

Archaeological heritage management in the Information Age: GIS applications and air photography processing in Wielkopolska (Greater Poland)

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Abstract. The beginnings of aerial archaeology in Poland date back to pre-war period, but until recently it has not been applied on a wider scale as a method of discovering and documenting archaeological sites. Considerable progress in this respect was accomplished thanks to the Leszno Workshop in 1998. A long run project of building up Polish SMR (Sites & Monuments Record; Polish abbreviation: AZP) has so far resulted in some hundreds of thousands of Site Register Forms, but without incorporating the possibilities of air photography method. The scope of information on archaeological sites collected so far seems to be - in several cases - insufficient for Monuments Protection Service to formulate a correct decision. When a new powerful tool known as GIS became available, it diversified the way air photographs are applied by archaeologists as it became possible to integrate the end products of this method with some others, i.e. results of surface surveys (field-walking) and geophysical examinations on the background of topographical map.

1. Pre-war beginnings

The use of archaeological photography in Poland dates back to 1935. The very idea for this originated among archaeologists from Poznań carrying out research in Biskupin. Since 1935, Zdzisław Rajewski i Wojciech Kóčka (co-workers of the director Józef Kostrzewski) were using photographic records. To achieve this, they used a hot air balloon with a camera

underneath which was controlled by a rope. This allowed photographs to be taken from altitudes ranging from 5 to 150m [1]. Those photos were of particular value in documenting the progress of the excavation and spatial arrangement of preserved wooden constructions. A similar method was applied in researching the Early Medieval fortified stronghold of Kłecko [2].

In 1935, a programme of photographic aerial recording of archaeological sites in Wielkopolska in co-operation with military pilots was initiated. In the framework of this programme mainly the photos of known earthwork sites - of strongholds and barrows were taken. Władysław Kowalenko in his book *Grody i osadnictwo grodowe Wielkopolski wczesnohistorycznej (od VII do XII wieku)* used the photos for illustration of his book on Early Medieval strongholds [3]. Until the beginning of World War II, the Poznań archaeological centre was the only one, which used aerial photographs. Two main trends of making use of aerial photographs appeared. The first one concerned the documenting of research work that was carried out. The second one concerned the taking of photographs of already-known archaeological sites that would allow the state of preservation of the site to be determined, and also be used for illustrative purposes. However, this new method missed what would have been its fundamental advantage for Crawford [4], [5] - it did not involve searching for new sites, the identification of their portions, or their verification by interpretation of the photographs.

2. After the war: series of episodes

After World War II, the use of aerial photography in archaeology visibly lost its momentum. To a large degree, this was the result of military-administrative restrictions. Many archaeologists also believed that this method was inefficient and expensive. Nevertheless, that is not to say that any projects which implemented this method were abandoned [6], [7]. In 1955 for example military pilots took pictures for archaeologists of the Early Bronze Age barrow cemetery in Łęki Małe. Since 1960, the programme of documentation of historic monuments by aerial photography from a helicopter was carried out in Wielkopolska. Zygfryd Ratajczak from the Archaeological Museum in Poznań took part in this programme. In the mid-1980s, Andrzej Marek Wyrwa and Andrzej Kijowski were working on using aerial pictures in research on the paleo-environment of the Łekno area [8]. Also in the 1980s, Aleksander Starzyński, the then-director of the Provincial Archaeological Conservation Centre in Leszno with its base in Trzebiny, took a decision regarding the aerial recognition and recording of archaeological sites in Leszno province. As a result of this, Wiesław Stępień, in co-operation with Jacek Nowakowski (the archaeological conservator), photographed the area in 1986 and 1989. At the start of the 1990s the Archaeological Museum in Poznań started to reinstate the practice of photographing sites which had already been identified. The photographic recording of archaeological sites in the area of Bytyń Lake, Niepruszewo Lake, Łęki Małe, Kowalewko, Gorszewice, Chaławy, Mirkowice, Ostrów Lednicki was photographed by Andrzej Kijowski [7], [2].

That practice of using aerial photography in Polish archaeology can be called the documentation stage. The majority of aerial pictures taken at that time registered already-known sites, in particular those sites with a distinctive form in the landscape such as strongholds and barrows. Pictures of levelled sites known from the Polish Archaeological Record (AZP) were also taken at that time, but they did not disclose any features such as

pits or other structures. Often these pictures were taken in a very unfavourable period, e.g. as in the case of series taken in Leszno in 1986 and May 1998. The inexperience of the photographers did not allow for full interpretation of the results. Reinterpretation of some aerial pictures taken at that time have facilitated the discovery of an unknown fortified stronghold from the Early Middle Ages in Czerwona Wieś site 1, which was later confirmed as a result of a trial trench carried out on the site in 1993.

However, this method did not gain wide recognition in Polish archaeology, which considers surface survey as the principal research procedure. Besides, the majority of Polish archaeologists believe that the only evidence for the existence of archaeological site consists of historic material (artefacts) gathered from its surface; whilst spots or other patterns visible on a photographic plate cannot be taken into account. This method was also considered by these archaeologists as costly and hampered by administrative military prohibitions.

3. Beyond the documentation

However, there was a group of scholars who tried to promote this method as supplementary to the Polish Archaeological Record Program, which had been in effect since 1978 (Włodzimierz Rączkowski, Zbigniew Kobyliński). At their suggestion, aerial archaeology workshops were organised in Leszno in 1998. In addition, they provided significant impetus to the development of this method in Poland. These workshops were organised by the Institute of Prehistory of Adam Mickiewicz University of Poznań, the Aerial Archaeology Research Group, the General Conservator of Monuments in Warsaw and also Poznań Prehistoric Society [8]. The value of aerial photography for the uses of heritage management was particularly emphasised in the course of the workshops. It was the first time in the history of the aerial photography programme that the search for new archaeological sites was more important than the documentation of existing ones.

As a result, after only one week, more than 100 new archaeological sites were discovered in the area around Leszno and much significant data about their character, type, and spatial structure was obtained. For many years, the lack of progress in discovering new sites had been a subject of criticism. It was also the main argument against the use of this method; however, it was soon completely overthrown. It turned out that, as in other European countries (for example in Great Britain, France, Germany, Czech Republic and Hungary), it is possible to carry out an effective aerial reconnaissance, which supplements significantly our hitherto existing knowledge of the sites.

4. Recent activities in Wielkopolska (Greater Poland)

Leszno has become synonymous with the change in the attitude to the use of aerial photographs in Poland. Apart from the prevalent practice of taking pictures of known sites (very important in respect of conservation aspects and possibility of its vulnerability evaluation), a trend of carrying out reconnaissance in pursuit of new sites has become more and more plausible. The monuments conservators who took part in the workshops in Leszno pass on the use of that method in many places in Poland. In the Wielkopolska Region aerial survey is carried out in Leszno (Jacek Nowakowski, Włodzimierz

Rączkowski), Piła (Miroslawa Dernoga) and in Poznań, along the planned Route A2 (Andrzej Prinke, Bogdan Walkiewicz [9] and Toruń province (Wojciech Sosnowski).

Since then, there has been a major breakthrough in implementing this method in Poland. It is also considered to be a new (second) stage, which is focused on searching for new sites, unlike the recording practice which has prevailed so far. Thus, since the beginning of this year in the area of former Leszno Province, the aerial survey has been a planned operation, which has produced very good results. There are some other limitations on the way, however, they mainly concern the financial side of it.

The results of the new work, in particular, those in 1999 and 2000, have brought about a change in attitude of Polish archaeologists towards the use of this method (1999 - a discovery of the fortified settlement of Lausitz Culture from the turn of the Bronze and Iron Age in the area where AZP was already completed, in Jurkowo (Krzywiń commune) [10]; 2000 - the discovery of settlements of late Linear Band Culture and its long houses in Kujawy (Włodzimierz Rączkowski - personal communication), in the Chełmno area (Wojciech Sosnowski - personal communication).

The use of archaeological aerial photographs was particularly well received by the Monuments Conservation Services. The majority of people who participate in aerial photography work in these services. They are well aware of the great potential for this method in their work. A few aspects can be mentioned:

1. supervision of the preserved state of archaeological sites; consequently, taking appropriate decisions preventing their further destruction.
2. necessity of enlargement of the protected zones, in the case of already known sites
3. it allows the full range of the sites and their spatial organisation to be determined without the employment of expensive wide-surface research methods
4. the possibility of penetration of zones barely accessible for surface survey
5. the location of damaged levelled fortified settlements known from archives
6. the confirmation of sites discovered within a framework of the AZP program
7. the discovery of new sites
8. determining sites which are to be included in the Schedule of monuments (the pictures of sites with diverse structures detected indicate their good condition)

In the two years since the aerial archaeology workshops in 1998, this method has become well known in some centres in Poland (Wielkopolska, Toruń) and it has been put into effect with positive results. Moreover, the sceptical attitude of a large group of Polish archaeologists has slowly been changing. This method really opens up new prospects, particularly if it is employed with the Polish Archaeological Record (AZP) and other research methods.

It should come as no surprise that the number of interesting discoveries is increasing continuously. One of the most spectacular ones seems to be the discovery of the fortified settlement from the turn of the Bronze and Iron Age in Jurkowo (Krzywiń commune).

5. Integration with regional SMR including GIS

A long-term project of building up Polish SMR (Sites & Monuments Record; Polish abbreviation: AZP) has so far resulted in some hundreds of thousands of Site Register

Forms, but without incorporating the possibilities of the air photography method. The scope of information on archaeological sites collected so far seems to be - in several cases - insufficient for Monuments Protection Service to formulate a correct site management decision.

The necessity of incorporating air photographs in the standard documentation set of chosen, most valuable archaeological sites is motivated by the fact that it can add such crucial data as the site borders and the structure of its inner space (especially of the location of subterranean features), as well as up-to-date overview of the state of its preservation and tracing of the destruction processes. In that way, it provides an objective procedure for estimation of the value of archaeological sites.

When a powerful new tool known as GIS became available, it diversified the way air photographs are applied by archaeologists as it became possible to integrate the end products of this method with some others, i.e. results of surface surveys (field-walking) and geophysical examinations on the background of topographical map.

The advances which have been made in the last few years in the methods of inventorying and documentation of archaeological sites have taken place mainly due to advances in computer technology. This exceptionally dynamically developing field has supplied exceptional applications of a universal character, and thus of use to the archaeological profession, and especially the heritage management services. Their everyday professional activities include the rapid selection of data from their huge resources of archives and documentation created by the long term programme called the Polish Archaeological their effective and accurate analysis.

Already the use of textual databases meant a great advance on the use of the traditional paper records and allows the automation of the creation of these databases, their updating, and the search for the basic information recorded in these inventories, that is textual information [11], [12], [13], [14], [15]. After mastering the new tool, the users rapidly came to appreciate its many advantages, such as:

- the possibility of establishing and maintaining precise data standards,
- the rapid identification of mistakes and missing information,
- the possibility of automation of part of the work connected with the completion of the data and the correction of mistakes,
- the possibility of the rapid and cheap creation of an unlimited quantity of copies of the data in order to safeguard them or disseminate them, or allow their synthesis.

The appearance of a new operation system, Microsoft Windows based on a graphic environment, has allowed the linking not only of textual information, but also graphic data in the database. This allows the enriching of the information in the archaeological database with drawings of artefacts, photographs etc.

After the increasing widespread use at the beginning of the 1990s of a new category of computer programs, defined by the term GIS, further development became possible which relied on the creation with the aid of the computer of digital maps (that is the electronic equivalent of geographic and topographic maps). The archaeologist, used to the daily wide use of various types of cartographic material, the perspective was opened of the creation of specialist archaeological maps with the aid of the computer. In order to apply these innovations it was necessary to supplement the database on archaeological sites with information concerning the situation of the site in the form of cartographic information. The fulfilling of this condition opened new perspectives in the use of the computer for

archaeological-conservation purposes, including the possibility of the realisation of a series of routine activities of the archaeological conservator, for example;

a) the printing of the record of an archaeological site in the same format as the record card of the AZP survey, together with an automatically-generated location map at 1:10000 of the situation and character of the site,

b) the creation from the database of a distribution map of sites for any region and of with unlimited possibilities for selection of sites by category, and then their analysis by the series of tools available in GIS programs. These include:

- buffer (selection of sites lying within a certain linear zone or within a given radius from a given point/axis),
- a series of basic statistical tests,
- graphical presentation of the results of the analyses (frequency diagrams etc.),

c) the integration of archaeological maps with other, more general digital maps of the same area (for example regional planning documents).

An important argument for the introduction of digital maps in the everyday work of the archaeological conservation services, apart from the time it would save and the increased precision of the obtained results, is also the fact that for some time these implements have been increasingly commonly used by our professional partners, who make use of archaeological data, that is planners, officials of the state and local government and other specialised public and communal services. In such a situation it seemed justifiable to introduce a systematic resolution, the creation of maps of archaeological sites as one of the layers of multiaspectual spatial planning maps. For the archaeological conservation services – apart from any other advantages - this would have an important strategic value, since it would allow the elimination of the frequent procedure of the ignoring of the problem of the preservation of the archaeological heritage in the decision-making process involved in local government, planning of redevelopment, administrative processes etc.

The Archaeological Museum in Poznań started work in 1996 on the *mAZePa* program which is intended for the creation and maintenance of digital archaeological maps which is compatible with the standards of AZP (both in its „paper” as well as „electronic” form). The basic principles accepted by the authors of the program are set out below:

1) Strict logical and programmatic compatibility with the existing text data standards (*AZP_Fox* and *AZP_Max*). Several conditions had to be accepted, the mutual exchangeability of data, respecting the format of generated documents, a common mechanism for the seeking of data etc.

2) The choice of a suitable GIS (Geographic Information System), which would fulfil the following desiderata, the standardisation, effectiveness and ease of use. The program which most suited our needs was the program *MapInfo* – one of the most popular in the world, and at the same time among the cheaper of the GIS programs. It is a system which has been developed over a number of years, and thus its current version is a mature product. This program is also available in a Polish-language version which undoubtedly aids the establishment of the projected standard. An important characteristic of the system is its programmability, due to the compilation of a special programming language called *MapBasic*.

In the course of the recent use of the *mAZePa* program in the Poznań Archaeological Museum (Department of the Conservation of Archaeological Monuments), apart from its everyday use, it has been employed as a tool for the creation of several large

cartographic projects for the needs of archaeological conservation in the former Poznań vojevodship, including:

- the basic inventory map of archaeological sites in the region of the former Poznań vojevodship (Plate 106),
- a map of sites lying on the route of the projected A2 motorway within the boundaries of the former Poznań vojevodship (Nowy Tomyśl - Poznań - Września) (Plate 107),
- a map of the archaeological sites lying on the route of the projected Jamał to Western Europe transit gas pipeline within the boundaries of the former Poznań vojevodship [16].

6. Next stage: ortophotomaps

The most recent initiative of the Poznań Archaeological Museum in the process of the development of computer tools for archaeologists is the creation (also with the aid of the *mAZePa* program) of so-called orthophoto maps, that is maps of a new generation, the background of which is created from numerous aerial photographs of a given region which have been mounted in such a manner as to eliminate the errors typical of aerial views, that is linear and angular errors, but allowing at the same time increased – because realistic – legibility of the map itself (Plate 108).

Each of these products can be used to insert the air photos in order to precisely locate the archaeological features identified from the air. It can be done by use of the shareware software *AirPhoto* (www.home.t-online.de/home/gcarver/Airphoto.htm).

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