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THE PROSPECT OF DIGITIZATION OF POLISH ARCHAEOLOGICAL RECORD ON AN EXAMPLE OF MATERIALS FROM THE TURN OF BRONZE AND IRON AGE FROM THE AREA OF POMERANIAN VOIVODESHIP (NORTHERN POLAND)

ABSTRACT

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Polish Archaeological Record (AZP) is a unique research program initiated by Polish archaeologists in the second half of 1970s. The aim of this project is to mark on unitary maps (AZP sheets) all archaeological sites that were recorded during surface surveys along with sites known from the archives.

The main purpose of this paper is to focus on perspective of future digitalization of AZP and technical issues linked with the problem. Therefore, a process of creation of digital sample dataset containing materials from the Late Bronze Age and Early Iron Age from selected AZP sheets from Pomeranian Voivodeship will be presented, together with brief depiction of past and present attempts in introducing GIS into AZP archives. This case will be also described on the background of national records of other European countries and their level of digitization.

Key words: Polish Archaeological Record (AZP), digitalization, GIS, national archaeological records, Eastern Pomerania, Late Bronze Age/Early Iron Age.

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1. INTRODUCTION

Polish Archaeological Record (Pol. name: Archeologiczne Zdjęcie Polski – AZP) is one of the greatest achievements in Polish archaeology. It is a unique on European scale project aimed at marking on standardized map sheets all known archaeological sites, discovered during broad-based field prospecting and known before from previous excavations and archives. According to data from 2014, 89,56% of Polish area was prospected and over 469 325 archaeological sites were recorded (Ministry of Culture and National Heritage 2014, 33).

AZP is also a subject of numerous problems that are especially visible in the perspective of inevitable digitalization of this vast archive. Unfortunately, nearly all of its content is in paper form. There were few unsuccessful attempts to digitalize it, but mainly on a local level. Even though the amount of information preserved in the AZP archives is vast, access and effective use is greatly hindered. The main difficulties stem from dissipation of archives among several dozen of cities in Poland as well as their analogue form, forcing researchers to browse through hundreds or even thousands of AZP sheets and cards. Summarizing, Polish archaeologists do have an exceptional database, but compared to modern standards a very problematic one, from technological and scientific point of view.

The aim of this paper is to focus on the previous attempts and future perspectives for digitization of AZP, also from the perspective of analogical solutions implemented in chosen European countries. Therefore – in order to present the practical problems – the process of creating of a geographical database based on Geographical Information System (GIS) relating to the Late Bronze Age and Early Iron Age sites from the selected sample area located in Pomeranian Voivodeship (northern Poland, Fig.1) will be presented (see: chapter 6.). It will be created solely from AZP records, thus giving an option to analyse – on a chosen fragment – the process of digitalizing the archive and all problems linked with it. These will be issues related both with methodical problems stemming from basics of AZP creation and practical execution of program. The nature of material from the Late Bronze Age and Early Iron Age gathered during the prospection, as well as inadequate state of archaeological research in Pomeranian Voivodeship, is also a substantial factor. All these elements have unquestionable influence on the outcome of AZP archive and in consequence, on the database that will be created from it. Having in mind stated above aims, this paper will be also a contribution to the discussion concerning the possible utilisation of digital AZP database in archaeological scientific researches.

2. AZP – HISTORY AND FEATURES

Polish surface surveys have long and fruitful traditions that place Polish archaeology in a positive light on the background of other countries. Up to the 1960s these activities were based mainly on trips during which – with the frequent use of improvisation – initiatory reconnaissance within the investigated area was conducted. The main aim of these activi-

ties was to discover or verify the sites that were later selected for the future excavations (Kruk 1995, 265). These surface surveys were rather informal archaeological investigations without clearly determined methods. However, in the 1970s this situation changed. Younger researchers started implementing more disciplined ways of surface surveying. The training ground where these methods were developed was area of loess located in Little Poland, north and east of Cracow (Kruk 1995, 265-266). As it turned out, effects of these researches were complementary with the previous results of studies concerning geography of prehistoric settlement. The source database was extended, giving new opportunities to analyse past processes that might have had an influence on local settlement during prehistoric and early historic periods (Mazurowski 1974, 32-39; Kruk 1981, 115-120).

On a side note, it is worth mentioning the first propositions to optimize the access to dataset that was created as a result of conducted surface surveys (Kruk 1975, 247-254). These propositions suggested utilisation of punched cards with the information about sites recorded during the field investigation. These would be the first – yet analogue – databases linked with this kind of investigations. The idea was not realised in a larger scale though.

Coming back to the main topic, it should be mentioned that the intensification of surface surveys which appeared in the 1970s – together with the emergence of specified and detailed methods – created a foundation for the future methodology of AZP surveys. Unfortunately, many of the initial observations that were done during surveys in Little Poland were not included in the final version of AZP (Kruk 1995, 266-268).

Eventually, Polish Archaeological Record program was initiated on a national level in 1978 (Jaskanis 1996, 9). Having in mind fact, that the surface surveys conducted in Little Poland led to creation of general methodology for this kind of examination, the final and specific procedure was introduced while conducting the detailed and complete surface survey of Błonie Flatland, a part of Mazovia (Konopka 1981, 6). Prospecting proved that this area, perceived previously as rather uninteresting from archaeological point of view, was saturated with findings. For example previously unknown remains of a large metallurgic centre from Roman Influence Period were discovered thanks to methodical prospection. Sheer numbers attest the scale of this local project. Before conducting the project, there were only 80 archaeological sites known in the area of 1600 km^2 of Błonie Flatland – most of them known from previous excavations. Due to prospecting, the number of known sites rose to over 1000 (Woyda 1981, 12). After this project, Polish archaeologists realized that their level of knowledge about archaeological settlement structure was highly incomplete. This situation shown, that the need to conduct standardized archaeological prospections on a national level was necessary. In the view of AZP authors, it was to become a vast catalogue of Polish archaeological sites. It was supposed that AZP will become a valuable tool for researchers and conservation service protecting cultural heritage. After a number of meetings and conferences, a common way of conducting archaeological prospections was set for the area of Poland (Konopka 1981). The whole concept of AZP project was very ambitious and assumed creating a detailed map of Polish archaeological heritage.

It quickly became obvious that idealistic goals were impossible to achieve in reality (Jaskanis 1996, 9-38). There were various reasons; beginning with political changes that took place at the turn of 1980s and 1990s in Poland that caused institutional disruption and severe underfunding of conservation service, responsible for AZP execution. Also, the approach of archaeologists had a fundamental influence on this developing archive and caused disproportions visible now in the quality of AZP sheets coming from particular voivodeships (Jaskanis 1996).

Original methodology of creating AZP (c.f. Konopka 1981; Jaskanis 1996) was as follows. Whole area of Poland was divided to equal AZP regions that were 5 x 7,5 km, giving around 37,5 km^2 surface area per region. This way they took the form of 1:25000 maps on A4 paper sheets. AZP grid was created on a 1:500,000 wall map with a drafting method, without any reference to for example International World Map or any other method used in cartography like map emblem (Kołodziej 2011, 91). Particular AZP sheets in 1:25000 scale were simply cut from larger maps of the same scale. Because of that, "ideal" rectangular maps of 5 x 7,5 km areas were created, without any relation to modern coordinate system. All of this was the effect of unintended lack of methods used in cartography (Kozioł *et al.* 2012, 134). It should be underlined that this situation was caused mainly by the permanent lack of more detailed and professional cartographical materials during the 1970s and 1980s. Also the classification of significant number of maps as confidential because of military purpose was a problem (Jaskanis 1996, 15).

This state quickly caused numerous problems that came to light especially recently, during attempts to digitalize AZP. The main problem is that AZP does not fit to maps that function within any projected coordinate systems created for Poland. This issue will be further touched in this paper, now it is worth noting that after a few years of AZP functioning, developers noted this problem and tried, at least to some extent, repair it. To every card of registered in AZP site a standard 1:10 000 map was attached, done according to national coordinate system: PUWG 1965 (EPSG: 3120, 2172, 2173, 2174, 2175) with exact location of the site (Jaskanis 1996, 14-17; Kozioł *et al.* 2012, 134). It helped with locating precisely particular sites but the whole problem of unclear AZP sectioning remained unsolved.

As it was mentioned above, for each distinguished AZP area, a surface survey was planned. Before that though, an archival query had to be done to place on a map every already known archaeological sites to verify them during the prospection. Unfortunately, practice from the first years of AZP functioning proved that makers of particular sheets were not accurate enough. (Jaskanis 1996, 21; Matoga 1996, 50). During next step the archaeological prospections were conducted. For every site found during these prospections as well as for archival sites a separate "Archaeological Site Record Sheet" was done (Pol. abbrev: KESA, however in 2004 this card was modified and the current name is "Archaeological Monument Record Sheet, Pol. abbrev: KEZA, see: National Heritage Board of Po-

land 2012, 4). On the first page there was information about site number, location according to administrative division and the most important data about the closest geographical environment. There was also separate place to describe the character of findings, pointing to function that the site once had (settlement trace and point, regular settlement, burial site, hoard etc.), chronology, archaeological culture, or found archaeological material. In case of surface surveys the material found is mostly pottery, sporadically flint and exceptionally, metal findings. Unfortunately, taking into account that most of the material found is pottery, trying to determine chronology on its basis is extremely risky and inaccurate (Czerniak 1996, 39-40; Matoga 1996, 49). Ceramic material gives only sparse knowledge about the chronological period that it descents from. On the other hand, when it comes to determining the function of site, it is usually done on the basis of amount of material found on the ground. According to the effective practice, 1-3 pieces of pottery mean settlement trace (suggestion), 4-9 pieces mean settlement point, and 10 or more pieces mean settlement. As it can be seen this divide does not describe the real function of a prospected site but the number of found materials. It is also important to mention that cemeteries and hoards were usually marked on the AZP sheets as a result of excavations – a final method that verifies character of a given site – or accidental findings.

Currently, a complete instruction on how to conduct AZP surveys and prepare documentation – including proper filling out "KEZA" – can be found on a National Heritage Board of Poland (Pol. Narodowy Instytut Dziedzictwa – NID) website (National Heritage Board of Poland, 2015). It is worth noting that even though over 38 years passed since the initiation of program, methodology of conducting prospections remained mostly the same. However, the latest instruction introduces quite significant changes in relation to the digital standards. From now on all surveys should be conducted with aid of precise GPS tools and the final results of this prospection – beside the paper version – needs also to be displayed in the digital GIS format (.shp files). What is more, each AZP area needs to be investigated and interpreted on a background of Lidar and aerial photography data. It is an important upgrade in the development of AZP methodology.

To sum up, there is a question pending whether this program is scientifically useful at all or does it only have protective value. It is difficult to unequivocally answer this question, however the solutions proposed inter alia in chapter 5 of this paper may have some influence in uprating the quality of this archive in the way that its utilisation from the scientific point of view could become more reliable. All in all it is possible now, in the era of GIS tools to perceive AZP from a different perspective. This archive may become much more worthy for modern researchers, for whom priority is receiving pool of numerous and high quality information – one that cannot be extracted from an analogue archive – even if we take under consideration only its protective usefulness.

3. ATTEMPTS AT DIGITALIZING AZP – HISTORICAL BACKGROUND

First countrywide initiative to digitalize AZP appeared in the 1990s. It was prepared by a national coordinator of the project who made attempts to introduce SYSETM_AZP software into this archives (Jaskanis 1996, 16-17). It was not though usage of GIS yet, because information about sites was written in the base just as records without any reference to digital map. Unfortunately, following years showed that these attempts were not giving expected results. It is worth reminding here though, reality in which institutions participating in AZP had to exist. Beginning of 1990s was a time of moving Polish archaeological service into new political and economic environment. It was related with significant cuts in funding, and scarce availability of equipment (hardware and other digital tools) that made Polish archaeological effort incomparable to the one represented by western countries.

Interesting attempts to digitalize AZP archive in Greater Poland were conducted during the 1990s and even in the 1980s by the pioneers of introducing computerization into AZP and at the same time creators of already mentioned SYSTEM AZP software (Jaskanis 1996, 17). At the beginning, geographical coordinates were just a text file in the digital version of AZP sheet, like it was in the case of SYSTEM AZP and its latter and upgraded versions: AZP_Fox and AZP_Max (Prinke 2002, 158-160; 2009, 72). Then a reference to spatial location of particular site was placed as a cartographic module that allowed visualization of given site on a digital map. It was possible because of mAZePa program, launched in 1996 and based on MapInfo (Prinke 2002, 158-162). Finally, a software related GIS module was used. Unfortunately, this program did not become a common standard in digitalization of archaeological prospection, even though it was sufficient and complementary.

Basing on above information, it can be said that the process of creating a solution that could enable transformation of AZP archives into digital form was divided into two phases. First phase was linked with the development of SYSTEM AZP, AZP_Fox and AZP_Max software. From the present perspective the lack of cartographic module is a significant weakness, however at that time the main aim of these programs was to optimize the available AZP text datasets, what was enough at least to solve some of the simplest problems stemming from the field of archaeological conservancy. Besides – as it was mentioned before – access to GIS tools was in Poland during early 1990s quite limited or even impossible (Prinke 2002, 160-166). The second phase of the earliest attempts to digitize AZP was the introduction of mAZePa program together with cartographic module based on MapInfo system. This solution was compatible with databases that were already prepared in AZP_ Max standard. Consequently, the introduction of mAZePa was an important caesura to be noted in the history of AZP digitalization, especially that beside utilisation of digital maps it opened the possibility for conducting spatial analyses (Prinke 2002, 160-166).

Over the recent years there were also other attempts to digitalize the AZP material. Regrettably all of them were conducted on a local level. Partial digitalization of AZP for Lublin voivodeship (Gawrysiak and Reder 2011, 132-141) or Chełmno Land, within borders of Kuyavian-Pomeranian Voivodeship (Kozioł *et al.* 2012, 133-143) are good examples. These two initiatives clearly show that even though there is no unitary AZP digitalization program, there are solutions, based on modern GIS achievements that are ready to use to digitalize archives on a national level. On the other hand not all problems were already solved.

At the moment, AZP digitalization progress is becoming more visible because of the introduction of new instruction for AZP makers that was released by NID in 2015 (National Heritage Board of Poland, 2015). As it was noted in the previous subchapter, from now on the documentation from conducted surface surveys needs to be prepared also in digital version editable in GIS environment (.shp files). On the other hand the archives in most of the provincial conservation service offices and their delegacies are still in paper form. Pomeranian Voivodeship is not an exception.

It is worth underlining here an important initiative of geoportal, created by NID (http://geoportal.nid.pl/nid/, accessed 08.05.2016). Data found there is partially coherent with information gathered in AZP and this may be the direction that will make the digitalization come true.

NID was created in 2011 and what is especially important, one of the aims of this institution is building and developing geospatial database for Polish monuments. This goal is connected with the implementation of the "Infrastructure for Spatial Information in the European Community" (INSPIRE) Directive (Kołodziej 2011, 83-84; 2012, 119-120). At the moment on the website of geoportal there is information about location of all archaeological sites put into registry of objects of cultural heritage, therefore exceptionally protected by conserver's service, from the perspective of Polish law. According to current data from geoportal, there are 7743 archaeological sites protected this way; compared to around 470 000 sites noted in AZP archives this is just a small fraction. Regardless, one of the indisputable advantages of this project are the WMS and WMTS services that can be added and used while working in GIS environment. Without any doubts, one of the most important services here is a virtual grid of AZP sectioning prepared by NID that will be described in the penultimate chapter. Besides that, there is also terrain relief done with LIDAR, however it was taken from the main governmental Polish geoportal (http://geoportal.gov.pl, accessed 08.05.2016). It is a very useful addition, especially in the case of sites that have their own landscape form. In the context of discussed here period in Eastern Pomerania this may refer to barrow burial grounds (Janiak 2014, 23-41).

To sum up, the attempts to digitize AZP archives have been conducted for almost last 30 years. On this field especially important are the achievements of the researchers from the Poznań Archaeological Museum who were preparing first solutions allocated for the Greater Poland – and in general – also for the whole Poland. However, the main problem

is that these and other described here attempts finally did not result in creation of country-wide AZP database. The processes of "global" digitization of AZP was accelerated only recently. The main impulse came in 2015 and new AZP instruction, however, in wider perspective, the change was also inspired by the implementation of the INSPIRE directive. On the other hand, full digitization of this archive is at the moment still in its initial stages, because the amount of paper data stored in the provincial conservation service offices – which needs to be digitized – is very high.

4. AZP AND OTHER EUROPEAN ARCHAEOLOGICAL RECORDS – A COMPARATIVE APPROACH

AZP may be an impressive project, but other European countries do have their own record system for archaeological sites and objects (de Wit and Ziengs 2009, 141-143; also: Larsen 1992; Wheatley and Sanjuan 2002; Schut 2009). Those solutions are one of the most important elements in modern system of archaeological heritage protection in Europe. These kinds of record in most cases are also an invaluable source of scientific data. Characteristic of chosen European systems, used to register artefacts and sites is discussed below. Information useful for comparative analysis with Polish accomplishments, especially in the field of advanced digitalization processes, was accented.

An interesting situation is observed in Spain that is very different from Poland when it comes to archaeological heritage, yet is quite similar when matters of acreage and number of inhabitants are concerned. Register of archaeological sites in Spain was strongly influenced by decentralisation of administration. Beginning with 1985, 17 of autonomous regions were obliged with preparation and development of separate registries of archaeological heritage within their borders. Even though there were a few attempts to coordinate those projects, none was successful (Cacho and Torres 2009, 29-30). The result is diversified degree of registration of archaeological sites in between regions and different approach towards documenting sites in the records. For example, whole areas of Basque Country and Madrid were prospected. The result was a high number of registered sites per km^2, much higher than in larger areas like Andalusia and Aragorn, where broad-based prospections were not conducted (Cacho and Torres 2009, 29-33). The level of digitalization of records is also varied. Andalusia is an example of region where the most advanced attempts of introducing GIS software were conducted (Amores *et al.* 1999, 351-358; Cacho and Torres 2009, 31-32). Moreover, some registries are not published in the Internet, or access to them is limited, to protect archaeological sites from plundering (Cacho and Torres 2009, 33-34). It should be supposed then that the number of formally registered sites is definitely lowered in comparison to the estimated level. It should also be taken as a truism that decentralisation does not support preparation of functional and complementary registers of archaeological heritage.

Another country worth mentioning is Hungary (Wollák 2009, 53-61). There are over 60 thousand archaeological sites registered there. At the turn of XX and XXI century Hungary began digitalization and unification of all data concerning archaeological heritage of this country. The main source of information was project „The Archaeological Topography of Hungary" initiated in the 1960s by Archaeological Institute from Hungarian Academy of Sciences (Hungarian: Régészeti Intézet – Magyar Tudományos Akadémia). Its goal was gathering all data from the archives, literature and museum storages that had any significance due to Hungarian archaeological sites. They were then verified in the field, new maps were prepared, photos, pictures etc. The effect of digitalization was a database made to collect information about sites, protected cultural goods, and later on historic monuments and listed buildings. This database was completed with an ArcView based GIS system. In 2008, 25% of the sites had maps of these kinds attached to their file, and the number was still growing. It is then clearly seen that digitalization of Hungarian inventory is advanced still, taking into account that the overall number is estimated at 100-150 thousand sites (Wollák 2009, 58), there is much to be done to complete it fully.

During the last few years an advanced system of geographical information involving archaeological sites was being developed in Romania. In 2005 Ministry of Culture began preparing National Register of Historic Monuments in Romania, (Rom. Lista Monumentelor Istorice). Text files were processed into a GIS system prepared for the project (eGIS-pat – link: http://egispat.inp.org.ro/, accessed 08.05.2016) based on ESRI software (Mihai and Angelescu 2009, 109). This system not only contains data on archaeological sites but also monuments and scheduled buildings. Furthermore, an online register of Romanian archaeological sites is available under the name of National Archaeological Record of Romania (Rom. Repertoriul Arheologic Naţional), with information about 15201 sites. This project is governed by The Institute for Cultural Memory (Rom. Institutul Naţional al Patrimoniului) and is tied with geoportal containing information from all the sources coordinated by this institution (Rom. Server cartografic pentru arheologie, link: http://map.cimec.ro/Mapserver/, accessed 08.05.2016). These are mainly sites excavated in the last 25 years, but also those known from archives and museum storages. A final stage of preparing GIS for governing Romanian archaeological and historical resources will be verification of sites and successive extending of database with GPS and mobile GIS. Everything depends on the amount of funds acquired (Mihai and Angelescu 2009, 113). It is then possible to state that situation in Romania, where a functioning digital register of relatively few archaeological sites, is reverse to the situation in Poland, where lack of digital register is confronted with vast analogue AZP archive.

In the context of discussed here question, Russia is an interesting example. This vast country has at the moment around 50 thousand officially registered and legally protected archaeological sites (Saprykina 2009, 100; Lbova 2014, 6399-6405). Approximately similar number of sites is registered in Hungary which is an incomparably smaller country. Additionally, the number of registered sites in Russia does not seem high and show the

very low level of traceability of archaeological sites, but one should take into account, apart from area and populace, also natural conditions and population density. Beside that, not all of known sites are in official register. Documentation standards for Russia were set by a project "The Archaeological map of Russia" (Rus. Археологическая карта России) initiated in the 1980s by The Institute of Archaeology of the Russian Academy of Sciences, (Rus. Институт археологии Российской академии наук) (Saprykina 2009, 100; see also, link: http://www.archaeolog.ru/?id=43, accessed 08.05.2016). This project is focused on European part of Russia, and research from particular areas are published in tomes. Each tome consists of area characteristic, history of research and description of sites within the area, along with the most important information about them. Attempts to digitalize this repertory are conducted now, with the aim to create a database with easy access, enabling easier protection of archaeological heritage and carrying huge scientific potential, taking into account significant amount of information that the analogue counterpart contains. As for now, it seems like the project is still in its initial phase, because only small amount of sites were registered.

A much smaller country than Russia, but with a similar natural conditions and proportion between inhabitants and area is Sweden. The Swedish archaeological register and its digitalization is completely different from the Russian one, though. During 2003-2006, on the basis of available data a monument register was created named Ancient Sites Information System – ASIS (Swedish abbrev: FMIS; http://www.fmis.raa.se/cocoon/fornsok/search.html, accessed 08.05.2016), that is coordinated by Swedish National Heritage Board (Swedish: Riksantikvarieämbetet). Having information about more than 1,5 million individual sites and monuments (including rune stones, rock carvings, cemeteries, mines, remains of crofts, places of execution, shipwrecks and much more) located in 570 thousand different locations makes this program remarkable. Enlisted sites date from the Stone Age to Industrial Age (Norman and Sohlenius 2009, 83); On the background of other European countries these numbers are very high. The cause is simple, for over 60 years Sweden was intensively prospected. The oldest mentions of such prospections come from XVIth century. Such impressive traditions in registering historical objects led to creation of functioning and effective database. Moreover, this database is an excellent source for archaeologists and amateur historians, though for the latter ones there are restrictions imposed on revealing precise location of some sites to protect them from plunder. ASIS is continuously updated, with numerous experienced specialists involved, working on the newest GIS software (Norman and Sohlenius 2009, 84-86).

Last but not least, there is English register of archaeological sites. Just like in Sweden, in the last few years in England, a well working system was created whose characteristic feature is deep involvement of local authorities. After splitting English Heritage institution in 2015 a Historic England was founded (Lean 2015). Its part, a National Record of the Historic Environment (NRHE) is central element of the discussed system. One of its main aims is maintaining and coordinating registers of archaeological sites, monuments and

even whole landscapes that bear historical value as well as aiming local authorities in protecting and restoring English cultural heritage. At the moment, NRHE consists of over 420 thousands records, relating to various relicts of human activity, from the Stone Age to Industrial Age. The project is based on GIS and published online (http://www.pastscape.org, accessed 08.05.2016). In case of English solutions an emphasis is placed on cooperation with owners of particular immovable artefacts or areas on which archaeological sites are located (Skaldawski *et al.* 2011, 6-9). Creators of NRHE, with a dose of caution, treat in the same way detectorists that helped to locate many valuable sites (Bowdler 2009, 105-106).

To conclude, mentioned above examples of approaching the subject of registering archaeological sites and creating a digital counterpart of register clearly shows vast disparity between European countries. On this background, Poland looks quite specific. During the last 40 years, Polish archaeologists managed to register nearly half million archaeological sites in, what is comparable to England, even though England is much smaller. Unfortunately, apart from publishing by NID locations of registered archaeological findings in geoportal, little was done to digitalize records of analogue catalogue. Most of other mentioned countries work on digitalization since at least decade. On the other hand, apart from England and Sweden, those countries have highly incomplete registers. It should be objectively said that digitalization of even a vast archive is less labour consuming than creating an archive like AZP. It seems like Poland has a good starting point, even though digitalization is way beyond expectations, to create a complete and "total" register of archaeological sites that will compete with even the most advanced European counterparts.

5. LATE BRONZE AGE AND EARLY IRON AGE MATERIALS FORM EASTERN POMERANIA. THE CHOICE AND THE QUALITY OF A DATASET FROM THE POINT OF VIEW OF AZP DIGITALIZATION

As it was mentioned at the beginning, one of the aims of this paper is to discuss the process of preparing a sample digital database based on analogue information taken from AZP archive. It will contain materials from the Late Bronze Age and Early Iron Age from the area of Pomeranian Voivodeship. The reason why this paper is focusing on this Voivodeship is a region called Eastern Pomerania (or Gdańsk Pomerania), which is located within the borders of this administrative unit. Eastern Pomerania was a very important settlement region assigned by Leon Łuka (1983, 7-29), where significant cultural, social and environmental changes took place at the turn of the Bronze and the Iron Age. This question was elaborately discussed in Polish archaeological literature (for current state of research c.f. Niedziółka 2013, 193-210). Below, a very general introduction into chronological division, together with description of the cultural changes in Eastern Pomerania can be found. The aim of this subchapter is to explain the choice of area that will deliver the AZP data for the sample database.

Chronological frames of the Late Bronze and Early Iron Age in Eastern Pomerania are linked with the development of societies identified with local group of the Lusatian Culture (so called Kashubian group) and Pomeranian Culture, which evolved on the background of the first one. In terms of the relative chronology (c.f. Kmieciński 1989, 760-761, table 9; Czopek 1992, 86, fig. 3; Dąbrowski 2009, 17, table 1; Gardawski and Woźniak 1979, 24, sheet 1) these frames begin with IVth and Vth period according to Oscar Montelius' chronology for Northern Europe. These periods are followed by Hallstatt C and D phases (further: HaC, HaD) according to the Hallstatt chronological system introduced by Paul Reinecke for the Early Iron Age in Central Europe. However, it need to mentioned, that according to Polish literature, HaC phase is partially coherent with VIth period, according to Montelius. In turn, the stipulated end of the Early Iron Age is identified with the La Tène A and B periods (further: Lt A, Lt B). Basing on these observations, together with the recent view on the European chronology of the Hallstatt phases (Trachsel 2004, 316-321) and more local perspectives focused largely on the Polish lands (Dzięgielewski 2010, 175; Woźniak 2010, 41; Kneisel 2012, 486-488, tab. 28) it is possible to estimate the chronological frame of this paper from the I half of the XIth century BC (IVth period according to Montelius) till the II half of the Vth century BC (Lt A).

According to the current state of research, the cultural situation in Eastern Pomerania during analysed periods was as follows. At the end of Bronze Age there were communities existing in the area of Eastern Pomerania that are described as a local branch of tied with Urnfield traditions Lusatian Culture; namely Kashubian Group (Dąbrowski 1979, 74). One of the most characteristic features of Eastern Pomerania in the Late Bronze Age were barrow burial grounds where cremated remains were placed (Podgórski 1992, 199-201). These burial grounds even though were not numerous, consisted of sometimes over hundred barrows.

A fundamental change in burial rite took place around VII century BC (HaC phase) to finally shape in next phase – Hallstatt D – when in place of barrows a more numerous yet smaller burial sites of stone box graves appeared (Malinowski 1990, 323-333; Podgórski 1992, 204-209). These square or rectangular constructions, made from flat erratic stones contained face urns which had more or less schematic facial features on necks and lids. These vessels are considered to be one of the most characteristic phenomena noted in the Polish prehistory. They were very closely analysed in the literature (Kneisel 2012, 23-34). In the archaeological approach these urns are tied with Pomeranian Culture that is distinguished also by the mentioned above stone box graves (Adamik 2012, 7). Eastern Pomerania should be considered as an initial area for this unit. From this region Pomeranian Culture spread to nearly whole modern Poland area, sometimes even surpassing these borders (c.f. Dzięgielewski 2010, 175, fig. 1).

Presented here reconstruction of cultural development clearly shows, that the turn of the Bronze and Iron Age in Eastern Pomerania was a time of evident cultural changes visible in archaeological record. On the other hand, all the cultural units that were divided during that periods, namely: Kashubian group, Pomeranian Culture and so called Wielka

Wieś phase (transitional phase between the first and second culture, dated to HaC phase; see: Fudziński *et al.* 2007, 47-59) derives from the same tradition. It can be identified with the Lusatian culture – and in wider context – with the Bronze Age urnfield traditions (Chochorowski 1999, 392-393; Dzięgielewski 2010, 174). Consequently, the archaeological materials from Eastern Pomerania from Late Bronze and Early Iron Age constitute a separate but also internally diverse whole, that is a relic of approximately seven hundred years of human activity. Taking this into account, it seems that it is a good material to present the process of digitization of AZP archive from chosen sample area selected within the area of Eastern Pomerania. On the one hand, it contains data from period that is long enough to give the eventual possibility to detect the variability of the archaeological material. On the second hand, in the light of a current literature it is quite well recognized period. However, the problem appears when the current state of researches will be confronted with the results of AZP from the same region. The main difficulty here is the fact that most of the sites recorded while conducting AZP were dated on the basis of pottery, material too imprecise for the needs of this database allowing only general chronological assumptions. The majority of the materials discovered during archaeological prospections in Pomeranian Voivodeship coming from the Late Bronze Age and Early Iron Age were simply described as just "late bronze/early iron". It is worth noting here that both local group of Lusatian culture (Kashubian Group) that was present in discussed area in the Late Bronze Age and Pomeranian culture from Early Iron Age, were distinguished on the basis of burial material (Podgórski 1992, 199). As long as burial sites and material coming from them is easy to distinguish in the context of Late Bronze Age and Early Iron Age divide, it is practically impossible to separate settlements this way. Even greater confusion causes the fact that during AZP surface surveys, archaeologist usually finds few pottery fragments and cannot fairly determine the function of discovered site. Above facts clearly show that archaeological prospection can only give a general idea about past societies that inhabited Pomerania in a broad period of Late Bronze Age and Early Iron Age. It does have a fundamental influence on the quality of data that are developed during AZP digitalization. Archaeologists must be aware that most of these materials are of limited usefulness for strictly scientific analyses. AZP – as a matter of fact – should be treated as a protective and cataloguing program (Czerniak 1996, 40). Admittedly, the scientific goal was one of the three main aims during the establishment of this program (Kempisty *et al.* 1981, 22), however this kind of approach without supplementary undertakings is rather unreliable (e.g. Czerniak 1996, 40-41; Matoga 1996, 51-57).

Taking above into account, is worth to consider how can researchers increase the usefulness of the digital data taken from the AZP for their use in scientific analysis. In other words – a question should be asked – is it possible to go beyond the limitations of this "conservational" program?

First and most obvious solution would be preparation of unitary standards that could be used to evaluate the chronology and cultural affiliation of the materials recorded during

the surface surveys (Czerniak 1996, 41). In case of pottery, clearly defined features like macro- and micro-morphology, ornamentation style and technology of production of ceramic body could be the main premises to determine the relative chronology. Up to now the dating was usually defined by individual archaeologist mainly on the basis of their personal experience. In this way lack of unitary standards results in more subjective evaluation of the chronology of the studied materials. On the other hand, implementation of this solution – indicating the need of conducting the verification of chronology of more than 400 000 AZP sites – would be a great challenge. But since the whole AZP program was established – as the biggest enterprise in Polish archaeology – it seems worthy to consider this possibility. Realisation of this idea without any doubts would raise the quality of AZP data from the point of view of scientific usefulness. Especially in terms of settlement studies for which surface surveys can be a very valuable source of data.

The next solution could be the removal of the less reliable records from the dataset. It can be especially useful, because many archaeologists while conducting AZP surveys do not know what kind of material they are finding. They mark them with question mark or very general description like "prehistorical pottery". The expurgation of this sort of uncertain materials from the analysed dataset will probably have positive effect on the quality of created this way database. This solution was used here (see: chapter 6), however this is not the ideal remedy, because most of the remaining records will still have wide chronology that cover the whole analysed here time scale.

There is also a third solution, based on the utilisation of fuzzy logic which beside the two main values present in classical logic – true and false – admits the existence of a number of intermediate values. On the field of archaeology, concept of fuzzy logic was used mainly with respect to predictive modelling (e.g. Jasiewicz and Hildebrandt-Radke 2009, 2096–2107; Ďuračiová *et al.* 2013, 255-268). However, in terms of this paper an attempt to use fuzzy logic due to archaeological datasets with unsure chronology are meaningful (Nakoinz 2012, 189-207). Introducing this kind of analyses may help to prevent the rejection of the most uncertain elements, what was proposed in previous paragraph. Conversely, Oliver Nakoinz in his proposition has based on the set of Iron Age fibulas, which are much better chronological markers than pottery collected during the surface survey. This shows, that fuzzy logic can rather be useful in the case of datasets with more precise chronology than this determined on the basis of ceramics.

To sum up, proposed in this chapter utilisation of archaeological materials from Late Bronze and Early Iron Age from Eastern Pomerania in order to present and analyse the process of digitization of AZP data can be considered as controversial, especially that AZP covers the whole prehistory and history of Polish lands. On the other hand, even the choice of shorter period – albeit where a significant cultural change took place – may show if there is a possibility to trace these changes in AZP data. From that point of view it may help to determine the wider processes and patterns that can be linked with the digitization of AZP. What is more – proposed here three possible solutions may also "upgrade" the level

of scientific usefulness of this archive – however only one of them will be presented in this paper. Therefore, next chapter present a detailed description of the creation of sample AZP database.

6. CREATING SAMPLE GIS DATABASE RELATED TO THE LATE BRONZE AGE AND EARLY IRON AGE MATERIALS FROM THE SELECTED PART OF POMERANIAN VOIVODESHIP

First problem that emerged during creation of database for Pomeranian Voivodeship is incomplete AZP archive (Fig. 2). Unfortunately more than 30% of AZP sheets were not done yet. Taken into account that for around 90% of Poland these sheets were already completed, percentage of undone sheets for this voivodeship is very high. It is difficult to point out unequivocally the reason behind this state. Undoubtedly responsible for this situation are many factors among which financial problems are the greatest ones. There are also researchers that instead of doing broad-based AZP prospections, prefer more limited researches. Therefore, at this point it is not possible to create comprehensive geographical database for Late Bronze Age and Early Iron Age for whole discussed region. A partial solution would be choosing certain number of representative test areas on which a more specific analysis of settlement is possible to conduct. Taking into account though high number of empty AZP sheets, final choice of test areas was greatly limited. Finally, 8 areas were chosen. The main criteria of this selection – beside of course complete AZP dataset – was to capture diverse environment of this region, something that was probably quite successfully achieved (Fig. 2). It was also important to get areas with a possibly regular shape of borders, square or rectangular. From this number of proposed test areas one of them – no. 2 – was chosen as a sample in order to present the process of digitization of this archive, while the rest is currently digitized as a part of carrying out of a wider project conducted by Author of this paper.

The chosen sample area (test area no.2 from Fig. 2) consisted of 12 sheets (no.: 11-39; 12-39; 13-39; 14-39; 11-40; 12-40; 13-40; 14-40; 11-41; 12-41; 13-41; 14-41; see: Fig. 3) and measured – along with additional margin (see below) – acreage of 485 km^2. It is located in central part of Kashubian Lake District that is the most important part of Eastpomeranian Lake District (Kondracki 2002, 74-48). In this area, the highest parts of the region are located, with some of the hills reaching over 300 m.a.s.l. with relative heights reaching 160 m. This land is characteristic because of postglacial valleys that shaped local waterway and high number of lakes. Around 500 lakes measuring at least 1 ha are located here with surface of the whole region reaching approx. 3,000 km^2. Kashubian Lake District is characterized also by diversified soil, albeit rather unsuitable for farming purposes (Kondracki 2002, 76). Within the range of the chosen sample area there were 178 archaeological sites from the discussed period that were marked on the 12 AZP sheets. Among them there were –

according to the AZP methodology – 39 burial sites (29 of which were known from archives, literature and contemporary excavations), 18 settlements, 24 settlement points, 96 settlement traces and one hoard (Fig. 3).

Further on, one of the most important problems that stand in the way of creating databases on the basis of paper AZP archives is form of the original grid that was a foundation for plotting sheets in 1:25000 scale. Currently, at NID geoportal, there is a virtual grid of AZP sectioning. It was done on the basis of analogue sectioning but is not an ideal reflection of it. The grid was done in two steps (c.f. Kołodziej 2011, 91-93; Kozioł *et. al* 2012, 139-140). First step was preparation of so called empirical AZP sectioning. For this a 1:500.000 scale map was scanned and then calibrated into PUWG 1992 (EPSG 2180) coordinate system. Then vectorization of AZP sheet intersections was done. Sectioning was created with a specially designed application, processing intersections into section data. In the second step a statistical AZP sectioning was done that was aiding in better fitting the grid to archaeological sites, by smoothing sections longitudinally and latitudinally. Here another application was used, that equalised corners of the grid (points). The main aim was approximation of lines created by points in longitudinal and latitudinal sequences to second degree polynomial curve. Coordinates were given in PUWG 1992 coordinate system (Kołodziej 2011, 91-93; Kozioł *et al.* 2012, 139-140).

Resulting grid is actually available as a WMS service on NID geoportal (Fig. 4)**.** This is now an official AZP divide. However, even though digital AZP division was done as closely as possible to analogue counterpart, effectively they differ, sometimes by a large margin. It was clearly observed during creation of AZP sectioning for Pomeranian Voivodeship on the basis of mentioned WMS service. After applying georeferenced scans of original AZP sheets on grid generated by NID, there are differences even up to 600 meters between borders (Fig. 5). This way, considerable amount of archaeological sites placed on original AZP sheets is located on different ones after placing them on NID grid. This makes site numbering problematic, because each sheet had separate numbering for sites placed on it. This problem was solved in the newest AZP instruction (National Heritage Board of Poland 2015, 6, 25) – while conducting surface survey on each area – it is required to give numbers for newly discovered sites according to the new digital AZP grid taken from NID website. In case of encountering a site that already had a number – that was given during earlier survey in the neighbouring area – it is required to consult with the local AZP coordinator in order to give a correct number. In this case it is also important to list all the changes in the previous numeration of sites and add this list to the final report from the AZP surface surveys conducted on analysed area. This is of course correct recommendation, but the problem with the wrong numbers among majority of analogue AZP archives remains and in case of full digitalization of this archive, this issue will have to be solved in a complementary way.

Another important problem is existence of possible „blank" areas that were left behind during archaeological prospection, because of lack of precise and consistent AZP sectioning

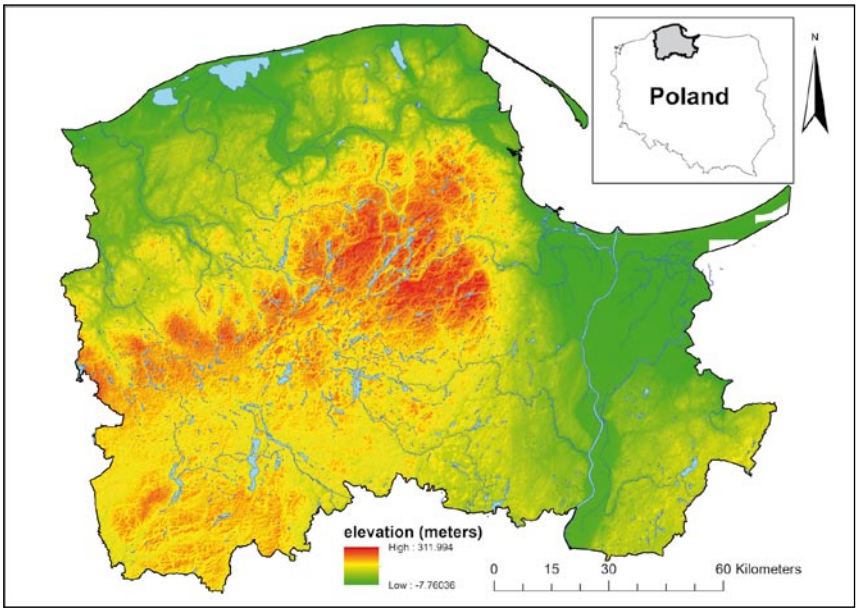

Fig. 1. Pomeranian Voivodeship with contemporary network of lakes and watercourses

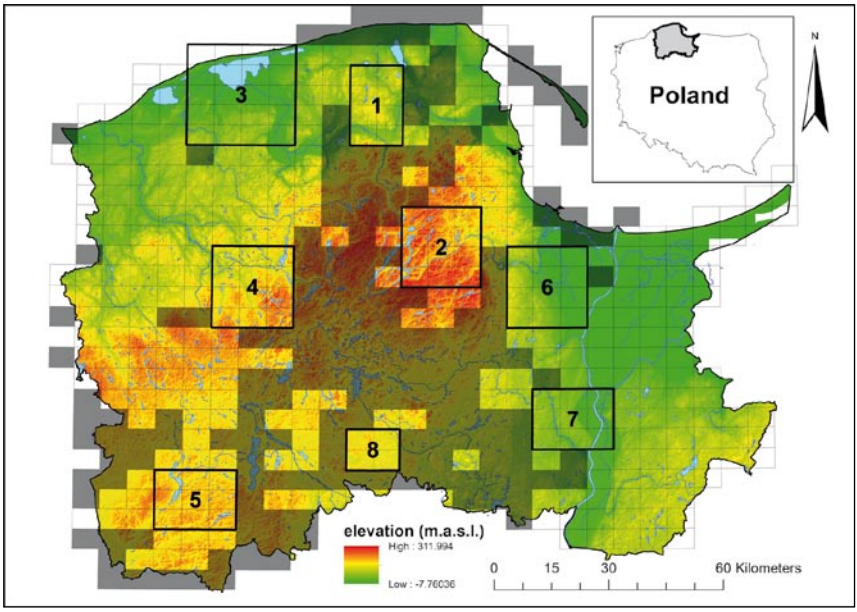

Fig. 2. AZP sectioning for Pomeranian Voivodeship together with eight selected test areas. Darker zones indicate lack of available PAR sheets

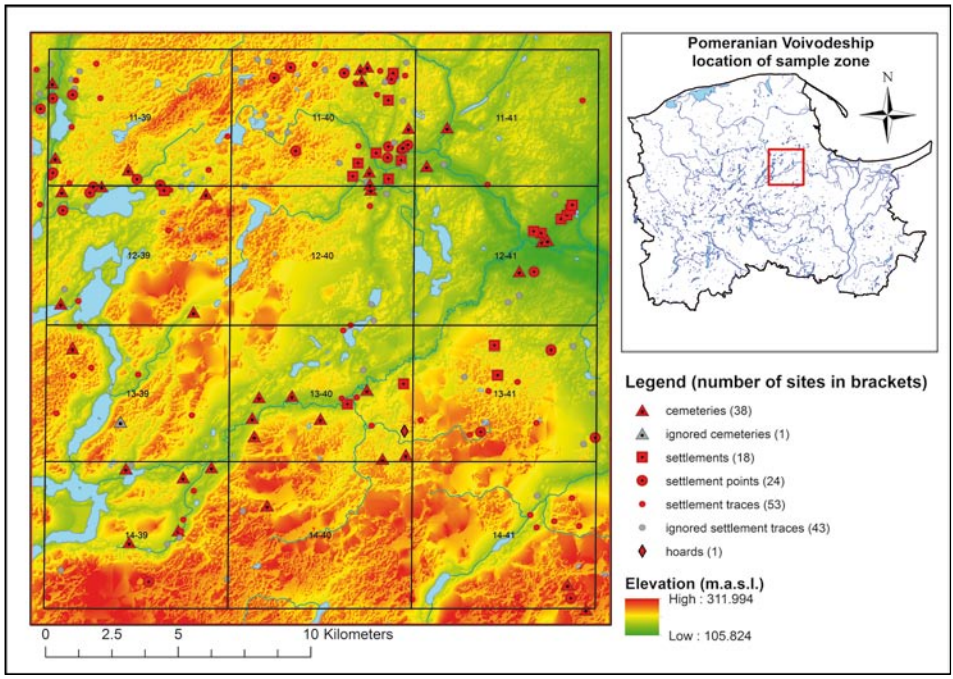

Fig. 3. Map visualisation of described in the text sample database based on AZP (test area no.2 from Fig. 2) with marked sites from the Late Bronze Age and Early Iron Age

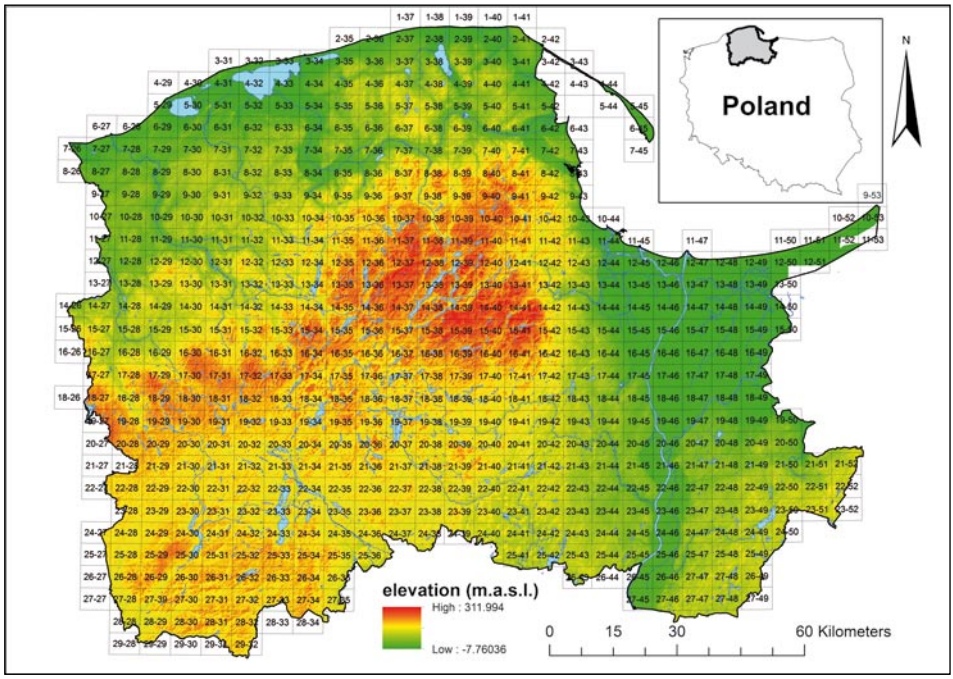

Fig. 4. AZP sectioning for Pomeranian Voivodeship with numbered sheets.
Grid was prepared on a background of WMS service available at the NID geoportal
(http://mapy.zabytek.gov.pl/AZP/service.svc/get accessed 08.05.2016)

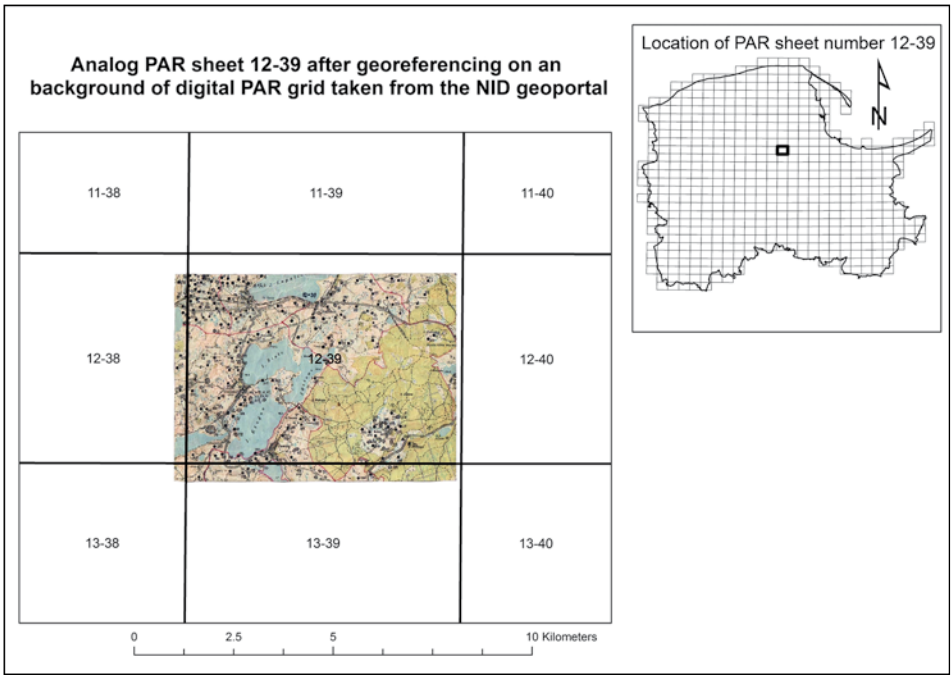

Fig. 5. Scan of analogue AZP sheet no. 12-39 georeferenced on a background of digital AZP grid taken from the NID geoportal

(Bryk and Chyła 2013, 22). This issue is also severe because the only solution here would be georeference of all existing 1:25 000 sheets and pointing out unexamined areas. It would be recommended to conduct prospection in these areas but the current situation seems to be nearly impossible due to problems with gaining funds for regular AZP prospections.

Coming back to the question of sample database – because of differences between original AZP sheets borders and those coming from sectioning generated by NID – borders in experimental database were determined in the following way. On the basis of NID grid 12 sheets were distinguished that were parts of the test, then to their borders an adequate margin of error was added, to encompass sites from particular paper AZP sheets that would otherwise be placed outside of the area. After such delimitation of the boundaries of the sample area all sites from 12 analogue AZP sheets were separately marked – with the use of ArcGIS – on the digital topographic map available online as a WMS service. The precise locations were taken from 1:10000 scale maps attached to each KESA/KEZA. The alternative may be the georeference of the 1:25000 maps of each analogue AZP sheets, but in this case results would be too imprecise. Now if we look at the margins that were previously added to the boundaries of sample zone, it is visible that there are 6 sites that lie outside of the southern and eastern border of analysed 12 AZP sheets according to the NID grid (Fig. 3). On the other hand it should be supposed that in this area – especially near the northern and eastern border – may be a number of sites that should be within the area, but in the analogue version are located on neighbouring sheets.

It is also important to mention ways in which archaeological sites should be marked on digital maps. Basing on AZP standards, processed for GIS needs, they may be marked as single points, or in case of larger sites, as polygons (Natonial Heritage Board of Poland 2014, 11-16). This problem is known in literature relating to similar, AZP-like, foreign projects (Wheatley and Sanjuan 2002, 157-158). It is obvious to say, that in case of sites where there are relatively few findings, borders are subjective at least at the time of archaeological prospection. It is then more reasonable to use point system, especially for smaller sites. Even in case of larger sites, any comments may be added to the attribute table. Of course the situation is different when there is a significant amount of discovered archaeological material or when visible in landscape forms are detected like for example barrows. In these cases utilization of polygon is advised. In the example of presented here GIS sample database, all of the sites were marked as a points, but with the usage of different attributes according to their character (Fig. 3).

Final step in preparing sample test area to the database in creation, was accepting selection criteria for chosen sites from the sample area. Here, a discretionary selection of information, that GIS allows, is crucial. In case of discussed here database for Pomerania, sites determined by only just one or two fragments of pottery found and those with uncertain chronology (or described just as a "prehistoric") were discarded. As a result, from 178 sites marked on the test area 44 of them, which is 25.88% of all the sites, did not meet criteria (ignored sites at Fig. 3) along with undetermined number of archival sites that were not located precisely.

The presence of archival sites is a very important obstacle in digitizing AZP database. Some of them were not taken under consideration in the sample database because of lack of precise location, with the exception of those sites, which were verified during the surface surveys. All in all, AZP makers are obliged to do query and place on a map sites known from previous archives and literature. In case of discussed time period – beside numerous articles and monographs – several catalogues were published, describing Late Bronze and Early Iron Age burial sites. There are also catalogues gathering particular forms of artefacts, in this case mainly face urns. Indisputable advantage of these publications is quite precise chronology of most of the sites mentioned there. On the other hand, in most of the cases – especially with reference to the catalogues – there is no precise information about their location, or this data is often out of date and useless. Admittedly these sites are placed on AZP sheets, but with accuracy to the nearest village or city. It would be then very difficult to use sites that have precise dating but very general location in GIS settlement analyses. Margin of mistake may be even up to several kilometres and that is unacceptable. The only solution in which those sites may be taken into account is a macro scale settlement analysis concerning whole Eastern Pomerania or Pomeranian Voivodeship. It may help to demonstrate dynamics of settlement changes in more accurate periods than just bipolar divide to Late Bronze Age and Early Iron Age, by fragmenting those periods to *circa* 100 years long phases. A constriction here will be a wider territorial context of the region, without possibility to delve deeper into particular microregions. In other words, maps in smaller scale should be prepared for these kinds of analyses.

To summarise, at the end a sample spatial database of archaeological resources linked with the end of Bronze and beginning of Iron Age was achieved with location of almost 180 sites (Fig. 3). Most of them are known only because of conducting surface survey as a part of AZP project. Their value from the scientific point of view is limited, and as it was mentioned before, a proper selection in required. According to data, 44 of them were indicated as unreliable (ignored sites) because of established earlier criteria linked with amount of recorded material and credibility in determining their chronology. On the other hand, 29 sites from this dataset are known from archives (and were verified during AZP) or current excavations, which means that our knowledge about them is much more comprehensive, in contrary to the sites known only from the surface surveys. Unfortunately incompleteness combined with various level of execution of AZP as well as problems specific for discussed period (very typical pottery with broad chronological range of use), plus imprecise location of archival sites and small number of excavated settlements, cause many problems in creating a successful archaeological sample database for Pomeranian Voivodeship.

7. SUMMARY

Creating a sample database with GIS tools for Late Bronze Age and Early Iron Age in the area of Pomeranian Voivodeship gives knowledge about numerous problems that one has to face while attempting to digitalize AZP archives in Poland. What is more, this particular area is especially surprising due to large number of empty sheets. The quality of already prepared AZP sheets is also varying.

Furthermore, analogue maps with Polish archaeological heritage, in confrontation with attempts to digitalize them, revealed numerous methodical deficiencies in the main AZP assumptions. There is no unitary sectioning grid that can be easily moved to a virtual state. Current grid, generated by NID is also problematic, but at least to some part is coherent with paper version of AZP map. Still, there is the question of "empty" areas that were never prospected. Another problem is insufficient level quality of AZP research. Sites have general chronology and unclear functionality. All of these problems lessen the quality of further analyses done on the basis of digitalized AZP archive. Consequently, as this paper shows, the utilization of AZP database into scientific purposes should be conducted in a careful way. On this field additional procedures – like inter alia the ones described in chapter 5 and 6 – should be introduced in order to improve the quality of data.

On the other hand, there are also clearly positive changes. Activity of NID is a proof that more wider attempts in order to digitize AZP – together with establishing the spatial information infrastructure regarding the Polish monuments (INSPIRE directive) – are being made. It should not be forgotten that apart from scientific aims, this program has a crucial meaning for Polish conservation service. Even more, making a GIS based database will create possibilities to integrate with other digital data, like aerial and satellite photography, geophysical research or LIDAR. It will be also easier to transfer data between other analogical European structures (Wheatley and Sanjuan 2002, 161-163). Such integration may have a positive influence on the quality of AZP data and in consequence may be a basis for other worthy databases for restorative and scientific purposes. The aim of creating a modern AZP database should be to achieve a level similar to the European countries that have the largest achievements on this field, like i.a. mentioned England and Sweden.

During realization of this project an educational license of ArGIS v.10.3 was used. All maps presented here were made in PUWG 1992 coordinate system.

References

Adamik J. 2012. *Idea skrzyni kamiennej jako formy grobu na terenie ziem polskich w późnej epoce brązu i wczesnej epoce żelaza*. Rzeszów: Fundacja Rzeszowskiego Ośrodka Archeologicznego.

Amores F., García L., Hurtado V., Márquez H. and Rodríguez-Bobada C. 2000. An exploratory GIS approach to Andalusian Archaeological Heritage Records. In K. Lockyear, T. J. T. Sly and V. Mihăilescu-Bîrliba (eds.), *CAA 1996 Computer Applications and Quantitive Methods in Archaeology* (= *British Archaeological Reports. International Series* 845). Oxford: Archaeopress, 101-114.

Bowdler R. 2009. How is England's Archaeological Heritage Managed? In P. A. C. Schut (ed.), *Listing Archaeological Sites, Protecting the Historical Landscape* (= *EAC occasional paper* 3). Brussels: Europae Archaeologiae Consilium, 101-108.

Bryk M. and Chyla J. M. 2013. Zastosowanie technologii GIS w lokalizacji stanowisk archeologicznych podczas prospekcji terenowej. *Roczniki Geomatyki* 63(1), 19-29.

Cacho F. S. and Torres D. V. 2009. From the archaeological heritage inventoriesto the historical landscapes of Spain. In P. A. C. Schut (ed.), *Listing Archaeological Sites, Protecting the Historical Landscape* (= *EAC occasional papers* 3). Brussels: Europae Archaeologiae Consilium, 29-39.

Chochorowski J. 1999: Żelazny oręż barbażyńców – wczesne epoka żelaza poza zasięgiem cywilizacji klasycznych. In J. K. Kozłowski (ed.), *Encyklopedia historyczna Świata*. Kraków: Opres, 304-395.

Czerniak L. 1996. Archeologiczne Zdjęcie Polski – co dalej? In D. Jaskanis (ed.), *Archeologiczne Zdjęcia Polski – metoda i doświadczenia. Próba oceny*. Warszawa: Ośrodek Dokumentacji Zabytków – Wydawnictwa, 39-45.

Czopek S. 1992. Uwagi o chronologii względnej i periodyzacji materiałów z okresu halsztackiego i starszego okresu przedrzymskiego w świetle analizy ceramiki kultury pomorskiej. In S. Czopek (ed.) *Ziemie Polskie we wczesnej epoce żelaza i ich powiązania z innymi terenami*. Rzeszów: Muzeum Okręgowe w Rzeszowie, 81-89.

Dąbrowski J. 1979. Kultura łużycka na Pomorzu. In J. Dąbrowski and Z. Rajewski (eds.), *Od środkowej epoki brązu do środkowego okresu lateńskiego* (= *Prahistoria Ziem Polskich* 4). Wrocław: Ossolineum, 74-80.

Dąbrowski J. 2009. *Polska przed trzema tysiącami lat*. Warszawa: Trio.

Ďuračiová R., Lieskovský T., Stopková E. and Kročková, K. 2013. The benefit of fuzzy logic to protection of cultural and historical heritage. In I. Ivan, P. Longley, J. Horák, D. Fritsch, J. Cheshire and T. Inspektor (eds.) *GIS Ostrava 2013 – Geoinformatics for City Transformations*. Ostrava: VŠB – Technical University of Ostrava, 255-268.

Dzięgielewski K. 2010. Expansion of the Pomeranian Culture in Poland during the Early Iron Age: Remarks on the Mechanism and Possible Causes. In K. Dzięgielewski, M. S. Przybyła, and A. Gawlik (eds.), *Migration in Bronze and Early Iron Age Europe*. Kraków: Księgarnia Akademicka, 173-196.

Fudziński M., Fudziński P., Krzysiak A., Cymek L. and Rożnowski F. 2007. Faza wielkowiejska a kultura łużycka i kultura pomorska – nowa próba ustalenia wzajemnych relacji. In M. Fudziński and H. Paner (eds.), *Aktualne Problemy kultury łużyckiej na Pomorzu*. Gdańsk: Muzeum Archeologiczne, 47-59.

Gardawski A. and Woźniak Z. 1979. Podstawy chronologii. In J. Dąbrowski and Z. Rajewski (eds.), *Od środkowej epoki brązu do środkowego okresu lateńskiego* (= *Prahistoria Ziem Polskich* 4). Wrocław: Ossolineum, 22-30.

Gawrysiak L. and Reder J. 2011. Zastosowanie GIS do opracowania bazy danych archeologicznych i analiz sieci osadniczych na przykładzie dorzecza Wolicy (Wyżyna Lubelska). In R. Zapłata (ed.), *Digitalizacja Dziedzictwa Archeologicznego. Wybrane Zagadnienia*. Lublin: Instytut Archeologii WNHiS UKSW, 132-142.

Janiak R. 2014. *Kurhany z młodszych okresów epoki brązu i wczesnej epoki żelaza na Pojezierzu Kaszubskim*. *Łódź*: Instytut Archeologii Uniwersytetu Łódzkiego.

Jasiewicz J. and Hildebrandt-Radke I. 2009. Using multivariate statistics and fuzzy logic system to analyse settlement preferences in lowland areas of the temperate zone: an example from the Polish Lowlands. *Journal of Archaeological Science* 36 (2009), 2096–2107.

Jaskanis D. 1996. Próba oceny metody Archeologicznego Zdjęcia Polski na podstawie doświadczeń ogólnokrajowego koordynatora. In D. Jaskanis (ed.), *Archeologiczne Zdjęcia Polski – metoda I doświadczenia. Próba oceny*. Warszawa: Ośrodek Dokumentacji Zabytków – Wydawnictwa, 9-38.

Jaskanis D. (ed.) 1996. *Archeologiczne Zdjęcia Polski – metoda i doświadczenia. Próba oceny*. Warszawa: Ośrodek Dokumentacji Zabytków – Wydawnictwa.

Kempisty A., Kruk J., Kurnatowski S., Mazurowski R, Okulicz J., Rysiewska T. and Woyda S. 1981. Projekt założeń metodyczno-organizacyjnych Archeologicznego Zdjęcia Ziem Polskich. In M. Konopka (ed.), *Archeologiczne Zdjęcie Polski. Archaeological Picture of Poland*. Warszawa: Ośrodek Dokumentacji Zabytków, 22-27.

Kmieciński J. (ed.) 1989. *Pradzieje Ziem Polskich* 1. Warszawa – Łódź: Państwowe Wydawnictwo Naukowe.

Kneisel J. 2012. *Anthropomorphe Gefäße in Nord und Mitteleuropa während der Bronze- und Eisenzeit. Studien zu den Gesichtsurnen – Kontaktzonen, Chronologie und sozialer Kontext* (= *Studien zur Archäologie in Ostmitteleuropa* 7). Bonn: Rudolf Habelt GmbH.

Kołodziej A. 2011. Bazy danych GIS o zabytkach nieruchomych i archeologicznych jako element infrastruktury informacji przestrzennej w Polsce: stan prac, aktualne problemy i wyzwania w procesie wdrażania dyrektywy INSPIRE. *Roczniki Geomatyki* 47 (3), 83-94.

Kołodziej A. 2012. Wykorzystanie danych referencyjnych oraz usług danych przestrzennych w projektach informatycznych dotyczących popularyzacji dziedzictwa narodowego Polski. *Roczniki Geomatyki* 54 (4), 119-132.

Kondracki J. 2002. *Geografia Regionalna Polski*. Warszawa: Wydawnictwo Naukowe PWN.

Konopka M. 1981. Wprowadzenie. In M. Konopka (ed.), A*rcheologiczne Zdjęcie Polski. Archaeological Picture of Poland*. Warszawa: Ośrodek Dokumentacji Zabytków, 6-7.

Konopka M. (ed.) 1981. *Archeologiczne Zdjęcie Polski. Archaeological Picture of Poland*. Warszawa: Ośrodek Dokumentacji Zabytków.

Kozioł K., Czerniec J., Bęgziak B. and Orlikowski R. 2012. Archeologiczne Zdjęcie Polski jako element infrastruktury informacji przestrzennej. *Roczniki Geomatyki* 54(4), 133-143.

Kruk J. 1975. Przyczynek do metody badań poszukiwawczych. *Sprawozdania Archeologiczne* 27, 247-254.

Kruk J. 1981. Kilka uwag o znaczeniu poszukiwań powierzchniowych w badaniach nad geografia osadnictwa pradziejowego. In M. Konopka (ed.), *Archeologiczne Zdjęcie Polski. Archaeological Picture of Poland*. Warszawa: Ośrodek Dokumentacji Zabytków, 115-120.

Kruk J. 1995. Poszukiwania powierzchniowe w badaniach nad geografią osadnictwa pra- i wczesnodziejowego. *Sprawozdania Archeologiczne* 47, 265-268.

Larsen C. U. (ed.) 1992. *Sites and Monuments: National Archaeological Records*. København: The National Museum of Denmark.

Lbova L. V. 2014. Russia: Management of Archaeological Heritage. In C. Smith (ed.), *Encyclopedia of Global Archaeology*. New Your, Heidelberg, Dordrecht, London: Springer, 6399-6405.

Lean G. 2015. *Does our history have a future in the hands of the English Heritage Trust?* [online] available from: http://www.telegraph.co.uk/news/earth/environment/conservation/11441254/Does-our-history-have-a-future-in-the-hands-of-the-English-Heritage-Trust.html [accessed: 08.05.2016].

Łuka L.J. 1983. Kształtowanie się osadnictwa na Pomorzu Wschodnim na przełomie epoki brązu i żelaza. *Pomorania Antiqua* 11, 7-30.

Malinowski T. 1990. Podstawy wyróżnienia kultury pomorskiej. In T. Malinowski (ed.), *Problemy kultury łużyckiej na Pomorzu*. Słupsk: Wyższa Szkoła Pedagogiczna, 323-335.

Matoga A. 1996. Archeologiczne Zdjęcie Polski – połowa drogi. In D. Jaskanis (ed.) *Archeologiczne Zdjęcia Polski – metoda i doświadczenia. Próba oceny*. Warszawa: Ośrodek Dokumentacji Zabytków – Wydawnictwa, 47-61.

Mazurowski R. 1974. Możliwości poznawcze badań powierzchniowych. *Wiadomości Archeologiczne* 39(1), 32-39.

Mihai D. and Angelescu M. 2009. A Centrally Managed GIS System for Protection of Romanian Archaeological Sites and Historic Monuments. In P. A. C. Schut (ed.), *Listing Archaeological Sites, Protecting the Historical Landscape* (= *EAC occasional paper* 3). Brussels: Europae Archaeologiae Consilium, 109-114.

Ministry of Culture and National Heritage. 2014. *Krajowy Program Ochrony Zabytków i Opieki nad Zabytkami na lata 2014–2017* [online], available from: http://bip.mkidn.gov.pl/media/download_gallery/20140818Krajowy_Program_Ochrony_Zabytkow_i_Opieki_nad_Zaby.pdf [accessed 08.05.2016].

Nakoinz O. 2012. Datierungskodierung und chronologische Inferenz – Techniken zum Umgang mit unscharfen chronologischen Informationen. *Praehistorische Zeitschrift* 87 (1), 189-207.

National Heritage Board of Poland. 2012. *Archeologiczne Zdjęcie Polski. Instrukcja opracowania Karty Ewidencyjnej Zabytku Archeologicznego* [online], available from: http://www.nid.

pl/pl/Dla_specjalistow/Badania_i_dokumentacja/zabytki-archeologiczne/instrukcje-wytyczne-zalecenia/Instrukcja%20AZP%202012 [accessed 08.05.2016].

National Heritage Board of Poland. 2015. *Archeologiczne Zdjęcie Polski. Instrukcja sporządzania dokumentacji badań powierzchniowych oraz wypełniania Karty Ewidencyjnej Zabytku Archeologicznego* [online], available from: http://www.mkidn.gov.pl/media/po2016/dokumenty/20151026_Instrukcja_AZP_2015.pdf [accessed 08.05.2016].

Niedziółka K. 2013. Przemiany kulturowe na Pomorzu Wschodnim we wczesnej epoce żelaza. Wybrane zagadnienia badawcze. *Gdańskie Studia Archeologiczne* 3, 193-210.

Norman P. and Sohlenius R. 2009. ASIS – more than a register of ancient monuments. In P. A. C. Schut (ed.), *Listing Archaeological Sites, Protecting the Historical Landscape* (= *EAC occasional paper* 3). Brussels: Europae Archaeologiae Consilium, 83-86.

Podgórski J. T. 1992. Fazy cmentarzysk kultury łużyckiej i pomorskiej na Pomorzu Wschodnim. In S. Czopek (ed.), *Ziemie Polskie we wczesnej epoce żelaza i ich powiązania z innymi terenami*. Rzeszów: Muzeum Okręgowe, 199-214.

Prinke A. 2002. Szansa na komputerową mapę archeologiczną Wielkopolski: program mAZePa – koncepcja i stan zaawansowania. *Wielkopolski Biuletyn Konserwatorski* 1, 158-167.

Prinke A. 2009. Seven years after Seville: Recent progress in managing the archaeological heritage in Poland In P. A. C. Schut (ed.), *Listing Archaeological Sites, Protecting the Historical Landscape* (= *EAC occasional paper* 3). Brussels: Europae Archaeologiae Consilium, 71-76.

Saprykina I. 2009. Safeguarding Russia's archaeological heritage – the current situation and proposed system changes. In P. A. C. Schut (ed.), *Listing Archaeological Sites, Protecting the Historical Landscape* (= *EAC occasional paper* 3). Brussels: Europae Archaeologiae Consilium, 99-100.

Schut P. A. C. (ed.), *Listing Archaeological Sites, Protecting the Historical Landscape* (= *EAC occasional paper* 3). Brussels: Europae Archaeologiae Consilium.

Skaldawski B., Chabiera A. and Lisiecki A. 2011. System ochrony zabytków w wybranych krajach europejskich. *Kurier Konserwatorski* 11, 5-33.

Trachsel M. 2004. *Untersuchungen zur relativen und absoluten Chronologie der Hallstattzeit*. Bonn: Dr Rudolf Habelt GmbH.

de Wit A. and Ziengs L. 2009. Listing and protection of archaeological sites in Europe – summary. In P. A. C. Schut (ed.), *Listing Archaeological Sites, Protecting the Historical Landscape* (= *EAC occasional paper* 3). Brussels: Europae Archaeologiae Consilium, 139-167.

Wheatley D. W. and García-Sanjuán L. 2002. Managing the spatial dimension of the European archaeological resource. Trends and perspectives. In D. W. Wheatley and L. García-Sanjuán (eds.), *Mapping the future of the past: managing the spatial dimension of the European archaeological resource*. Sevilla: Universidad de Sevilla, 151-166.

Wheatley D. W. and García-Sanjuán L. (eds.) 2002. *Mapping the future of the past: managing the spatial dimension of the European archaeological resource*. Sevilla: Universidad de Sevilla.

Wollák K. 2009. Listing – precondition of protection? In P. A. C. Schut (ed.), *Listing Archaeological Sites, Protecting the Historical Landscape* (= *EAC occasional paper* 3). Brussels: Europae Archaeologiae Consilium, 53-61.

Woyda S. 1981. Archeologiczne Zdjęcie Terenu – Ogólne założenie metody w oparciu o doświadczenia mazowieckie. In M. Konopka (ed.), *Archeologiczne Zdjęcie Polski. Archaeological Picture of Poland*. Warszawa: Ośrodek Dokumentacji Zabytków, 11-21.

Woźniak Z. 2010. Kontakty mieszkańców ziem polskich ze światem celtyckim u schyłku okresu halsztackiego i we wczesnym okresie lateńskim. *Przegląd Archeologiczny* 58, 39-104.