Section 1. Introduction to the GIS Guide#

1.2 Applications of GIS in Archaeology#

The explosion of interest in GIS since the 1990's reflects the importance of space, spatial concepts and spatial modelling, both in the present and in the past. Although the technology of managing and analysing spatial data is now a multi-million dollar industry - which, it should be noted, pays scant regard to the specific requirements of archaeologists - our discipline has been innovative and proactive in developing its own applications of GIS. This section will serve to trace the main developments in this process, illustrating the evolving shape of GIS applications within archaeology. As will be seen, these cover a wide range of approaches and serve to emphasise the breadth and diversity of such applications within the discipline.

1.2.1 Some Core References

Throughout the discussion reference will be made to a carefully selected set of mainstream references that should be easily accessible. The following four volumes of published conference papers (in order of conference not publication: Allen et al. 1990; Aldenderfer and Maschner 1996; Maschner 1996; Lock and Stancic 1995) act as a useful core framework. These provide a considerable range of case-studies and theoretical discussions together with valuable overviews of the development of GIS in archaeology (for example, Harris and Lock 1990; Kvamme 1995; Harris and Lock 1995; Maschner 1996). Another important source of references are the proceedings of the annual Computer Applications in Archaeology conference (CAA), which saw its first GIS paper in 1986. From 1992 CAA became more international and all aspects of the theory and application of GIS now form a major component of its programme (the proceedings in order from 1986 until 1995 are: Laflin 1986; Ruggles and Rahtz 1988; Rahtz 1988; Rahtz and Richards 1989; Lockyear and Rahtz 1991; Lock and Moffett 1992; Andresen et al. 1993; Wilcock and Lockyear 1995; Huggett and Ryan 1995; Kamermans and Fennema 1996). Two particularly useful web-based resources are GIS in Archaeology Bibliography 1995 and a list of Archaeologists using GIS.

1.2.2 The Early Years and Spatial Statistics

The first archaeological use of GIS was in North America, where it developed within the requirements of cultural resource management based on the predictive modelling of site location (Kohler and Parker 1986). The statistics involved were well suited to raster data models and effective methodologies and results were rapidly accumulated (Kvamme and Kohler 1988; Kvamme 1990; Warren 1990). More recently there has been interest in these approaches in The Netherlands (Brandt et al. 1992; van Leusen 1996), and Wheatley (1996) has incorporated cultural data to overcome a major criticism concerning the emphasis on environmental data and the resultant accusations that such studies fostered an uncritical environmental determinism.

Although it has been recognised for a long time that the GIS environment is an ideal medium for the development of new approaches to spatial analysis there are very few formal statistical methods generally available (Openshaw 1991; Fotheringham and Rogerson 1994), since most commercial GIS packages lack the most basic statistical facilities. Within archaeology there is an emphasis on cell-based manipulation as an extension of the earlier work, for example auto-correlation (Kvamme 1993), statistics and simulation (Kvamme 1996), perhaps within the wider procedures of cartographic modelling (Tomlin 1990, generally; van Leusen 1993).

1.2.3 Landscapes, Present and Past

The archaeological awakening to GIS and the resulting rapid increase in applications started with the publication of Interpreting Space (Allen et al.) in 1990. Since then, in very general terms, there have been two streams of development which can be categorised as Cultural Resource Management (CRM) and landscape analysis. While any definition of GIS will undoubtedly emphasise analytical capabilities (Martin 1996 for an introduction), it must be recognised that a major strength of the software lies in its ability to integrate and manage large and diverse data-sets. The integration and georeferencing of different types of spatial data over large geographical areas, typically a region or even a whole country, together with textual databases is a central concern of CRM. This is usually based on statutory obligations and frequently involves the integration of data sources at a range of varying scales. As a result of the flexibility and strength of these data management capabilities it is not surprising that in the majority of cases, though by no means exclusively, analysis is relegated to a secondary role.

The potential of GIS in CRM was recognised by many countries at a conference in 1991 (Larsen 1992), and has since been realised by some of them, for example France (Guillot and Leroy 1995), The Netherlands (Roorda and Wiemer 1992) and Scotland (Murray 1995). The adoption of GIS by national and regional CRM organisations is a complex business, often embroiled within a range of concerns including information strategies (not least upgrading from an existing system), communications and standards, politics and funding. There has been a great deal of published discussion about these wider issues including European Union initiatives (van Leusen 1995), various data models (Arroyo-Bishop and Lantada Zarzosa 1995; Lang and Stead 1992) and the issues involved in the restructuring of an existing database (Robinson 1993).

While CRM systems are usually based upon a vector data model, they often need to incorporate a number of raster data layers into the database, for example the integration of aerial photographs into the Scottish National Monuments Record (Murray and Dixon 1995). Other common raster data-layers that could be encountered include the results of geophysical survey (a good example of this, although not strictly CRM, is the Wroxeter Hinterland Project (Gaffney, van Leusen and White 1996)) and satellite imagery (Cox 1992; Gaffney, Ostir, Podobnikar and Stancic 1996).

Within the field of non-CRM landscape applications there are a considerable number that utilise the mapping capabilities of GIS rather than any of its analytical functionality. Even so, analysis can be central to GIS-based landscape studies, as demonstrated by the early case-study of the island of Hvar (Gaffney and Stancic 1991; 1992) and the seminal paper by van Leusen (1993), where the archaeological analyses engage a battery of techniques including various statistics and distance functions. Such applications served to generate a vigorous debate on the underlying epistemology of GIS and the symbiotic relationship between GIS and archaeological theory. This is a debate that raged in geography several years ago (Taylor and Johnston 1995, for an overview) and surfaced in archaeology as an argument against a return to positivism and environmental determinism (Wheatley 1993), both parts of an outdated theoretical stance long since rejected by the majority of archaeologists (Gaffney and van Leusen 1995).

Reactions to this debate have focused on attempts to integrate current theoretical notions of landscape within GIS functionality involving various ways of effectively humanising the landscape. Initially these approaches attempted to comment on the perception and cognition of an individual situated in the landscape based on visibility and intervisibility studies involving line-of-sight and viewshed routines (for example, Gaffney et al. 1995; Lock and Harris 1996). This resulted in the development of a new technique specifically of interest to archaeology, cumulative viewshed analysis (Wheatley 1995).
