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PROCESSING OBLIQUE AERIAL PHOTOGRAPHS IN FLANDERS: THE HAVIK PROJECT AT THE GHENT UNIVERSITY. A CONTRIBUTION TO ARCHAEOLOGICAL RESOURCE MANAGEMENT

1. Introduction

The archaeological aerial survey at the Ghent University started some 20 years ago. For several practical reasons, this survey covers only the provinces of East and West Flanders. In this area small allotments are common use, but by using the following-up technique (each year the already known archaeological sites are photographed again), many features were discovered in different years, in different cropmarks. As a result of these activities, some 50,000 slides have been realised. They reveal thousands of archaeological structures, from the Neolithic up to the most recent periods (Ampe *et al.* 1996; Bourgeois, Semey, Meganck 2001).

2. The basic databases

2.1 *The primary source*

For practical reasons, the pilot (J. Semey) is also ongoing with the survey and the making of the photographs. Every year the pilot-photographer gives a full description and a localisation of each photograph he made that year. This standard procedure covers 20 years of intensive work. All the descriptions were made on a paper based version: each form has the name of the community, the full description of all features seen on the photograph, the exact co-ordinates (X- and Y-axes, Lambert 72) of one special feature on this photograph, the date of the photograph, the co-ordinates of the map he used at that specific moment (Bourgeois, Meganck, Semey 2001).

2.2 *The aerial photography database*

From last decade onwards we tried to make different databases to carry out queries in this archive. The information given by the photographer was integrated in a first database (Access 97). Presently, additional information is integrated (is it a photograph or a slide, where are the negatives stored, is the photograph in colour, in panchromatic or in false colour, is there a digital image of the original, is this image rectified, what program was used,…). The aim is to make an objective description/interpretation of the features seen on each photograph, also to describe the type of marks and crops. Each feature

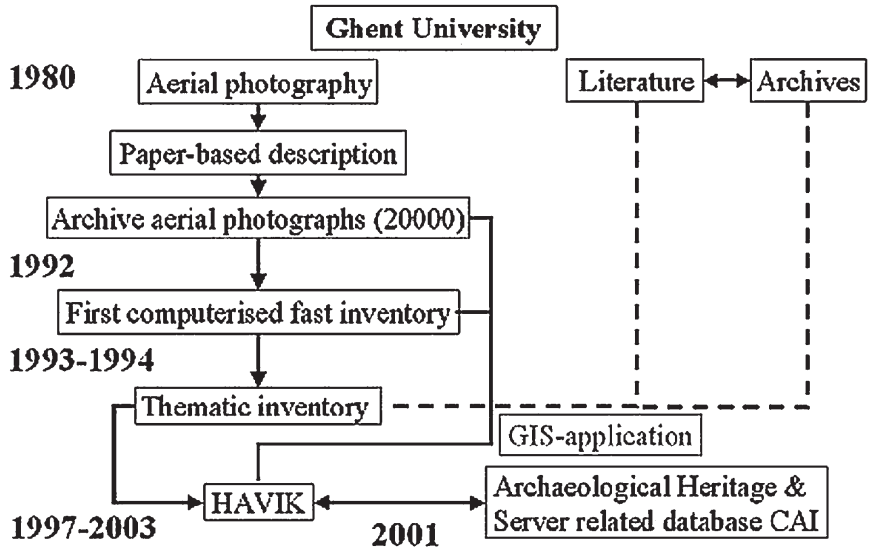

Fig. 1 – Chronological organigram showing the different phases of the inventory of the archaeological archives at the Ghent University.

gets a unique number, and will be drawn as a polygon in a GIS environment (Esri-Arcview 3.1). The global conclusion of this information will be integrated in the HAVIK database (see further). Each digital aerial image (copy or original) in the database contains a hyperlink to view this picture (Fig. 1).

2.3 *The thematic databases*

From 1993 onwards specific research and inventory projects were started. One of the main topics in the aerial archive was the presence of several dozens of circular structures. They were highlighted because of there different shape in the existing rectangular parcels. Before the aerial photography, only few of those structures were known in East and West Flanders. Some remaining monuments are still visible in the forest on the top of the hills in southern East Flanders. Some excavations on these features proved them to be the fossil ditches of Bronze Age barrows. It was necessary to make an exhaustive inventory of all these structures in East and West Flanders, combined with data from the fieldwork and the geopedology. The inventory was carried out in two years (1993-1994) and financed by the Research Council of the Ghent University[1]. Fourteen years of aerial photography (1980-

[1] The project "The circular view. Aerial photography and the discovery of Bronze Age funerary monuments in East- and West-Flanders (Belgium)" was directed by J. Bour-

1994) were analysed and the results were very astonishing: about 600 circular structures were recorded. The inventory was continued until 1997, some 1,000 structures are already revealed. More recent excavations confirm the Bonze Age date of the circular structures (Ampe *et al*. 1995; Bourgeois, Meganck, Semey 1998; Bourgeois *et al*. 1999).

Other scientific projects are dealing with this subject and carrying out further research (see the contribution of B. Cherretté and J. Bourgeois in another volume of this Congress).

Other scientific projects were realised: during a period of three years (1997-1999), the Ghent University (Departments of Archaeology and Geography) with the financial support of the Flemish Fund for Scientific Research, studied the possibility to come to an understanding of the structure of the pre-medieval landscape of the north-western Gaul[2], by applying combined geo-archaeological methods (Antrop, Vermeulen, Wiedemann 1998; Vermeulen, Antrop 2001).

3. The Havik Project

3.1 *History*

In 1997 started a complete new project: all features appearing in the aerial photographs have to be described in a related database (Access 97) in combination with a GIS-system (Esri-Arcview 3.1). Beside these features, also older data from field-walking, augerings, excavations, loose finds and archaeological literature will be integrated (Roovers *et al.* 2001).

Thanks to the funding of the Flemish Government (financed by the Flemish Fund for Scientific Research and the Max Wildiers Fund), the Havik Project was set up as a collaboration between the Archaeological Departments of the Ghent University and the University of Leuven[3]. In the first stage the project had three main goals: to catalogue the information of the archaeological archives of both Universities, develop a GIS-databased inventory and preserve the aerial-photographic collection at the Ghent University (consisting of some 50,000 slides).

geois, in collaboration with R. Langohr, and co-executed by archaeologist M. Meganck and geo-pedologists C. Ampe and L. Fockedey.

[2] The project "Geographical-archaeological study of the road network and field systems in the Civitas Menapiorum during the Roman period" was directed by F. Vermeulen, in collaboration with M. Antrop and J. Bourgeois, and co-executed by B. Hageman (archaeologist) and T. Wiedemann (geographer).

[3] The project "Registration and computerisation of archives of the Archaeological Departments of the Ghent University and the University of Leuven (Belgium)" was directed by J. Bourgeois, in collaboration with M. Lodewijckx, and co-executed by archaeologists M. Meganck and I. Roovers. This project was prolonged until 2003 with the same financier, senior and permanent staff.

3.2 *Development*

After several meetings between the two partners about the contents, and looking abroad at different systems (e.g. Archis in the Netherlands), a database was developed at the Archaeological Department at the Ghent University.

The new built database contains information from both archives (such as dissertations, seminar papers, studies of earlier excavations, augerings, field surveys and aerial photographs). Only a small part of those archaeological data is already entered. The visual information primarily consists of excavation plans, drawings of artefacts and older photographs of fieldwork (panchromatic, colour). To preserve this kind of information, everything will be digitised or scanned.

3.3 *The database*

3.3.1 Structure

The database has a relational structure which means that additions and corrections are automatically updated, older external already existing databases can be also imported or linked to the database.

3.3.2 Content

The database groups the basic information on archaeological sites and occasional finds, museum collections and known literature. The information is processed one site at the time and can be added using several forms:

– Data concerning the location of the site are entered on a first form: municipality, province, land registry and soil type; the degree of precision of the location is added, together with a number for the heritage management (number and X and Y co-ordinates – Lambert 72 – of the mathematical centre of the polygon). In attachment, a factor from 1 to 3 indicates how reliable the information is. This allows the user to take into account whether or not the information should be approached with any care.
– The second form includes a description of the information source. Both archaeological and non-archaeological sources are considered: field surveys, mechanical survey, excavations, archaeological control of soil-disturbing activities (watching briefs), occasional finds, archives and literature, private and museum-collections. Information on the date of find, X and Y co-ordinates (Lambert 72) of features and individual finds are stored, as well as linked databases concerning people involved in archaeological activities, bibliography, digitised photographs and scanned maps. The form also contains information in support of management concerning the protection of a site, historic or archaeological value, visibility, recognition and allocation of the parcels according to the mid-scale base map.

– For each site recommendations are offered concerning the archaeological research that should be conducted in case of soil-disturbing works threatening the site. This form deals also with the material found on the site (extensive typologies of the different find categories are – at the moment – not yet included in the database structure). However thesauri can always be added. Most fields contain a scroll list so the operator can choose between a rather small range of possibilities.

– For every artefact and/or structure, a date can be added on the next form. Both typological date and absolute date can be entered.

– The interpretation of every single find is described on the next form. A specification of every find indicates whether it concerns a contextual find or a singular find.

3.4 *The GIS based inventory*

GIS requires accurate spatial locations in order to match archaeological evidence throughout the landscape. Unfortunately, a lot of information from archives is difficult to process, because this information on the location of the sites is often incomplete, inaccurate or incorrect. Precision was often neglected when the sites were entered and in some cases, the spatial dimension of a site was not considered at all. Many sites are therefore difficult to locate today. On the other hand, information of well captured aerial photographs is very precise and can be located exactly. For the more incomplete location we therefore add a scale of accuracy with a degree of precision (ranging: the location is exactly known, the toponymy/street is known, only the community is known). The degree of precision can be included in the legend of the maps in the GIS-application, and can be seen when consulting the map.

The archaeological sites can be entered into the database as different features: polygons for heritage management and/or for scientific purposes. These features are stored in different themes in the GIS-application. A site can include several different polygons. The sites are clusters of small polygons: each observed feature is drawn as a polygon.

3.4.1 Polygon for heritage management purposes

For planning and conservation purposes, the archaeological site is represented as a polygon that matches the land registry parcels where the site is located. These polygons include a safety buffer around the perimeter of the site in order to minimise the effects of any miscalculation in the case of nearby development.

3.4.2 Polygon for scientific purposes

If the boundaries of the site are more or less known, the site or a part of the site can be represented as a polygon for scientific purposes. Usually,

those polygons can be the result of scientific archaeological research (e.g. the inventory of bronze age barrows) or excavations (e.g. a Roman settlement). Individual traces or groups of traces within one site can be designated as a scientific polygon.

4. Accessibility of the archives

Another goal is to make those archives more accessible.

4.1 *The SPIDI meta-database*

The 'SPIDI meta-database' (of the Support Centre GIS-Flandres) contains a full description of the project. SPIDI (Spatial Information Directory) is a data-processing system, which contains all descriptions of the spatially referenced data for the Flemish Region. The meta-database is set up according to European standards.

4.2 *The CAI (Central archaeological information database)*

In the second stage of the project, one of the main goals is to look for a more general approach. The Flemish Government asked all institutes, dealing with archaeological affairs and archaeological heritage, to have "round table" discussions in order to build a new server-related archaeological database in which all partners will have continuously admission to the top-slice information. This new database will start from two already existing databases (HAVIK – made by the Universities – and ARGIS – made by the Province of Antwerp). At this moment all the Flemish Provinces, different local and town Archaeological Services, the Flemish Institute for Archaeological Heritage (IAP) and the two Universities are busy to work out the first version of this database (= CAI). The daily maintenance of this server-based database will be hold by the IAP.

A part from this business, both Universities are carrying further out their own digitalisation. Still a lot of information of the archives must been put in the database.

5. Digitalisation of the aerial photographical archive

Ghent University has a unique archive of aerial photographs at its disposal, covering the provinces of East and West Flanders (Bourgeois *et al*. 2002). This archive has been developed over the last 20 years. About 25,000 out of 50,000 slides, were digitised in the last five years (for financial reasons only 1 slide out of 2 will be digitised) (Fig. 2).

All the images are preserved on Photo-Cd. Each Cd-Rom contains 100 photographs digitised in different resolution formats. The little snapshots are very useful in database-environment. The bigger formats are very good for detailed

Name	Resolution	File-size
Snapshot	128 X 192	72 Kb
	256 X 384	288 Kb
	512 X 768	1.13 Mb
	1024 X 1536	4.5 Mb
Poster	2048 X 3072	18 Mb

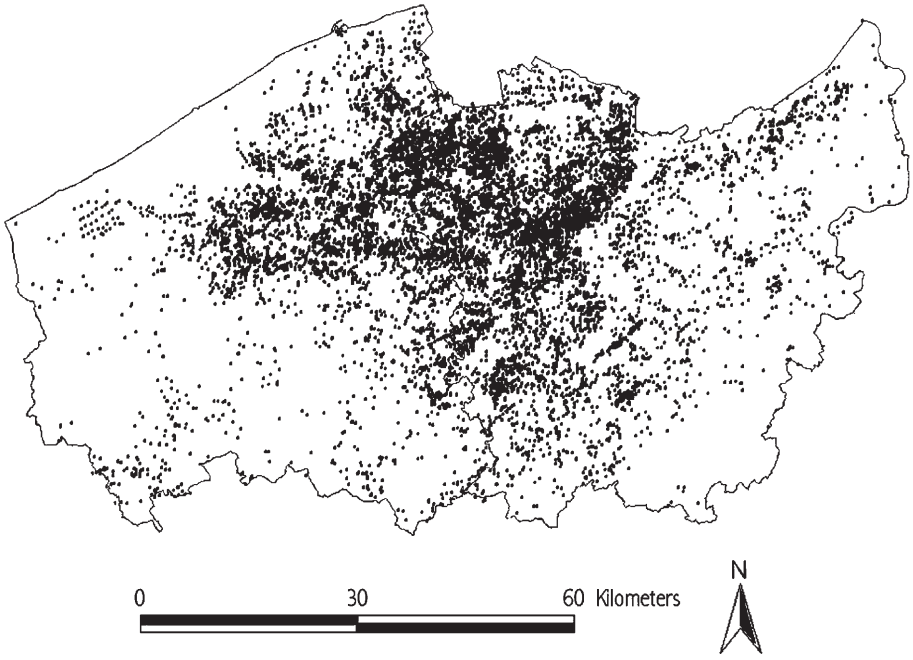

Fig. 2 – Aerial photography in the provinces East-and West-Flanders.

analyses of the different features. They are also made for publication purposes.

Since the co-operation in 1997 with the Ghent University, the University of Leuven has started with archaeological aerial photography too. Two areas were selected: the northern Campine (Antwerp), and the region of Tienen-Tongeren (mainly Flemish-Brabant).

6. Georeferencing, Spatial Analyst and 3D

6.1 *Image Warp 2.2.*

To locate exactly the features on aerial photographs, the oblique images are georeferenced with Esri Image Warp 2.2. This small software package allows the user to georeference oblique coloured images. After several attempts we prefer to relocate the oblique images on vertical aerial photo-

graphs. Such vertical aerial photographs are mainly taken for topographical reasons and they give us better and detailed information of the land registry parcels at a certain time. At the other hand most of these vertical photographs are taken in winter or early spring, when there are less leafs on the trees. This is necessary to locate in detail the corresponding points between the vertical and the oblique photographs. When using topographical maps instead of vertical photographs, it is not always possible to work in detail. The signs on those topographical maps are standard, which means that every line or spot consists of several square pixels. The width of a road is not of the same size as in reality. This diversity of scale will be also processed in the georeferencing of the oblique photographs.

6.2 *Shape Warp 2.1.*

In some occasions digital excavation maps are also georeferenced: this is done with the software package Esri Shape Warp 2.1. Both packages (Image Warp and Shape Warp) are sometimes combined (Tav. IIIa).

6.3 *Spatial Analyst and 3D*

For further analyses the use of Spatial Analyst is required also the extension 3D. Digital terrain models are made, a combination of different Arcview scripts are used (e.g. line2point). Clusters of features, like graveyards of Bronze Age barrows, seen on aerial photographs are further processed within 3D (Tav. IIIb). For other scientific purposes we calculate the slope, the visibility of the surroundings or between the different graveyards,…

7. Extended aerial photography of Flanders

A totally new project is forthcoming: in the near future there will be a budget to establish different regions with different pilots to cover the whole area of Flanders. At this moment, already three pilots are working on oblique aerial photographs and covering mainly 60% of the Flemish region. In the meanwhile we are looking for older collections of aerial photographs, like the archive of Charles Léva. This archive, consist of several thousand of aerial photographs of Belgium and was integrally bought by the Walloon Government. However the know how to inventory aerial photographs (localisation, description, interpretation of the features) still remains at the Ghent University. The first conversations between the Walloon Department for Archaeological Heritage and the Ghent University have already taken place. In exchange of our applied knowledge we could have at our disposal all the information about the archaeological features seen in the Flemish region. With this collaboration, each partner will work on the

good management of archaeological heritage in both federal regions (Flanders and Wallonia). For this purpose our basic database for aerial photographs is in further development (additional information will be stored (as who has taken the photographs, where the collection is stored, who is the owner of the archive,…).

8. Processing digital excavation maps

In order to get a better management of the different features/actions discovered on older excavations, a new way of working will be installed. The old excavation maps will be digitised (Autocad LT98) and georeferenced in Arcview. Behind the different layers of this image a database with the basic information of the feature (number and measurements of the feature, description of the form, colour and size, number of the structure this feature forms a part of, hyperlink to the detailed drawn map and profile,…) will be created. Also results of analyses conceived by other natural sciences will be put in this database (^{14}C, dendrochronology, palynolgy, pedo-geomorphological analyses,…).

9. Conclusion

Computerisation of archives offers interesting perspectives for Flemish Archaeology. The examples we have encountered so far show that the design of a systematic inventory for Flanders makes an effective management and protection of the archaeological heritage possible. It goes without saying that such an archive – as a source of information – is also of great scientific value for the charting of "evaluation maps", for the conduct of regional studies, and for the design of distribution patterns and models.

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ABSTRACT

Ghent University has organised an archaeological aerial survey of both provinces of East- and West-Flanders since the beginning of the 1980s. As a result of these activities, some 50.000 slides have been realised. They reveal thousands of archaeological structures, from the Neolithic up to the most recent periods. From 1997 on, financial support by the Flemish Community aimed at the realisation of a GIS based database (Access 97 relational database - Arcview 3.1) and the digitalisation of some 50% of the slides. As a result it was possible to locate all 50.000 items and connect them with geographical information afforded by the support centre GIS Flanders. It is expected in the near future that this information will be available for SMR-purposes and archaeological heritage management. There are also several scientific outputs: one of them is the study of Bronze Age barrows.