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THE ROLE OF GIS IN EVALUATING CARTOGRAPHIC AND SURVEY EVIDENCE IN THE DETERMINATION OF HISTORIC AND CULTURAL LANDSCAPES

В статье рассматривается роль ГИС в сохранении и воссоздании ландшафтов на базе документационных и картографических материалов с использованием сведений культурного, исторического и промышленного характера о территориях. Статья содержит выводы и рекомендации по использованию ГИС для анализа, оценивания и презентации ландшафта в историческом аспекте на основе исследований, проведенных в университетах: University of East London (Англия) и University of Agriculture в Кракове (Польша).

This paper will provide a generic background to the role of GIS in recording and re-creating landscapes based upon a range of documentary and cartographic material, with case studies derived from the analysis of historic, cultural, and post-industrial case studies. The paper will then address the specific use of GIS in analysing, evaluating, and presenting a range of historical landscape scenarios based upon research that has been conducted at the University of East London (England) and the University of Agriculture in Kraków (Poland). Finally, the paper will address some of the fundamental issues and recommendations relating to the role of GIS in landscape analysis. N.B. Throughout this text, the reader is recommended to relate the names and locations to Google Earth, which provides a far superior illustration of the landscape than could be achieved through countless maps and illustrations.

1. Introduction

Cultural and historic landscapes are the result of consecutive reorganizations of the land in order to adapt its use and spatial structure better to changing societal demands and their analysis is dependant upon an integrated approach that ultimately aims at the integration of fundamental and applied research and policy implementation (Antrop, 2005). This approach calls for specialised tools and Geographical Information Systems (GIS) have proved to be invaluable software in handing spatial data in a number of different forms and situations. Mapping plays a pivotal role in the definition of historic and cultural landscapes characterisation and the use of GIS has now reached the stage where it is a requirement for the successful delivery of many such projects (Clark et al., 2004: 6). However, we must treat this with care since the interactions that exist(ed) between various aspects of identity might encompass a range of interpretations based upon the ‘position’ of the interpreter. For example, a young person or one newly arrived might view a settlement as a good place to live, with good schools, a large village institute, and several large housing estates, without having any knowledge of the existence of a former coal mine. In contrast, older people who have lived in the village and are aware of the past importance of the coal mine and of the nature of the infrastructure remaining in the landscape may still consider the village to be a mining village. It is easy to see how landscape representations may be interpreted and re-interpreted in either a current or historical perspectives and how the ‘seeing’ of a landscape is largely conditional upon knowledge (Cosgrove, 1993). This concept of ‘seeing’ a landscape that is recognised by ‘local’ people may be identified as a ‘cultural’ landscape. Given this knowledge it is important that although the application of GIS to land-related problems is now quite routine and ranges from the examination of historical and cultural landscapes to the identification of specific sites within the landscape, the implications of landscape are understood by those who use the data generated.

In most cases the use of GIS follows the generation of a two, three or four-dimensional model of spatially-related digital data that evolves through a number of different stages. Jansson et al (2004: 15) identify four distinct stages: data capture; pre-processing; geometric adjustment; and finally data analysis, evaluation and dissemination. When dealing with the landscape, data capture is either through directly acquiring the data in the field, using existing raster or vector data, or by scanning an existing analogue photograph or map. In some cases it might involve the examination of documentary information. The second stage involves the pre-processing of the images or data, perhaps relating the documentary information to a spatial framework, or possibly adjusting the resolution of raster data and modifying the colour balance or definition of the data. This is particularly important if data has been acquired from archives in which digital images have been captured of old maps and documents under artificial lighting. Many of the old maps would have been hand drawn on velum, which would subsequently have been folded and effected by differential wear and lighting conditions. Thirdly, the images and data must be fitted to a common geometric framework. Data acquired directly in the field normally presents the least problems whereas old maps can create the greatest problems – both in terms of accuracy and distortions often caused through past storage. This stage is normally conducted whilst the archival images are still in their raster form. The final part of this stage comes with the vectorisation of the raster images, which often involves digitising directly from the raster images using the GIS software. Once the data has been converted into a vector form, polygons can be generated and attribute tables linked to them. Much of this tabular information would be derived from the documentary evidence. The final stage involves the analysis and evaluation of the data, which must be guided by the research question and will inevitably involve the presentation of the information, either as a series of maps, graphs or tables – or combinations of each in the form of a report.

Cultural and historic landscapes are becoming valuable assets in all states, both in urban, per-urban and rural areas as changes in the ways in which land is managed presents both opportunities and threats. For example, across England the Council for the Protection of Rural England is seeking the protection of National Park status to many rural areas to protect them from creeping urbanisation and the effects of development and industrial farming (CRPE, 2009). In all instances, it is impossible to forecast exactly what might happen to the landscape although a better knowledge of historical landscape conditions and changes might help inform and predict future landscapes as well as identifying locations that are worthy of preservation or conservation (Marcucci, 2000; Bender et al, 2005). This is particularly relevant in two distinctly different types of landscape: on a micro-scale where changes are important in relation to conservation planning, such as the designation of conservations areas; and on a macro-scale across which there are landscapes that are of a regional or even of international importance for their scenic or historic values (Vogt et al., 2002; von Haaren, 2002; Oldfield et al., 2000). In both cases, the problem is often one of fragmentation, in the former fragmentation within a landscape of ‘point’ conservation zones and in the latter, the problem of fragmented ownership or land use that might be a combination of point, linear or areal features. The analysis of the relationships between different landscape elements, such as geology or settlement pattern, is also viewed as central to Landscape Character Assessment (LCA) and many of those elements are represented in either an analogue or digital form of maps, aerial photographs or satellite images (CA & SNH, 2002: 1). The role of GIS in this can facilitate a better end product that can be disseminated in a variety of forms to a wider range of users. A further advantage is that once the data has been modified and stored in a GIS can be accessed and manipulated interactively to serve as a test bed for analysing the results of trends, or for anticipating the possible results of planning decisions.

This is particularly valuable for more effective landscape planning at the local level, where landscape changes are important relative to conservation planning and the appropriate links between historical, cultural, environmental and social data and scales need to be established for effective planning. Bender et al. (2005a) describe this process as the establishment of a large-scale “diachronic cultural landscape information system”, which provides a means of compiling data relating the history and character of landscape change over a long period to assess and evaluate the various eras of landscape use and to examine the causes of major shifts in landscape development whilst providing an explanation of landscape change that has resulted from natural and anthropogenic influences through a quantitative approach. This involves a process of modelling through attribute databases to relate past land-related development, use and ownership patterns to provide a basis from which future landscape planning and land management developments may be viewed and evaluated whilst socio-economic changes may be derived through this parcel-based, multi-temporal GIS (Bender et al, 2005b).

Given the versatility of a GIS, it is a relatively easy task to develop maps of landscape change through overlaying the various temporal levels and adjusting those levels to a common geometric framework irrespective of the scale of the maps, their form, and their respective ages. The chosen scale while clearly influence the level of detail of the representation and may range from individual parcels at a micro-scale through to settlements, coastlines and broad land-use categories at a macro-scale. The scale used will depend upon a number of factors such as the availability of maps of a known scale, their relative accuracy and also the availability of related attribute data. Bender et al. (2005) suggest that a suitable scale for identifying structural change of agrarian landscapes through the use of land-record attribute data would be 1:5 000 and this would also be suitable for the definition of cultural and historical landscape changes. In all cases, the attribute data should include the categories of land ownership, parcel structure, land use, and related planning and conservation regulations.

2. Historic Landscapes

Such landscapes may be variously described as historic but are the result of a continuous process of change that has lead to the formation of temporal layers within the landscape leading to the formation of a cultural landscape. For applications such as these, GIS provides the only practical option for analysing the multiple datasets necessary to fully understand the range of archaeological, historic and environmental developments (Cook et al., 2008). Most surveys involve geo-referenced sensor, photography (both terrestrial and aerial), and cartographic data in which information may be entered through a database using standard terminology – type, period, and location.

The National Trust has been instrumental in making a series of historical surveys of their property (individual estates and buildings as well as larger landscape entities) and two such surveys were conducted within the lake District National Park of Ennerdale and Langdale (Lund & Southwell, 2003; Quartermaine et al., 2003). The purpose of these archaeological historic landscape surveys is threefold; the construction of a historic and cultural narrative for the local landscape, the identification of all sites and monuments of archaeological or historic importance within the survey area and the production of management recommendations for both sites and landscapes (Lund & Southwell, 2003: 5). The methodology for both was very similar consisted of the thorough survey of existing documentary and cartographic evidence combined with extensive fieldwork, all of which was archived to professional standards in accordance with current English Heritage standards (EH, 1991), which specifies the incorporation of the digital and attribute data within an industry-standard GIS yet made available also as a report in a printed form. With respect to the digital presentation of the data, the field survey data was superimposed upon Ordnance Survey digital 1:10,000 mapping (Quartermaine et al., 2003: 76). One of the features that characterises the area are the physical boundaries, which consist of substantially built stone walls. The position of those boundaries was field checked against existing and past cartographic evidence and stylistic character of the walls (often indicative of their age), their type, condition, maximum height, and key features within them such as openings, blockings, sheep creeps, etc., entered into a data logger. The pro-forma developed allowed the build type and character to be entered as attributes in order to develop a local typology of walling types to enable categorisation of the wall form. This will define the basic forms of construction, such as orthostatic founded walls and those with multiple rows of through stones (Quartermaine et al., 2003: 77-78). In addition to this mapping data, the documentary evidence held by the County Record Offices was used to provide further attribute data and included such source material as early maps (including estate plans and tithe maps etc, appropriate sections of county histories, early maps) with particular documents being sought that might provide evidence of post-medieval occupation and land-use of the area to aid a reconstruction of the historic landscape.

Similar surveys have been conducted elsewhere, using similar techniques although at a coarser scale, on a county-wide basis. For example, Ede & Darlington (2002) examined an area of the County of Lancashire in which they not only examined the rural areas but also the major settlements and conurbations using a combination of mapping and documentary evidence to review the Historic Landscape Characterisation types against broader landscape characterisations that exist for Lancashire and investigated opportunities for further assessment, including urban areas and individual districts.

For all such reports it now accepted that data collection and recording will be undertaken digitally. This ranges from digitising from raster data through to field checking to test and verify the decisions already taken as part of the desk-based assessment. In the case of the historic landscape aspect of Brecknock any adjustments were made to the digital data set on a portable computer in the field and therefore did not generate a paper-based record. Consequently, there are no paper record forms, hand drawn maps or photographs submitted with this report (Britnell & Martin, 2003: 4-5). This methodology has been tested in Wales to create base-level data that may be used to define Historic Landscape Character Areas in Historic Landscape Characterisation projects promoted by CADW and the Countryside

Commission of Wales as a means of presenting historic landscape information and is similar to that promoted by English Heritage.

As well as basing the analysis upon a methodology defined by formal bodies, it must also be accepted that at a local level many of those who wish to develop an understanding of landscape change may not have the training and experience to be able to relate one multi-temporal layer to another. In this respect McLure & Griffiths (2005) suggest the inclusion of an additional layer based upon modern aerial photography that has been modified using mapping evidence to simulate the appearance of, for example, a pre-enclosure landscape (or indeed any other form of landscape). Such problems also exist in the case of landscapes that have effectively ceased to exist such as pre-industrial landscapes, particularly those related to deep coal mining activities.

3. A Coal Mining Landscape

In describing the landscape of the coal mining area, the first consideration is what exactly meant by a coal mining landscape? With the visible artefacts, it could be defined as the collieries and their infrastructure, including the headgear, pit heaps, washeries, railways, etc. However, in the absence of those features in a landscape in which there has been history of coal mining, the landscape quickly takes on the appearance of an agrarian landscape, apparently devoid of evidence that has 'healed' and virtually reverted to its previous form. There are, however, certain symbolic qualities of a landscape (Duncan, 1995) that may be recorded either in text or image form, which can be used as evidence of past landscapes when viewed in an organised manner (Seymour, 2000: 193). However, the interactions that exist(ed) between various aspects of identity might encompass a range of interpretations based upon the 'position' of the interpreter.

In this particular case study the area chosen was in north-east Wales, located in a band stretching between the settlements of Wrexham and Chirk. Whilst most of the larger and more obvious artefacts relating to the mining landscape of the Chirk area have been removed, there is a considerable quantity of indicators that provide direct evidence of the coal mining heritage of the area. For example, there are the large housing estates found in St Martins, the location of Ifton Colliery, that now appear to support no apparent industry, a large Miners Institute, playing fields, children's playground, and bowling green. They are clear indicators of past industrial use and the relative affluence of the village compared with that of neighbouring villages in the area. Close by, Black Park Colliery, being a much older undertaking that Ifton was less well served with amenities and the workforce more widely dispersed, with the majority travelling from the Chirk area, Cefn, and the village of Halton. The amenities were concentrated at Halton, which contained a row of 50 small houses occupied by some of the Black Park workforce, a Welfare Institute, and some leisure facilities. Since the concentration was less than in St Martins, and the colliery closed almost 20 years earlier, there is less obvious evidence in the present landscape.

In addition to the infrastructure of the settlements, there are also the traces of the railways and tramways still within the landscape, some of which as been obliterated through road improvements but much still remains to be seen, providing the viewer looks in the correct place. Much of the track bed of the railway linking Ifton Colliery to the mainline at Preesgweene is still evident apart from that near to the location of the colliery, which has been reclaimed for agriculture. Strangely, there is also evidence of an earlier tramway linking Ifton Rhyn Collieries to the Shropshire Union Canal, in the form of an embankment to the north of the canal between Preshenlle and the Sarn bridges. Also noticeable is the widened tow path between the Sarn bridge and the wharf at St Martin's Moors bridge to make room for the tramway. The evidence of the rail link between Black Park Colliery and the main line may still be seen in places but, because the earthworks required for the railway were less extensive than those for Ifton Colliery, the former track bed is not so clear.

Within the context of this paper, we need to be able to explore whether it is possible to re-create a landscape through the presentation of information based typically of maps, photographs, journals, historical sources, and anecdotal evidence (Seymour, 2000: 195)? Can a 'real' material landscape and its symbolic representation be based upon empirical reconstructions? Some work has been made on a pilot project at the University of East London in which the feasibility of using a GIS to recreate a coal mining landscape based upon old maps and other documentary evidence that is available in the public domain.

One of the most important elements of any GIS is the data. For the purpose of setting up this system two basic maps sources were used: the First Edition Ordnance Survey 1:2,500 County Series maps of Shropshire and Denbighshire, originally surveyed in approximately 1870; and the current Ordnance Survey

1:2,500 National Grid maps, surveyed during the latter part of the twentieth century. The major problem with these two data sources is that were constructed to different geometric frameworks, the County Series maps on a county basis using the Cassini Solner map projection, whilst the later National Grid series were constructed on a national basis using the Tranverse Mercator map projection. This problem of different geometric frameworks is a common one, particularly when using historical maps and the GIS is capable of merging the different sets of data together into a common geometric framework. Nevertheless, great care must be taken in checking and assessing the likely errors since although it is possible to adjust all features on the map, the more precise the adjustment, the longer it will take and in most instances a balance has to be made between time (costs) and overall accuracy.

A detailed examination of maps of rural areas revealed a significant level of detail relating to former mining landscapes, such as old shafts and the formation of the old tramways linking collies to canal and the railway network. In the case of urban areas the project located and identified almost 100 old shafts within an area of 15*15 kms, together with the often associated brickworks and tramways. These features were mapped and placed in a separate 'layer' of data that could be shown on top of the old maps. Whilst the identification of shafts from old Ordnance Survey maps is problematical (could the original land surveyors identify with accuracy what was an old shaft(?), all locations could be verified through other documentary sources. In those instances where shafts cannot be verified, they should be identified as such until their position can be confirmed or denied. This should be standard mapping practice for any such historical project.

To test the feasibility of extending this 'pure' mapping function of GIS, the next stage was to build up another level of data that consisted of the current 1:2,500 maps that would be merged with the data sets comprising the old maps, and the data extracted from those maps (Figure 1). This was a comparatively simple operation but tests were made to analyse whether the two sets of data of maps merged or whether there were any residual geometric errors. Whilst the location of shafts in open areas might not necessarily give any indication of geometric errors, the coincidence of linear features that have not significantly changed position, such as roads, are reliable indicators. By examining those features when overlain, it was clear that even without any form of numerical analysis, there was a good level of reliability between the two maps. Both maps also give a clear indication of how the coal mining landscape has been redeveloped and, in particular, the location of the old shafts with respect to the current residential development. In many instances, new housing estates had been built over old collieries and mine shafts. This latter factor, that of the redevelopment of the coal mining landscape, could potentially bring into question the possibility of the location of shafts beneath residential or commercial properties even though those shafts might have been filled and capped. Therefore, in order to examine the possible area of uncertainty concerning the precise location of the shaft, the GIS was set to place a 'bound' of 50 metres around the location derived from the old map.

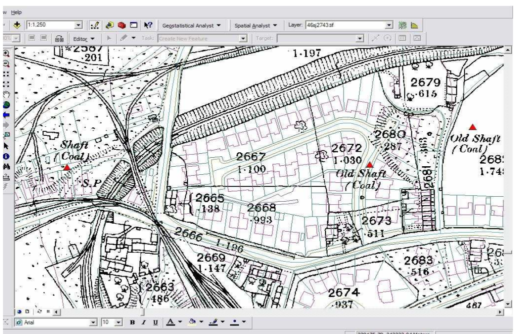

Figure 1. Detail from the overlay of the two maps and detail of shafts extracted from old maps. (Crown Copyright Controlled)

The next stage in this exercise was to incorporate additional point data, such as information, maps and photographs relating to a specific location or colliery. Such an approach has already been tested by Hughes (2005), which resulted in the development of a Geographical Historical Information System (GHIS) used to store and display a large amount of map, textual, interviews, and image material related to specific locations around an area in the north-east of England. This system effectively forms the prototype to the system that will be developed to recreate the 'virtual' coal mining landscape of the Chirk area.

4. Enclosure and Land Claim in North-West England

The social and industrial development this area was, at the early part of the nineteenth century largely unchanged from that that had existed since the medieval period. Searle (1993) and Winchester (2000) discuss the systems of land tenure in the rural areas, with customary tenants having the right to sell or pass their land down from one generation to another. The advantageous nature of such tenancy agreements was recognised and it was not until the early part of the nineteenth century when cattle herders from Ireland and Scotland, transporting their livestock to the industrial centres, overwhelmed the common grazing lands of the tenants, that they themselves petitioned for the land to be enclosed, in some cases over 100 years after Parliamentary Enclosure had taken place in many other parts of England and Wales (Whyte, 2000). Thus, there was little opposition to enclosure when the lords of the manor sought consent, both landowner and tenant being mutually supportive for radically different motives. From the perspective of the lords of the manor, enclosure was a mechanism that allowed them to detach the commons from customary tenure that had kept the rents at low levels. With enclosure, the customary tenants became freeholders but, in so doing, lost their customary use of the commons – most of which were allocated to the lords of the manor.

Parliamentary Enclosure

Prior to formal enclosure it had always been possible for groups of landowners to enter an agreement whereby land could be consolidated, enclosed, and redistributed in logically-arranged parcels. Enclosure of land through a legal Act and Award was a more formal process that was expensive – because it necessitated lawyers, but it also called for the appointment of an Enclosure Commissioner who was normally a local land agent or surveyor who had no conflict of interest in the scheme. Why, therefore, if provision had existed for land to be enclosed was it necessary to involve the formal process of Parliamentary Enclosure, and why did it gain such national popularity? The main advantage is that it was formally binding upon all landowners in the area of the Act and Award and the processes involved not only the enclosure of the land but improvements to the land (through drainage) and infrastructure, such as the construction of drains, roads, and bridges. It was also an intervention through the State aimed at improving the land to increase both its yield and access.

The important consideration relating to enclosure in the context of land management and land use are whether tangible advantages can be accrued from the process. A further consideration is the actions that took place immediately and following enclosure and the changes of land use from, for example in the case of the Cartmel Enclosure Award, the reclamation of a considerable area of land from the sea to provide land for arable farming (Stockdale, 1872: 326-384).

Enclosure involved two main elements: firstly the removal of communal rights from an area of land and its replacement by the management of a single owner; and secondly, the surrounding of the land by a clearly demarcated boundary (Whyte, 2003a; 2003b: 9). According to Kain et al (2004: 3) the elements were supported by two processes: firstly, the organisation of property in the case of existing fields and meadows; and secondly, the reclamation and improvement of wastes and commons. These actions are very similar to those undertaken at regular intervals across Europe, referred to as land consolidation (Dixon-Gough, 2006). Enclosure Commissioners has great powers to modify the landscape and whilst their main function was to divide and enclose the commons, wastes and mosses amongst the correct owners, it was also necessary to re-plan the landscape in a much wider sense. Their legally enforceable powers included not only defining the location of the new boundaries but establishing the form they should take (Chapman, 1993). Through this process, the commissioners had the power the realign roads, tracks, and footpaths, and in areas of former common or waste land, to construction new public and private roads. Streams and watercourses could be similarly re-aligned, partly to ensure that all farm units had a supply of water but also to straighten streams and water course to provide a more rapid flow of water through the area and, in conjunction with the construction of patterns of drainage ditches, to drain and improve the land (Chapman, 1993).

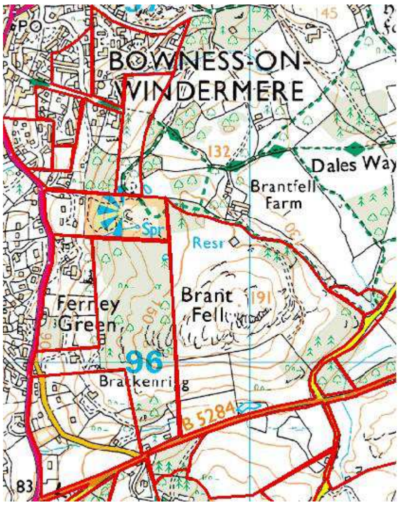

Figure 2. A section of the Undermill Beck Enclosure Award superimposed on the current OS 1:25,000 maps showing the extensive expansion of Bowness-on-Windermere. (Crown Copyright Controlled)

The formal allocation of the land between the owners was either based upon their collective responsibilities and rights, such as the number of animals they had been permitted to graze upon communal land, the reallocation of fragmented ancient fields into contiguous parcels, or the reallocation of narrow, strip fields into a more regular pattern suited for 'modern' agriculture and farming techniques. One of the problems in interpreting the Enclosure Awards is that there appears to be significant discrepancies between the size of the plots allocated according to the Award and the shape of the boundaries, which cannot be reconciled to the amalgamation of parcels. The research currently being undertaken is to firstly analyse the distribution of landownership patterns according to the information contained within the Award and, secondly to related the existing field boundaries to those set out in the Award. The problems of this form of analysis is twofold: firstly deciphering the old handwriting (often badly faded) of the Awards, transcribing it and then entering the information into an Excel spreadsheet; and secondly relating the boundaries of the hand drawn maps to those boundaries that exist on the Ordnance Survey (OS) maps. There is little likelihood that the boundaries have changed since they were originally constructed since they consist either of stone walls (0.5 m thick at the base rising to a height of 1.5 m) or ditches of a similar dimension but in the ground. GIS provided a suitable tool for this analysis (Figure 2). Information concerning the boundaries was digitised from the OS raster images and polygons created to represent the parcels. Once these had been created it was possible to link the polygons to the Excel spreadsheet to provide the attribute data concerning ownership and the assumed area of the parcels take directly from the Enclosure Award. From the layer within the GIS related to the digitised polygons, it was a relatively simple task to calculate their areas and to establish the centroid of each parcel within the national grid system of Great Britain. In addition to this approach, images of the Enclosure maps in a *.JPG format were overlaid on the OS raster image and warped to fit to establish the direct relationship between the shape, orientation, and nature of the boundaries as designed on the Award and how set out on the ground. Finally, the full extent of the Award (based upon the existing boundaries) was calculated and compared with the extent of the Award as originally stated. Numerous significant discrepancies have been noted but the project has resulted in an improved understanding and appreciation of landownership patterns.

This is part of an ongoing research project which seeks to compare through GIS the evolution of landownership patterns across parts of north-west England using several land-related inventories: the Enclosure Awards, Tithe Surveys, 1910 Valuation Survey; and the National Farm Survey conducted between 1941and 1943.

Land Claim

Fringing Morecambe Bay and the estuaries of the Kent and Leven are large areas of low-lying land (below 6 m AOD) which were formerly covered by the sea. Originally, these areas have progressively silted and have been the subject of land reclamation, initially by the monks of Furness Abbey during the thirteenth century. The banks constructed by them enclosed over 1,200 ha of saltmarsh or sandflats, although only about 400 ha was actually reclaimed for agriculture (Gray & Adam, 1974). Today a combination of sea defences and railway embankments protect some 55 km of coastline between Ulverston and Morecambe.

The first attempt at reclaiming agricultural land was made near Lindale where over 400 ha of inter-tidal land was successfully reclaimed and drained. Following this experimental land claim, Lord Cavendish of Holker Hall initially had built a series of banks on the shore of the Leven preventing the occasional tidal flooding of adjacent inter-tidal lands followed by the constriction of the embankments across Grisepool Marsh, at Old Park, Park Head, Frith, Maenhouse, and Ladydyke in about 1781. Prior to their construction, at spring tides the sea would flow up Grisepool Beck to within about 400 m of Holker Hall (Stockdale, 1872: 397). Alexander Bogden (the railway engineer of the Ulverston and Lancaster Railway) also reclaimed much of the Winster valley and estuary, including the land behind the embankment between Grange and Meathop to drain and reclaim a large area of land south-east of Meathop village. The pattern of the former saltmarsh can be clearly seen from aerial photographs or satellite images. .

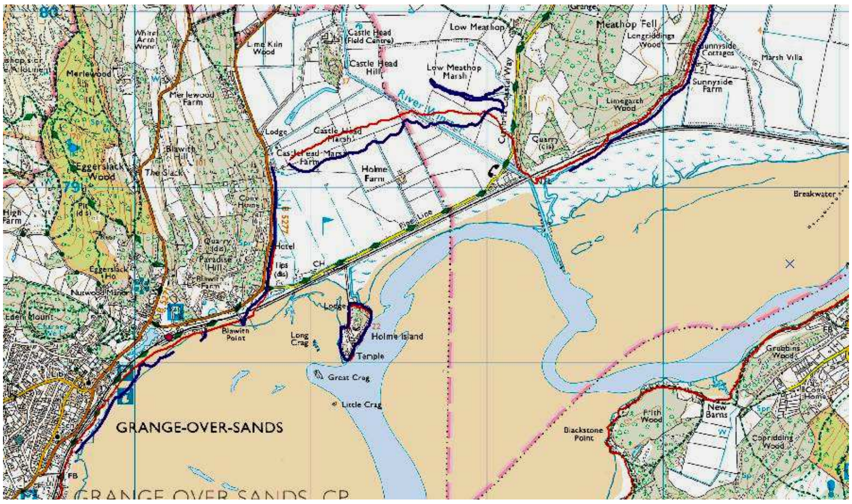

Figure 3. Detail extracted from old maps overlaid on the current OS 1:25,000 map. The purple line represents mean high water from the OS 1st Ed. County Series of Lancashire (1849 -1888) whilst the red line represents mean high water as shown on the OS 1st Ed. County Series of Westmorland (1849 -1888). (Crown Copyright Controlled)

Most of the work relating to the claim of land from the inter-tidal areas was conducted on a piecemeal basis that was never fully documented although much may be deduced from an examination of cartographic evidence, particularly in the case of deeds and tenancy agreements, the Enclosure Awards, Tithe Maps, and First Edition OS maps although in this latter instance the amount of material available is dependant upon the series and the date of survey (Figure 3). Again this project is heavily reliant upon the evaluation of data using a GIS to merge disparate datasets whilst modelling some of the effects and implications of land claim upon the subsequent growth in the extent of saltmarshes. The re-establishment of a former coastal line is of interest from the perspective of local environmental change and to monitor the implications and effects that climate change might have upon such low-lying, vulnerable and dynamic coastal areas that are influenced both by storm events at sea and fluctuating river flows especially after prolonged rainfall or deluges within the headwaters of the catchment areas.

5. A Detailed Study of the village of Węglówka

The protection of the mountain slopes of cultural landscapes together with the limitation of water erosion can be achieved through landscape planning based upon the construction of digital terrain models (DTMs). From surveys conducted in the region of the Małopolska voiovodeship it has been observed that there are no effective and satisfactory solutions in local plans concerning cultural landscapes and the prevention of erosion soil. To change that situation and introduce effective mechanisms for spatial planning it is necessary to develop a landscape plan that will also include protection to prevent or minimise soil erosion. Since Poland ratified the European Landscape Convention, there are obligations including landscape identification, a part of which concerns the creation of landscape plans identifying the location of possible soil erosion and means of its prevention. Józefaciuk & Józefaciuk (1999) consider that the identification of programmes to prevent soil erosion can best be developed through directions, rules and methods that prevent soil erosion coupled with financial incentives and practical encouragement as well as identifying the socio-economic effects of the planned erosion prevention measures.

As part of a pilot project, detailed studies have been carried out in the area of Węglówka, which is located in the southern part of Wiśniowa commune within the range of Łysina (894 m above sea level) and Lubomira (904 m above sea level) (Beskid Makowski). Significant differences in bed-rock resistance in the area of the terrain of this area have created a belt-shaped layout of the relief. Steep slopes, flat or rounded ridges and domed peaks predominate in the northern part of the area (Paul & Ryłko 1996) whilst to the south the steepness of mountain slopes and ridges is much lower, and on the level of foothills (Burtan et al. 1978). The mountain ranges stretch from north-west to south-east, and within the area there are significant plateaus. Wiśniowa commune is located in the Małopolska (Little Poland) voiovodeship (province), which is threatened with surface water erosion (around 57 percent of the total area), of which about 26 percent has suffered from severe erosion (Józefaciuk & Józefaciuk, 1999). The existing soil erosion constitutes a serious problem for the development of the rural areas in specific and the landscape in general. Of all geomorphological processes, soil erosion and landslides must be numbered among the significant causes to the changes of mountain slopes in cultural landscapes.

Nowadays, DTMs are universally used in the analysis of erosion processes. These models constitute an important element of new technologies for predicting water erosion. In the conceptual phase of the programme it was decided that for the realization of research assumptions, Surfer, Corel Draw and Winkalk would provide the best, professional level software platforms. Corel Draw provided the graphic environment whilst Winkalk was used for the essential calculations, with Surfer being used for the digital terrain modelling. The base for creating a DTM was the base map at a scale of 1:10,000. The information from the analogue maps was scanned and the contour lines digitised and sampled at 2 m intervals for use within Surfer. Characteristic terrain points (break points) were added manually, such as the bottoms of valleys, peaks of hills, saddles and the data were saved in a text file and used to create the DTM from which the slopes were calculated. As part of this stage a tachimetric survey of the nature and characteristics of selected mountain slopes was conducted using TCRA 1203 total station.

Next the numerical model of the area was used to generate a map of the magnitude of gradients throughout the area of the Wiśniowa commune (Figure 4). The following values of gradients magnitudes, expressed in degrees, were identified in the area: 0-5, 5-10, 10-15, 15-20, 20-25, 25-30. The aim of the gradient map is to identify and depict the numerous mountain slopes throughout the area, which would be instrumental in drawing up a landscape plan. The landscape plan should also include for the mountain slopes the hazards such as the increase in afforestation of the mountainsides, which leads to a decline of that element of the cultural landscape; any uncontrolled building development on these mountainsides; and any uncontrolled agricultural use of the mountainsides.

As a part of the landscape plan, the programme of soil protection of the mountainsides can be drawn up through the use of the universal soil loss equation (USLE). USLE may be used to compare soil loss, in particular fields with particular systems of farming and management, with the indices of tolerated soil loss. Alternative farming and management systems may also be evaluated to define properly applied protection means in the planning of agricultural activities. Erosion values shown by these factors can significantly differ due to changing weather conditions and thus the values obtained from USLE depict long term mean values more accurately (www.omafra.gov.on.ca). After calculating the estimated potential annual soil loss for a given field a programme soil protection may be recommended for the area in the context of sustained development. That programme may also include ways of lowering that loss to an acceptable level. From our preliminary studies on the use of USLE for the mountain slopes in the area of Węglówka village it has been recommended that a precise DTM be created to calculate the factor of length and gradient of a slope (LS).

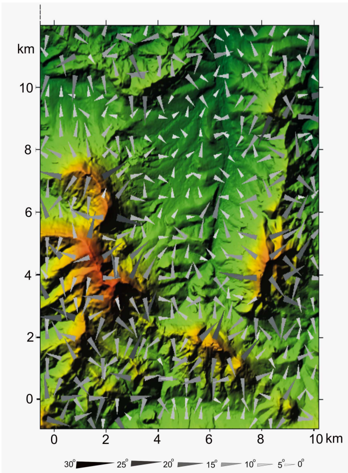

Figure 4. Map of gradients magnitudes of Wiśniowa commune.

The process of erosion spreads very quickly each year. Therefore, it is only possible to measure the necessary by sampling various fields over a number of years. This measurement process is very extensive and does not provide the necessary quantity of results that are urgently needs. The universal soil loss equation is important to calculate the likely quantity of soil erosion occurrences that might occur over a longer time period, which is vital for the protection and preservation of cultural landscapes.

6. Conclusion

This paper has provided a general background to the role of GIS and spatial data in recording, re-creating, and providing protection for landscapes based upon a range of documentary, cartographic, and surveyed material. It has provided case studies based upon the analysis of various forms of spatial data to analyse, evaluate, and present a number of issues relating to historical and cultural landscapes based upon research, co-operation, and the exchange of ideas between the University of East London and the University of Agriculture in Kraków.

It has been established that cultural and historic landscapes have gradually evolved yet are under increasing threat from changes in the ways in which those landscapes are viewed and used changing societal demands. Their protection can only be ensured through an integrated approach of analysis and evaluation based upon applied research and policy implementation. Surveying, mapping and spatial data analysis through tools such as GIS provide one way handing that spatial data in such a way to provide a multi-disciplinary means of holistic land management for the future.

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