CORA Cork Open Research Archive
Cartlann Taighde Oscailte Chorcaí

Title	Historic land reclamation in the intertidal wetlands of the Shannon estuary, western Ireland
Authors	Healy, Michael;Hickey, Kieran R.
Publication date	2002
Original Citation	HEALY M. & HICKEY, K. R. (2002) Historic land reclamation in the intertidal wetlands of the Shannon estuary. In: Cooper, J. A. G., and Jackson D. W. T. (eds.), Proceedings from the International Coastal Symposium (ICS) 2002 (Templepatrick, Northern Ireland). Journal of Coastal Research, Special Issue No. 36, pp. 365-373
Type of publication	Conference item
Link to publisher's version	http://www.jcronline.org/page/special_publications
Rights	© 2002 Coastal Education and Research Foundation, Inc. (CERF)
Download date	2024-04-19 20:24:58
Item downloaded from	https://hdl.handle.net/10468/2521

UCC
University College Cork, Ireland
Coláiste na hOllscoile Corcaigh

Journal of Coastal Research	SI 36	365-373	(ICS 2002 Proceedings)	Northern Ireland	ISSN 0749-0208

Historic land reclamation in the intertidal wetlands of the Shannon estuary, western Ireland

Michael G. Healy† and Kieran R. Hickey‡

†Department of Geography
Mary Immaculate College,
University of Limerick, Ireland
‡ Department of Geography,
National University of Ireland,
Galway, Ireland

ABSTRACT

There is abundant landscape evidence for extensive land reclamation conducted within the Shannon estuary wetlands. To date, little published research is available which identifies how much reclamation has occurred, its timing and the likely environmental implications. This paper addresses these questions on the basis of available cartographic and documentary data on land reclamation in this area. Identification of reclaimed land was based on the 2nd Edition Ordnance Survey of Ireland Map Series of 1924. These maps represent landscape features relating to reclamation, such as embankments, artificial arterial drainage channels and sluices. Using such indicators for the purpose of demarcation, the extent of the lands reclaimed has been mapped. Documentary information on reclamation schemes was acquired from the National Archives files on the Irish Quit Rent Office, including letters, memoranda, draft bills and Government Acts, legal documents and statements of account, and these support and supplement cartographic data.

In total, approximately 6,500ha of the Shannon estuary lowlands were reclaimed for agriculture and other purposes. This has significantly altered the morphometric characteristics of the estuary, as embankments and revetments for flood protection have reduced the potential energy dissipation area and the water storage capacity of the estuarine wetlands. Reclamation has resulted in modification of the estuarine physical environment and its hydrodynamics, and altered the character of the wetland habitat in the estuary environs.

ADDITIONALINDEXWORDS: *estuaries, reclamation, land claim, wetlands, embankments, drainage, cartography, historical evidence*

INTRODUCTION

Anthropogenic influences appear to have played a significant role in the evolution of the Shannon estuary lowlands. O' SULLIVAN (2001) documents a body of archaeological evidence that indicates long-term use of the estuary by humans. It appears that settlements existed around the estuary from at least Neolithic times, with attendant deliberate manipulation of the local environment. It is almost certain that local wetland succession patterns were affected by early rudimentary agricultural activities, producing consequent morphological responses within the estuary system. Technological advances through time are likely to have increased the potential for human intervention, though the scale and significance of prehistoric human-induced environmental change still remains speculative.

Aims

Extensive land reclamation works have been carried out in the Shannon estuary over several centuries, possibly beginning as far back as the 10th/ 11th centuries. However, detailed research to identify precisely how much reclamation has occurred, when it occurred and what were the likely environmental implications of human intervention in the estuarine environment has not been published to date. This paper addresses this deficiency in the literature through an analysis of cartographic and documentary data relating to land reclamation and drainage in the Shannon estuary area.

THE CONTEXT FOR RECLAMATION IN ESTUARIES

Estuarine geomorphology

Coastal zones and 'coastlines' are transient in time (CARTER, 1988). The estuaries of western Europe were largely formed following the rapid recovery of early Holocene relative sea-level, and their form and function

remain closely related to sea surface elevation. An abundant supply of offshore glacigenic sediment allowed significant sedimentation of estuarine basins to take place, a process often augmented by additional sediment supply from fluvial sources. Estuary morphodynamics therefore reflect the relative balance between competing marine and fluvial processes (COOPER, 2001). The relatively sheltered character of estuarine environments, in particular where tidal currents are weak, allows sediments to flocculate and fall out of suspension. This process has resulted in the widespread development of mudflats and sandflats in European estuaries, though there is considerable variability among estuaries in the pattern and distribution of their sedimentary structures, depending, inter alia, on topography, sediment supply, turbidity and current flows. Changes in the configuration of estuary bedforms and channels occur routinely, as well as similar changes in associated salt marsh environments. Estuarine landforms are commonly constrained by retaining walls at high tide levels, as well as training walls and embankments that are used to fix channel positions. These nullify the natural tendency of mudflats, sandflats and their associated channel systems to migrate in space and time, responding to changing estuarine morphodynamics. Consequently, estuarine morphology has become increasing inflexible in responding to natural coastal change. This problem is exacerbated by the process of reclamation of estuarine flats for agricultural, industrial and commercial purposes in recent centuries, as described by DAVIDSON *et al*. (1991) for the UK.

Table 1. Habitat loss in English estuaries (Adapted from DAVIDSON *et al*., 1991)

Estuary Name	Area lost (ha)	Reclamation Period
The Wash	47,000	Since Roman Times
Severn Estuary	c. 8,000	Since Roman Times
Dee Estuary	6,000	Since 1730
Humber Estuary	4,600	1600-1850
Greater Thames Estuary	4,340	Mostly pre-1800
Tees Estuary	3,300	Since 1720
Ribble Estuary	2,320	Since 1800
Morecambe Bay	1,320	1200-1900
Ore/Alde/Butley Estuary	3,640	Since 1200
Deben Estuary	2,240	Since 1200
Stour Estuary	1,600	Since 1200
Blyth Estuary	1,280	Since 1200
Orwell Estuary	980	Since 1200
Southampton Water	690	Since 1830
Poole Harbour	530	Since 1807
Portsmouth Harbour	490	Since 1540
Mersey Estuary	490	1800-1900
Total	**88,820**	**Since Roman Times**

Wetland reclamation in estuaries

It has been estimated that c. 50% of the population of the industrialised world lives within 1 km of the coast, a substantial proportion being located around estuaries. This gives rise to concerns about the management of the coastal resource, including the issues of shoreline erosion and sea defence, habitat degradation, pollution and reduction of coastal biodiversity (HEALY, 1995; SMITH and WARD, 1998). On a global scale, pressure on the coastal land resource has frequently resulted in reclamation of the coastal lowlands, particularly, but not exclusively, within estuarine environments (e.g. PETZELBERGER, 2000). Large areas of salt marsh have been reclaimed, such as low-lying areas around the Irish Sea and the English Channel, and most notably in the Netherlands (VILES and SPENCER, 1995; ALLEN, 1998).

In the UK reclamation (sometimes referred to as 'land claim') on estuaries and coasts has been carried out at least since Roman times (DAVIDSON *et al*., 1991). BORER (1939) reports extensive land reclamation around the Wash from the 17th Century onwards. It would appear that initial phases of reclamation sought to enclose salt marshes and mudflats with earthen banks for agricultural purposes (KING, 1959), by a process such as that described by UDNEY (1831) for formal intertidal flats adjacent to the Forth estuary, Scotland. These works have been extensive and progressive in Britain through the centuries, accounting for much of the estuarine habitat loss. Of the 155 British estuaries, it is accepted that 136 (or 88%) have experienced habitat loss to agricultural reclamation. DAVIDSON *et al*. (1991) report the scale of these changes at a variety of sites (Table 1). Urban development and port and harbour infrastructure have had significant impacts. More recently, reclamation for industrial, commercial and recreational uses has taken place, as well as works for suburban expansion and housing development.

In Ireland, outside of the Shannon estuary area, the majority of land reclamation works have been concentrated on the east and south-east coasts (MULRENNAN, 1989; FURLONG, 1996; ROWE and WILSON, 1996). Of these the most extensive and significant works were carried out around Wexford Harbour. According to FURLONG (1996), efforts to reclaim land from the harbour are first recorded in 1813, with subsequent works in 1814-1816, 1840-1851 and 1854-1870. In all, it appears that in excess of 2000 ha were reclaimed to produce the North Slob and South Slob around Wexford Harbour. These works indicate the degree of interest and British Government support for land reclamation in Ireland in the 19th century.

THE SHANNON ESTUARY

Site description

The Shannon estuary is the largest estuary in Ireland and its present shape and character is largely a product of Holocene marine transgressions. The greater Shannon estuary comprises the lower reaches of the River Shannon (between Limerick City and the sea) and incorporates the Fergus estuary south of Clarecastle (WHEELER and HEALY, 2001). The estuary is macrotidal, with the tidal range in the inner estuary at Limerick being the largest on the Irish coast. At Foynes Island, the mean high water spring tide (MHWST) level is 4.9m O.D., while the mean high water neap tide (MHWNT) is 3.7m O.D. Here, the mean low water neap tide (MLWNT) is 1.5m O.D., with the mean low water spring tide being 0.0m O.D.. At Limerick Docks corresponding levels are 5.44m O.D. MHWST, 4.04m O.D. MHWNT, 0.74m O.D. MLWNT and -0.06m O.D. MLWST.

The Shannon estuary environs incorporate bordering lands in north Co. Kerry, north Co. Limerick and west Co. Clare. The Rivers Shannon, Fergus, Suck, Inny, Brosna and Maigue together drain an area of c. 15,700 km^2 or about one-third of Ireland, feeding freshwater into the estuary. The drainage basin of these rivers incorporates much of the Irish central lowlands, as well as major inland lakes, including Lough Derg and Lough Ree and Lough Allen (Figure 1).

Seawater enters the estuary from the Atlantic Ocean between Loop Head and Kerry Head. The tidal influence extends beyond Limerick City c. 96 km to the east, and north of Clarecastle on the Fergus estuary (Figure 2). Rivers, streams and tidal inlets abound around the estuary margins. Much of the land around the estuary is low-lying, seldom exceeding 60 m O.D, and its associated fluvial system requires a flood protection and drainage infrastructure. The drainage system operates through a dense network of rivers, streams, creeks, arterial drainage channels and sluices. The majority of the lands around the

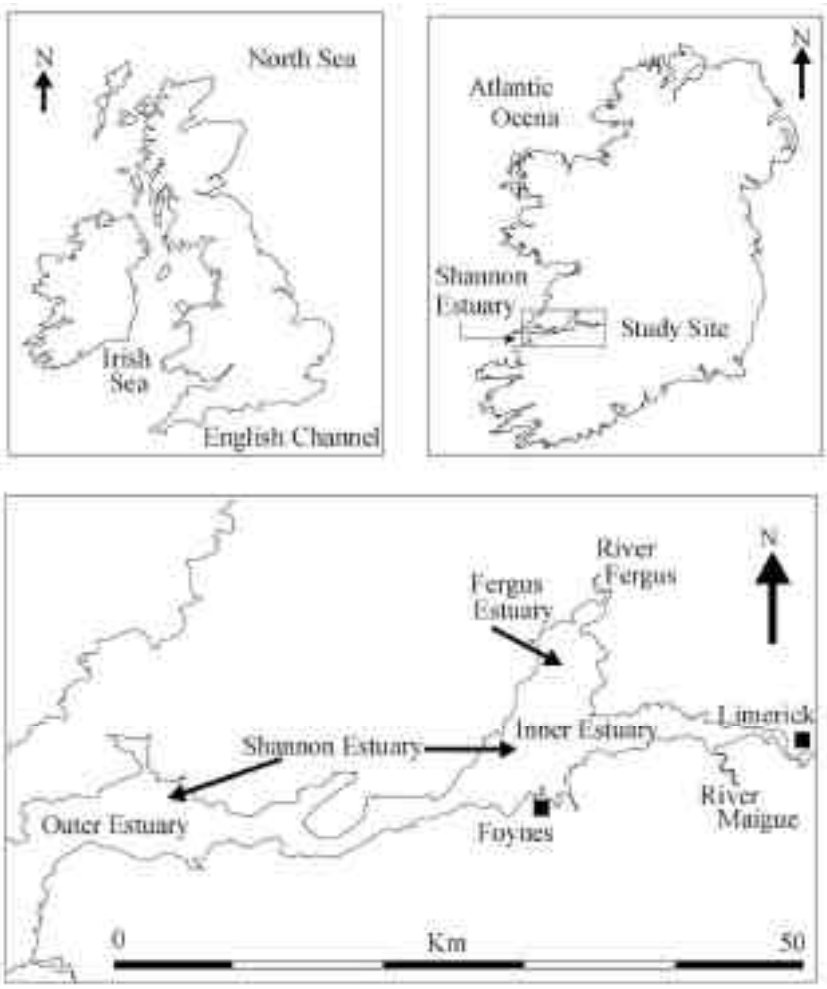

Figure 1. Location and extent of the Shannon river catchment, western Ireland.

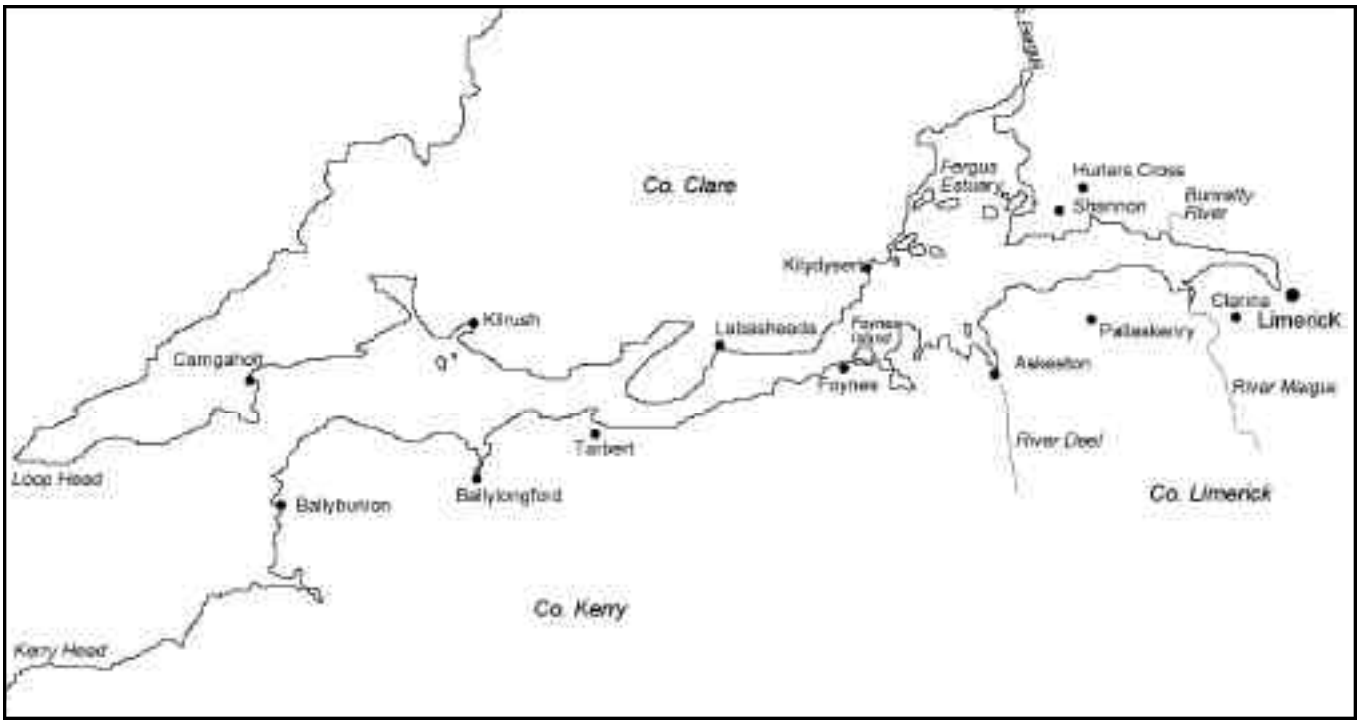

Figure 2. The Shannon estuary, incorporating the study area upstream of Foynes Island.

estuary lie between the tidal High Water Mark (HWM) and 30 m O.D. (Ordnance Survey of Ireland, 1974) except on the southern shore of the estuary between Tarbert and Foynes and on the northern shore between Labasheeda and Clarecastle (WHEELER and HEALY, 2001). Here, the estuary is constricted, being c. 1.25 km wide, whereas its widest dimension occurs at the confluence with the Fergus estuary where it reaches up to c. 14.5 km across. Water depths are greatest near the mouth of the estuary (c. 37 m), shallowing eastward to c. 19 m at the confluence with the Fergus estuary and ultimately to less than 5m in the channel at Limerick City, with the exception of dredged navigation channels.

Population and Land Use

The 1996 Census of Population of Ireland shows that the main centres of urban population around the estuary are Limerick (c. 52,000), Ennis (c. 15,300), Clarecastle (c. 2,300) and Shannon Town (c. 800), with several small villages on the flats (e.g. Pallaskenry, Clarina, Bunratty, Hurler's Cross). The rural population in the immediate environs on the estuary (based on District Electoral Divisions (DEDs) adjoining the estuary margin) is relatively small and dispersed. In County Kerry the total rural population along the estuary is c. 2000, while in County Clare and County Limerick the respective totals are c. 34,300 and c. 15,700 respectively. Taking urban and rural populations together, the total population of the immediate estuary environs is c. 122,000.

Landuse

Much of the lowland around the estuary consists of reclaimed alluvial deposits at or below sea-level, which may have experienced artificially induced settling, self-weight compression and over-consolidation (BARRAS and PAUL, 2000) or autocompaction, as described by ALLEN (2000). The alluvium provides a mixture of partially drained pasture and marsh/salt-marsh, some of which is drained using channels leading to flap sluices and other outlets to artificial drainage channels and tidal creeks. The most extensive land use remains agricultural (O' DALAIGH, 1998). In addition, however, important industrial and transport infrastructure lies adjacent to the estuary, including the Shannon Industrial Complex and Shannon Airport. Limerick, the largest urban centre in the region, lies at the head of the Shannon estuary and acts as the main industrial, commercial and transport

centre for the Irish mid-west region. In 1993 Limerick Harbour was the second largest port in the Irish Republic, with a throughput of 6.925 million tonnes of cargo. It is projected that this will shortly exceed 10 million tonnes. Further dredging of the shipping channel through the estuary is envisaged, as well as large-scale infrastructural developments at Moneypoint, Tarbert, Limerick Docks and Shannon Airport. These activities will take place in an environment considered to be "at risk" in the context of coastal management in Ireland (GOVERNMENT OF IRELAND, 1996; CARTER, 1991).

METHODOLOGY

A dual methodology was employed for the purposes of this study. This consisted of an examination of the available cartographic evidence for reclamation in the historical period, and research on archival records of reclamation in the form of historical documents.

Cartographic evidence

Initial identification of reclaimed areas around the Shannon estuary was based on the 2nd Edition Ordnance Survey of Ireland (OSI) Map Series of 1924 (Scale 6" to one mile or 1: 10560). Surveying for this series was carried out up to 1923. These maps provide detailed representations of features relating to reclamation works, including embankments, artificial arterial drainage channels and sluices. The 50' (15.24 m) contour is used to initially delimit the estuarine lowlands, circumscribing the zone in which reclamation works may have occurred around the estuary. In cartographic terms, reclaimed lands are easily distinguishable. Field boundaries are relatively regular in shape; fields are usually larger than elsewhere, drainage ditches often occur between fields, flap-sluices mark drain outflows and embankments mark the limits of reclaimed areas (Figure 3). Additionally, local place-names referring to now land-locked islands (e.g. Islandmagrath, Islandavanna) and previous marshland (corcas) highlight the changed character of the estuarine lowlands of the Shannon. Many reclaimed land tracts lie adjacent to the banks of the estuary and associated rivers and streams. Using these indicators the extent of the lands reclaimed by 1918 was mapped from cartographic evidence. Where necessary, ground proofing was undertaken by sampling sub-surface sediments. These consist of an estuarine blue-grey sand-silt-clay sediment matrix c. 0.30m beneath the current surface.

Figure 3. Oblique air photograph of reclaimed land and associated infrastructure in the Shannon estuary (based on CABOT, 1999).

Documentary evidence

There is no significant surviving documentary information relating to land reclamation in the Shannon wetlands from the archives of the Irish Quit Rent Office (QRO) or the Irish Office of Public Works (OPW) for the period prior to 1839-1840. For the period 1840 to the present, the majority of documentary information was recovered from the National Archives files on the QRO, which was responsible for British Crown lands in Ireland, including the foreshores (land below high water mark). Proposals for reclamation schemes were predicated upon the sale of the relevant foreshores by the Crown, which usually required sanction through an Act of the English Parliament. Through parliamentary records related to this process, the QRO amassed considerable information on each reclamation scheme, much of which has survived. The QRO files include letters, memoranda, draft bills, legal documents, statements of account and Government Bills and Acts (Table 2). These documents record the process of establishing and operating reclamation schemes. Where schemes were successful there was little further involvement of the QRO, but if a scheme failed then the QRO was sometimes entitled to repossess foreshore areas or to seize land in lieu of non-payment of money owed to the Crown, activities that generated further documentary information on reclamation history.

Table 2. Examples of Bills and Acts of the English Parliament relating to land reclamation around the Shannon estuary (Bills did not become Acts in all cases))

{PRIVATE}Parliamentary Bills and Acts	Date
Kerry and Clare Reclamation Bill	1853
Kilrush and Kilkee Railway and Poulnasherry Reclamation Act	1860
Kilrush and Kilkee Railway and Poulnasherry Reclamation Amendment Act	1861
Kilrush and Kilkee Railway Act	1865
Kilrush and Kilkee Railway and Poulnasherry Reclamation Act	1872
Clare Slobland Reclamation Act	1873
Clare Slobland Reclamation Amendment Act	1878
Clare Slobland Extension Act	1879
Kilrush and Kilkee Light Railway and Poulnasherry Reclamation Bill	1883
South Clare Railway Company Bill	1884
Fergus Reclamation Bill	1886

RESULTS AND DISCUSSION

Land Reclamation

It is possible that reclamation around the Shannon estuary may have begun as early as the 10th /11th centuries (or the Viking period), as seems to have been the case in some other parts of western Europe. It is likely that some works on a small scale had taken place by the fourteenth century, according to evidence from Newtown in Co. Limerick, where an earthen bank of late medieval date is found 2km inland of the current sea defence (WHEELER and HEALY, 2001). Cartographic evidence from the Down Survey Maps suggests that the Shannon estuary had experienced some reclamation by 1655, though further work is required to substantiate this. Reclamation supported by government-backed schemes began in the first half of the nineteenth century, with the first known survey in 1822 and the first Shannon Navigation Act in 1834 for "the improvement of the River Shannon from its source to its mouth" (PARLIAMENTARY PAPERS, 1835).

Reclaimed land areas of the Shannon estuary west of Foynes are relatively small in scale and few in number, and consequently are not included in this study. Figure 4 shows the distribution and approximate extent of lands reclaimed upstream of Foynes Island, where the estuary basin is

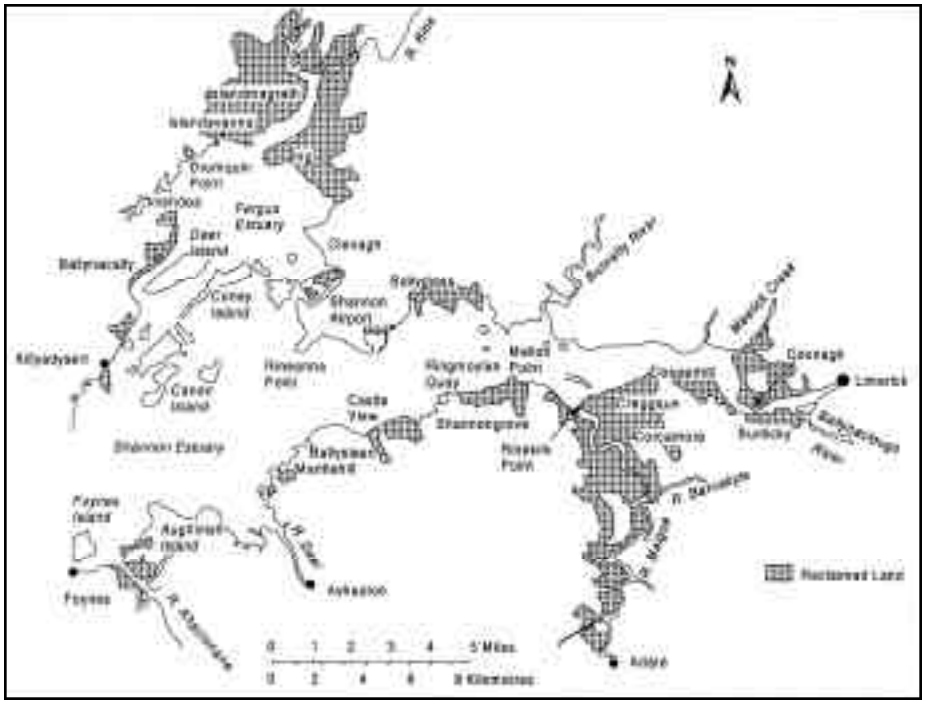

Figure 4. The reclaimed lands of the Shannon estuary.

generally shallow with extensive tidal flats. Here reclaimed and improved land is widespread, with individual pockets of such land often associated with embayments, river and stream outlets and tidal channels.

Three main areas of reclamation can be identified around the estuary on the basis of size and scale from cartographic evidence. These are the lowlands of the Fergus estuary to the north (the Fergus reclamation); the floodplain of the River Maigue to the south (the Maigue reclamation); and the lowlands of the inner estuary near Limerick City which occur on both banks of the estuary (the Limerick reclamation).

The Fergus Reclamation

Some 2370ha of land has been reclaimed or improved around the Fergus estuary. On the west bank this extends from near Drumquin Point northward to Clarecastle. Corresponding works on the east bank extend from Clarecastle south towards Clenagh. While this land now forms a contiguous area, reclamation took place in a number of phases and schemes. Companies specifically established for the purpose of land reclamation carried out the larger schemes. An example of one such company is the Clare Slob Reclamation Company, established through the Clare Slob Land Reclamation Act of 1873. The Act details the works envisaged in reclaiming the 'slobs' (intertidal wetlands), including the ‘requisite embankments, walls, banks, fences, waterways, tunnels, engines, sluices, roads, ways, culverts and bridges’. It empowers the company to divert and turn the course of any ‘river, stream, creek and drain’ and to cancel existing rights of way, as well as to purchase land by compulsory order. This gave the company leave to significantly alter the estuarine environment, though not to ‘impede existing land drainage’or to ‘impede existing navigation’of the Shannon.

The Clare Slob Reclamation Company was primarily concerned with reclamation on the western side of the Fergus estuary between Islandavanna and Islandmagrath, an area of c. 580ha. This scheme was designed to further extend a tract of land that had been reclaimed prior to 1839-1840. The earlier reclamation had joined the two islands of 'Island Avanna' and 'Island Magrath' to the mainland, incorporating an extensive additional area in between. Reclamation works under the new scheme extended considerably further into the intertidal flats, effectively land-locking these two islands. Due to breaches in some of the embankments the company failed to complete the works and was wound up in 1891. The 2nd Edition OSI Map Series of 1924 and the Discovery Series (1996) shows that some of the original retaining walls failed within 20 years of construction, with consequent flooding of much of the reclaimed area. The experience of this company highlights the opportunities and risks associated with reclamation schemes of this period.

The Maigue Reclamation

A total of c. 2075ha was reclaimed or improved along the tidal course of the River Maigue and its tributaries, on the southern shore of the Shannon estuary in County Limerick. National Archives files on various reclamation initiatives carried out between 1848 and 1871 on the County Limerick estuarine lowlands demonstrate a high level of interest and activity in reclamation. Unlike the Fergus reclamation, the majority of the Maigue schemes were of a modest nature, involving the embankment, drainage and improvement of relatively small areas. Details of some such schemes are given in Table 3, with the main concentration of reclamation activities focused on the River Maigue, where the tidal lowlands were most extensive.

The Maigue reclamation penetrates a considerable

Table 3. Examples of reclamation initiatives carried out along the Shannon estuary in County Limerick (1857 – 1871)

{PRIVATE}National Archives File Number	Location in County Limerick	Hectares (Acres) Reclaimed	Year
660	Ballyculhane	8.1 (20)	1860-1864
666	Ballynacorrig	28.3 (70)	1860
672	Farranshonemore, Clonmacken, Coonagh West	15.8 (39)	1860-1871
675	Shannon Grove	42.5 (105)	1857-1860
676	Ballycasey Kilcurley		
	Islandea		
	Blackabbey Ardshanbally Mondellihy Kilgobbin	40.9 (101)	1861-1865
677	Corcamore Cloghatacha Glascurram Cloonanna	12.1 (30)	1848-1866

distance inland from the confluence of the River Maigue with the main estuary channel. Substantial tracts of reclaimed and improved lands extend c.10.5 km inland from Rinekirk Point almost to Adare, forming a large, contiguous area. The widest dimension of this new land area occurs close to the mouth of the Maigue (incorporating Creggaun and Corcamore), where it extends c. 5.7 km across. It is likely, according to field surveys, that the process of embankment of the River Maigue took place incrementally, though more complete historical information is required to reconstruct the full pattern of events.

The Limerick Reclamation

The Limerick reclamation consists of c. 760ha of land that lies north and south of the Shannon estuary channel on the approach to Limerick City. Similarly to the Maigue, the associated reclamation works appear to have been carried out piecemeal, responding to changing needs and opportunities as they arose. The main area of reclamation on the north bank is around Coonagh, between the Meelick River and the estuary channel. On the south bank reclaimed lands occur from Cooperhill through Bunlicky to the River Ballynaclough floodplain towards the city.

Other Reclaimed Areas

In addition to the larger contiguous reclaimed areas, several other locations were also reclaimed, albeit on a smaller, but still significant, scale. On the southern shores of the estuary west of the River Maigue reclaimed lands totalling c. 640ha occur at Shannongrove, Castle View and Mantlehill, as well as around Aughinish and Foynes. On the western shore of the Fergus estuary reclaimed lands at Killadysert, Ballynacally, Inishdea and elsewhere represent a yield of c. 280ha, while east of the Fergus another c. 300ha of reclaimed land occurs around Ballyglass and Shannon airport. In combination, these smaller areas represent in excess of 1000ha of reclaimed estuarine lowland.

CONCLUSIONS

Reclamation and enclosure of approximately 6,500ha of the Shannon estuary lowlands for agriculture and other purposes has taken place. While archaeological evidence suggests that some modifications were carried out in the prehistoric period, the majority of land reclamation resulted from government backed schemes, mainly in the nineteenth century. Resulting lands form large contiguous areas around the Fergus estuary, the River Maigue and Limerick City, with several additional pockets of reclamation distributed widely around the estuary margin, usually associated with embayments, river outlets and tidal channels.

Reclamation has significantly altered the morphometrics of the inner estuary through constricting the estuarine water body within its current artificial embankments. The use of embankments and revetments as flood protection devices has significantly reduced the dissipative and water storage capacity of the adjoining low-lying areas, which were once tidal wetlands. This has had a two-fold effect: (a) modification of the estuarine physical environment and its hydrodynamics, and (b) alterations in the character of the wetland habitat in the estuary environs. It is almost certain that there have been important consequences for sedimentary and morphodynamic processes within the estuary, including changes in water and sediment circulation, transport patterns and changes in the tidal prism, with associated alterations in ecology, hydrology and relative sea-level. The precise nature and impact of these environmental changes are as yet unknown, and substantial additional research is required in these areas. It nevertheless appears likely that future management of the Shannon estuary lowlands will be required to accommodate natural process-response systems as the estuary seeks to restore a natural dynamic equilibrium. As pointed out by CARTER (1991), it is important to evaluate the future functioning of the Shannon estuary in the light of long-term environmental adjustment to climate change and relative sea-level rise. The impact of large-scale land reclamation is likely to be a major factor in determining how these adjustments operate in the future.

ACKNOWLEDGEMENT

The authors wish to acknowledge the Academic Research Committee, Mary Immaculate College, for funding the data collection element of this project.

LITERATURE CITED

ALLEN, J.R.L., 2000. Holocene coastal lowlands in NW Europe: autocompaction and the uncertain ground. In: PYE, K. and ALLEN, J.R.L. (eds.), *Coastal and Estuarine Environments: sedimentology, geomorphology and geoarchaeology*. London: Geological Society Special Publication No. 175, pp. 239-252.

ALLEN, J.R.L., 1998. The geo-archaeology of land-claim in coastal wetlands: a sketch from Britain and the north-west European Atlantic and North Sea coasts. *Archaeological Journal*, 154, 1-54.

BARRAS, F.B. and PAUL, M.A., 2000. Post-reclamation changes in estuarine mudflat sediments at Bothkennar, Grangemouth, Scotland. In: PYE, K. and ALLEN, J.R.L. (eds.), *Coastal and Estuarine Environments: sedimentology, geomorphology and geoarchaeology*. London: Geological Society Special Publication 175, pp. 187-199.

BORER, O., 1939. Changes in the Wash. *Geographical Journal*, 93, 491-496.

CABOT, D., 1999. Ireland: A Natural History. London: Harper Collins, 512p.

CARTER, R.G.W., 1988. *Coastal Environments - An Introduction to the Physical, Ecological and Cultural Systems of Coastlines*. London: Academic Press.

CARTER, R.W.G., 1991. *The Impact on Ireland of Changes in Mean Sea-Level*. Custom House, Dublin: Department of the Environment Report Number 2, Programme of Expert Studies on Climate Change, 128p.

COOPER, J.A.G., 2001. Geomorphological variability among microtidal estuaries from wave-dominated South African coasts. *Geomorphology*, 40, 99-122.

DAVIDSON, N.C.; LAFFOLEY, D d'A.; DOODY, J.P.; WAY, L.S.; GORDON, J.; KEY, R.; DRAKE, C..M.; PIENKOWSKI, M.W.; MITCHELL, R., and DUFF, K.L., 1991. *Nature Conservation and Estuaries in Great Britain*. Peterborough, UK: Nature Conservancy Council, 422p.

FURLONG, N., 1996. The history of land reclamation in Wexford harbour. In: ROWE, D. and WILSON, C.J. 1996. (eds.) *High Skies – Low Lands : An Anthology of the Wexford Slobs and Harbour*. Enniscorthy, Co. Wexford: Duffry Press,, pp. 83-90.

GOVERNMENT OF IRELAND, 1996. *ECOPRO: Environmentally Friendly Coastal Protection*. Dublin: The Stationery Office, 48p.

KING, C.A.M., 1959. *Beaches and Coasts*. London: Edward Arnold, 403p.

HEALY, M.G., 1995. European Coastal Management: An Introduction. In: HEALY, M.G. and Doody, J.P., (eds.), *Directions in European Coastal Management.* Tresaith, Cardigan, U.K: Samara Publishing, pp. 1-6.

MULRENNAN, M., 1989. Management of the coastal environment. In: SWEENEY, J.C. (ed.), *The Irish Sea : A Resource at Risk*. Maynooth, Co. Kildare: Geographical Society of Ireland, Special Publication 3, pp. 99-106.

O' DALAIGH, B., 1998. (ed.) *The Stranger's Gaze – Travels in County Clare 1534-1950*. Ennis, Co. Clare: Clasp Press, 370p.

O' SULLIVAN, A.(ed.) 2001. *Foragers, farmers and fishermen in a coastal landscape: an intertidal archaeological survey of the Shannon estuary, 1992-97.* Dublin: Royal Irish Academy.

PARLIAMENTARY PAPERS, 1835. Parliamentary Papers 5 and 6 *Will*. IV, c67.

PETZELBERGER, B.E.M., 2000. Coastal development and human activities in NW Germany. In: PYE, K. and ALLEN, J.R.L. (eds.), *Coastal and Estuarine Environments: sedimentology, geomorphology and geoarchaeology.* London: Geological Society Special Publication 175, pp. 365-376.

ROWE, D. and WILSON, C.J. 1996. (eds.), *High Skies – Low Lands : An Anthology of the Wexford Slobs and Harbour*. Enniscorthy, Co. Wexford: Duffry Press, 367p.

SMITH, K. and WARD, R., 1998. *Floods – Physical Processes and Human Impacts.* Chichester, England: Wiley, 382p.

UDNEY, J., 1831. Essay III: Embankments. *Transactions of the Highland Agricultural Society*, 13, 100-103.

VILES, H. and SPENCER, T., 1995. *Coastal Problems - Geomorphology, Ecology and Society at the Coast*. London: Edward Arnold.

WHEELER, A.J. and HEALY, M.G., 2001. Coastal landscapes and environment change in the Shannon estuary area. In: O' SULLIVAN, A. (ed.) *Foragers, farmers and fishermen in a coastal landscape: an intertidal archaeological survey of the Shannon estuary, 1992-97*. Dublin: Royal Irish Academy, pp. 5-22.