Predictive Modelling in Dutch Archaeology, Joining Forces.

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Introduction

The Netherlands is one of the most densely populated countries in the world. More than 15 million people live in an area, measuring 41.526 km². This is a density of 370 inhabitants, per km². Spain, a country 12 times as large, only has 2.5 times as many inhabitants; that gives a density of 77 inhabitants per km². This means that the population density of the Netherlands is almost 5 times that, of Spain. So many people, in such a small country, means a lot of infrastructural interventions, in the Dutch landscape. The result is that every year, roughly 1% of the country, is under development. The fact, that the landscape is changing so rapidly, has a devastating effect on the archaeological record. In the last 40 years, more than 30% of the archaeological information, in Dutch soil, has been lost, without it having been looked at, by archaeologists (Groenewoudt, *et al.*, 1994). Archaeologists working in Cultural Research Management (CRM) are doing what they can to protect the archaeology that is left, and to record and study what is threatened by demolishing. Not only CRM archaeologists are doing this. In the Netherlands, we have the unique situation, that almost all academic research is done, as rescue archaeology. So much is threatened and destroyed, that academic archaeologists are trying to answer most of their research questions, with rescue archaeology.

This has resulted in the situation, that CRM archaeologists, doing predictive modelling for environmental planning, and academic archaeologists, doing predictive modelling for regional analysis, are often working with the same data set, using almost the same methods. The advantage is that this makes comparisons easy. However, it has also led to a situation, in which academic archaeologists are criticising CRM archaeologists (Van Leusen, 1995, 1996; Kamermans & Rensink, 1998), and CRM archaeologists, inturn, are criticising academic archaeologists. But is there a reason for this criticism?

Recently, a group of Dutch archaeologists with different backgrounds, both academic and CRM, have joined forces, in order to make an inventory of the procedures and the problems in predictive modelling, in the Netherlands, and to find solutions to these problems. The group consists of researchers, from the State Service for Archaeological Investigations (Jos Deeben, Daan Hallewas and Ronald Wiemer), the RAAP-foundation for Archaeological Consultancy (Eelco Rensink and Philip Verhagen), the University of Groningen (Martijn van Leusen) and the University of Leiden (Harry Fokkens, Hans Kamermans, Jan Kolen, and Milco Wansleeben). We feel that this group will be able to improve the use of predictive modelling in Dutch archaeology, by exchanging knowledge and comparing procedures. Already, a lot of criticism has been replaced by mutual understanding.

The current practice of predictive modelling

Archaeologists deal with the transformed, archaeological heritage, and the outcome of their investigations is the currently known, archaeological heritage, on which archaeological analysis is based (Gifford, 1978; Hamond, 1980; Schiffer, 1972, 1976). Archaeologists reconstruct, or, in post processual terms, construct the original, spatial patterning of material culture. One way, of doing this, is by means of predictive modelling.

Predictive modelling is a technique, used to predict archaeological site locations in a region, on the basis of observed patterns, or, on assumptions about human behaviour (Kohler & Parker, 1986; Kvamme, 1988, 1990).

There are two different approaches to predictive modelling, inductive (fig 1a) and deductive (fig 1b). In practice, these approaches overlap. With the inductive approach, a model is constructed, based on the correlation between known archaeological sites and attributes, from (mostly) the current physical landscape. This model is then used, to predict site location, and these predictions, in turn, can be used for planning purposes. External, expert knowledge is used, to evaluate and adjust the models.

The other, lesser used approach, is the deductive one, where the model is constructed on the basis of a priori knowledge (anthropological and archaeological knowledge), and the known sites are then used, to evaluate the model. An example of this approach is the technique for archaeological land evaluation (Kamermans, *et al.*, 1985, 1990; Kamermans, 1993, 1996).

Critique

The current practice, of predictive modelling for CRM purposes, in Dutch archaeology, is complicated by a lack of digital information and a lack of resources, such as time and money. In the Netherlands, most CRM archaeologists use an inductive approach (Deeben, *et al.*, 1997). At the moment, predictive modelling, in the Netherlands, is based on simple correlations, between site locations and present-day, physical parameters (Brandt, *et al.*, 1992; Odé & Verhagen 1992, Odé, *et al.* 1995; Verhagen, 1995). Carr (1985: 118-119) calls this approach, the density transfer method, and lists a number of theoretical and practical disadvantages. Savage (1990: 26) considers this form of predictive modelling to be "empirical observations, which inductively project site location". In the Netherlands, in most, if not in all cases, no effort is made to try to understand the cultural or environmental mechanisms, that are causing these correlations, or to take distorting factors into account. This is understandable. Dutch CRM archaeologists are under great pressure, to produce reports and maps for environmental planning. Archaeology is on the political agenda, and CRM archaeologists have to make clear, that in a sense, the location of archaeological material is predictable, and their value is determinable. Political decisions, concerning the environment, will be based on these "facts".

Academic archaeologists are, in general very careful with their statements, but they **can** be even more careful. They also have to produce results, and for them, negative results are also results. They can write articles, about the methodological implications of their research, and they are not forced to say, whether a certain area has a high or low "archaeological potential". In the eyes of CRM archaeologists, they are, therefore not producing "useful" results.

Another difference, between academic and CRM archaeologists, is that academic archaeologists are mainly interested in human behaviour, and try to reconstruct past societies, while CRM archaeologists are interested in the current archaeological heritage, in order to protect it, or manage it, in a different way. It looks as if they don't have to take into account the physical and social landscape, the site formation processes, and the post-depositional processes. However, these factors play an important role in decisions, concerning the assessment and selection of sites. Erosion and sedimentation, for instance, play a completely different role. Sedimentation usually protects archaeological sites, and knowledge, about areas with sedimentation, can guide future interventions in the landscape. CRM archaeologists take a longer route, than necessary.

Results

One result, of the group's work, is that it became clear that most researchers use a combination of inductive and deductive approaches. Each is a cycle, in a continuous process, over time, where the model can be reformulated. At any given point, in the cycle, it is possible to present or publish the model, although, during each following cycle, the model will gain more stability (fig 2).

Apart from making an inventory, of the existing approaches, the group has looked at different methodological and practical aspects of current practices, in order to improve current procedures. In this section, we give three suggestions for possible improvements.

The first possible improvement is that, for predictive modelling, there is a methodological necessity to divide the archaeological record of a region, into different time periods, and analyse each, separately. The second improvement is the incorporation of distorting factors, to the analysis, and a third improvement has to do with the statistics used, to test the statistical significance for correlations.

Environmental planners are only interested in the presence, or absence, of archaeology. They want to know which areas they have to avoid, and, if that is not possible, how much research will cost. They are not really interested in whether or not an area is rich in Middle Palaeolithic, or Late Bronze Age, sites. All they want to know is if there are any archaeological sites of importance. Often, the total density of sites, is used as a measurement, for the archaeological value of an area. However, in order to make viable predictions, you have to know, or at least have an idea, about what causes the correlation, between environmental variables and archaeological sites. The first step is not to make predictions, for all archaeological sites, in one analysis. It is important to make, at least, a distinction, between different economic systems, like hunter-gatherers, agriculturalists, or, better, horticulturalists, and societies, with a market economy. Prehistoric systems tend to correlate more with environmental variables, and historic societies, with a market economy, show higher correlations with, for instance, transport routes.

The second important topic is the incorporation of distorting factors, in analysis. The normal procedure is that the actual distribution, of sites in a region, is analysed for the entire region, at once. What is overlooked in that procedure is that, due to distorting factors and research factors, the archaeological information comes from a selection, only from the area. The information goes through a series of filters: a geology filter, a land use filter, and a research filter. In most cases, only a small part of the area has really been investigated. Ignoring this information, and analysing the whole area, has a devastating effect on any inference.

The third example has to do with statistics. Common practice, in the Netherlands, is to use the chi square test for testing a correlation between site density and land units. Many authors have warned that the use, of the chi square test, presents many problems (Siegel, 1956: 110; Hays, 1981: 541). The most important one is that the chi square test may not be used, if fewer than 20 % of the cells, in a contingency table, have an expected frequency of less than five, **and** if no cell has an expected frequency, of less than one. It is almost impossible to comply with this condition in archaeology. Several solutions have been suggested. One is the use of the Attwell-Fletcher test (Attwell & Fletcher, 1985, 1987; Kamermans, 1993; Wansleeben & Verhart, 1995; Kamermans & Rensink, 1998). Another possible solution may be the use of the principles of the Fisher exact test to the site location analysis chi square application. Instead of a continuous chi square distribution, we compute a discrete distribution to determine the statistical significance of the chi square outcome. In this way, we avoid the problem, with the expected frequencies.

We hope that by joining forces, we have kick-started a discussion, in the Netherlands on how predictive modelling can be usefully applied, both for CRM and academic purposes.

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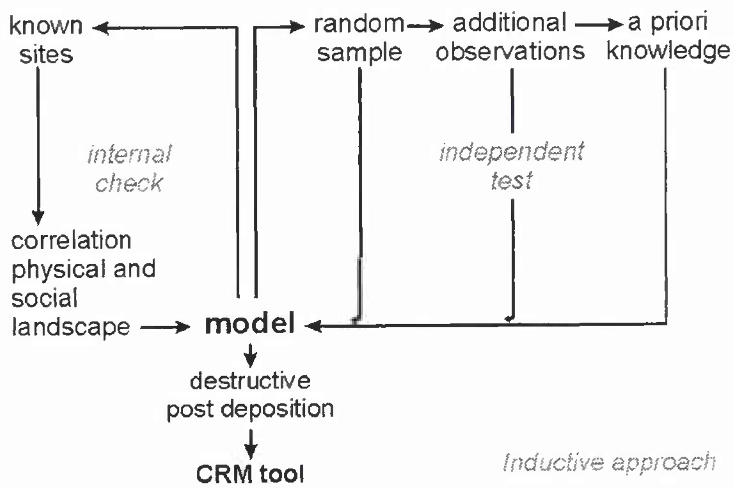
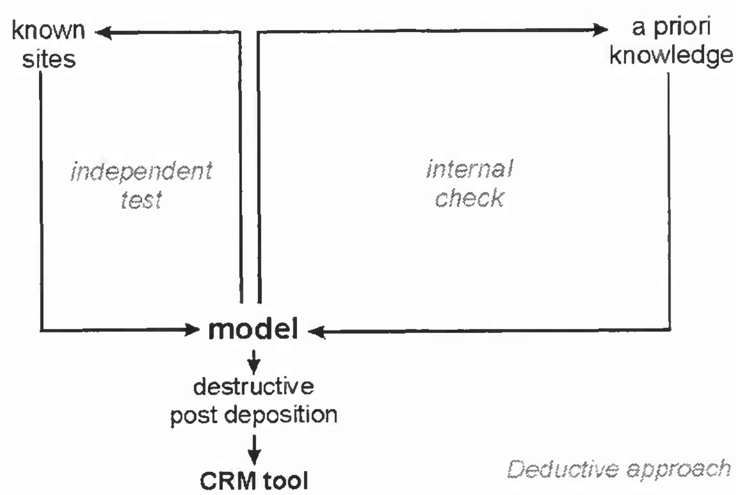
Figure 1a and b.

The inductive (top) and deductive way (bottom) to construct a model, of the distribution of archaeological sites, in a region. The model should always be followed by a test, against independent information sources, to assess the model validity. Areas that are seriously destroyed, by post-depositional processes, can be subtracted from the model, for CRM purposes.





CAA 98, Barcelona, Kamermans and Wansleeben, figure 1a (top) and 1b(bottom)

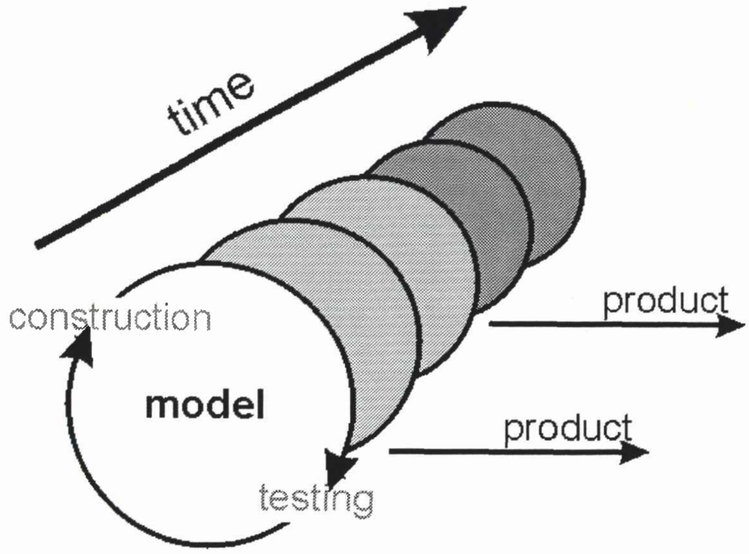


Figure 2.
The cycle of construction and testing of a model can be repeated in different ways. Although the model will probably gain reliability and stability each time, intermediate results are useful products.