ARCHAEOLOGICAL PREDICTIVE MODELING IN EAST ANGLIA AND NORFOLK

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Abstract

I briefly detail my research into archaeological modeling in East Anglia (UK) and in particular Norfolk. I expand upon the difficulties I have encountered with modeling across political boundaries and across topographical regions, and I explain how I have derived an independent dataset with which to test my models against. I conclude with some thoughts and ideas about using archaeological predictive modeling for cultural heritage management.

***Key words**: Archaeological modeling, Predictive modeling*

For reasons that will become apparent, my research concentrates on the Late Anglo-Saxon (850 to 1066 AD). East Anglia currently has over 100,000 archaeological records (entitled the Historic Environment Record – HER) held in four county databases. Unfortunately, a single record can represent one isolated artefact or an entire archaeological excavation consisting of thousands of artefacts and/or features. The density of these records varies because of differing county funding and past data collection strategies. The density of archaeological records in Norfolk is 7.4 records/Km^2, in Suffolk it is 6.2 records/ Km^2, in Essex it is 6.0 records/ Km^2 and in Cambridgeshire it is 6.7records/ Km^2 (figure 01). Since the 1990s, Developers have had to pay for any archaeological work considered necessary by the County Archaeologists to preserve or record archaeology which would be destroyed by building work. Over the years Norfolk and Suffolk have built up a good working relationship with local metal detecting enthusiasts and hence a large proportion of their archaeological record comes from this source, along with past research excavations, field walking

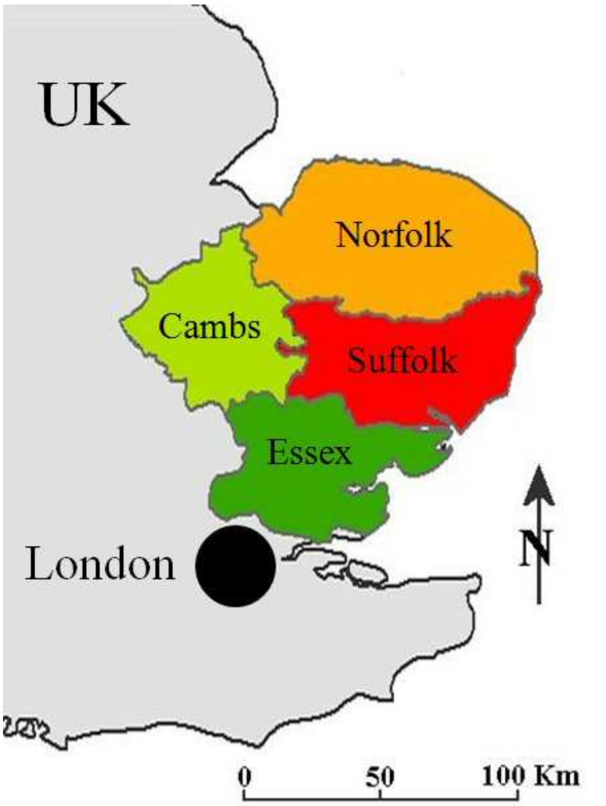

Figure 1. Figure 01. Location and counties of East Anglia.

surveys, etc. Essex and Cambridgeshire do not have such a good rapport with metal detecting enthusiasts and hence a large portion of their archaeological record comes from development archaeology, museum collections, etc. In England, building is normally concentrated in well defined areas where development is allowed by the County Planners, which is often within the confines of existing urban or rural built-up areas. Conversely metal detecting and field walking surveys, by their very nature, are normally conducted outside such areas. Thus, the HER data for East Anglia is highly biased and distorted and any archaeological predictive model based on such data would also be biased and distorted.

To overcome this problem of a biased database, I have initially concentrated on developing an archaeological predictive model for Late Anglo-Saxon Norfolk using binary regression analysis techniques. The following model (figure 2) has a 50m resolution and is based on 3873 Late Anglo-Saxon archaeological records (the red dots represent archaeological features, standing buildings & spot finds) and 3873 random points sampled against five environmental factors. I did this by adding each factor one at a time and then checking the results to ensure that factors did not ‘interfere’ with earlier factors. I did not incorporate any social factors such as superstition, prior land ownership, conflict, etc, because I do not possess such datasets! The dark grey areas are High prediction (over a 50:50 probability) and the light grey areas are Low prediction (under a 50:50 probability). The model has a relative gain (over a 50% chance) of 24.6% in predicting its own input data compared to a gain of -1.1% for predicting random data. That is to say the dark grey areas have a near 75% success rate.

But why doesn't the model predict Late Anglo-Saxon archaeology in the area marked within the red circle? During the Late Anglo-Saxon period this area (called the Fens) was a large area of freshwater and salt marsh, unsuitable for agriculture. The Domesday Survey of 1086 AD records very few ploughs in this area and shows that it was predominately used to graze sheep. A plot of plough density within individual Anglo-Saxon Hundreds (a land unit) shows that the Fens had below 0.3 ploughs/Km^2 compared to up to 2.5 ploughs/ Km^2 in other parts of the county (figure 3). Plotting the success rate of the model for different plough densities shows that the higher the plough density the higher the gain of the model (figure 4). In other words, the environmental factors I used to formulate the model work best for agricultural based economies as opposed to pastoral economies.

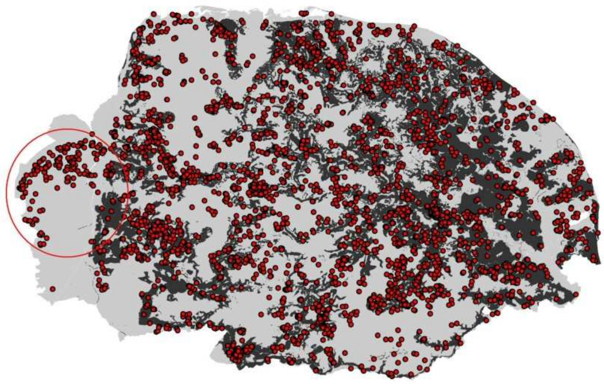

Figure 2. Archaeological predictive model of Norfolk.

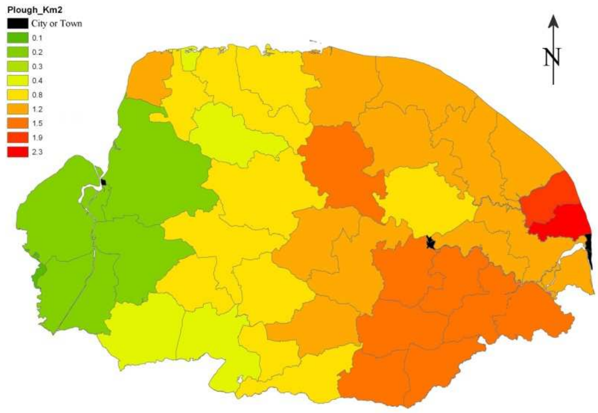

Figure 3. Density of ploughs recorded in the Domesday Survey of 1086 AD.

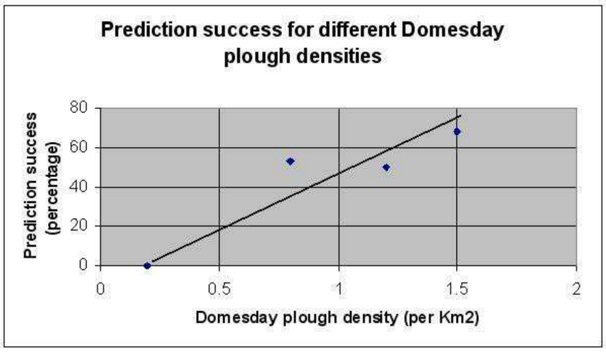

Figure 4. Success of the model for different plough densities.

The obvious solution was simply to remove the problem by cutting out the Fens, which constitutes about 9% of Norfolk. Re-sampling the HER data over the revised model (figure 5) increases the relative gain to 30.6% compared to – 3.0% for the same number of random points. That is to say the dark grey areas have a success rate of over 80%.

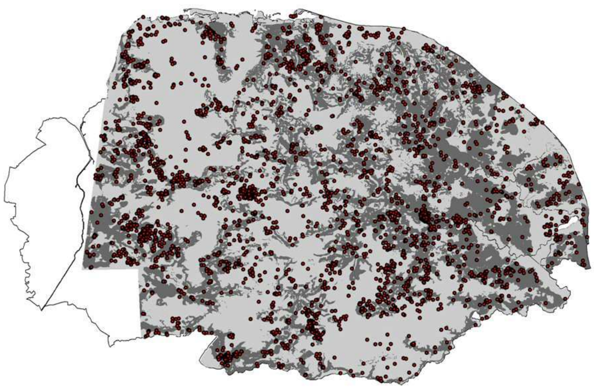

Figure 5. The Norfolk model with the Fens removed.

I have based my research on the Late Anglo-Saxon period as I wished to test the model using the Domesday Survey of 1086 AD.

'The stable settlements that had emerged in Middle Saxon times continued (through the Late Saxon period) into the 11th century, usually acquiring the parish churches that mark their position today' (Williamson, 2006).

To test this statement I made two assumptions; the lord of every Domesday vill had a church near or next to the hall of that vill and that the hall was in the middle of the principle settlement plus, on the whole modern parishes are a continuation of the Domesday vills and share the same name. Using a gazetteer of surviving and ruinous medieval churches in Norfolk I made a test database of Domesday vills with later medieval churches. Then using GIS I produced three buffers around each 'church' at 250m, 500m & 750m radii and determined the percentage of Late Anglo-Saxon archaeological data within each buffer compared to a random sample;

Distance	*Archaeological data*	*Random sample*
< 250m	23.5%	2.3%
< 500m	45.3%	9.3%
< 750m	61.6%	20.3%

Nota bene: this is purely a *spatial* analysis! However, from the results I conclude that the above statement is correct and that the positions of medieval churches are a good indication of a significant number of (Middle &) Late Anglo-Saxon settlements and hence archaeology. Sampling this test dataset over the model gives a relative gain of 22.5%, which is very similar to the gain of the input data!

I have noticed that predictive models which tend to produce high gains are in areas where the terrain restricts or funnels human settlement either by access to water (e.g., in Australia) or steep ground slope (e.g., in West Virginia), etc. I have taken 16 published predictive models and have compared the relative gain of the model with the general ground slope of the study area (figure 6). In some cases I have had to estimate the average ground slope and I acknowledge that these models represent different societies (hunter-gatherers, farmers, etc). I also accept that there are numerous other factors that influence the success of a predictive model. However, I feel that the graph gives credence to the fact that ground slope significantly contributes to the success of a predictive model.

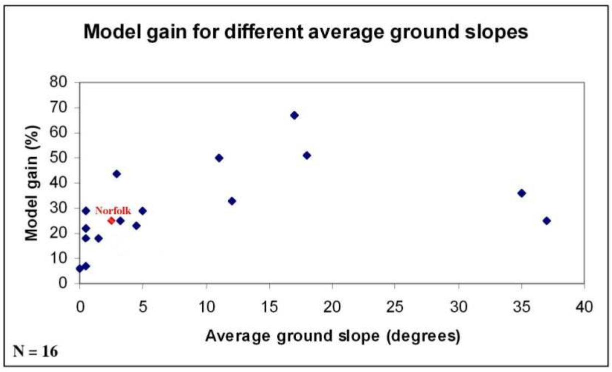

Figure 6. A graph of 16 archaeological predictive models with their gain plotted against the general ground slope.

Currently cultural heritage management in Norfolk is primarily carried out with reference to the HER. If a proposed development is near to known archaeology, it is more likely to have an archaeological brief (archaeological excavation, test trenches or the foundations inspected by an Archaeologist) imposed upon it. Archaeological predictive models are often accused of being self full-filling (Wheatley, 2004) – if you only look in High prediction areas you can never find archaeology in Low prediction areas. However, the current system does exactly this with proximity to known archaeology – if you only look in areas near to known archaeology you can never find archaeology in areas away from known archaeology! For the year 2007/8, Norfolk had 12537 planning applications, 59.5% involved sub-soil work, 9.3% were short-listed as possible candidates for archaeological investigation but only 1.4% (175) archaeological briefs were issued. Norfolk is typical for the region and the country, the more archaeological briefs the local Archaeological Unit issues, the more staff and finances they need to evaluate them! The total percentage of archaeological briefs issued within a year is considerably less than the percentages given in my Norfolk prediction model.

Based upon my research I have come to the following conclusions;

1. Virtually all available data for predictive modelling is flawed or biased in some way.

2. The lack of social factors is a problem with no easy solution. Different historical societies exploited the land in different ways, depending upon their level of technology. Hence, predictive models should be produced for unique periods in history.

3. Modelling across modern political boundaries is a problem.

4. Within an historical period, it is difficult to model across different terrains as they were exploited differently.

5. The power of a predictive model appears to be proportional to the type of terrain being modelled. A non-homogenous terrain will produce higher gains, compared to a homogenous terrain, as it funnels human settlement.

6. All archaeological predictive models should be tested by an independent means.

7. Archaeological predictive models used for cultural heritage management should only be used by people who understand their intricacies and short-comings as it is easy to be beguiled by pretty coloured maps. Final decisions must be made by a human expert, not a computer!

Blind acceptance of modelling results from the bowels of a computer is as irrational as reliance on the ancient skills used by the oracles in deciphering messages in the entrails of a sacrificial chicken (Church, Brandon & Burgett, 2000).

An archaeological predictive model is a tool which needs an expert to know how to use it correctly, in the wrong hands it becomes dangerous as superficially the model appears very easy to use and implement.

8. The economic reality of cultural heritage management within East Anglia could over-ride the advantages of employing an archaeological predictive model.

Bibliography

Church, T. J. Brandon, G. Burgett. “GIS Applications in Archaeology: Method in Search of Theory,” in Wescott, K. and Brandon, R. (eds.), *Practical Applications of GIS for Archaeologists: A Predictive Modelling Kit* (Taylor and Francis: London, 2000).

Wheatley, D. “Making Space for an Archaeology of Place,” *Internet Archaeology* 15 (2004).

Williamson, T. *East Anglia,* English Heritage (Collins: London, 2006).