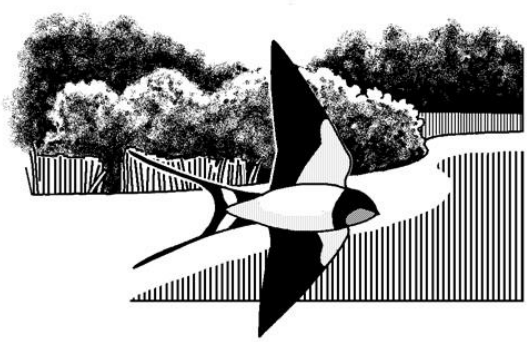

The Little Ouse: aspects of the history of a river.

Tom Williamson: December 2013

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The purpose of this report is to investigate the history of that portion of the Little Ouse river which is the principal concern of the Little Ouse Headwaters Project: that is, the section between its source at Lopham Ford, and a point a little to the south west of Gasthorpe Lodge – a length of 7.5 kilometres in all. The intention was to identify not only changes over time in the course of the river, and its principal tributaries; but also developments in the wider catchment of the river which might have affected its character. For reasons which will become apparent the project was only partially successful in these aims, but has nevertheless thrown much important new light on these matters, and highlighted a number of areas for further research.[1]

1. Introduction: the river and its catchment

The Little Ouse forms the boundary between the counties of Norfolk and Suffolk, an administrative division already fixed by the time of Domesday Book (1086) but perhaps then only recently in place, and still with some irregularities: Domesday shows, for example, that Diss Hundred (an administrative subdivision of the county) lay within Norfolk, but the town of Diss itself is recorded under Suffolk (Williamson 2006, 28). In its upper reaches the river takes a meandering course through damp fens and meadows, but with a number of straighter and evidently engineered sections. The two longest of these lie to the north of Hinderclay Fen, and to the other to the south and south east of Blo Norton Hall, respectively: these were already in place when the earliest detailed maps of the area were surveyed in the nineteenth century. The former is followed by the present county boundary; the latter is not, the boundary here following the line of a subsidiary watercourse, more serpentine in character and evidently marking the course of the original river, a little to the north.

The river, in its course between Lopham Ford and Gasthorpe Hall, is fed by four main tributary streams, three on the Suffolk side and one on the Norfolk. Well-defined in their lower reaches, their upper sections merge eventually with the pattern of field ditches, so that it is difficult to estimate their precise length in any meaningful way.

The character of any river can only be understood within the context of its catchment: that is, the area of land from which it derives its water, at least in terms of surface flows (Ferrier and Jenkins 2010). Changes in the character of land use, especially the relative extent of arable, pasture and woodland, can have a significant impact on water flows and quality. The catchment of this section of the river extends over an area of around 95 square kilometres, extending into parts of no less than 23 parishes: Hopton, Coney Weston, Market Weston, Barningham, Bardwell, Sapiston, Thelnetham, Hepworth, Hinderclay, Redgrave, Wattisfield, Rickinghall (Inferior and Superior), Botesdale, Burgate

[1] I would like to thank Duncan Livingstone and Adam Stone for their advice and assistance.

and Wortham in Suffolk; and North and South Lopham, Garboldisham, Gasthorpe, Kenninghall, Riddleswoth and Blo Norton in Norfolk. It embraces a diverse range of soil types and geologies. The level floodplain of the river itself, and of the lower reaches of its principal tributaries, comprises soils of the Isleham Association, formed in peat and sandy drift, which are naturally waterlogged for much or all of the year (Hodge *et al* 1984). These are interspersed with slightly higher ground, formed in glacial gravels which give rise to poor, acid soils of the Newport Association. Most of the higher ground away from the river, in contrast, comprises soils formed in chalky boulder clays laid down in the Anglian glaciation. Just under 75% of the catchment soils are formed in clay, soils which fall into two broad categories. A little over 30% of the total catchment comprises soils of the Burlingham Association, slightly sandy clays occupying the sloping sides of the principal valleys cutting through the clay plateau; while around 44% fall within the Beccles Association, very poorly-draining stagnogleys occupying the more level, higher ground. Only in the west of the catchment, on the edge of Breckland, are the 'uplands' characterised by freely-draining soils formed in chalky or in overlying sandy drift: soils of the Newmarket 3 and 4 and Worlington Associations (Figure 1). Here, substantial areas of heathland survived into the nineteenth century.

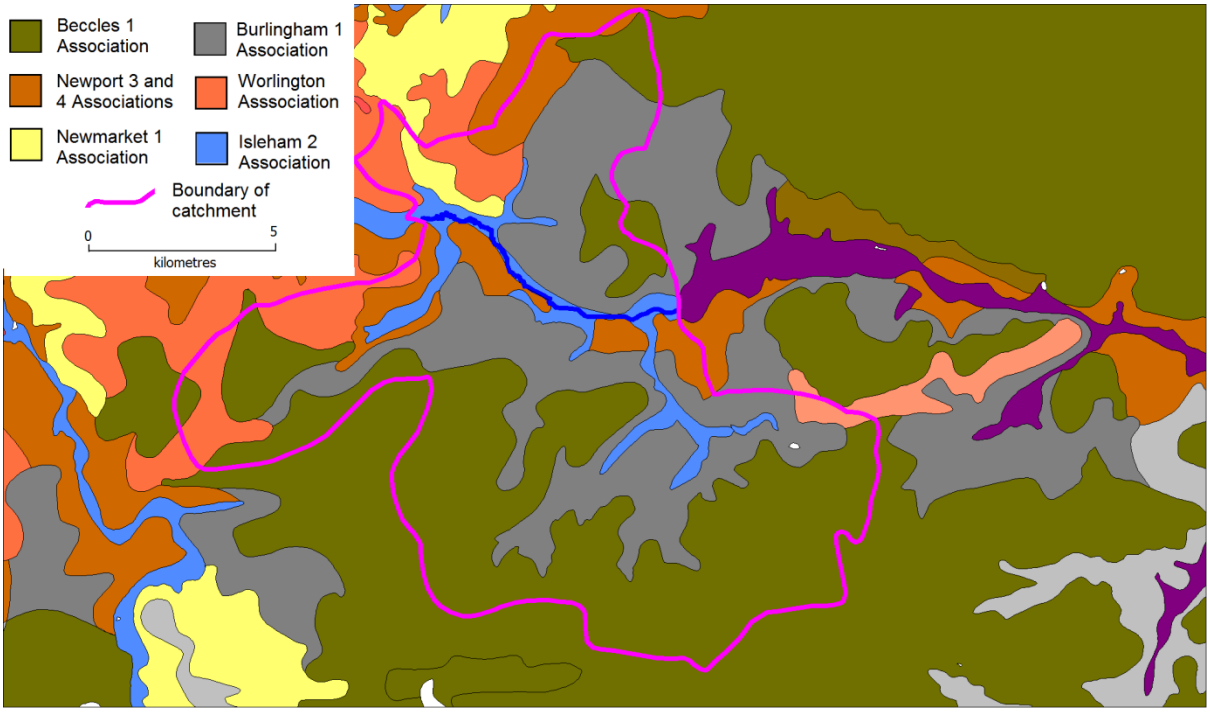


Figure 1: the Little Ouse catchment and principal soil types (source: Soil Survey of England and Wales, Soils of Eastern England).

2. The history of the river

2.1 Administration

Unfortunately, the history of the river – how it was altered and managed within historic times – is poorly documented in public archives, especially compared to many other watercourses in East

Anglia – including the *lower* reaches of the Little Ouse. This is partly due to a marked absence of early maps for the district. Although most parishes within the catchment had part of their area (usually common land) enclosed by parliamentary acts in the early nineteenth century, and thus have enclosure maps showing all or part of their area; and all have tithe award maps dating to the 1830s or 40s; very few earlier maps exist. In part, however, this lack of information is a consequence of the character of the administrative structures relating to the Little Ouse.

In medieval times, the maintenance of drainage in areas which were particularly subject to inundation, and in which the susceptible land was of high agricultural value, was the responsibility of 'commissions of sewers', the earliest of which was established in Lincolnshire in 1258 (Purseglove 1989, 44). These institutions, which were answerable to central government and could levy a local rate towards the cost of maintaining river walls and sea defences, and other flood prevention work, proliferated over subsequent centuries and survived until 1930, by which time they had been supplemented by other forms of private cooperative organisation, especially the Drainage Commissions established by individual acts of parliament in the course of the eighteenth and nineteenth centuries. These forms of administration were modified by the Land Drainage Act of 1918 but were only systematically reformed by the Land Drainage Act of 1930 (Purseglove 1989, 68-71). This established a system of Catchment Boards (which in 1948 became River Boards, and in 1964 River Authorities), within which – in areas in which there was a particular need of flood prevention –Internal Drainage Boards (IDBs) were established which empowered - like earlier bodies – to levy a rate on those likely to benefit from flood amelioration measures.

Courts of Sewers, Drainage Commission, and Internal Drainage Boards did not exist everywhere in England. They were developed in places in which there was a particular need to protect valuable assets – settlements and agricultural land – from inundation. Elsewhere, responsibility for the maintenance of the principal water courses – for ensuring that they remained scoured, and did not become blocked by fallen trees or vegetation – devolved to local authorities, usually by the sixteenth century the churchwardens in particular parishes; and by them, in most cases, to individual landowners. The work of maintaining water courses was essentially reactive, in the sense that the bodies and individuals responsible did not usually create new drainage channels. The details of such activities are usually poorly documented. In the case of minor streams, moreover, all maintenance work was left to local landowners, and is thus even less visible in the documentary record.

Large areas of East Anglia were subject to some form of organised drainage administration in the medieval and post-medieval periods, especially the Broads in the east and the Fenlands to the west. By the 1930s Internal Drainage Boards administered land drainage in the valley of the river Waveney to the east of the Little Ouse catchment area, and in the low-lying land around East Harling to the north (http://wlma.org.uk). But no organised drainage authority appears to have been established within the catchment of the Little Ouse itself: it lay within the Great Ouse Catchment Board, but not within an IDB, and there are thus only sporadic references to the maintenance of the river and other channels in surviving documents, usually when larger projects were being 'outsourced'. In 1733 the principal landowners in Blo Norton thus agreed to pay Samuel Askew, John Creeme and seven other men to clear the river between Thelnetham Bridge and Lopham for £8 15s., plus 5s worth of beer (NRO MC 649/2/787X7).

One reason for this absence of a local drainage authority was probably that, until parliamentary enclosure in the early nineteenth century, most of the low-lying land in the catchment remained as common land, of low economic value; even after enclosure its value was such that it made little economic sense to invest in major schemes of, or bodies to supervise, drainage improvements. But in addition, because this area lay around the headwaters of the Little Ouse, serious flood events were less frequent than they would have been in the river's lower reaches. There are signs, however, that this situation may have changed to some extent in the course of the nineteenth century; or at least, that by this stage traditional forms of drainage administration, based on local initiatives by parishes or individual landowners, were proving insufficient to the task at hand. In the late 1880s the District Association for the Prevention of Floods in the Valley of the Little Ouse between Redgrave and Thetford was established:

> With a view of remedying the bad state of the River, and for some time the various Owners and Occupiers have held meetings to settle on the necessary steps, and a Committee was appointed to view the River (Holt-Wilson archive).

This reported on a number of issues concerning the narrow, obstructed and silted character of the river channel, and the resulting poorly-drained condition of adjoining land. It is unclear what became of this initiative, but it is likely that it fell victim to wider economic circumstances. From the late 1870s British, and especially East Anglian, agriculture fell into a major depression which continued, on and off, until the outbreak of the Second World War in 1939, and which was caused by the escalating scale of imports of cereals and, subsequently, frozen meat from the Americas and Australia (Perren 1995). This reduced the amount of money available for investment in any kind of agricultural improvement, and the value of the land in the area was evidently not deemed sufficiently high for it to receive its own Internal Drainage Board under the terms of the Drainage Act of 1930.

2.2 Changes to watercourses.

Given the apparent absence of organised and co-ordinated arrangements for land drainage in the area in the medieval and post-medieval periods, the existence by the nineteenth century of what are clearly straightened sections of the river, and in some cases of its main tributaries, remains intriguing. As already noted, there are two main engineered sections on the river itself: one, 700 metres in length, to the north of Hinderclay Fen and another, of around 500 metres, to the south and south east of Blo Norton Hall. It is difficult to ascertain the date of either, given the paucity of early maps for the district, already alluded to. Although we might expect that both were created when the valley floor fens were enclosed by parliamentary acts in the early nineteenth century, the acts for Hinderclay, Blo Norton and Thelnetham leave no doubt that these straight sections were already then in place. The only earlier maps available are the county surveys by Faden for Norfolk (1797) and Hodskinson for Suffolk (1783), but these are drawn at too small a scale, and are too schematic in character, to throw much light on the issue, although both seem to suggest that the section by Hinderclay Fen, in particular, had not yet been straightened. If this alteration was indeed made in the late eighteenth or early nineteenth century, it is surprising that the new course is followed by the county boundary (unlike the section by Blo Norton Hall), and that no record of the change

appears in surviving documents. Precisely how this new course was created, given the divided character of authority across both parish and county boundaries, remains very uncertain.

The river channel appears to have remained remarkably stable since the late, and probably since the early, nineteenth century. The principal local maps surveyed in the early and middle decades of the nineteenth century – the various enclosure maps and tithe award maps – appear (when due allowance has been made for accuracy) to show the line of the river as more or less identical to that which is depicted on the First Edition Ordnance Survey 6" maps from the 1880s. Only four relatively minor alterations to the river's course have been made since that time (Figure 2). All, significantly, are in places where particularly tortuous meanders occur and were evidently made to speed up the flow of the river and thus reduce the incidence of flooding. None of them existed when the Second Edition Ordnance Survey maps were made in c.1905; but they are all clearly present on the RAF vertical aerial photographs of 1946. These do not suggest that the changes had been recently made, however, as there are no signs of spoil etc., implying that they had been completed before the start of the War, or just possibly in its early stages.

The lower sections of the streams draining into the river have also been straightened in a number of places. Good examples include the angular course of the stream in Hopton Fen, and the two straight alignments of the stream running through the former area of Garboldisham Common. These appear to have been realigned when the common fens through which they ran were enclosed by parliamentary acts in the early nineteenth century: in part to speed up the flow of water and thus improve drainage, and in part to facilitate the allocation of land, in measured parcels, to those receiving allotments in lieu of common rights. Some straight or angular sections higher up the course of tributary streams can also be correlated with areas of former common grazing enclosed by parliamentary acts, as for example where one passes through the former area of Weston Fen

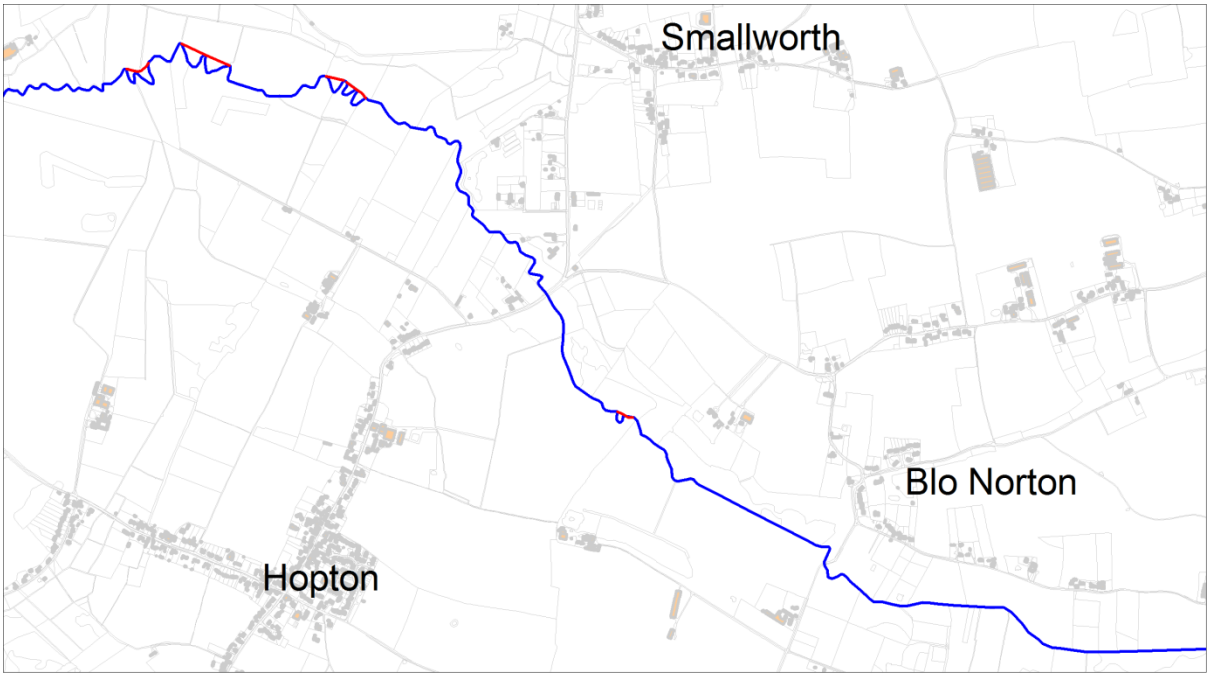


Figure 2. The four main changes to the course of the river Little Ouse made between the 1880s and the Second World War (in red). With these exceptions, and excluding examples of possible minor widening , the course of the river appears to have remained unchanged for over a century.

between Hopton, Market Weston and Coney Weston. But others must represent the consequence of initiatives taken by single landowners, or groups of landowners, to speed up the flow of water through low-lying ground – probably in the post-medieval period but in some cases, perhaps, earlier. One of the most dramatic changes to a tributary in the area was, however, nothing to do with drainage improvements: the creation of the lake within Redgrave Park, reliably attributed to the activities of Lancelot 'Capability' Brown here in the 1760s (Stroud 1965). The New Water higher up the stream, outside the park, was added later in the century.

Assessing the course of, and length of, the various tributaries of the river and how these changed over time is, in more general terms, made difficult by problems of definition. By the time the earliest surviving maps were made, and presumably for a long time before this, the upper reaches merged almost imperceptibly into the network of man-made field ditches, and in a number of places (as for example between Thripskin Farm and Green Farm in Thelnetham) followed ditches running along the sides of roads. The Ordnance Survey 6": one mile First Edition Surveys of the 1880 and 90s thus show the lower reaches of the tributary streams as blue lines, often accompanied by an arrow showing the direction of flow: but the upper reaches are more ambiguously depicted, as single black lines which can only be distinguished from field boundaries in places where the stream runs clearly through the middle of meadows, rather than coinciding with the field margins, as for example in the area between Rickinghall Inferior village and West Hall. The tithe award maps from the late 1830s/early 1840s make a similar distinction, and are generally in agreement with the OS. The lower reaches are clearly defined, with double lines or wide blue lines, but the upper reaches are shown in the same way as the field boundaries or roadsides with which they usually, indeed, coincide. Figure 3, showing the course of the principal tributaries in the nineteenth century, thus similarly distinguishes between the 'defined' length, and the more ambiguous upper reaches, the principal line of which has often been deduced simply from continuous and serpentine alignments of field boundaries.

2.3 Summary

Drainage on the upper reaches of the Little Ouse never seems to have been administered by an organised body (such as a Drainage Commission or an Internal Drainage Board). In spite of this, individuals, groups and parishes appear on occasions to have altered and straightened sections of the river and its principal tributaries. In some cases this was when areas of low-lying common fen were enclosed by parliamentary act in the early nineteenth century, but in others the date of the alteration remains unclear. The upper reaches of the tributaries were more radically affected by human activity, for here poorly-defined upland flows were given greater definition through the expansion of cultivation and the division of land in the medieval period, so that the 'natural' watercourse, if it ever existed, was redefined as a ditch running along the margins of a road, or as a field boundary.

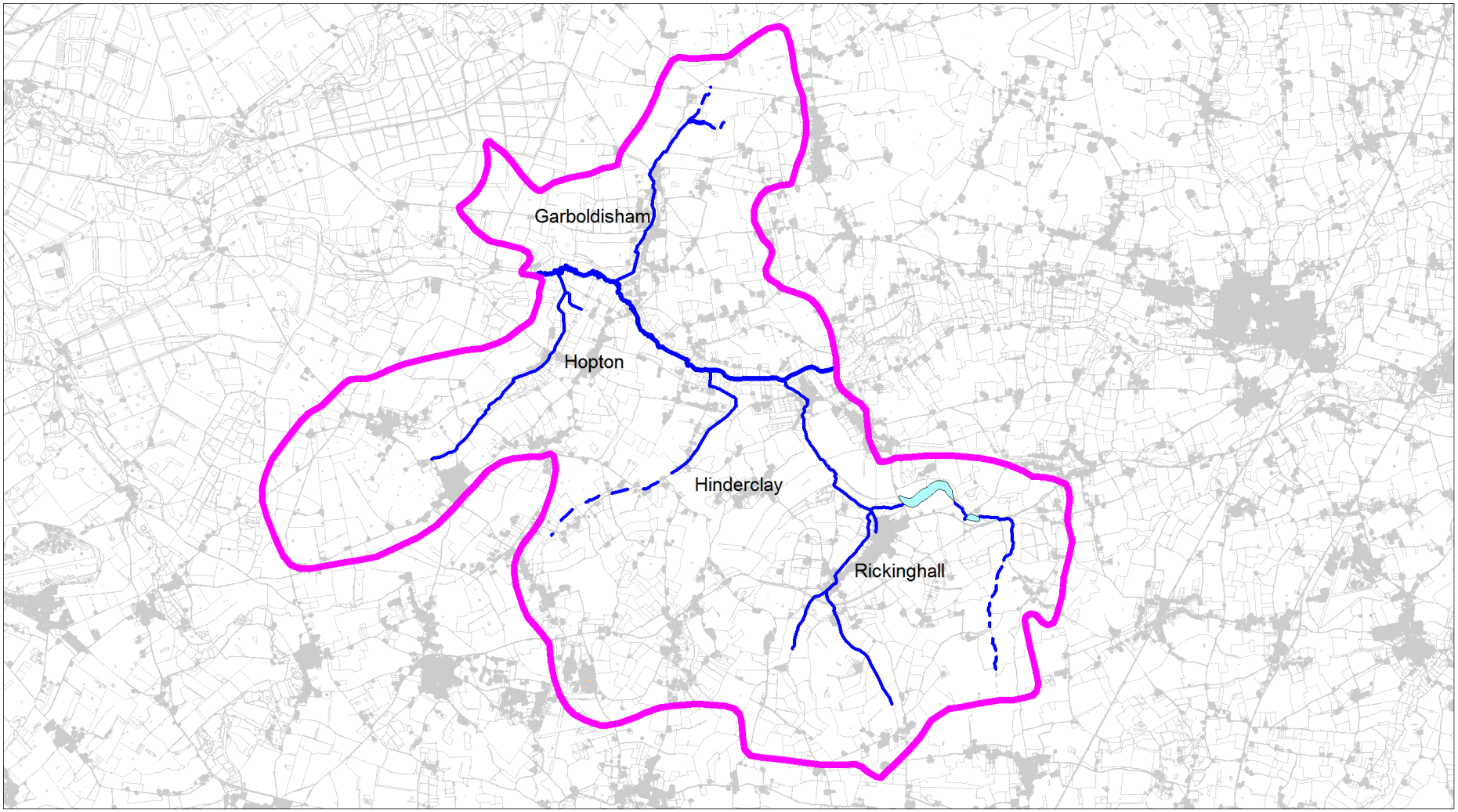


Figure 3. Principal tributaries, as depicted on the mid-nineteenth century Tithe Award maps, and the late nineteenth-century Ordnance Survey 6" maps.

3. Early Land Use in the Catchment.

3.1 Land use patterns in the mid nineteenth century.

The first point in time for which we can make a reasonably accurate assessment of patterns of land use within the catchment is c.1840. This is because all local parishes, with the exception of Sapiston, have tithe awards with accompanying maps – that is, surveys of ownership and land use drawn up on a parish-by-parish basis when tithes were commuted under the terms of the 1836 Tithe Commutation Act (for individual map references, see bibliography).[2] Although additional classifications were sometimes employed, such as ''Turf' for areas of unreclaimed fen, most of the land assessed falls into three categories: arable, pasture (including heath and meadow), and woodland (Including both ancient, semi-natural woods and post-medieval plantations). Yards and orchards are sometimes described as 'pasture' and sometimes not, and on Figure 4 I have grouped such areas, associated with farms and villages, under a separate category of 'gardens, yards and orchards'. There are, in all, several thousand parcels of land listed for the nineteen parishes with land in the catchment, so 100% accuracy is not claimed, although the mapped results should be generally correct. Parcels of *arable* land were not individually mapped, but only non-arable areas, arable thus being treated as the 'default'. Minor linear features such as roads have not been included.

In broad terms, around 73% of the catchment appears to have been under arable cultivation in c.1840. Much of the unploughed land was to be found on the damp land in the floodplains of the Little Ouse and its tributaries itself: if we consider only the surrounding 'uplands', the area under cultivation rises to around 80%. East Anglia was already, by the middle decades of the nineteenth century, a predominantly grain-growing district (Wade-Martins and Williamson 1999, 49-52), although it should be noted that most farms, as well as retaining some permanent pasture and meadow to supply their livestock, were also practising a four or five-course rotation on their arable land which included a sown grass lye, cut for hay or directly grazed by livestock: so the amount of pasture and meadow in the landscape was actually rather greater than these bald figures suggest.

3.2. Land use patterns in earlier periods

We have no source which could provide figures for land use patterns within the catchment at any previous period in time, but there is little doubt that a century earlier the area under arable cultivation would have been significantly less extensive. There were two reasons for this. Firstly, a substantial body of evidence indicates that in the sixteenth, seventeenth and early eighteenth centuries most farms on the East Anglian claylands specialised in livestock farming, often with only a quarter of their land in tilth: this was cattle-rearing and dairying country (Theobald 2002; Wade-Martins and Williamson 1999, 21-28; Holderness 1984). Secondly, large areas of open common land still existed in the area until the spate of enclosure acts in the early nineteenth century. It is true that

[2] The tithe map for Wortham is illegible and was not used

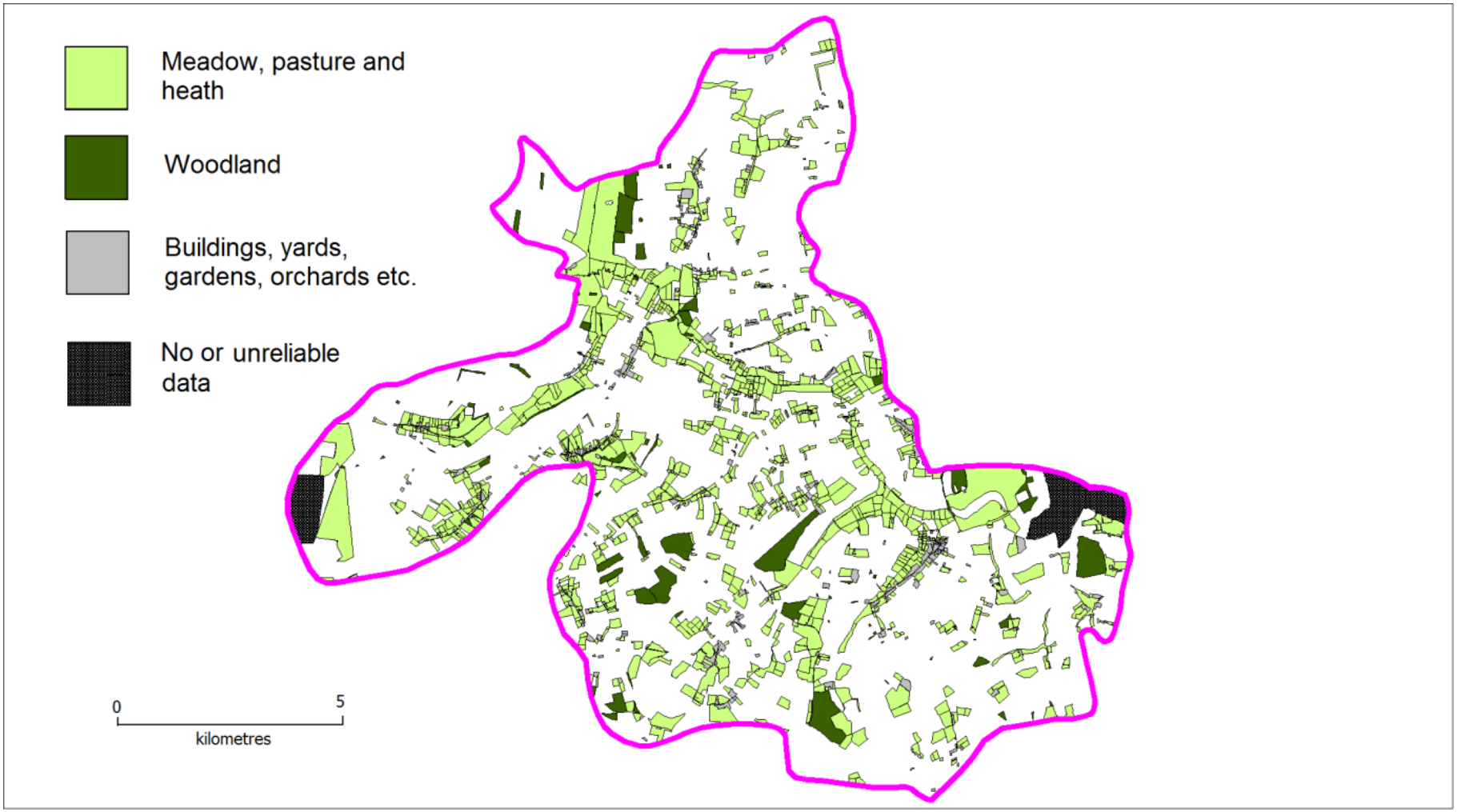


Figure 4. Areas of non-arable land use within the catchment in the mid nineteenth century (source: tithe award maps. For dates of individual maps see References: Archive Sources).

much of this land was – after enclosure – still used for grass, especially that on the floor of the Little Ouse valley. But much, especially on the uplands, was converted to arable.

Although it is impossible to provide an accurate estimate for the relative extent of pasture and arable in this earlier phases of agricultural history, some approximations are possible for the middle decades of the eighteenth century, a time when arable was beginning to expand. Figure 5 shows the location of the principal areas of common grazing land in the eighteenth century, derived from enclosure awards and the county maps produced by Faden (for Norfolk, 1797) and Hodskinson (for Suffolk, 1783); together with the probable extent of woodland, based on the woodland shown on the tithe award maps which can, with reasonable confidence, be identified as being of 'ancient', semi-natural character.[3]It also shows the areas of parkland, and associated woodland and belts, which were in existence by c. 1760. It is not possible to indicate on the map the areas of *private* pasture which existed within the catchment at this time, for no source exists from which this might be calculated. We can, however, provide a conservative estimate of the extent of this by assuming that all it was roughly equivalent to the area of private grassland existing in the catchment in c.1840. In fact, this will provide a very conservative figure for, as noted, the local landscape became increasingly arable in the later eighteenth and early nineteenth centuries. Nevertheless, on the basis of these assumptions we might estimate that around 60% - 65% of the total catchment area was under arable cultivation in c.1760.

Moving earlier in time, we might assume that this figure had been slightly lower during the seventeenth century, when cattle farming formed such a significant element in the local economy – perhaps 50 - 55% - but higher again in c.1300, at the peak of the pre-Black Death population explosion, perhaps – as in c.1760 – reaching around 60-65% of total catchment area. This was the result of a gradual expansion from early Saxon times, prior to which – in the Roman period – an abundance of settlement sites recovered by field surveys suggests an earlier, lower peak.[4] In short, the extent of arable will have fluctuated over time, but in the later eighteenth and nineteenth century reached unprecedented levels within the catchment, rising from around 60 – 65% to around 73% of surface area.

[3] Based in part on the name and shape of the wood in question and in part on its modern character, if it has survived: and especially on whether it appears in the *Ancient Woodland Inventory* maintained by Natural England.

[4] At least five Romano-British settlements are known from Hopton alone (Suffolk HER). Early Anglo-Saxon finds are in contrast sparse in the locality, as they are in areas of clay soil more generally, reflecting at least in part a dramatic decline in population. Nevertheless, pollen evidence from Diss Mere, some7 kilometres to the east; and from Hockham Mere, 8 to the north; shows little evidence of post-Roman woodland regeneration. This said, there was a marked contraction of arable, and an expansion of pasture, from late Roman times, which only began to be reversed from the seventh or eighth century (Bennett 1983; Peglar *et al.* 1989).

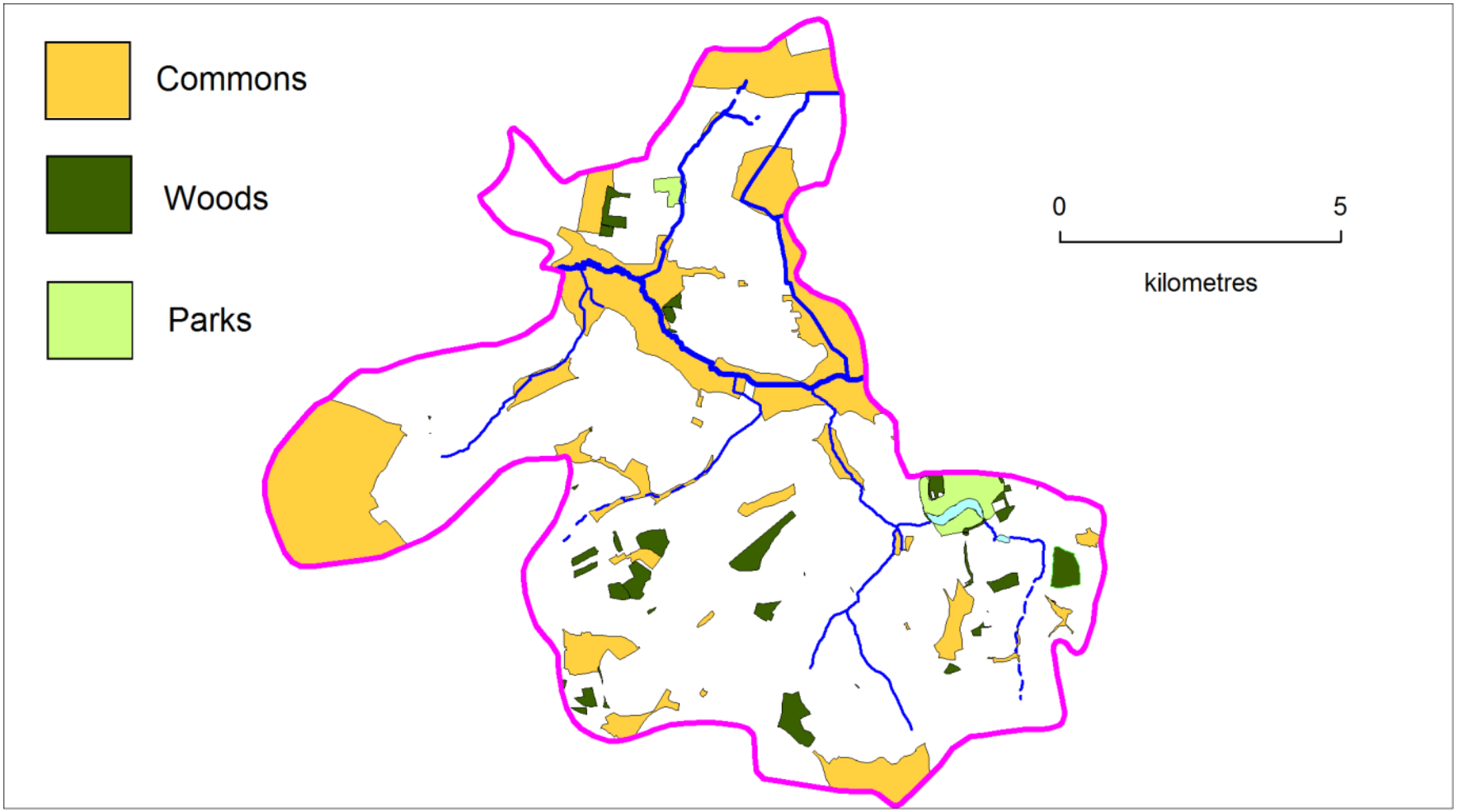


Figure 5. The catchment area in the mid-eighteenth century, showing probable extent of woodland, parks and commons. Note the continuous band of common land flanking the river. Based on Hodskinson's map of Suffolk, published 1786, and Faden's map of Norfolk, published 1797, with additions from other sources).

3.3 The implications of agricultural change.

Variations in land use over time are important because they will have affected the rapidity of surface run-off entering the river after precipitation, and also the quantity of silt and suspended nutrients held in that water. In broad terms, run-off is most rapid where land is under arable cultivation, and especially where the soil surface is relatively bare during the winter months. In modern farming, water entering watercourses tends to be most enriched by nutrients in areas where livestock husbandry is practised ,but this is largely because modern husbandry systems involve the fattening of stock on imported foodstuffs. In pre-industrial farming, where stock are largely kept on grass and locally grown hay, there was probably little difference in the degree of nutrient loading produced by arable and pastoral systems. But these things were also, in addition, affected by particular details of farming practice.

In the middle ages, much of the arable land within the catchment comprised *open fields* - that is, areas in which the holdings of cultivators were intermixed as narrow, unhedged strips – although a significant proportion, particularly of the demesne land (i.e., directly exploited by the manorial lord) lay in closes (see the discussion of Walsham le Willows, just outside the catchment, in Martin and Satchell 2008, 170-78).In the course of the fifteenth, sixteenth and seventeenth centuries the open fields were gradually enclosed, partly to facilitate the expansion of livestock farming but also, more generally, to allow farmers to cultivate their land on a more individualistic basis. Such early enclosure was not achieved through the kind of large-scale, planned reorganisation which saw the removal of the local commons in the early nineteenth century. It was instead the consequence of gradual, piecemeal initiatives. Individual landowners bought, sold and exchanged strips so that they acquired consolidated blocks of land, which they could then surround with a hedge and farm as they liked, free from the communal controls and uses which, to varying extents, applied to the open arable. Although some open field arable survived, especially in Garboldisham, at the end of the eighteenth century, the bulk of the open fields within the catchment had gone by the end of the seventeenth century: an estate map for a property in Hopton, surveyed in c.1740, shows a landscape almost entirely composed of hedged fields (Suffolk Record Office, Bury St Edmunds, EB 1/1). On the other hand, even in 1773 some of the land shown on an estate map in Blo Norton still lay in unenclosed strips (NRO MC 2477/2/976X5). Institutional land, such as the glebe or property belonging to local charities, could not be consolidated easily as private land and as a result strips often came to lie in the middle of consolidated parcels: such land might initially have been rented out to the individual whose property surrounded it, but there were obvious opportunities for illegal appropriation. In 1840 the Charity Commissioners reported that this had happened to many of parcels making up the endowment of Bole's charity in Garboldisham.

> Neither the site nor quantity of the lands in respect of which some of the rents are received could at the time of our enquiry not be ascertained: with some trouble persons locally acquainted with the parish may succeed in making the discovery (NRO).

Piecemeal enclosure has often left clear traces in the landscape, for the gradual establishment of hedges along the edges of contiguous groups of strips preserved the basic layout of the old landscape. Strips in the open fields were seldom straight: they were usually slightly sinuous, sometimes taking the form of a shallow 'reversed S' (caused by the need for the ploughman to move towards the left as he approached the end of the strip in order making to avoid too tight a turning circle) (Eyre1955). In

addition, two strips running end to end were seldom enclosed in line by this method, so that the boundary of one of the new enclosures generally ran not to the corner of the next, but to a point a little way in along the boundary line, creating distinctive kinks and 'dog's legs'. Such shapes, although less visible in the landscape as a consequence of large-scale hedge removal in the second half of the twentieth century, dominate large parts of the local field pattern depicted on earlier maps.

It remains uncertain how far enclosure *per se* may have changed the character of surface flows of water into tributaries, and thus into the Little Ouse itself. In open-field landscapes, water was conducted along furrows into slades and washes on the margins of blocks of strips, whereas in the enclosed landscape fields were surrounded by hedges, flanked by deep ditches. The rapidity of run-off may have been more rapid after enclosure but counteracting this was the fact that much of the enclosed land was laid to grass. We might guess that the result was largely neutral.

More important were the changes which occurred within farming systems in the period after c.1760, in the period of the 'agricultural revolution', and during the 'high farming' period of the middle decades of the nineteenth century (in effect the first phase of modern industrial farming).

3.3.1 Land Drainage.

The later eighteenth and nineteenth centuries saw, for the first time, the widespread adoption within the catchment of the practice of *underdrainage*: that is, the cutting of drains beneath the surface of the soil which removed water first downwards, beyond the root zone; and then laterally, into perimeter ditches (Wade Martins and Williamson 1999, 62-4). It was an innovation of considerable importance both in raising yields, and in expanding the area under cultivation, on the heavy soils of south Norfolk and north Suffolk. Before the adoption of earthenware tiles and pipes in the nineteenth century drainage was usually carried out using 'bush' drains. As their name implies, these were trenches cut across fields which were filled with brushwood cut from pollards, coppiced woods or hedges, capped with straw or furze, and then backfilled with soil. The drains either emptied directly into the ditches surrounding the field, or into a larger underground drain which did so. Field drains of this kind would commonly last between ten and fifteen years, although they could survive for longer (Young 1804, 92).

So far as the evidence goes, the idea of laying single drains, or small groups of drains, to improve particularly damp areas of ground had been known since at least the early seventeenth century. The practice of 'thorough' drainage, in contrast - filling a clay field with a dense network of drains - seems only to have developed in the course of the eighteenth century, and especially of the period after c.1780. One of the contributors to the Raynbirds' *Suffolk Agriculture* of 1849 reported:

> The statement of old farmers, who allege that sixty or seventy years ago the practice was just being introduced into the parish in which they had been brought up, and that previous to that time the system of *thorough* drainage by placing drains at regular and close intervals throughout a whole field was not practised, but merely drains put in here and there to carry water from a particular wet spot (Raynbird and Raynbird 1849, 112).

Various farming journals and diaries confirm that under drainage was being carried out on a large scale by the last decades of the century. Randall Burroughes, an energetic improver on the Norfolk clays near Wymondham, some 15 kilometres to the north east of the catchment, was draining around 25 acres of his large (c.300 acre) farm each year in the 1790s. Here, as elsewhere, the drains were generally spaced at intervals of 12 yards (c.12 metres) and dug to a depth of 24" or 26" (c.0.6 metres). They fed into main drains dug to a depth of 28" (Wade Martins and Williamson 1995, 27; Young 1804a, 89-93; Young 1795, 172-3). In the late eighteenth century new sorts of drainage 'fill', more durable in character, were being devised (Harvey 1980, 72). Horseshoe tiles, set upside down on a flat 'sole' tile, were increasingly used, or simple hand-made pipes But these were expensive, and the spread of underdrainage using tile pipes was slow until a number of important technical developments were made. In 1835 Robert Beart of Godmanchester (Huntingdonshire) invented machines for the mass production of tiles and soles, and a number of similar inventions soon followed (Phillips 1999, 64). At the same time, experiments were being made into methods of cheaply producing cylindrical drainage pipes, endeavours which culminated in the pipe-making machine designed by Thomas Scraggs, which was patented in 1842. But so far as the evidence goes, even in the later nineteenth century most smaller farmers in East Anglia were using bush drains, rather than tile pipes.

Although direct references to the practice of underdrainage in the Little Ouse catchment in the eighteenth and early nineteenth century are rare, there is little doubt that it was here, as elsewhere on the East Anglian clays, standard practice by the middle of the nineteenth century. This is certainly implied by the comments in the 1838 tithe file for North Lopham: 'Good and effectual underdraining is constantly necessary and this in the case of the small owners and occupiers is *sometimes neglected* on account of the heavy expense…' (TNA IR 18/6069: my italics).

The main environmental effect of the spread of field drainage was unquestionably to increase the speed with which water falling on the ground arrived in major watercourses. This was noted as a potential problem as early as 1863 by John Bailey Denton, for example, who thought that 'floods are more quickly precipitated into the valleys, in proportion to the extent of under-drainage in the various river basins', and urged that if yet more agricultural land was to be drained, rivers would need to be extensively engineered (Denton 1863, 579).[5] Increased velocity of run-off also increased the amount of suspended silt in watercourses.

3.3.2. New rotations, livestock numbers and nutrient loading

It might be thought that to some extent the speed of run-off will have been reduced by the fact that the new rotations adopted in the district in the course of the eighteenth and early nineteenth centuries involved, not only the cultivation of fodder crops (turnips and clover or other 'improved grasses) in rotation with cereals (mainly wheat and barley), but the eradication of year-long bare fallows. The soil surface would thus have been less exposed to rainfall, and that water in consequence have moved less rapidly into field ditches and water courses, run-off being retarded in all stages of the rotation by the presence of cereals,

[5] J. Bailey Denton, 'The effects of under drainage on our rivers and arterial channels', *Journal of the Royal Agricultural Society of England* 24 (1863), pp. 573-589; p. 579.

turnips or rotational grass. Such a view is based on a misunderstanding of how these new rotations worked in practice: in reality, the new rotations were at best neutral in this regard. The uncultivated fallow which had featured every third or fourth year in conventional husbandry was removed, but in the most commonly adopted form of the 'new rotations' the wheat course was followed by turnips. The wheat was harvested in September, but the turnip seed was not sown until the following summer. Not only was there thus still, in effect, a 'fallow' in the new systems but its character may have increased the rate of surface run-off. This is because the traditional fallow had taken the form of rapid, spontaneous weed growth which was grazed, for all or most of the year, by livestock. In the new rotations, in contrast, in the period between wheat harvest and turnip seeding the land was only grazed for some of the time: from the early spring it was usually 'bare fallowed', repeatedly ploughed and harrowed to provide the fine seed bed required of the turnips.

It is usually accepted that the main achievement of the 'new rotations' was to raise the numbers of livestock kept on farms, thus increasing the amount of manure produced and in turn raising cereal yields. This will have had an effect on the amount of Nitrogen and Potassium entering watercourses, especially where cattle were grazed on the clover leys in the rotation, for half the N and more than half the P they produce is contained in the urine, which when dropped in the fields largely leaches away. In fact, the story is more complicated than this: in most arable districts, especially in East Anglia, the adoption of the new rotations was accompanied by the ploughing up of both common and private pastures, as I have already noted, and to some extent the new fodder crops now being grown in the arable fields simply compensated for the loss of feed available from permanent grass. By a remarkable stroke of luck such an idea can be tested in a local context. Two series of tithe accounts have survived from the village of Stansfield, twenty kilometres to the south west of the catchment area, and on similar clay soils, one dating to c.1760 and one to 1808. The former provides figure from which stocking densities can be calculated for ten farms covering 759 acres; the latter, eight farms, 678 acres (SRO (Bury) FL 627/3/18 and 6/3/21). Using the method developed by Yelling in the 1960s for calculating livestock densities (Yelling 1970)[6]we can see that there was, in fact, little change in the ratio between stock numbers and cropped acreage: 0.29 per acre in c.1760, and 0.24 per acres in 1808, and in absolute terms the increase in livestock numbers within the catchment may have been modest. Yet this situation almost certainly changed to some extent during the nineteenth century. Artificial cattle feed, in the form of oil cake – a by-product of the rape and linseed oil industries – began to be used on East Anglian farms at the end of the eighteenth century but was adopted on an ever-larger scale in the course of the nineteenth: in 1839 3,384 tons of cake were being imported through Great Yarmouth alone *per* annum, a figure which had risen to 7, 452 tons by 1843 (Bacon 1844, 115). By the middle decades of the century farmers were buying very substantial quantities: one 330-acre farm at Harleston on the south Norfolk clays used between 15 and 20 tons a year (NRO Mf/RO10). There was, moreover, general agreement amongst contemporaries that the dung produced by sheep and cattle fed on cake was far richer in nutrients than that from stock fed on turnips and clover. In the period between c.1820 and c.1870, therefore, there will unquestionably have

[6] This calculates stocking units on the basis of the nutritional needs of the animal in question: total stocking density = (no. of horses X 1.0) + (oxen, cows, bulls X 1.2) + (immature cattle X 0.8) + (sheep X 0.1).

been some increase in the levels of N and P entering the watercourses within the catchment, although perhaps a relatively small one. In addition to this, from the 1830s local farmers began to use imported and artificial fertilisers – guano, bone dust, and superphosphates. James Caird recorded in 1851 how, on the Euston Hall estate on light land a few kilometres to the west of the catchment, the fields were treated with guano (two hundredweight per acre) rape dust or bones prior to the sowing of turnips, 'the dung being reserved for the wheat crop' (Caird 1851, 160). This will have further served to raise nutrient levels in local watercourses.

3.4 Summary

Although we lack the kind of detailed data which would allow us to calculate, with any degree of accuracy, changes in land use patterns within the catchment of the Little Ouse over the long term, it is clear that the extent of arable land has fluctuated to a significant degree, perhaps reaching c.60 – 65% in c.1300, falling over subsequent centuries to 50-55%, before rising once more to perhaps 60% by c.1750. Thereafter, with the ploughing up of local commons and a general shift towards a primarily cereal-growing economy during the 'agricultural revolution' and 'high farming' periods, the arable area rose to unprecedented levels, reaching around 73% of the total catchment by c. 1850 – rather more if the low-lying fens and meadows of the valley floor are excluded. This expansion in arable area was, moreover, accompanied by other changes, especially the widespread adoption of underdrainage and the use of manufactured animal feeds and fertilisers which served both to increase the rapidity of run-off and to raise the amount of suspended nutrients.

More rapid run-off from agricultural land within the catchment would in itself have increased the likelihood of flooding in river valleys: but in addition, water moving at higher velocity carries more silt which, deposited in major watercourses, causes shoals and banks which further inhibit flow. We might thus expect that incidents of localised flooding would increase to some extent in the course of the nineteenth century. Increased nutrient loading might also have exacerbated this situation as it would encourage the growth of emergent vegetation – that is, plants which are rooted in the bed of the stream but which rise above the surface of the water – further constricting flows of water. In this context, it is noteworthy that the first major flood recorded in Thetford came in 1830, and that by the 1880s local landowners had become so concerned about flooding that they formed the District Association for the Prevention of Floods in the Valley of the Little Ouse between Redgrave and Thetford, as already described. In their report they noted how the upper reaches of the Ouse were in general need of dredging, with significant accumulations of silt which 'considerably impede the flow of the stream'; and that in a number of places the movement of the water was slowed by excessive weed growth, including the 'big standing beds of rushes' by Hopton Fen.

4. Recent Changes in the Catchment, c.1880-2010.

4.1 The Agricultural Depression

I have already noted how, from the late 1870s, the fortunes of farming – especially in the arable east of England – declined markedly, heralding a depression which is often described as continuing until the outbreak of the Second World War (Perren 1995; Douet 1989; Wade Martins and Williamson

2008, 11-39). In reality, this was a complex period of adjustment and change. There was thus some recovery in the agricultural economy in the years around 1900; a more rapid return to profitability during the First World War; renewed slump in the early 1920s; some recovery in the late 1920s, aided in particular by the cultivation of a new crop in the locality, sugar beet; further decline in the early 1930s; followed by slow improvement towards the end of that decade (Wade Martins and Williamson 2008, 11-39). This said, overall farming was carried out at lower levels of intensity than it had been for much of later eighteenth and nineteenth centuries, and some land in East Anglia –

Figure 6. Land use in the catchment area in the early 1930s, from the Land Utilisation Survey.

Key: brown, arable; pale green, pasture and meadow; dark green, woodland; yellow, 'unproductive' land (heath, derelict land etc.); purple, houses and gardens. Compare with Figure 4.

principally in Breckland - went out of agricultural use altogether, although there is little evidence for this within the catchment, except perhaps on the valley floor (see below). There may have been some limited expansion of pasture on the clays, for dairy farming remained relatively buoyant, but this was mainly a feature of areas close to railway stations, because milk and other produce needed to be transported with some speed to distant urban markets, and the catchment, it should be emphasised, was not crossed by any rail line (Rew 1895, 31-6). Indeed, our next evidence for land use within the catchment, from the early 1930s, shows a pattern remarkably similar to that ninety years before, at the time of the tithe awards.

Between 1931 and 1934, the Land Utilisation Survey of Great Britain, directed by L.Dudley Stamp, recorded land use on a field- by-field basis across the whole of the country. Although the data were gathered mainly by schoolchildren supervised by teachers, they were then extensively checked by Stamp and his academic collaborators, and are generally considered to be broadly reliable. The survey recorded a limited number of land use types: farmland was divided into arable and

permanent pasture; built-up areas divided into “houses with gardens” and “agriculturally unproductive”; while other areas appear as “rough grazing”, marsh woodland and water. Time and resources have not allowed the information mapped by the LUS to be digitised but the published map (Figure 6) shows, if anything, some expansion of the arable acreage since c.1840. It is true that by the early 1930s the very worst of the depression was over, but it is nevertheless likely that throughout the depression years the catchment continued to be overwhelmingly arable in character, and that any shift to pasture was both spatially and temporally limited. It is thus probable that 70% or more of the land area continued under arable cultivation throughout the depression period.

This said, circumstantial evidence suggests some reduction in the intensity of farming which may have affected the character of water flows.

4.1.1 Neglect of Field Drainage.

Contemporaries were agreed that throughout eastern England the poor state of the farming economy led to a neglect of field drainage. Bush drains became unserviceable after fifteen or twenty years, and even tile pipes became blocked after three decades or so. Field drainage was not entirely neglected, especially in the early years of the depression. John Baxter, owner-occupier of Grange Farm at Pulham Market, some 15 kilometres to the west of the catchment area,, kept a careful account of all his drainage work between 1887 and 1895. In 1888 alone First Low Field and Eleven Acres were drained at a cost of £5 10 shillings and two men spent five days digging drains on Station Meadow and laying 850 pipes (NRO BR108/18 and 20). But with farm incomes low, field drainage does in general appear to have been neglected as the depression deepened, presumably reducing to some extent the rapidity with which precipitation entered the principal watercourses.

4.1.2 Reduction in inputs.

There is also some evidence that, as cereal prices fell, farmers reduced the quantities of artificial fertilizers applied to their land, and of artificial feed given to their livestock. There is, it is true, surprisingly little hard data to demonstrate this but contemporaries believed it and it appears intrinsically likely (see discussion in Wade Martins and Williamson 2008, 38-42).

In short, the depression period of the late nineteenth and earlier twentieth centuries saw little if any reduction in the proportion of land under arable cultivation within the catchment, but some reduction in the speed with which precipitation falling on the fields entered watercourses, and in the amount of suspended nutrients carried by such water.

4.2. The Second World War and its Aftermath

As is well known, the outbreak of war in 1939 brought the depression in farming to an abrupt end. The Farmers’ Weekly, in its edition immediately following the declaration of war, stated proudly that ‘British farming is mobilized up and down the country’ (Farmers Weekly 08/09/39). The County War Agricultural Executive Committees (WAEC)s immediately came into existence and under them, the District Committees (DCs). These powerful bodies could order the ploughing up of pasture for crops and even dispossess inefficient farmers, and work land directly. Ploughing-up targets were laid down

and in Norfolk alone 25,000 acres of grass and derelict land was to be returned to arable (Douet (1989), 266). There were carrots as well as sticks: the Agricultural Development Act of May 1939 offered farmers a grant of £2 an acre to plough up old grass land (Douet 1989, 268). Advertisements urged farmers to plough night and day, and the slogan 'Plough Now' regularly appeared in the local newspapers. 'Every acre brought under cultivation is a nail in Hitler's coffin'. Prices for the main agricultural products were fixed. Tractors began to appear in far greater numbers and tractor sheds became a standard building type. Some 83,000 acres in Norfolk and 29,957 in Suffolk were converted from pasture to tillage, but in percentage terms this only increased the arable acreage from 76% to 82% of the farmed landscape (Upcher 1946).

Within the catchment of the Little Ouse, already largely arable, there was probably little change in land use. But there was unquestionably greater attention paid to land drainage, not least because fifty per cent drainage grants were now available: schemes were approved by WAEC and drawn up by its drainage sub-committee. No less than 8.2% of the heavy land in South Norfolk and 18.8% in Suffolk was scheduled for mole draining – a relatively new method - in 1940 alone (Nicholson 1948, 212). In all, over 15% (161,000) of Norfolk's farmland was re-drained during the war (Douet 1989, 271). The figure for Suffolk was probably similar. Within the catchment, the use of nitrogenous fertilisers will also have increased markedly during the war years – rising nationally by as much as 64% between 1939/40 and 1940/41, in part as a consequence of price subsidies (Murray 1955, 112). As a consequence of such developments, wheat yields increased in Norfolk from 17.5 cwt per acre in both 1940 and 1941 to 20.2 cwt per acre in 1942 (Wade Martins and Williamson 2008, 205). It is probable that greater attention was paid to scouring the river and the main drainage ditches on the valley floor – a surviving letter suggests that under the emergency War Regulations, the Great Ouse Catchment Board attempted to enforce better maintenance (NRO PT12/125), and further information on this may be available in the records of the War Agricultural Executive Committees.

When the war ended in 1945 continuing food shortages, and a desire to reduce foreign imports in order to help in the repayment of war-time debt, ensured that for the most part there was no diminution in the intensity with which land was farmed. Farming became more mechanized, further improvements were made to field drainage, and the use of artificial fertiliser increased still further. But the higher levels of investment required for such changes encouraged a growth in the size of farming units; and as tractors and combine harvesters became more widely used, fields were enlarged, hedges removed, and small woods grubbed out. Already by 1950 the rate of hedge removal and field rationalization was accelerating throughout the region. Tractors worked more effectively in larger fields, particularly before the widespread adoption of the three-point linkage made it easier to lift ploughs and other equipment clear of hedges and similar obstacles; while combine harvesters were best adapted to the environment of a prairie. Hedge removal was also easier than it had ever been, with bulldozers and mechanical diggers now widely available, while from 1956 it was subsidised by the government. In Norfolk alone around 500 miles of hedgerow were grubbed out each year from 1946 to 1955, rising to around 2,400 per year by 1962, and reaching 3,500 miles per year over the next four years (Baird and Tarrant 1970).

Small and medium-sized family farms sold up, or expanded through absorbing the land of former neighbours. Large landowners capitalized on the booming land market: estates were sold, and broken up, and within the catchment Redgrave Hall was demolished and its park ploughed up. Above all, the post-war period saw the development of an increasingly arable landscape in eastern

England. In the pre-war period even farms mainly involved in the cultivation of cereals had kept some animals, for traction or manure, and to some extent to diversify incomes. The increasing use of tractors and combines, and the availability of cheap fertilizers, both allowed a greater degree of specialisation: farms in arable areas now became exclusively arable in character, with no livestock at all, leading to a further reduction in the already limited area under grass. The instigation of various agro-environment schemes from the 1990s saw some reversal of these developments, with limited reinstatement of hedges and sowing of grass on field margins, but their overall impact, though welcome, was limited. Within the Little Ouse catchment around 80% of the land area is now under cultivation, in fields which, on the heavier land, are effectively underdrained, and heavily fertilized (Figure 7).[7] Two points are worth emphasising here. Firstly, although the landscape has suffered greatly from hedge removal, and a number of areas of ancient woodland have been lost, the expansion of the arable area is less than might be expected in part because of the increase in the area occupied by housing and in part because of the overall increase in pasture within village 'envelopes', in fields which – even though often of small size – might be under cultivation in the nineteenth century. Secondly, although field boundaries have disappeared on an awesome scale the main tributary streams have survived well, their full length (as reconstructed for the nineteenth century – see above) still in most cases shown as blue lines on the modern Ordnance Survey maps.

The most important recent changes to the hydrology of the Little Ouse fens came, not from the effects of agricultural intensification in the catchment, but from the borehole which was drilled at Redgrave and Lopham Fen, into the chalk aquifer, in 1959 to provide drinking water. This had a significant impact on water levels in the valley fens to the east, as well as in theborehole's immediate vicinity. No less than 3,600 cubic metres of water were soon being extracted per day, with disastrous effects on the adjacent fens: it became apparent that around a quarter of the pumped groundwater was taken at the expense of spring water flowing into them (Hiscock 2009, 305; Burgess 2002). Redgrave and Lopham Fen began to dry out in the summer, leading *inter alia* to an expansion of scrub and loss of traditional fen communities (Harding 1993). Following the recognition of the fens as a RAMSAR site in 1991 the borehole was relocated some 3.5 kilometres to the east, and by 2002 water levels had been restored. This brief period of pumping had an impact on patterns of land use in the valley of the Little Ouse to the east of Redgrave and Lopham Fen, with some localised expansion of arable.

4.3 Summary

The period of agricultural depression that lasted from the late 1870s until the outbreak of World War II may initially have seen some expansion of the area of pasture within the Little Ouse catchment but, if so, this had been reversed by the early 1930s, when the Land Utilisation Survey suggests that – as in the 1840s – around 70% of the land area was under arable cultivation. Such land was, however, farmed less intensively, with lower inputs of nitrogenous fertilisers, while a neglect of field drainage will have reduced the speed with which precipitation falling on fields within the catchment entered the river. All this changed rapidly with the advent of War, and in the second

[7] This is based on an examination of aerial photographs and has not been effectively 'ground truthed', but ought to be reasonably accurate as an estimate.

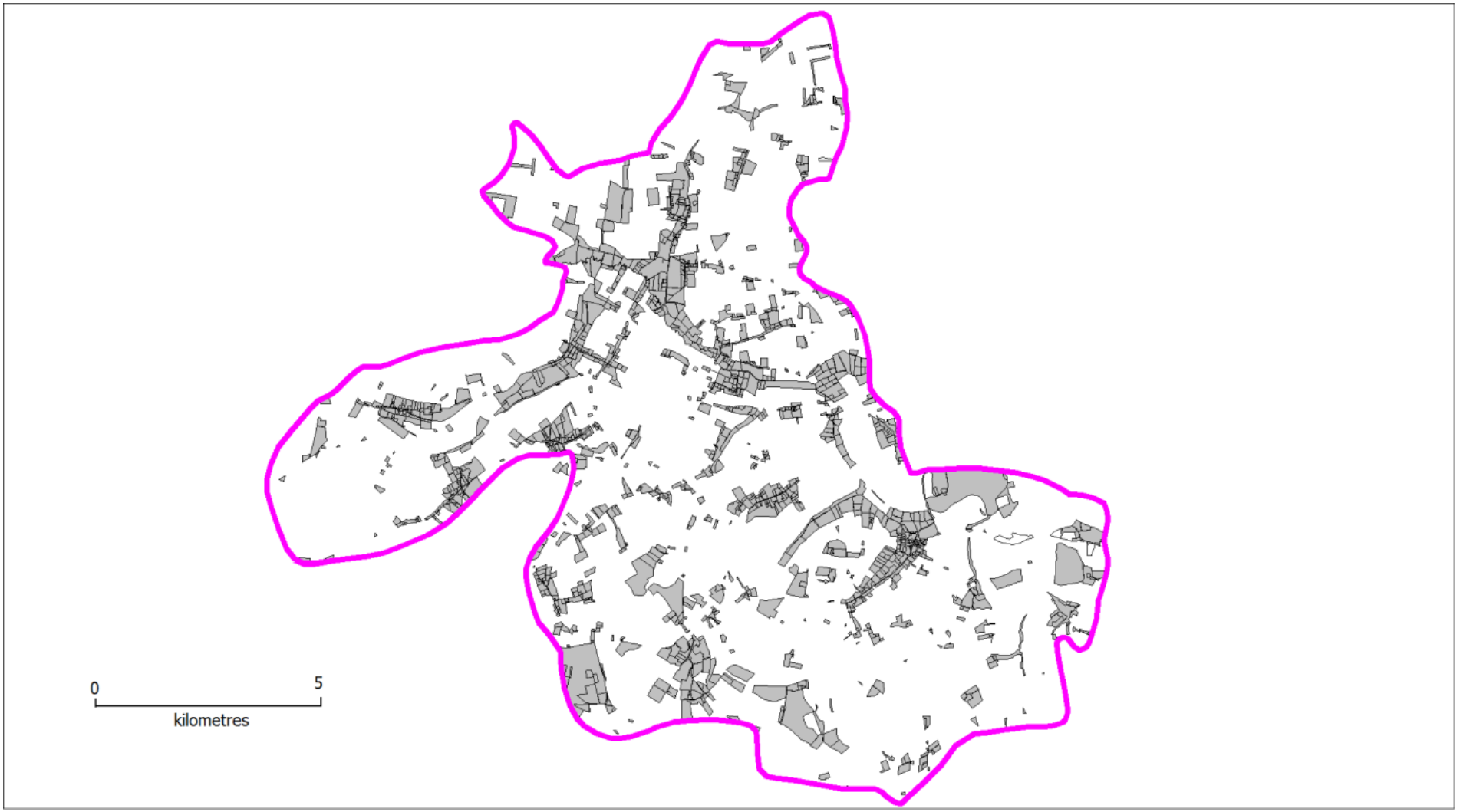


Figure 7. Current areas of non-arable land use (other than roads) within the catchment. Source: Google Earth/ground survey.

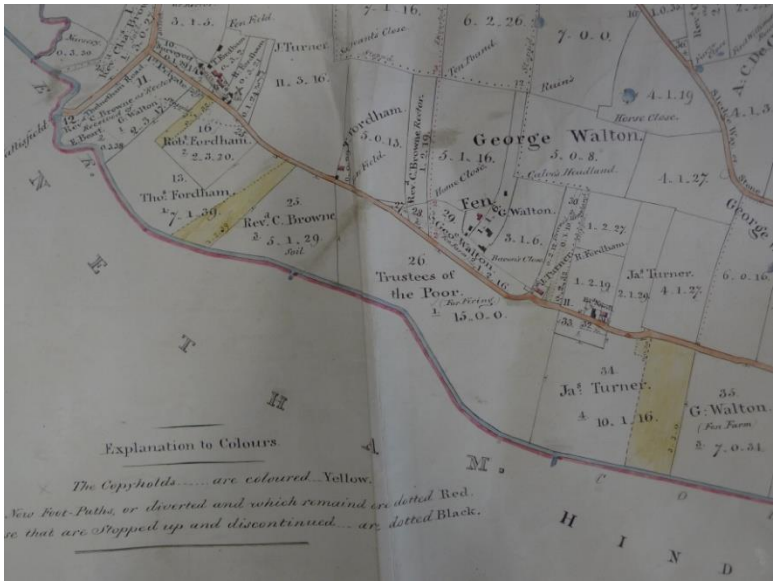
half of the twentieth century the arable acreage increased still further, reaching around 80% of surface area by the end of the century, field drainage was improved and unprecedented levels of fertiliser applied to the fields.

5. The Drainage and Land Use of the Valley Floor.

The history of the area immediately flanking the course of the Little Ouse is of particular interest to the LOHP. Up until the early nineteenth century, as already noted, this was occupied by a wide band of common land which extended into the valleys of the principal tributaries (Figure 5). It must be emphasised, however, that such land did not entirely comprise poorly-drained fen formed in waterlogged soils on the valley floor: although the latter is hard to define in many places, the sides of the valley sloping upwards very gradually, it is nevertheless clear that the commons also embraced areas of acidic, and usually slightly higher, land formed in glacial sands and gravels, characterised by soils of the Newport 4 Association.

The pattern of field boundaries and drainage dykes within this area was largely created by the enclosure of these various commons by parliamentary acts in the early decades of the nineteenth century, and by subsequent piecemeal alteration: so far as the evidence goes, few if any drainage ditches had formerly existed within these areas. Successive maps – the tithe awards of c.1840, the various editions of the Ordnance Survey 6": 1 mile – show how the original parcels were often subdivided, to form more manageable units; and how these were then sometimes further amalgamated or divided, the orientation of the boundaries in general replicating that of the divisions first established at enclosure (see Figure 8). What these maps do not tell us is the condition – depth, width – of such ditches, which may to some extent have changed over time in response to developments in land use.

At the time of the tithe award maps, c.1840, most of the land formerly occupied by the valley commons was used as pasture, as we might expect given the relatively marginal nature of the soils and, in some places, their waterlogged condition. The larger parcels, however, were allotted as fuel allotment, cut for peat directly by the poor or leased, and the income used to purchase coals. Poors allotments need to be distinguished from common land. Although the latter was technically owned by the lord of the manor a defined group of inhabitants (which often, in fact, excluded the very poor) exploited them by right. Poor allotments, in contrast, were administered by a committee of local worthies – typically including the lord of the manor and the incumbent – rather than being regulated by the users themselves. The Lopham enclosure award described how the 200 acres allotted to the



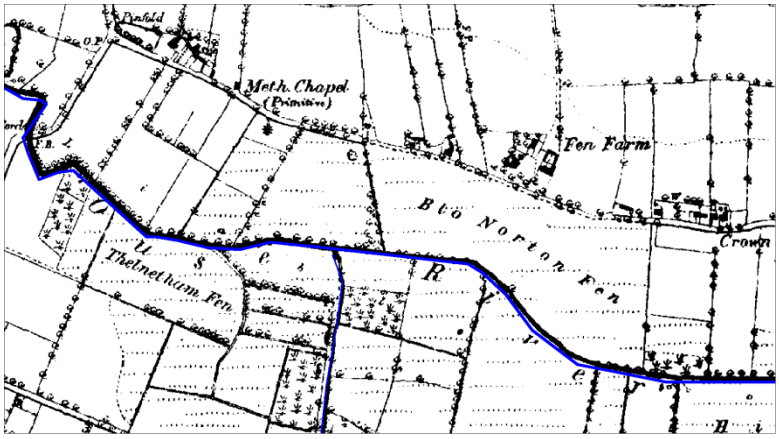


Figure 8. Top, pattern of dykes in Blo Norton established by the enclosure award of 1822. Centre: pattern of boundaries shown on the tithe award map of 1838; bottom, boundaries shown on the First Edition OS 6", 1884.

poor in the parish were actually given to:

> The Lord of the Manor of Lopham, and also to the Rector, Churchwardens, and overseeers of the Poor … and to their respective successors for ever … For .. the purpose of providing Fuel for the necessary Firing of the said poor persons, or otherwise appropriated, and the Produce and Profits arising therefore applied for their use and benefit; the Fuel so directed to be raised and cut, taken, and used by them, in such Quantities and Portions, and at such times in the year, and under such Orders, Rules and Regulations, and in such manner as the Lord or Lords, Lady or ladies of the said Manor, and the Rector, Churchwardens and Overseers of the Poor of the said Parishes of North Lopham and South Lopham … or the major part of them, shall from time to time deem most beneficial for such persons (NRO C/Sca 2 188)

Most of the largest, undivided allotments on the valley floor were poors or fuel allotments: of the parcels of land currently managed by the LOHP, three originated in this way (Blo Norton Fen, Blo Norton Little Fen and Hinderclay Fen). Following enclosure, most of the land on the floodplain was thus used for turf cutting, or managed as grazing or meadow. But some, to judge from the tithe awards, was under cultivation by the 1840s, especially in Thelnetham (see Figure 4).

The 1880s Ordnance Survey 6" maps do not specifically show the details of agricultural land use – that is, they do not distinguish between pasture/meadow and arable – but they do show a number of different areas of rough land, broadly distinguished as waterlogged marsh, rough grazing and heathy ground (Figure 9). They are thus hard to compare with the tithe award maps, but the impression conveyed is nevertheless that there had been some reduction in the area under cultivation, largely perhaps reflecting the onset of agricultural depression but possibly also a consequence of an increased frequency of flooding events on the lower ground. The report drawn up for the District Association for the Prevention of Floods in the Valley of the Little Ouse in the 1880s noted how the allotments of land made when the fen commons at Blo Norton were enclosed had 'suffered much' from the river flooding, while those at Hinderclay had been 'profitless for nearly two years'. What is particularly striking, however, is the evidence for land use beside the river provided by the Land Utilisation Survey from the early 1930s. This shows a similar proportion, and disposition, of 'rough grazing' and 'marsh' to that depicted on the OS, but it also distinguishes between parcels of land under grass and those under arable cultivation, and as Figure 10 shows some of the latter lay on or close to the flood plain, as for example at the western end of Hinderclay Fen. Some, but not all, of these arable parcels can be correlated with cultivated areas shown on the tithe award maps.

The 1946 RAF vertical air photographs have not been examined in detail but appear to suggest a similar disposition of land use to that shown by the 1930s Land Utilisation Survey, although with some extension of the arable acreage in the area around Mill Road and Thelnetham Road. By 1988 slightly more land was under cultivation here, and also in the area to the south and west of The Banks on Fen Road, presumably as a consequence of water extraction by borehole near Redgrave and Lopham Fen, which began in 1959.

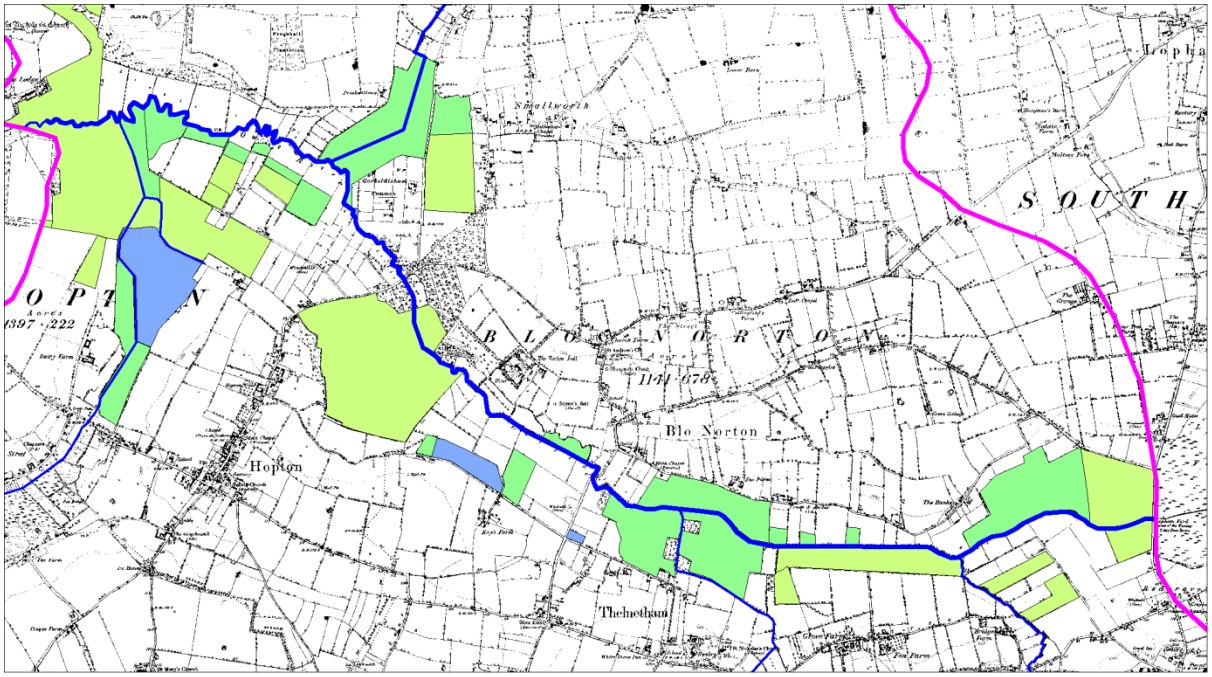


Figure 9. Areas of rough ground near the Little Ouse shown on the First Edition 6" OS, surveyed in the 1880s. Blue = marsh; dark green = rough grazing; light green = rough grazing with some heath

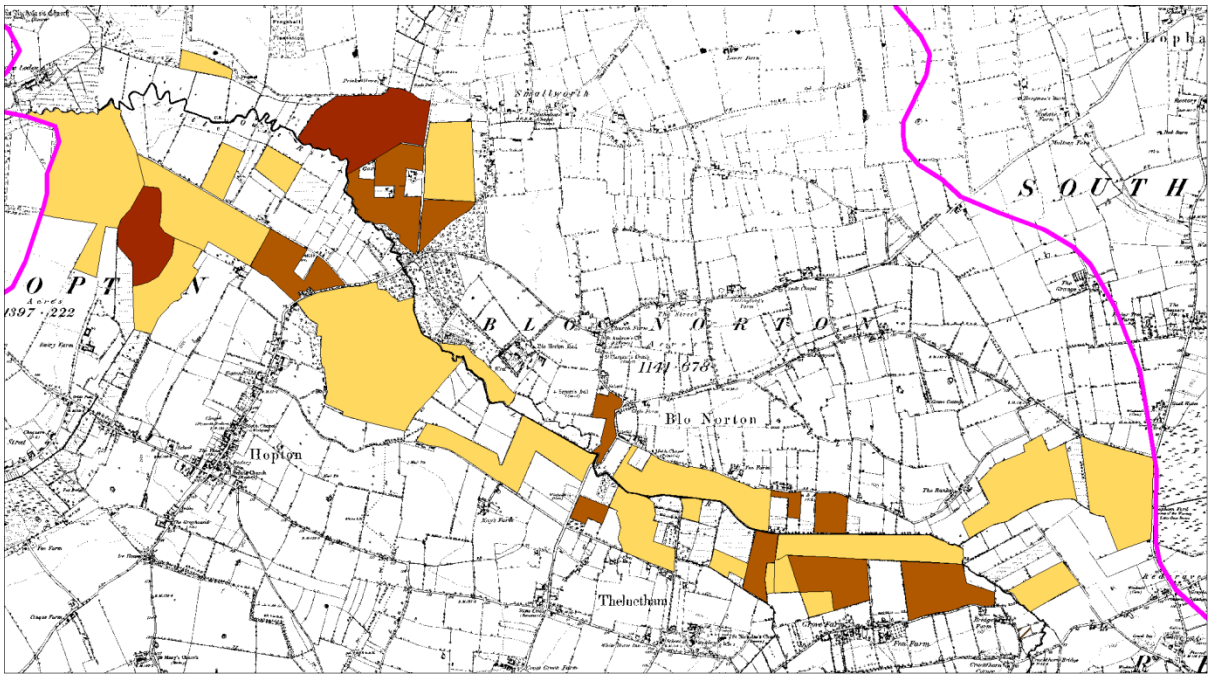


Figure 10. Land use beside the Little Ouse, as depicted by the Land Utilisation Survey (early 1930s). Yellow = rough grazing; red = marsh; light brown = selected areas of arable land (i.e., those extending onto the valley floor). Land unshaded on the valley floor was under pasture.

More research into this issue is required but it is clear that while for the most part the land lying close to the river has been used as pasture, meadow or rough grazing since enclosure, a minority has been cultivated as arable, including some located on the low-lying Isleham soils. Such areas may lie slightly higher than the surrounding land; they may represent short-term and unsuccessful attempts to capitalise on market conditions. Where land was so used – but also where finances permitted on grazing or meadow land – ditches would have been maintained with greater diligence than when it was used less intensively, but no documentary evidence relating directly to this issue has yet been discovered.

6. Conclusion

The principal findings of this report may be summarised as follows.

- The history of the Little Ouse is intimately connected with that of its catchment, which largely comprises a dissected boulder clay plateau. This was deforested, probably to a significant extent, by the end of the Roman period, and as population grew during the Middle Ages became increasingly arable. By c.1300, around 60-65% of the land area was probably under the plough: that is, most of catchment, excluding common land, woods and village tofts.
- The post-medieval period saw some expansion of livestock farming within the catchment and the extent of arable may, in the seventeenth century, have been reduced to little over half. By the mid eighteenth century, however, 60-65% was again under the plough, and this rose in the course of the following century to around 73%, as a consequence of the enclosure of upland commons and a shift to a predominantly arable economy, although most of the land was cultivated under rotations which featured short grass leys. The same period saw the widespread adoption of underdrainage; the increasing use of artificial fertilisers; and an increasing use of artificial livestock feed; developments which must have increased the rapidity of water entering the watercourses within the catchment and raised the amounts of suspended nutrients and silt it contained.
- The stretch of the Little Ouse under consideration here does not ever appear to have been subject to the authority of any organised drainage body, probably a consequence of the relatively low agricultural value of its floodplain and the fact that, comprising as it does the higher reaches of a watercourse, it was seldom affected by serious flood events. The establishment of the short-lived District Association for the Prevention of Floods in the Valley of the Little Ouse between Redgrave and Thetford in the 1880s may indicate that the agricultural changes in the uplands during the previous century had ensured that land bordering the river had become more liable to flooding.
- The agricultural depression which began in the 1870s does not, perhaps surprisingly, appear to have brought about any long-term reduction in the area of the catchment under arable cultivation, although the levels of agricultural inputs appear to have declined, together with the efficiency of field drainage, presumably with some impact on local watercourses. This situation was reversed from 1940, however, and in the second half of the twentieth century drainage systems were restored, fertiliser use reached unprecedented levels and the arable acreage was further expanded, currently reaching around 80% of catchment area.

Table 1: approximate estimates of area under cultivation within the catchment.

c.1350	c.1650	c.1750	c.1850	Today
60-65%	50-55%	60-65%	c.73%	c.80%

- Following enclosure of the valley commons in the early nineteenth century some areas, mainly the poorest land, were exploited as fuel allotments; most of the private land was used as pasture, but a few parcels were ploughed. This pattern continued into the early and middle decades of the twentieth century, the Land Utilisation Survey of the early 1930s showing a number of parcels of arable land extending down onto the valley floor.
- The course of the river has remained largely stable since the late, and probably the early, nineteenth century, with only minor adjustments apparently made to increased the speed of flow in four places where tortuous meanders existed. Earlier straightening has certainly taken place, in two places in particular. Both of these changes had been made before the early nineteenth century, but their origins remain unclear.

Although this research has provided much important information about the history of the Little Ouse and its catchment, it has also served to highlight important gaps in our knowledge. Some of these can probably never be filled, due to the character of the surviving evidence. But future work might usefully be directed towards, in particular, the history of land use and drainage on the valley floor in the period after 1940. This would involve a detailed examination of the surviving War Agricultural Executive Committee and Drainage Subcommittee minutes; digitisation of the Land Utilisation Survey for 1932-33; digitisation of the second Land Utilisation Survey, from the 1960s (not yet consulted); and oral history; as well as an examination of any relevant material held in the archives of the Environment Agency. In addition, while this report has concentrated on the impact on the river of changing patterns of agricultural land use, the effects on the spread of paving – of roads, yards etc. – on surface flows in the course of the twentieth century would repay further investigation.

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