled *Inland Navigation in England and Wales before 1348: GIS Database,* using ESRI ArcGIS 10.2 software tools. In this dataset the polyline vector data depicting waterway courses was mostly obtained from modern Ordinance Survey (OS) raster maps. In recognition to human modifications and natural changes to the courses of waterways, however, older historical courses have been reconstructed when possible using historical parish and county borders, historical maps including the First Edition one-inch-to-the-mile OS map (1805-69), maps of archaeological, historical and geological surveys, and satellite and LIDAR imagery. The work in retracing medieval courses has been particularly extensive in the Fenland and the Somerset Levels, where canalisation during the Middle Ages and subsequently has greatly changed the hydrological landscape (for overviews, see Bond 2007, pp. 182-188; Hall *et al.* 1985-1996; Rippon 2007).

By dividing the historical and archaeological evidence into three classes, three GIS polyline vector datasets are obtained: (i) *navigated waterways* for which there is direct evidence of navigation or canal building; (ii) a subsection of these waterways which appear to have served as *significant channels* of transportation, judging by their cargo-carrying capacity or connectedness to interregional and overseas trade; and (iii) a dataset collecting *indirect evidence* of inland navigation from primary sources, principally place-names. A linked point-data vector dataset marking heads of navigation will also contain further historical information and references to primary sources and literature.

(i) *Navigated waterways*. The composition of this dataset begins with a re-examination of the wealth of primary sources investigated by Edwards for his 1987 PhD dissertation. Crown commissions on waterway obstructions are not included as evidence of navigation, except in a handful of cases where the texts specifically state that the waterway in question had previously been navigable. Edwards' survey is here expanded by
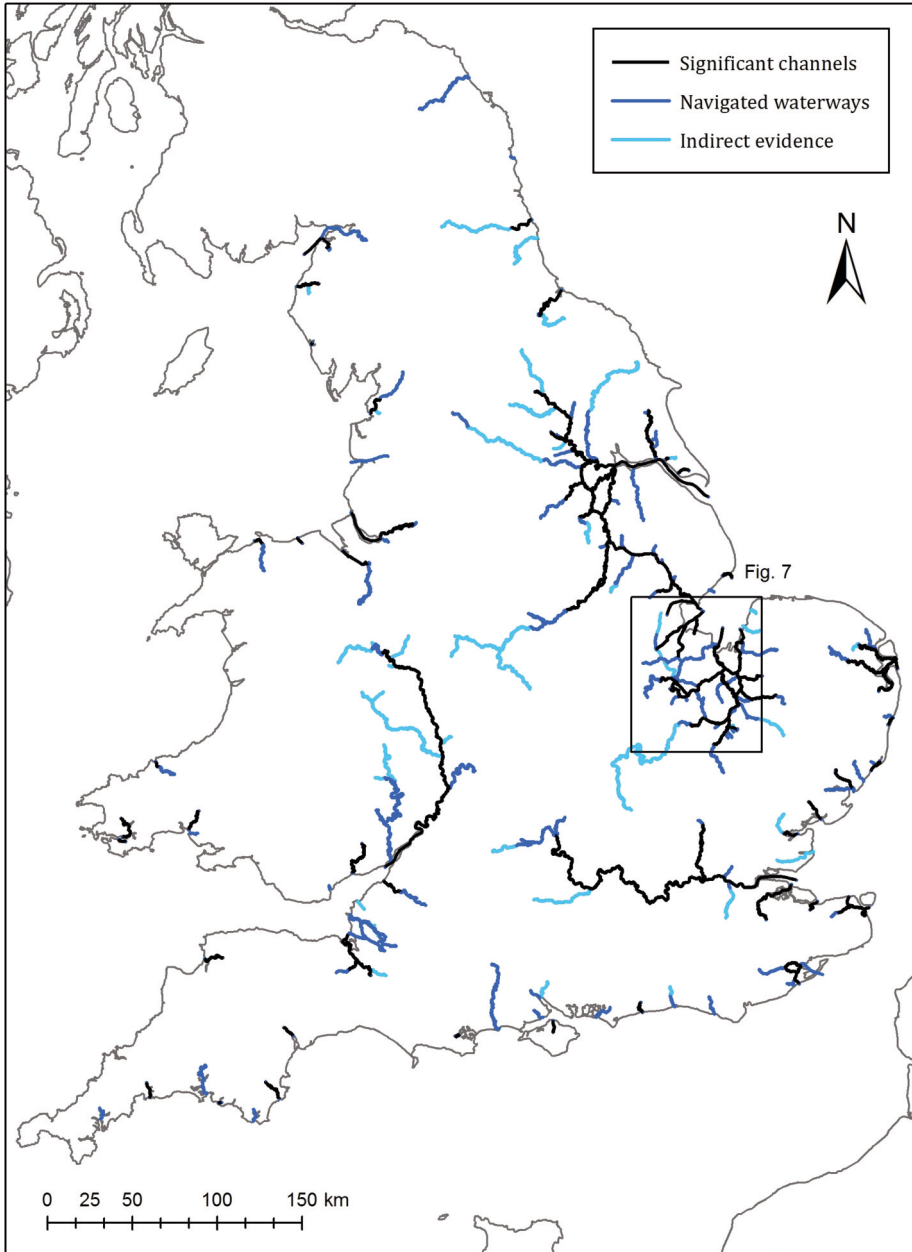
Fig. 1. Inland navigation in England and Wales before 1348 (map of Domesday England and Wales here and in other figures courtesy of Stuart Brookes, *Landscapes of Governance* project, University College London).

sources he did not use (e.g. *Inquisitions Post Mortem*) and more recent scholarship, especially regional and local studies. Additionally, D.J.M. Caffyn's 2010 PhD dissertation *River Transport 1189-1600* deserves be highlighted as a recent national-scale review (Caffyn 2010). Edwards' and Langdon's work favoured royal administrative sources, but Caffyn's research incorporated archaeological finds and expanded the pool of documentary evidence on local sources, such as the records of ecclesiastical institutions. Caffyn, however, also incorporated a great deal of scholarly commentary (such as suggestions that stone for building projects may have been locally transported by river) and records of boating accidents (which may be attributed to local fishing or bank-to-bank ferrying, not necessarily river traffic) (for example on the river Wear: Caffyn 2010, Appendix pp. 282-283). While this material has the potential to be very useful in informing fine-grained research on local waterway conditions, it cannot be classified as direct reference to navigation and will not be considered here. In the revised dataset the extent of known navigated waterways, including tidal sections and estuaries, is roughly 4.000 km.

(ii) *Significant channels*. This dataset sets apart waterways that, based on primary sources, possessed substantial bulk transport capacity or appear to have enabled direct participation in interregional and international trading networks. The evidence considered focuses on the first half of the 14th century. John Langdon's work on the purveyance accounts 1294-1348 offers the most extensive survey of the probable reach of long-distance bulk transport. The mean volume per vessel transported on the twenty-four routes he investigated varied from 2,6 tons (upper Parrett) to 26,7 tons (Lea) (Langdon 2007, p. 130). While the accounts do not cover Wales or the eastern and northern counties of Cornwall, Herefordshire, Staffordshire, Shropshire, Cheshire, Lancashire, Westmorland, Cumberland, Northumberland and Durham, they are complemented by records pertaining to ports and local custom duties, which offer geographically less restricted information on bulk transportation. As was already noted by Jones, a custom on wool, hides and wool-fells in 1333 indicates that direct overseas trade reached up the Severn as far as Shrewsbury in Shropshire (*Calendar of Close Rolls 1333-37*, 53; Edwards 1987, p. 333; Jones 2000, p. 63). Royal orders issued in 1324 and 1326 provide port lists for the procurement of ships with a load capacity of at least 40 or 50 tuns (0,96 kilolitres) (*Calendar of Close Rolls 1323-7*, 183-184, 640-642; *Calendar of Patent Rolls 1324-7*, 310-311). These include several inland ports located on

waterways not covered by the purveyance accounts, especially on the west coast. The function of this dataset is thus to indicate the minimum extent of bulk transportation routes. Altogether, their total length is some 2.300 km.

(iii) *Indirect evidence*. A more difficult category of primary sources, ones that strongly imply navigation took place but do not directly prove it, have been collected into a third dataset that can further be divided into two classes. The first consists of a mixed bag of ten or so instances of difficult to date archaeological evidence or references to navigation where river sections are not unambiguously specified. For example, shipping downstream of Kelveden on the River Blackwater in Essex is suggested by a customary payment called 'ship-hire' (*schipur*) owed by the tenants of Westminster Abbey, which was made instead of transporting agricultural goods to nearby coastal settlements (Blair 2007, p. 14). Tolls from late 12th to the early 14th century prove that ships travelled upstream from Montfort Bridge on the Severn. It is not known how far they may have passed, but it seems plausible shipping reached at least as far as Welshpool, the next major market town on the river (Edwards 1987, p. 332).

The second set of thirty waterways draws on Old English place-name evidence. Ann Cole's important 2007 article examined several terms related to water transport, of which the most relevant to this study are *hȳð* ('landing place'), *stæð* (originally 'riverbank' but later also 'landing-place'), *lād* ('artificial watercourse') and *ēa-tūn* ('river settlement'). Examples include 'hythes' around the southern edge of the Fenland where the medieval marshland gave way to firm ground (see fig. 2), Birstwith (*Beristade* in Domesday Book) in a lead-mining area in West Riding of Yorkshire, and several 'load' place-names associated with 12th- and 13th-century canalisation efforts in the Somerset Levels. 'Eatons' tend to appear in the upper reaches of rivers, and as Cole argues the place-name element seems to be associated with maintaining shallow waterways open for navigation. Three of the four 'eatons' in the Wye basin are within a mile of an old Roman road. Their function may be interpreted as nodal points in a regional transport network incorporating both water and overland routes (Cole 2007, pp. 61-84; see also Gardiner 2007).

Onomastics is a vital tool for understanding how people in the past interacted with their physical landscape (Gelling, Cole 2000, pp. 65-96; Cole 2011, pp. 51-67). In absence of dated evidence, however, it is difficult to estimate exactly how far place-names reflected the reality of

water transport through an extended chronological period. For example East and West Ayton (*Atune* in Domesday Book) on the Yorkshire Derwent are 60 km upstream from the furthest known point of navigation at Stamford Bridge. The place-names may consequently reflect traffic of only limited scope both spatially and temporally (Cole 2007, p. 81).

On the other hand, a good case can be made for the navigability of the Ilchester Yeo in Somerset. The Yeo links the town of Ilchester with the River Parrett, one of the rivers indicated in the purveyance records. Ilchester is situated along the Fosse Way from Exeter to Lincoln, a major cross-country route called one of England's four royal highways in 12th-century sources (Henry of Huntingdon, *Hist. Anglorum*, 22-4; *Leges Edwardi Confessoris*, §12; *Leis Willelme*, 510). There is no direct evidence of medieval navigation along the Yeo but Roman wharves found at Ilchester, 12 km upstream from the confluence of the Yeo and the Parrett, show that pre-medieval navigation certainly reached the settlement. Much later in 1633 a description of a local bridge noted that 'boates and crayes' could reach within a few kilometres of the town (Caffyn 2010, Appendix pp. 407-408; Jervoise 1930, p. 92). The river winds its course between two *lād* settlements (Long Load and Little Load), first attested in 1285 and 1365 (Cole 2007, p. 78). This indicates efforts had been made to improve the river, and in the context of other historic evidence plausibly suggests that the Ilchester Yeo was the missing link between two main medieval transport and communication routes of south-western England. Not least because of the scarcity and undoubted incompleteness of the available direct evidence, place-names must be considered as an important source. The category of indirect evidence adds a further 1.200 km to the surveyed waterways.

2. Qualifying navigated waterways

There are four points that must be clearly stated about the character of inland navigation and any attempt to represent it cartographically. First, a map such the one provided in fig. 1 is not an image of inland navigation at any one given point in time, but rather a collation representing the maximum extent of navigation of which we have information in the Central Middle Ages, with a strong focus on the hundred or so years before the Black Death. It must be allowed that across a period of several centuries conditions were subject to change, as indicated by both the cutting of new canals and reports of obstructions. In order to represent the temporality of the reach of navigation, the planned database will in-

clude a linked point-data file that present information on the chronologically last known instances of navigation by 1348 as well as references to obstructions.

Second, this dataset does not represent the totality of river navigation that took place in the Middle Ages; the evidence is simply too sparse to allow such a confident assertion. In many cases only a single piece of direct evidence of navigation survives, especially along smaller rivers or on the upper reaches of major waterways. The navigability of the final 25 km before Barnwell, Northamptonshire, on the Nene is attested only by the record of a journey by the sacrist of Ely in 1322x41 (*Sacrist Rolls*, II, 3). Chester's status as a maritime port is well known, but the fact that goods were sent down the River Dee from Overton, 20 km further upstream, is mentioned in just one entry in the Cheshire county accounts (*Accounts of the Chamberlains*, 42). Without the discovery of a 12th-century wharf at Skenfrith, more than 15 km above the point where the Monnow joins the Wye in Wales, there would be no evidence at all that the former river had been navigated (Evans *et al.* 2003, p. 76). The number of now unknown navigable waterway sections can only be guessed at.

Currently ongoing GIS research led by Max Satchell on Early Modern and Modern navigation, however, has created an independent database that supports the general picture described in fig. 1. Satchell's research shows that the extent of navigation in 1600, and even more so after new improvements had been made by the 1680s, was remarkably similar to that discussed here, especially along the more significant channels (Satchell *et al.* forthcoming). The Fenland, a water landscape modified over the centuries by human intervention, is the one region where major differences stand out. A handful of omissions on the upper stretches of large rivers and their tributaries may be attributed to the dearth of direct medieval sources. Indeed place-name evidence indicates medieval navigation along certain of these sections (e.g. the Thames to Water Eaton and the Great Ouse/Ouzel to Eaton Bray), which further highlights the potential of onomastics to convey vital information.

Third, a cartographic representation, one marking the furthest known head of navigation and describing the course of the waterway below, can in some respects create a misleading impression of total navigability. Interviewing obstructions, whether natural or man-made, temporary or permanent, may have prevented direct access to the sea. Mills built on the Derbyshire Derwent at Borrowash blocked navigation in the late 13th century, but the situation must have been resolved and the river was still navigable a hundred years later. There are several sources that

show that the Aire was navigable to Pontefract in West Riding of York-shire (Edwards 1987, pp. 162-164, 188). Further upstream, a pontage grant from 1384 shows that a stretch of 14 km between Cononley and Coniston Cold was also used for transportation (*Calendar of Patent Rolls 1381-85*, 414). Yet over 60 km separates Cononley from Pontefract. Given the absence of other evidence, it would be incautious to assume a connection over such an extensive length and the section is classified as indirect evidence in the dataset.

Fourth, navigation along different waterways, and along different sections of a single waterway, varied in character and consequently enabled very different forms of traffic and transport. Seasonality played a role, with periodically higher water levels enabling navigation on otherwise difficult to access river sections. Modern surveys of river regimes show that the mean flow on British rivers is exceeded on average during a period covering 30% of the year. On several great rivers – the Thames, the Severn, the Nene – the maximum flow in winter was recorded as much as four times the volume of the minimum flow in summer (Ward 1981, pp. 18-25). Fig. 2 contrasts navigated rivers in the Midlands with geological indicators of flooding mapped by the EDINA Geology Digimap Service (EDINA 2010). It is noticeable that sections of several major waterways in the indirect evidence category coincide with flood risk areas. Settlements along these rivers may have been accessible by water only on a seasonal basis. Conjecturally, so may have those along rivers for which there is no evidence of medieval navigation. For example the Wey, flowing into the Thames, was made navigable to Guildford in the 17th century (Satchell *et al.*, forthcoming). Judging by their propensity for flooding, other possible seasonal water routes could for example include the Trent tributaries of the Dove, the Soar and the Tame beyond its intersection with the Anker.

The Thames provides a range of examples of varying conditions along a single river. It is conventionally divided into three sections. The navigability of lower Thames to around Henley is well known, and it could be accessed directly by seagoing vessels. A cluster of place-names including the element *hȳ∂* ('landing place') located between Henley and London suggests this region was a favoured transhipment point (Cole 2007, pp. 69-70). Middle Thames to Oxford was an important shipping route, but the purveyance accounts record the mean load of vessels halving above Henley. The accounts also indicate how seasonality governed transport. This section was preferred above overland routes mostly in winter, presumably when higher water levels and degraded conditions on roads made it appealing for larger cargoes. Furthermore, it is possible that the majority of the traffic from above Henley was downstream, with west-
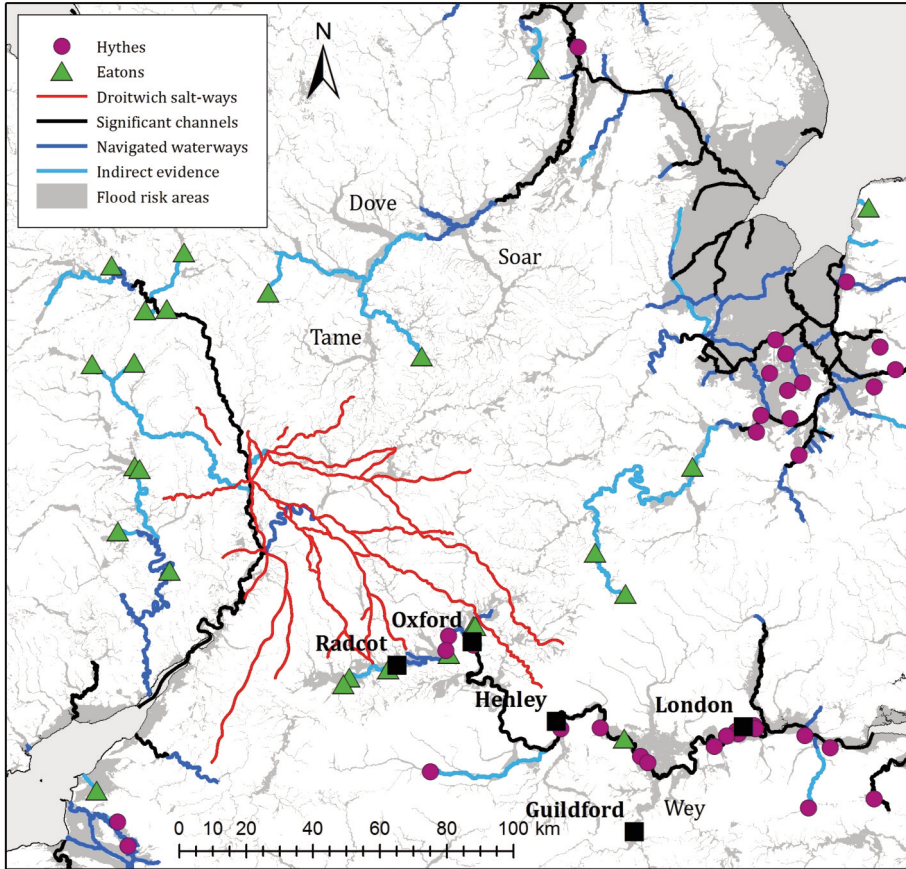
Fig. 2. Flood risk areas and place-names related to navigation in the Midlands (source: EDINA Geology Digimap Service; Cole 2007; Hooke 1981).

wards-bound goods travelling by land (Baker, Brookes 2013, pp. 269-293; Blair 2007b, p. 14; Blair 2007c, pp. 257-260; Langdon 1993, pp. 5-6; Langdon 2007, p. 130). Conditions on this section had decayed by the 15th century: at least one builder was forced to transport his stone overland owing to obstructions on the river above Reading (Colvin 1963, p. 282; Jones 2000, p. 66). Finally, upper Thames was navigable from Oxford up to Radcot as late as 1271, and place-names suggest navigation extended at least a further 20 km to Water Eaton (*ēa-tūn*) in Wiltshire (*Calendar of Patent Rolls* 1266-72, 610; Edwards 1987, pp. 267-268; Cole 2007, p. 80). Multiple overland routes – of which the most notable were the Droitwich salt ways (Hooke 1981) – connected the Thames above Oxford with the Severn river valley, and made this region

a crossroads between the eastern and western halves of the country. Indeed, the strength of local commerce is marked by one of the densest concentrations of medieval markets and fairs in England (Oksanen 2015, pp. 197-199). Owing to the physical character of this stretch, however, most of the traffic was probably conducted by small ships, boats and rafts, and the river trade had a stronger local character than down-stream (Blair 2007c, pp. 283-286).

3. Economic and settlement context

To summarise, the total known navigated length of inland waterways in England and Wales in the surveyed sources is 4.000 km. Of this length at least 2.300 km were capable of conveying vessels with a capacity in excess of 2 tons, or otherwise participated in long-distance commerce. Navigation along a further 1.200 km of waterways is suggested by place-names and a handful of other indirect references. 96% of the total length of known navigated waterways lay in England. This no doubt owes to the rugged geography of Wales, combined with a poorer coverage by documentary sources of the English royal administration, which provides our major set of sources.

The rest of this paper will seek to establish the reach of navigation in the context of the English landscape of settlements, urban centres and commercial sites. The economic advantages afforded by waterways for transportation alone are clear: James Masschaele's study of records on the carriage of wheat in the 14th century show a cost ratio of 8:4:1 be-tween land transport, river transport and coastal transport (Mass-chaele 1993, p. 273; Miller, Hatcher 1995, pp. 149-155). In the first place, the clear relationship of the larger urban centres with navigable water is worth restating. Alan Dyer's ranking of English towns based on the 1334 tax assessment provides a rough and ready guide to the top one hundred urban centres in the kingdom, with valuations ranging from £11,000 (London) to £133 (Bath) (Dyer 2000, pp. 755-757). This dis-tribution had a long tail: the top third accounted for *c.* £32.000 (of which London alone contributed as much as the next ten towns counted together), the middle third *c.* £10.000 and the bottom third *c.* £6.000. Of these towns 46 were inland settlements located directly by a known navigated waterway (of which 32 were along significant channels), 8 were along waterways for which navigation in speculative, a further 8 were coastal, and 38 were not within the immediate vicinity of navigated water – a breakdown of 46(32)/8/8/38. The importance of inland navi-

gation becomes even clearer if we compare the top third with the bottom third. The breakdown in the top category is 22(17)/1/4/6, whereas in the bottom category it is 9(3)/5/1/18. Altogether, approximately one quarter of the *c.* 560 boroughs in England by 1348 (source: Letters 2002) were located by a navigated inland waterway.

About one tenth of the vills surveyed were assessed at £100 or more, and there was therefore a considerable population of non-borough market settlements and other vills that rivalled small urban centres in terms of taxable wealth. If we move outside the formally recognised urban sphere, how much access did these, and the thousands of small rural settlements and farmsteads where perhaps 80% of the population lived, have to inland navigation? Large-scale spatial analysis of medieval settlement patterns has been made possible by pioneering digital humanities projects on wealth surveys of English vills, a subdivision of local administration. In towns the returns could specify individual wards, but in the countryside vills can be used as shorthand for settlements. For the early 14th century the key resource is the 1334 lay subsidy that assessed taxable wealth in movable goods by vill through most of England (Barry *et al.* unpublished; discussed in Campbell, Bartley 2006). Only the counties of Durham and Chester were not included in the assessment, and in the county of Kent the returns were recorded by the Hundred. In the latter two counties it has been possible to largely reconstruct vill location information with data from the Domesday survey of 1086 (source: Baxter *et al.* 2010). This creates a settlement dataset of 14.500 locations with a high degree of spatial coverage and information on 14th-century wealth across medieval England outside the specified counties.

Fig. 3 shows the number and percentage of vills located within a radius of 1 km of navigated waterways, with 2 km wide band at the coast included for comparative purposes. Some 6,6% of the surveyed vills, located at 4,5% of England's surface area, enjoyed immediate access to inland navigation. The scope of the broader hinterland that may have benefited from being in the vicinity of water routes must also be considered. In the 13th-century legal treatise *De Legibus et Consuetudinibus Anglia* a reasonable day's journey 'according to the sayings of the elders' is set at 32 km (20 miles). The author used this distance as a base unit for measuring whether a newly establish market could be considered a harmful competitor to an exciting franchise (Henry de Bracton, *De Legibus*, III, 198). A direct line over a landscape does not reflect the reality of travel, of course, but halving the distance to 16 km (10 miles) provides a likely reference for relative nearness. It is, for example, a gener-

	Significant channels	Navigated waterways	Indirect evidence*	Coastline
Vills within 1 km	534	957	389	1.096
% of vills	3,7	6,6	2,7	7,6
% of surface area	2,7	4,5	1,6	5,8**
Vills within 16 km	6.400	8.801	1.742	5.025
% of vills	44,1	60,7	12,0	34,6
% of surface area	40,5	56,3	12,0	30,9**

* Excluding overlap with navigated waterways
** Within 2 or 16 km inland of the coastline

Fig. 3. Number of English vills near navigated water (source: Barry *et al.*, *Database of English Lay Subsidies of 1327/1332/1334*).

ous approximation for the size of the economic hinterlands of small towns (Dyer 2002, pp. 13-14). Used as a measure just over half of the surface area of England, and 60,7% of the surveyed locations, falls within a short journey from a navigated river.

At the most general level of analysis there is a significant correlation between navigable waterways and the pattern of vills. A two-sample Kolmogorov-Smirnov test of navigated inland waterways against the surveyed locations returns the p-value < 2.2e-16, a very strong indicator that there is a spatial relationship between the two sets of data. (A p-value indicates the degree of certainty to which a null hypothesis — here that there is no spatial correlation between waterways and vills — is correct. In social sciences context a p-value of 0.05 or less is considered a strong result). It would, of course, be misleading to attribute this solely to transport advantages: nearness to rivers provided a multitude of benefits to a community that included access to fresh water, food and energy resources (e.g. fishing, water mills), flatter or agriculturally favourable land (e.g. meadow, valued two to four times higher than the very best pasture land) and intangible benefits such as command of culturally or politically important features in the landscape (Lipson 1929, I, p. 70; Pelteret 2009, p. 31).

However, if we compare the 1334 valuation of vills near navigated waterways against those located on other rivers, there do emerge differences in the pattern (fig. 4). Data for non-navigated English rivers were obtained from the CCM River and Catchment Database (Vogt *et al.* 2007). After navigated sections have been removed, this provides a
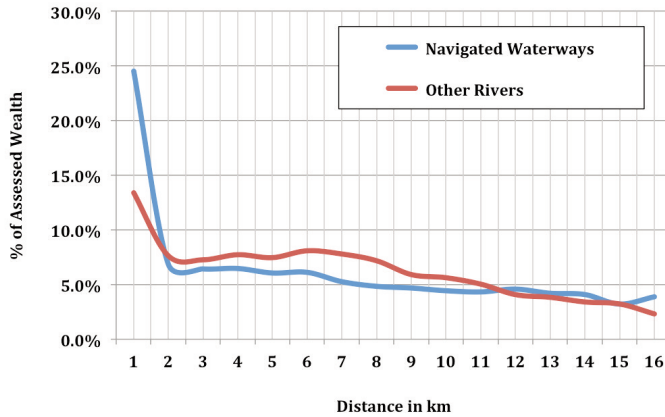
Fig. 4. Distribution of taxable wealth in the lay subsidy of 1334 against inland navigation (sources: Barry *et al.*, *Database of English Lay Subsidies of 1327/1332/1334*; CCM River and Catchment Database).

comparative river network 5.100 km in length. It is apparent that there is a significantly greater concentration of wealth in the first 1 km of navigated waterways as a proportion of the total within the first 16 km (24,5% against 13,4%). Major urban centres along navigated waterways, especially London, will have exerted an influence. But even if we remove all boroughs, and all sub-urban locations within their immediate orbit (arbitrarily defined as 3 km), vills along navigated waterways were in average wealthier. The mean valuation of taxable wealth in 1334 among non-urban locations within 1 km of a navigated waterway was £50, whereas within 1 km of the non-navigated waterways this was £34. Of the ten wealthiest towns, assessed at £22.000, only Coventry is not by a navigable river. As is shown on fig. 5, the geographical distribution of wealth in non-urban vills retains an association with inland navigation in parts of the country, in particularly by upper Thames and around the Fenland by the Wash. It would be too prescriptive to equate rural prosperity with enhanced transport connections, as there is little correlation for example in parts of the south-west. But these figures are nevertheless suggestive of the economic advantages that water routes will have afforded to regional economies.

Waterways multiplied the geographic reach of direct foreign trade past the coastal sites into the interior of the kingdom, and enhanced opportunities for not only the townsfolk but also the rural population to participate in the flows of interregional and international commerce. While
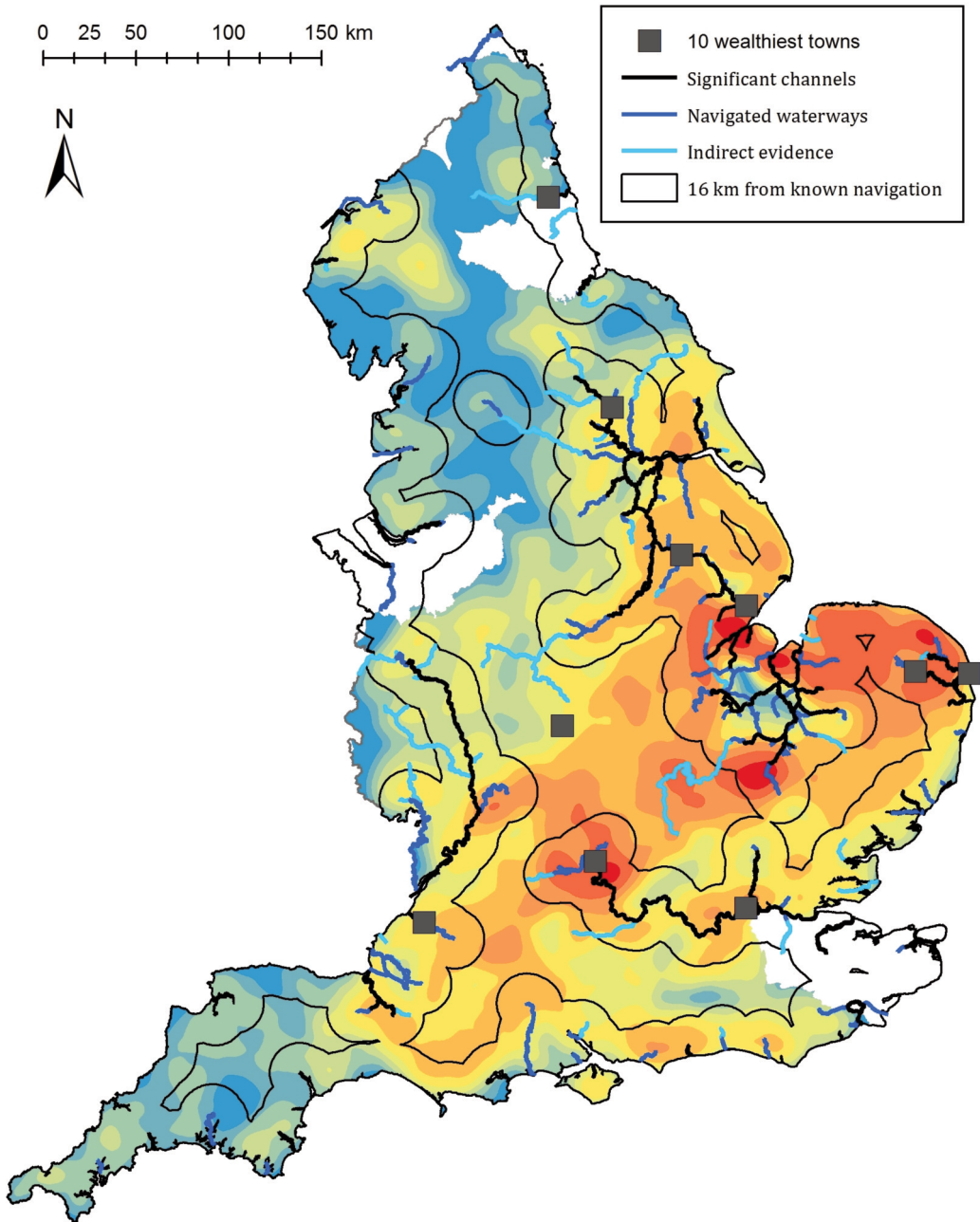
Fig. 5. Kernel density map of non-urban taxable wealth assessed in 1334 in relation to navigation (r = 16 km, breaks at geometric intervals) (sources: Barry *et al.*, *Database of English Lay Subsidies of 1327/1332/1334*).

the integration of local village economies to a national market should not be overstated (Britnell 2000), by the middle of the 13th century it is possible to trace networks linking rural markets, fairs and small towns to regional centres, and ultimately to broader channels of interregional and international trade. Transportation technology changed in reflection of the changing economic framework: the displacement of oxen by horses as draught animals among the peasantry from the middle of the 12th century onwards appears to have owed to the latters' greater suitability for hauling agricultural goods to nearby commercial centres (Langdon 1984, pp. 62-66; Masschaele 1997, pp. 47-105). Customs records show that in 1289-90 some eight million wool fleeces worth £275,000 were exported from England and Wales, and it has been estimated that half of these were produced by peasants (Campbell 2008, p. 918; Masschaele 1997, p. 53).

The entanglement of inland navigation with local commerce is reflected in the spread of formally recognised commercial events. Samantha Letters' *Gazetteer of Markets and Fairs in England and Wales to 1516* records an impressive 2.400 weekly markets and 2.478 annual fairs by 1348 (Letters 2002). While hardly all exchange in the countryside was confined to these events (Dyer 1992), they provide a useful metric of assessing economic developments on a regional and national scale. Some shifting is required to separate the wheat from the chaff: many of the recorded events will have soon failed or may have never existed outside the awarding document. From King John's reign (1199-1216) the royal administration increasingly asserted its prerogative to grant market and fair rights. Especially from the 1250s onward large numbers of grants were made as tokens of political patronage. Whereas earlier franchises were able to establish themselves at economically optimal locations, between 1200 and 1300 the average long-term survival rate of new markets in an increasingly saturated commercial landscape dropped by half (Britnell 1981, pp. 218-219; Masschaele 1994, pp. 256-259; Letters 2002; Letters 2003, pp. 218-219; Jamroziak 2005). A more cautious and representative picture of the spread of formally recognised commercial sites is therefore provided by setting the map to 1250, which yields 934 weekly market events in 861 English vills, and 662 annual fairs in 559 vills. The middle of the 13th century is also after the period of significant canal building by ecclesiastical institutions (Bond 2007, pp. 178, 188-199) and, if Evan Jones' thesis is correct, before decline in the use of waterways began to set in. In this respect it may be supposed to represent the high-water mark of the reach of medieval inland navigation.

(a) Markets by 1250 from Navigated Waterways

(b) Fairs by 1250 from Navigated Waterways

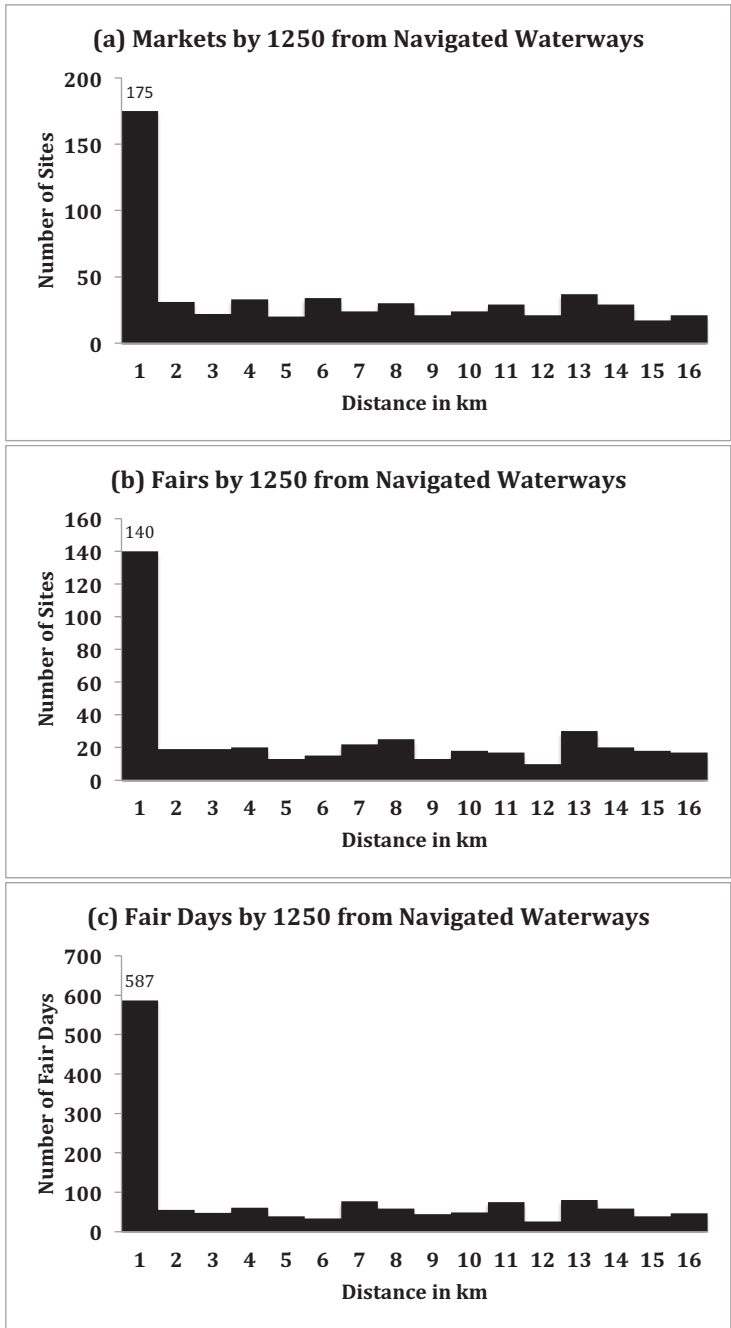**(c) Fair Days by 1250 from Navigated Waterways**

Fig. 6. Relation of commercial sites by 1250 to navigated waterways (source: Letters 2002).

The association of the commercial sites with waterways is evident: in average there are five times more settlements with markets within the first 1 km of a navigable waterway than at one-kilometre intervals over the next 15 km (fig. 6a). For markets recorded 1251-1348 the multiplier drops to 2,5, which supports the argument that later market grants were made more commonly for non-economic reasons and to places located less optimally with regards to transportation routes. The association with navigated waterways is sharper yet when it comes to annual fairs (*b*), with six times the number of fair locations within the first kilometre. If we consider fairs by their length in days (*c*), the factor rises to fourteen. Most medieval fairs lasted three days or less: the vigil, feast and morrow of the associated Christian feast (55% by 1348, source: Letters 2002). These events were probably of largely local or regional importance. But longer fairs were usually located by major overland and water transport routes and their intersections. Of 59 fairs lasting over a week by 1250, only one was not by a navigated river, the coast or a principal road (here former Roman roads, the four royal highways and routes depicted in the Gough map of *c*. 1400) (Oksanen 2015, pp. 195-197).

Ellen Moore's study of great fairs in the 13th and the 14th centuries has documented both their geographically far-ranging significance and their strong association with water transport. Her tabulation of the fair-goers at St Ives in Huntingdonshire shows that not only did it attract merchants from Hampshire to Yorkshire, but also from over the sea: the Low Countries, France and even Italy. The Calendars of State Rolls document that the crown and other major purchasers, such as foreign merchants and ecclesiastical institutions, exchanged cloth, wool, furs, spices and livestock in bulk quantities. In 1252 alone the royal household spent £653 9*s* 4*d* on cloth brought from Douai in Flanders at the fairs of Stamford, St Ives and Boston (Moore 1985, pp. 24-62, 76-85; *Calendar of Liberate Rolls 1251-1260*, IV, 47).

These settlements — like other nearby fairs of importance at Peterborough and King's Lynn — belonged to a nexus of commercial sites linked by a network of navigated channels flowing into the Wash. It would be appropriate to conclude this overview of medieval inland navigation by zooming in on this region particularly well appointed with waterways. (figs. 7a and 7b) A classic view of the medieval Fenland economy read from the Domesday Book of 1086 and the lay subsidies of the 14th century is one of transformation: the fortunes of a sparsely populated and poorly exploited landscape were radically improved by the efforts of the region's numerous monastic houses (Darby 1974, pp. 119-142).
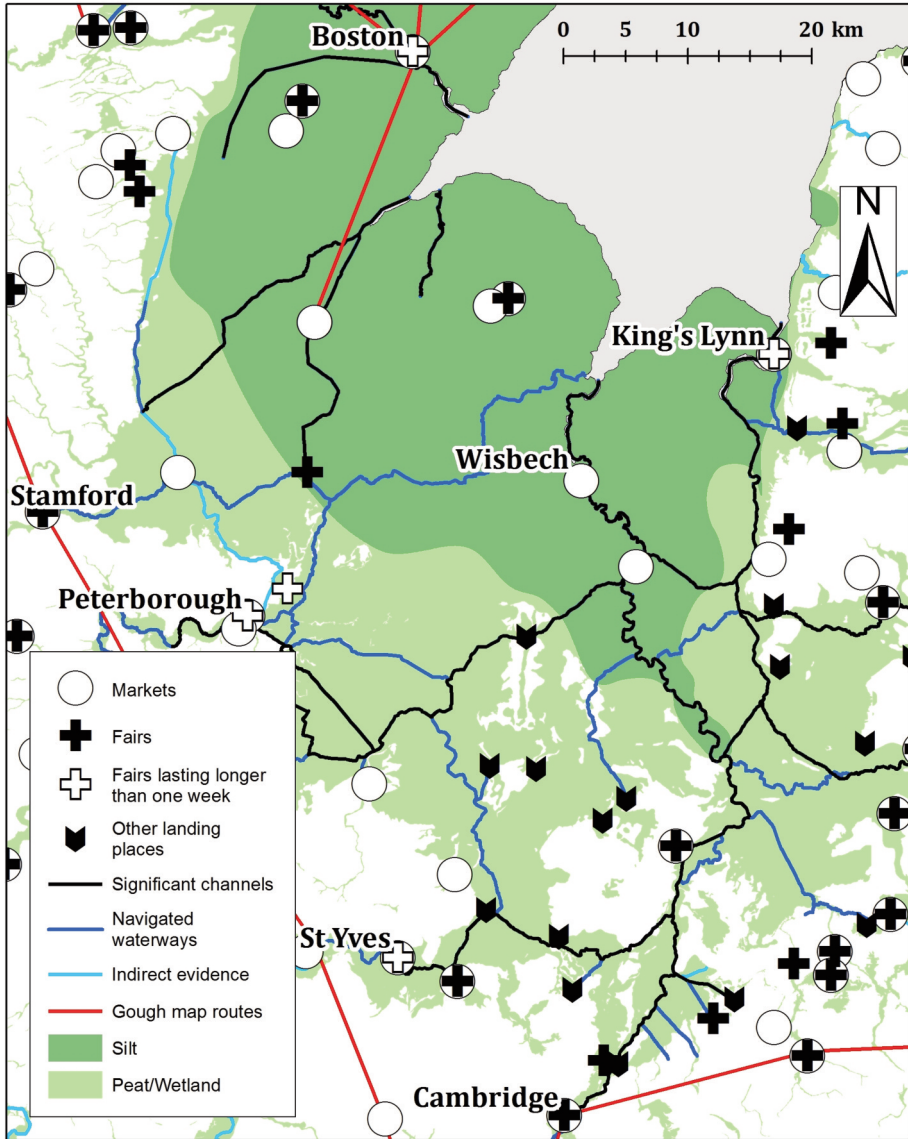
Fig. 7a. Commercial sites by the Fenland by 1250 (sources: EDINA Geology Digimap Service; Gardiner 2007; Letters 2002).
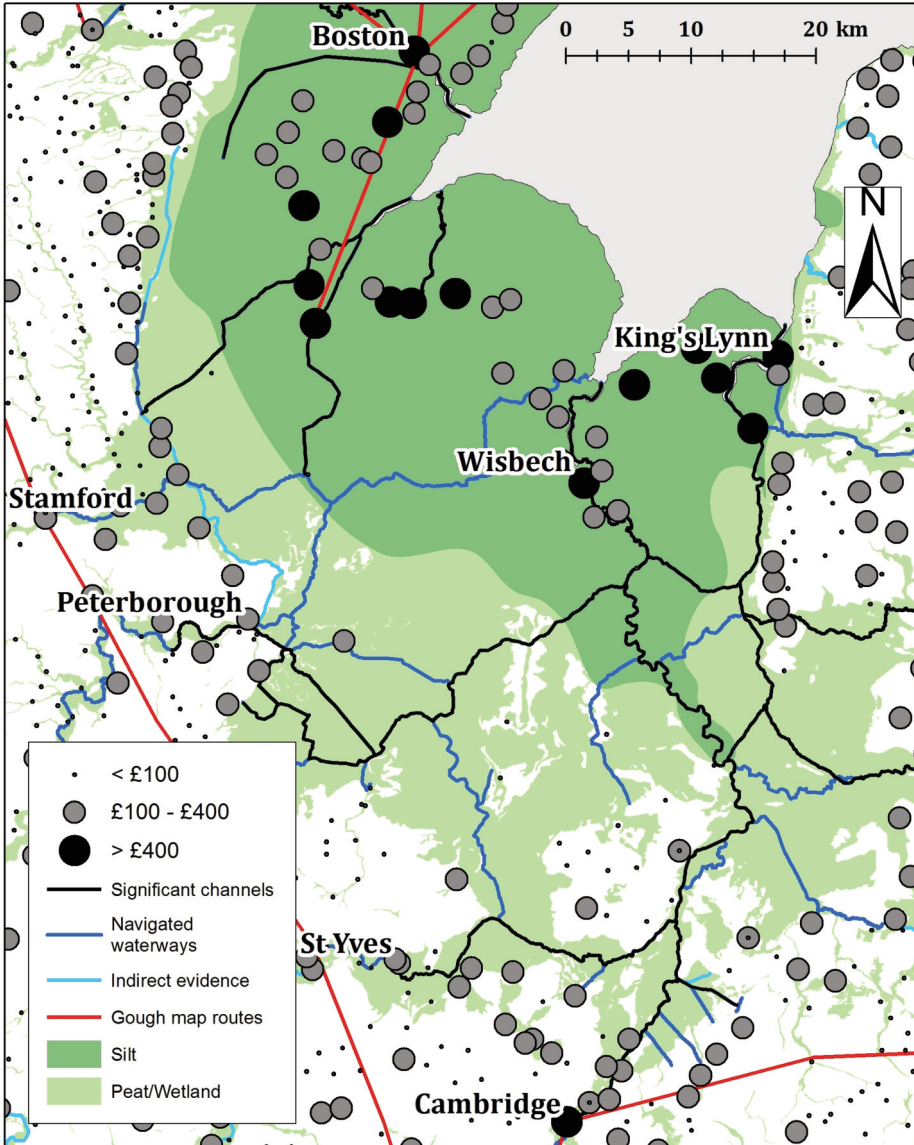
Fig. 7b. Assessed wealth by the Fenland in 1334 (sources: Barry *et al.*, *Database of English Lay Subsidies of 1327/1332/1334*; EDINA Geology Digimap Service).

Recently Susan Oosthuizen has provided a more nuanced view in her re-examination of the Domesday evidence against the physical geography of the region. She has argued that habitation was concentrated in often densely populated pockets of well-cultivated land above the flood risk line. Fenland prosperity in the Later Middle Ages is consequently to be understood as rooted in a demographic structure that had been in place for centuries (Oosthuizen 2014).

Rather than a wasteland, the Fens provide a straightforward example of how the hydrological environment may intensely shape human settlement and activity patterns. The importance of water communications in the medieval Fenland is now well known, and the landscape of markets and fairs as it is recorded by 1250 further clarifies the integration that the region's commercial sites enjoyed with its chief means of transport. Markets and fairs hugged the edge of dry ground or congregated along, or a short distance away, from channels and canals (see also Oosthuizen 2011). The returns of the 1334 assessment reflect and expand upon this economic arrangement.

The zone of very high value vills that had emerged by the 14th century along the coastal silts must have fed upon the intersections of inland and maritime traffic. The Fenland did not only enjoy a coherent internal transport network that facilitated the movement of goods, but also benefited from a central position in English overland and overseas trade. The coastal routes brought in ships down from Yorkshire and points further north, or up past the East Anglian coast from Flanders and France (Oksanen 2013). The Welland, the Nene and the Great Ouse linked waterborne traffic from the east directly with the Great North Road that ran along the western edge of the Fens and connected London with York. Thanks to the Foss Dyke, reopened by King Henri I in 1121 between the Trent and the Witham, the Wash rivers were linked with those of the Humber system. Bar a single short break between the Welland and the Witham estuaries, this joined together a network of rivers that spanned at minimum from Cambridge on the Cam to Boroughbridge on the Ure — a distance of 235 km as the crow flies. As is recorded in the journey of a group of Cambridge scholars to King Edward II's court at Christmastime 1319, a nearly 200 km long river voyage from Boston by the Wash to York could take just five days (Stenton 1936, p. 20). Moore located six out of England's eight internationally most important 13th-century fairs along the rivers of the Wash basin (Moore 1985). As is also indicated on the map of the 1334 returns (fig. 5) this was undoubtedly one of the kingdom's most economically dynamic regions. It would be hard to argue that its wealth did not rely on the extraordinary direct reach of its communication routes.

Digital humanities offer a set of techniques involving spatial, temporal and statistical analysis that are established among archaeologists, but perhaps a little less so among medieval historians. Analysis of 'big data' (though 'big' in the context of historical studies is rather smaller than, say, medical research) has the possibility to offer novel perspectives on traditional topics. Preliminary research results suggest that, for example, the online database of hundreds of thousands of small archaeological finds collected by the Portable Antiquities Scheme opens possibilities to chart developments in the use of individual water routes. A case study of coins found by metal detecting along the now-extinct course of the Wellstream near Wisbech (fig. 7a) shows that through comparing relative coin loss rates against the broader regional pattern it is possible to trace shifts in the river's economic importance (Oksanen, Lewis 2015, p. 58). This GIS research on inland navigation before the Black Death would not be possible without the groundbreaking work done by many scholars upon which it draws. In particular Edwards, Hindle, Langdon and Cole have opened doors to a deeper understanding of medieval water transport. Its role was vital to the emerging geography of economic exchange in the medieval period, which in turn still informs the urban landscape of modern Britain. Beyond bringing together and updating the material collected, the purpose of creating new digital resources will be to continue the task of making available new tools for the study of the history of travel and communications.

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