

18 Gardermoen Project — Use of a GIS system in antiquities registration and research

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18.1 INTRODUCTION

The planned development of a new airport for the Oslo region has required a tremendous amount of archaeological effort. The current plans call for the airport to be located in the Gardermoen area of Akershus county, a region rich in prehistoric remains. In contrast with other large projects in Norway, it was decided that a GIS system would be an integral tool in this project. In this paper we discuss the GIS system that is under development to aid in dealing with the massive amount of data that has been produced from these archaeological surveys.

In the following we first discuss the goals for the Gardermoen project's computer system. The first of these was the development of a user interface that is "archaeologist friendly", and allows the use of the system by archaeologists with little computer experience. The second goal was to develop a database that would allow the study of the antiquities in the Gardermoen area within a regional context, both archaeologically and geographically. The archaeological data comes from the National Register, and the geographic data will come from planned map databases currently under development in Norway. While both the archaeological and geographical data do not constitute a perfect database, this does not mean that these data can not be used in the study of regional scale problems. It does however mean that the questions that can be asked must be formulated in relation to the strengths and weaknesses of the data.

18.2 GOALS FOR THE SYSTEM

The use of computers in Norwegian archaeology is primarily limited to word processing and occa-

sional small databases. In connection with large projects there have been few efforts to integrate computers into the overall project strategy. A large part of the reason for this is that, the senior archaeologists in charge of these projects have, on the whole, had limited and usually negative experience with computers. While the situation is changing rapidly, for the most part computers are still viewed with scepticism, and the belief that the ability to understand and use a computer is limited to a few individuals.

One of the goals for the Gardermoen Project's computer system was to change this perception by developing an archaeologist friendly system. One of the pre-requirements for such a system is that it can be used by people with little computer experience, which necessitates the use of a graphic interface. Another pre-requirement is that the system be archaeologically intuitive. That is, that the process of making a map and selecting the types of antiquities that are to be displayed on the map coincides with the way that archaeologists go about making such maps.

The GIS program we decided upon is ARC/INFO. ARC/INFO is perhaps better characterised as a loose confederation of more or less independent subroutines than as a single program. A major problem with this program is the command line interface and the non-intuitive, "user-contemptuous", nature of the commands. However, the accompanying macro language did allow the development of a menu driven system, that is a step towards the development of an archaeologist friendly system.

The system that was developed is based upon the use of a menu bar with popup menus (Figure 18.1). Each of the selections on the main menu bar brings up a popup menu, which provides further options. The first selection (*File*) adds titles, symbol explanations, and prints out a map. The sec-

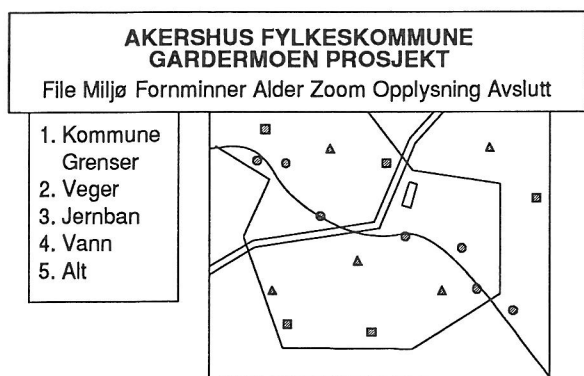


Figure 18.1: User interface for the Gardermoen Project.

ond command (*Miljø*) allows the inclusion of map data; township boundaries, roads, railroads, and water bodies. The *Fornminner* menu brings up a list of antiquity types and then displays the types chosen by the user. The *Alder* menu allows the selection and display of antiquities of a certain age. The *Zoom* menu provides the ability to zoom in and out, based upon an area selected by the user. The *Opplysning* menu provides summary information on a particular antiquity, or provides a list of all antiquities within a user specified area. The final option, *Avslutt*, returns the user to DOS.

It is important to note that the development of this system did not require a great deal of programming. As such the development of this system provided access to the computer for people in the project that otherwise would not have thought of touching the computer, without noticeably affecting the budget for the project.

18.3 THE ARCHAEOLOGICAL DATA

A major aspect of the construction of the database for this project has been the incorporation of data regarding previously registered antiquities, which were obtained from the National Register. The records that comprise this register are stored in a "free text" database called SIFT. Each antiquity in this register is described by a single form (Figure 18.2). This is also the form that is used to report newly registered antiquities in the Gardermoen project, as well as from all other surveys in eastern Norway for the foreseeable future. This form was developed as a result of surveys conducted by the Land Use Mapping Agency (*Økonomisk Kartverk*) that began in 1963 (Larsen 1990:48–49), and has subsequently been systematised (EDB Utvalg 1988).

The first few lines of this form place the antiquity geographically with increasing degrees of

precision; county, township or parish, farm name and number and section name and number within the farm. Every farm in Norway is identified by a unique name and a number within each township. Other geographic information is air photo number, place name, economic map number, map co-ordinates and elevation above sea level.

Following these geographic data comes summary information on the type of antiquity represented (burial mound, stone age site, iron extraction site, etc.), the number of these and their ages. This brings us to one of the more complicated aspects of this form, this is that it is not necessarily the description of a single antiquity. A single form is often used to describe a group of antiquities that may or may not have any relationship to each other, other than geographic proximity. In the example shown in Figure 18.2, which describes a series of iron age burial mounds and associated rock alignments, the antiquities are most likely related. However in other instances, a Mesolithic site and a Medieval house ground could be recorded at the same location.

The majority of the description of the antiquity occurs in the lower part of the form. This consists of written descriptions of the antiquity and its surroundings; the terrain in the area, distinguishing features that can be used to relocate the antiquity, the size of the antiquity, and relevant oral traditions and literature references. As such the lower part of the form provides the most detailed and thorough description of the antiquity. This part of the form also provides the kinds of data that are archaeologically interesting; the assessment of what type of antiquity is present, its condition, and the potential for the presence of other, unreported, sites in the same area.

While this allows for a thorough description of an antiquity, the types of data that are recorded are not those that lend themselves to analysis by GIS or other statistical means. The problem is that the majority of the archaeological data are written descriptions from which it is impossible to systematise, quantify or extract data. For example, in most cases the diameter, height and shape of a burial mound are placed in the written description. As such it is impossible, without manually re-entering the data, to use these data in subsequent analyses.

However the data in the upper part of the form contains several variables that can be extracted from the existing database. These are the variables that deal with the location, type, number and age of the antiquity. Since each description can consist of a description of an area, the values

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*****
* FASTE FORNMINNER *
UNIVERSITETETS OLDSAKSAMLING, FREDERIKSGT. 2, 0164 OSLO 1
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FYLKE: Akershus      KOMMUNE: 0213 Ski      FORNMINNENR: 0025
GNR: 14 GÅRD: Harastad
BNR: 4  FNR:      BRUK: Harastad Østre
GNR: 15 GÅRD: Harastad
BNR: 5  FNR:      BRUK: Harastad Østre
LOKALITET: Havna
ØK-KART: CP 039-5-1  FLYFOTO: 1887 C4 R-X-NR: R16
M711-KART:1914 III  KSYS:  NORD(X):38569  ØST(Y):89562  HOH:155
FORNMINNETS-ART: Gravhaug      ANT: 5      DAT: jernalder
FORNMINNETS-ART: Steinsetning  ANT: 1      DAT: jernalder
FORNMINNETS-ART: Gravhaug usikker ANT: 4      DAT:
FORNMINNETS-ART: Steinsetning  ANT: 2      DAT:
EIER: A. Jahre, Tonsberg
*****
GNR-BNR-BRUK: 14/ 4, 5 Harastad Østre
BRUKER:
REG-AV: T. Vesenet 10.08.1978
KONTR-AV:A. Jahre
TERRENGETS-ART:
Dyrket mark i S-helling av Krøkstadmorenen. Utsikt i Ø til S mot Opsal og
Harastad.
ORIENTERING:
450m VNV for vønningshuset på Harastad vestre 14/22, 185m ØSØ for vøn-
ningshuset på Glenne lille av Tomte 13/2.
UTSTREKNING: Gravfelt NV-SØ 135m, SV-NØ 75m.
FORMMINNEBESKRIVELSE:
I beitteland, gravfelt bestående av 5 gravhauger, 1 steinsetning, 4 usikre-
gravhauger og 2 usikre steinsetninger. Gravhaugene er bygd av stein og
jord og 3 av dem har fotkjede. En urørt i S har ei grop i N-del, d 1m dybde
0,4m. Den sikre steinsetningen har 6 stående stein i ring og en midtstein
som er faltoverende. Fellet er bevoskt med gress og løvskog, noe kratt.
Gravhaugene: D 5-15m, h 0,3-1m. Steinsetningene: D 10-15m. En av de
tidligere registrerte gravhaugene ble ikke gjenfunnet.
TRADISJON:
FOTONR:
LITTERATUR:
UO top ark: E. Skjelsvik. Top ark reg 1958 u 14/4.
ANMERKNINGER:

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Figure 18.2: Antiquity description form.

for these variables are often not discrete. For example, in cases such as a large iron age burial mound field, a single form can often encompass several different farms. Similarly in the case of traces of prehistoric agriculture a single form can contain several different types of antiquities (stone fences, clearance cairns, etc.). As such it was necessary to design a data structure that could cope with the possibility that a single point, or area, on the map could be associated with a variety of different farm numbers and antiquity types. The data structure that was developed to cope with this variability is shown schematically in Figure 18.3. The most frequently used data forms the main record, in this case the data regarding the type, count and age of the antiquity. These data can be linked to the farm name and

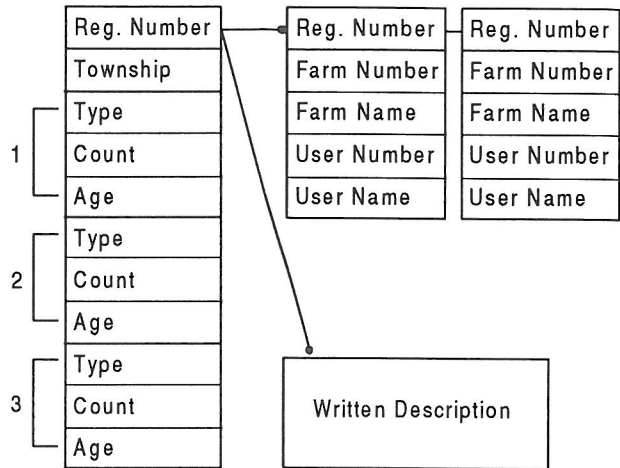


Figure 18.3: Data structure for Gardermoen Project database.

number, through the use of the antiquity registration number. The written description of the data can be accessed as a large text field.

The list of antiquities in the Gardermoen area was extracted from the National Register on a township basis, and the output was obtained in the form of ASCII files. The relevant data from these files was extracted by Pascal programs that consisted mainly of string manipulation functions. The data from the newly registered antiquities was entered into a database in laptop computers in the field and as such could be directly placed into the GIS database. The location of the antiquities was entered into the data base by digitising the Economic Maps for the region, which are at a 1:5000 scale. These data were then linked to the descriptive data by the antiquity number.

18.4 GEOGRAPHICAL DATA

At this juncture, with the archaeological data established, it is time to turn to the establishment of the geographical data. The growth and clear utility of GIS systems in Norway have lead to efforts to provide ways of sharing GIS data. These efforts have lead to the planning of NGIS (*Nasjonalt Geografisk Informasjons-Senter*, National Geographic Information Centre), which will provide a database of the available map data within Norway, and should be completed in 1996. In the course of the development of this system, a set of guidelines regarding how such data can be shared has been developed. The KAFKA project (*Kontaktgruppe for Anvendelse av Felles Kartdatabaser i Akershus Fylke*, Contact group for the application of map databases in Akershus county) has

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.HODE 0:
..TRANSPAR
...COORDSYS 3
...ORIGO-NØ 0 0
...ENHET 0.100
..OMRÅDE
...MIN-NØ 175200 -3200
...MAX-NØ 196800 10600
..KVALITET 55 200
.LINJE 86:
..FORNM-NR 21400058
..NØ
1895070 18604
1895084 18721
1895100 18800
1895127 18848
1895160 18904
1895205 18967
.PUNKT 87:
..FORNM-NR 21400057
..NØ
1894776 17923
.KURVE 91:
..FORNM-NR 2140234
..NØ
1894213 22837
1894224 22880
1894228 22920
1894234 22971
1894238 23019
1894239 23079
1894242 23158
1894249 23210
1894262 23289
1894267 23348
1894252 23410
1894250 23452
1894257 23509
.SLUTT
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Figure 18.4: Example of SOSI format file.

used these guidelines to begin the development of a map database for Akershus county. The goal of the KAFKA project (KAFKA 1990) is the development of a database of the different types of GIS data that are being collected by the different departments of the county administration. The types of data that will be included in this project are: existing and planned roads and highways, development plans, land use data (agricultural and forest areas), boundary data (county, township, farms), elevation contours and the boundaries of shorelines, rivers and lakes. Rather than attempting to enforce a rigid series of software and hardware standards, the KAFKA project only requires that the participants have programs that can read and write files in SOSI format.

SOSI (*Samordnet Opplegg for Stedfestet Informasjon*, Standard Format for Geographic Information) is a file format developed by the National Cartography Agency of Norway (*Statens Kartverk*

1990) in order to allow the movement of geographic data between different programs. A SOSI file is a structured ASCII file, that uses a series of conventions to describe geographic information. A very simple example of a SOSI file is shown in Figure 18.4. The first part of the file gives the basic map information; coordinate system, map boundaries, etc. Following this comes the information regarding the data; the data type, an identifier in this case the antiquity number, which is followed by the coordinates for the object.

The database planned by the KAFKA project is a collection of SOSI files that will be available on a server. As such the use of SOSI files is critical, and allows the exchange of data between a variety of different programs. SOSI translators are available for the majority of the GIS programs available in Norway. It is also possible to create translators with minimum knowledge of programming. As such the KAFKA project, when completed, will increase the access to geographic data, which would otherwise be inaccessible.

18.5 USE OF AN "IMPERFECT" DATA BASE

At this point we have created a powerful database that gives us the ability to combine archaeological and geographical data. The question now becomes, does this database meet the goals that were discussed earlier?

In the administration of a large field project, this GIS system has been of tremendous value. The ability to produce maps of survey areas that show the location of the known sites, gave the field leaders access to information that would have otherwise been extremely difficult to obtain. Access to data regarding the locations of previously known antiquities was important not only in preventing double registrations, but also in planning the survey intensity of the various corridors. Further, the ability to produce maps and listings of both existing and newly registered antiquities have greatly aided in the process of writing reports.

However, the utility of this database for further research is less clear. As in any type of archaeological data analysis it is necessary to understand both the strengths and weaknesses of the available data in the formulation of research problems. In this case the major questions revolve around the quality and representativity of both the archaeological and the geographical data.

There are two major concerns with the adequacy of the archaeological data. The first is the placement of these monuments. Most of eastern Norway is covered by large areas of dense spruce

forest and irregular terrain, which can quite often make the map placement of a given location extremely difficult, if not impossible. The placement of any given antiquity is in large part dependent upon the visibility in the area and the ability to use landmarks to place the site. In areas where visibility is good, (agricultural areas, shorelines) the placement of a site can be considered to be more precise than in areas with poorer visibility, such as dense forests. As such the precision of the location of the antiquities in this database is variable, some are placed precisely, while the placement of others is less accurate.

The representativity of the data in the National Register, both in terms of the adequacy of the coverage and the adequacy of an individual description are also important concerns. The surveys that have provided the majority of the data in the National Register have largely focused on agricultural areas, while other areas, largely the immense, forested, non-agricultural areas are not as well surveyed. Further, the majority of the data in the National Register is based upon visible monuments. As such subsurface antiquities are generally underrepresented (Larsen 1990). Surveys in Østfold county (Boaz 1991) have indicated that the data in the National Register is, on the whole, representative for the larger, more monumental types of sites (burial mounds, large areas of rock art, etc.). However less visible antiquities, such as stone age sites and clearance cairns, are under represented.

Another major problem, as shown by recent research in Akershus county (Uleberg 1990) which has clearly indicated that what is visible above the surface is in most cases the tip of the iceberg. The subsurface features often greatly outnumber the visible features in quantity, variability and the time periods that are represented.

Archaeologists are trained in almost every possible method that can be used to criticise archaeological data, however we have a tendency to accept data from other fields at face value, and this includes geographic data and map data. It is necessary to be as critical of the adequacy of this data as we are of the archaeological data. A map is an approximation of the real world, not a description that is precise to the nearest millimetre. In most cases this is a question of the scale. The visibility of variability on a soil map, or a GIS data file, is dependent upon the scale at which the data is recorded. In many instances, small scale variability is often not of interest to the soil scientists who collect the data that forms the basis of these maps, while such variability often is of interest archaeologically. For example, there are

many areas of eastern Norway where the soil maps show that the soils are primarily clayey soils. However scattered throughout these areas are pockets of sandy and gravelly soils, that are often rich in Mesolithic sites, while none are found in the clayey soils. While a GIS analysis of these data would most likely indicate an association of these sites with clay soils, the opposite is true. Similar problems may be expected with the distribution of water bodies, where the smaller creeks and rivers that could have been a factor in prehistoric settlement, may or may not be present on such maps. Also in many cases, the distribution of modern water bodies may or may not have a relationship to the prehistoric situation.

As such, both the archaeological and the geographic data can largely be considered to be approximations. However National Register databases are one of the few, in our case the only available sources of regional scale data, and in the study of regional scale problems some degree of approximation is a necessary evil. While the weaknesses inherent in National Register databases do constrain their utility, it is a mistake to exclude these types of databases automatically in the study of regional scale problems.

First we should not underestimate the possibilities for EDA types of analysis that are inherent in such a system. The ability to display the distribution of known antiquities from a large region will reveal a wealth of patterns. Also the ability to display antiquities of certain types or ages, and to shift between varying scales, is a capability that simply does not exist when these distributions are limited to paper maps. While using a GIS system for such simple things as «show me where all the Iron Age sites are» could easily be equated with using a rocket to down a mosquito, such exploratory analyses are a necessary step in developing an understanding of the structure of the database.

However, the use of these types of databases in quantitative studies of spatial patterning, such as association between different types of antiquities with the environmental background, must be treated with a great deal more caution. There are biases in this data that increases the visibility of both certain types of antiquities and their environmental context. For example, since the surveys that make up a large part of this database emphasised agricultural areas, quantitative studies will most likely indicate a positive relationship between antiquities and the conditions favourable for modern agriculture.

This is not meant to imply that this and similar databases can not be used in studies of spatial

patterning. As in most aspects of archaeological data analysis, the discovery of patterns in the data is not difficult. The difficult part is the identification of the processes that are responsible for these patterns. The major consideration is the relationship between the problems that are archaeologically interesting and the data that are at hand. Quite often there is a large gap between the type of answers which we want, and those which the data are capable of answering. In quantitative studies using these types of databases it is necessary that the research questions and methodology are formulated with the nature of the data in mind, that is, that we ask questions which we can answer.

GIS systems provide a tremendous opportunity to advance the study of regional analysis, by allowing the combination and reduction of massive amounts of data. However, if we don't develop the theoretical and methodological tools to deal with the ambiguities inherent in the archaeological and geographical data, GIS analysis will be limited to "just-so" stories.

18.6 SUMMARY

In this paper we have discussed the factors involved in the development of the GIS system that is being used in the Gardermoen project. One of the main goals was to develop a system that was easily used, and as such could be used by archaeologists without extensive experience with computers. The data that constitutes this database comes from newly registered antiquities and the National Register. Because of recent efforts of various land use planning and mapping agencies, access to digitised data regarding distributions of environmental variables will soon be available.

This provides a database that contains both archaeological and geographic data for a large area.

However the bias in data collection, of both the archaeological and geographic data, limits the utility of this database in the study of regional scale problems. However these limitations do not mean that National Register databases, are inappropriate in such studies. They do, however require that the such studies should be formulated in relation to the strengths and weaknesses of the data.

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