OBJECT AND EVENT RECONSTRUCTION (WW II) WITH GIS

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KEY WORDS: GIS, Cartography, Archeology, Military Historical Reconstruction, Analysis, Archiving

ABSTRACT:

Now GIS is increasingly becomes popular in humane disciplines. In our research we use it to support military historical reconstruction. We deal with the Attila lines, which was a defence line around Budapest in World War II. Our goal was a particular and dependable reconstruction, which contains environmental, object and, event parts. To complete this task we had to collect and manage a lot of variable-quality archive data. This information came from different sources: libraries, archives, archive maps and arial photographs, field measrements, and personal reminiscences. We can manage this information in a standard system with GIS. This database can be used as a reference system to support further research and to identify new parts of the defence line. Using the attributes we can make queries and various reviews. The database is usable as a digital data archive, too. Our next research goal is to follow the search of the Attila lines and other defence lines and to present them to the wider scientific and public audiance.

1. INTRODUCTION

In areas where map-based data collection, data handling and service are in use, it is indispensable to use this modern solution. Beside the conventional technical applications, GIS became accepted in other disciplines too. The humane disciplines are not exceptions to this concept. Our research emerged from this last area too. In this study we tried to apply GIS in military historical reconstruction. Along this type of reconstruction we had to manage data from archive maps and airial photographs, written documents and verbal information. Beside the archive data it was necessary to search the present state of the fortifications when it is possible. A complete reconstruction has to contian all important infromation about the fortification. In searching Hungarian WW II objects it is seem almost impossible in practise because of the large number of incomplete data. The archive data needed to be handled in special manner. In contrast to the primary data sources (field surveys, GPS, photogrammetry), archive data sources often lacks precise parameters. This condition greatly influences when the reconstruction results in a large scale. The attributes of quality (precision, reliability and fullness) can vary widely. Additionally it is not enough to deal with fortifications only. We had to search the environment and the events too. Without considering those last two parts, the reconstruction is not of much use (Juhász, 2004).

Our aim was to create a dependable and particular map-based military historical reconstruction. The result can make up the lost wartime documents and maps. This GIS database can support the scientific and public enquirers. Because of those above mentioned facts, this task is not an easy one. The researchers had to deal with several kinds of information. GIS offers such a unique solution to this problem like no other. The most important advantage of GIS is that we can manage these different types of data together in one system. So the various data sources and the different projection systems don't cause difficulty during processing. In this system we can easily match the archive data with our new field measurements. The other advantage of GIS is that besides handling the geometrical information it can also store attributes. The objects attributes are stored in table form. The user can create various queries and reviews using the complete data base, classify and visualize the objects on the grounds of selected attributes (Detrekői, 2002).

2. THE RECONSTRUCTION PROCESS

2.1 GIS in military historical reconstruction

Military historical reconstruction is a special process. We had to manage a lot of information with different precision and reliability. Naturally the researchers created military reconstructions before the emergance and availability of computers. The bases of these projects in that time maps and analog registrations were similar to present day, but data handling and carrying out variuos analysis were much more difficult. It was an interesting example when the french carthographer Berthier tried to reconstruct the Yorktown battle (US Revolutionary War, 1781) by superposition of analog map layers. We can conclude that data of military historical reconstruction principally spatial data, so we can use GIS to manage this data. The reconstruction will be acceptable only in the case that fortification objects and military events are correctly presented in space and time. To reach a precise and reliable result we have to manage this information and knowledge in a uniform system, where GIS is perfect, for this task. (Detrekői, 2002) This kind of uniform data management allows for excluding contradictions and the most unreliable data. Unfortunately these mistakes happened several times in our project. We divided this study to three parts according to the reconstruction task. Each part relies on the previous one.

1. The first step is the environmental reconstruction.
2. The second step is object reconstruction.
3. The last step is the event reconstruction.

We had to create the GIS data system considering different viewpoints and demands. Researchers and ordinary enquirers are the potential users. Hereafter let's see the most important factors in creating a military historical GIS database.

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The first and probably the most important factor we must mention is uniform data management. We have to take into consideration two points in creating this unifom system. First we have to use a geographical area frame which can be a county or a country or even a continent. Second we have to work within a unified geometry system. Our project's frame is the Carpathians, and the most suitable coordinate-system at our disposal is the Hungarian EOV coordinate-system.

Beside the geometrical presentation of the environment, the reconstructed objects and the events we created an attribute-database which contains the environmental, military and event object's properties. It means that we have to collect several kinds of attributes which is not an easy task.

In this kind of GIS application we need to represent many documents that are not needed in conventional GIS applications (local-government, public works). These documents have an important function in military historical reconstruction. We can "link" them to the military objects so they are indispensable in a complete project. These documents can be text (for example the personal reminiscences), photos, videos (outside records), CAD files (object sketches). We summarized this information in a document data base. Besides the geometrical and attribute data bases, this "document data base" is the third part of our system. On the other hand, there is another account to collect this type of documents. This way we can create digital document archives.

The sample database obtained can be used as a reference system. Therefore it must contain the search period's typical fortification objects. The goal of this function is that we can define the type and the period of a new identified military object. In the last few years we studied a couple of foreign samples, to promote military object search and identification. The foreign WW II fortifications remain in much better state compared to the Hungarian ones. On the whole we can use the digital data base as a registry to study the development of fortifications.

The sample database constitutes a suitable base for further research. So carrying out careful research and implementing sound methods are very necessary steps.

The military historical reconstruction data base is suitable for all types of users. The first one is the ordinary enquirers of this theme. This is the larger group. The second one includes researchers of WW II. We do not have to separate the two groups. If our system can serve the researchers then the enquirers will be pleased, too.

2.2 The environmental reconstruction

The first step in our project is environmental reconstruction. At first glance we may think that this is unnecessary step because the most wanted goals are the military objects and events. However, the presentation of the period environment is necessary in most of the cases, especially in military history. The geographical environment and the terrain always have an important role in strategy. Besides the strategical viewpoint there are more important reasons for reconstructing the environment. This component creates the frame of the objects and events. The user can easily get orientation too. The attributes of the environmental objects (size, shape, form) can signal that there was a fortification on the searched area, so we can use the vegetation as an indicator. Further on, in event reconstruction we also need to represent the environment, because in most of the cases there are only few data sources and the information is associated with the environment. In practice this part of the project means that we create a digital base map.

2.3 The military object reconstruction

In this component we had to reconstruct the part of the searched fortification. In our case this was a defence line called the Attila lines. This was the biggest and the most interesting component, because the result was obtained through complex search work. To reach our goal we had to carry out varied and diversified tasks like pre-collection of data, object identification and insert this into the GIS system. Unlike the environmental objects here we searched not only the geometrical data but the attributes too. The common data sources also had archive sources. Before direct research (interpretation of the archive aerial photographs and maps) it was helpful to study the geometrical data and the attributes of the searched military objects. This knowledge was from different disciplines such as history, geography, military history and art, archaeology, warfare knowledge, cartography and civil engineering. The most important questions we had to answer was what to search and where. Along with previous researching we collected many publications about the Attila lines: books; archives; articles; etc. We also studied the fortification regulations of the fighting armies. In the German, Russian and Hungarian regulations we found exact information about the fortification objects (Figure 1). When we finished the previous data collection we began to know the size of the defence objects and the whole Attila lines, so we decided the scale of the data collection and the data density of the GIS project.

After the previously mentioned data collection map and aerial photograph interpretation was carried out. Maps at scale of 1:25000 and 1:10000 were used to locate the big objects like anti-tank dikes, flaks and areas which were attacked with heavy artillery fire. The large number of aerial photographs was the base for search and object location. The range of photograph scales used can be seen in Table 1. We used aerial photographs that were taken in the 1950s. The photographs have larger information content than the maps. A skilful photointerpretator specialist can locate the fire-trenches and rifle placements. The following factors influence the geometrical identification in the case that parts of the fortification are located on the surface:

- object size;
- object visibility (colour, contrast);
- object limitation possibilities (shading, cultivation, listing);
- the geometrical attributes of the photograph (pixel size)

Difficulties are encountered cases where military objects are located under the surface. However in this case we can also interpretate the covered fortification elements like anti-tank dikes from the photos, because the soil quality is changed along these covered dikes. These are

- soil drainage and waterkeeping;
- soil temperature changes above covered walls and dikes;
- in case of uncovered terrain, the soil colour denotes the differences;
- in case of vegetation covered (specially homogeneous vegetation) terrain, the rich greenery signals the dikes.

In this case we used vegetation as indicator.

Section	Scale	Useful Piece	Typical Settlements
L-34-3-C-d	1:20000	12	ALSÓGÖD
L-34-15-A-b	1:20000	9	DUNAKESZI, FÓT
L-34-15-A-d	1:20000	7	K.MEGYER,
L-34-15-B-a	1:20000	7	GÖDÖLLŐ, SZADA
L-34-15-B-b	1:20000	8	BAG, ASZÓD
L-34-15-B-c	1:20000	7	KISTARCSA, CSÖMÖR
L-34-15-B-d	1:20000	7	VALKÓ, ISASZEG
L-34-15-C-b	1:20000	7	PESTSZENTERZSÉBET
L-34-15-C-c	1:10000 1:6000	3	DUNAHARASZTI
L-34-15-C-d	1:20000	7	SOROKSÁR
L-34-15-D-a	1:20000	7	GYÖMRŐ
L-34-15-D-b	1:20000	7	MAGLÓD, PÉCEL
L-34-15-D-c	1:20000	7	VECSÉS, ÜLLŐ
L-34-27-A-a	1:10000	4	TAKSONY
L-34-27-A-b	1:20000	4	ÓCSA

Table 1. Archive aerial photographs from the Attila lines region

The final step of the object reconstruction, is the field data collection.This included in-site field measurements and other ground-truth data collection. The most common method we used was measuring with a simple GPS navigation receiver. The accuracy of these receivers is suitable for the precision expectation of our datacollection. The field data collection had two basic goals. At first we can verify the information coming from other data sources, second we can find new fortification objects or parts. Beside the above mentioned goals we can trace the present-day status of such objects. It is enough to measure the main points of the located object, and after a coordinate transformation we can fit it to our uniform system.

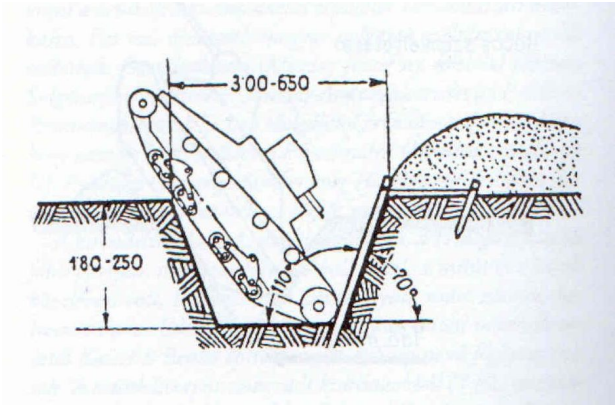

Figure 1. Anti-tank dike according to the Hungarian fortification regulation (Honvédségi Közlöny, 1941)

2.4 The event reconstruction

After a successful environmental and fortification object reconstruction we can proceed to reconstruct military events. While the object reconstruction is possible without environmental reconstruction, to present the events we always needed the previous two steps. We have to match the military movements and the residence of the corps in the environment and fortification reconstruction elements. The event presentation accuracy depends on two factors. Firstly, when the event happened and secondly the kind of data sources that can be used. These two factors are naturally related. We can notice that when we move further and further back in time the amount and value of data available becomes lower. The three major data collection possibilities are the various maps (thematic maps, military operational maps), the written documents and the personal reminiscences. There are some important considerations we had to meet during data collection and the presentation. Here personal reminiscences have an important role in this reconstruction elementt, but in most cases we can not verify such information, which, in many cases, can provide conflicting facts. The solution to this problem is to present all the alternatives or to create a reliability scale. To represent the events in GIS we can use levels (as thematic maps) or link animations.

3. RECONSTRUCTION OF THE ATTILA LINES

3.1 Construction of the Attila lines

After the withdrawal of Rumania in 1944 Hungary remained the only allied power of Nazi Germany. The main goal of the Red Army fighting units in Hungary was to conquer the country and especially the capital (Budapest) as soon as possible, and to force the Hungarians to abandon the Germans like all the other axis powers had done. Budapest had a strategic importance. It was the focus of transport systems (road network, railway lines), and the majority of the Hungarian industry was concentrated here. The Red Army wanted control, while the Germans wanted to defend it. Therefore the German staff of the South Army Group made a plan of a fortification system to protect Budapest, and the Transdanubium. A part of this defence system was situated around Pest, and called the “Attila lines”, after the famous Hun ruler.

On the 22nd of September 1944 Hans Freissner the general-commander of the South Army Group ordered the start of construction of this defence system around Pest. It consisted of three lines, each lines wings ending at the river Danube. The form of the lines was like a horseshoe. The names of the three lines were: Attila I; Attila II; and Attila III. Attila III is situated near the border of Budapest while the Attila I is quite far from the city.

Many units took part in the construction of these lines. For example 3000 troop of the Slovakian Engineering Corps, some Jewish population of Budapest forced labour troops and the civilians of the territory. Altogether more than 28.000 troops and civilians worked on these lines.

The central part of the defence system was anti-tank dikes. These were 5 to 6 m wide and sometime more than 10 m deep. They were dug by hand. These dikes were too wide and too deep to get across with a tank without any help, so they had to stop and the anti-tank guns could destroy them at that moment. But the Soviet engineering infantry could build bridges over the dikes. Hence infantry troops had to protect the anti-tank dikes and they needed fortified positions like machine-gun pits, fire-trenches, bunkers and other fortified objects. These were additional elements of the defence system.

3.2 The Red Army broke through Attila lines

The Red Army reached the Attile I line at the beginning of November 1944. The first attempt was successful and their units could break through the first line around Soroksár and Vecsés villages. But the additional attacks were failures. Later the Germans could recapture their original positions of Attila I. Similar heavy fighting took place between Isaszeg and Maglód villages. At last, Malinovszkij the commander of the 2nd Ukranian Front stopped the offensive (Tóth, 1975).

On 24th of December Malinovszkij ordered again an offensive to break through the Attila lines, and capture Pest within 3 days. The offensive was again a failure. Only the third attempt was successful after the German and Hungarian units were encircled in Budapest by the 3rd Ukranian Front. The Soviet troops broke through the Attila III line on 1st January 1945. Two weeks later the Germans evacuated Pest (Ungváry, 2001).

3.3 The contemporary sources of Attila lines

There are not any written sources on the Attila lines from the war period. All the plans, documents were destroyed in the war. The war diaries and the autobiographies of the commanders only mention the existence of the line but we can not find any specific information on it. The only description on the line that remains the following:

"The Attila lines were build after 22nd September in 1944. The wings of the lines ended at river Danube, and it connected the Carol line and the Margaret line. It consisted three defence belts. The Attila I. line is situated: Dunaharaszti – Vecsés – Ecser – Maglód – Valkó – Gödöllő – Szada – Veresegyház – Csomád – Alsógöd, The Attila II. line is situated: Soroksár – Sokorkáspéteri – Pesztszentimre – Pécel – Isaszeg – Kerepes – Mogyoród – Fót – Dunakeszi, the Attila III. line is situated: Csepel – Pestszenterzsébet – Pestszentlőrinc – Rákoskeresztúr – Rákoscsaba – Cinkota – Rákosszentmihály – Rákospalota – Újpest. In Buda there have not been any part of the Attila lines. The Attila lines have not completed until the Red Army arrived, because of the lack of manpower, ammunition and time."(Ungváry, 2001)

It was the only description for historians. Many books and essays dealt with the battle of Budapest and all of these books mentioned the "Attila lines". There have been some maps created above, the "Attila lines" by historians, but all maps delineated different location of the line.

3.4 The sources of the reconstruction of Attila lines

There are no surviving war maps, sketches or reports on the "Attila lines". Nevertheless we wanted to make a detailed description of the defence system. So we needed some kind of source that is measurable and gives an objective view on the situation of the defence objects (anti-tank dikes, bunkers etc.). The only available sources that fulfil our requirements were the aerial photographs. Unfortunately the reconnaissance photographs that were taken by the Hungarians are not available in Hungary because the Red Army captured them and carried them to the Soviet Union. The Germans also took many photographs, but these were captured by the US Army and are now in Washington D.C. In Hungary, the earliest aerial photographs available in Hungarian archives were taken in the period 1950-1952.

In our research we used these photographs. The scale of the photographs is diverse (some are of 1:5,000, but the majority are around 1:25,000 and 1:30,000). The quality of the photographs also varies and they are generally poor.

During interpretation the wide anti-tank dikes were the most obvious fortified landmarks. The detection of these dikes was easier than any other defence objects. The identification of the wide zigzag lines was much easier to see than the narrow fire-trenches. The interpretation of a 1 m wide fire-trench in a 1:25,000 scale aerial photograph was a rather challenging task.

Besides the anti-tank dikes and fire-trenches, there were a lot of non-linear objects of the defence system (e.g. ground, wood bunkers, anti-aircraft guns pots and other establishments). The majority of these objets were built before the construction of the "Attila lines". These objects consisted of the anti-aircraft alarm and defence system of Budapest. The common features of these additional military objets were small extensions. Moreover, the Hungarian troops camouflaged these objects to protect them.

Figure 2. Anti-tank dikes near Pestszenterzsébet

After the war the areas of the "Attila lines" were abandoned, and the vegetation overtook them. Additionally in agricultural areas farmers removed the bunkers and vegetation could grow-over them quite fast. In the aerial photographs bushes and trees now cover all these objects. Hence we could not find any bunkers by using aerial photographs.

Unlike the bunkers, the interpretation of the anti-aircraft batteries pots was successful. The batteries were sat up in a hexagonal form. The pits of the guns were rather large. The diameter of a pit was around 30 m. The size of the pits were enough large to identify them on the aerial photograph.

Many photographs were taken from specific sites, but there were differences between the photos. The farmers filled the trenches, and dikes as soon as possible to begin the agricultural use of the land. Since then we could find hardly any military objets on the aerial photographs that were taken after 1953.

Nevertheless the use of aerial photographs for the early 1950's was not enough sources for the reconstruction of the "Attila lines". The identification of some kind of objects (bunkers) was not possible because of the resolution of the photographs (the size of a bunker is around 3-5 m). A part of the linear objects of the "Attila lines" were filled before 1950. So we needed other sources to get know where these objects were.

These focused on the secondary sources in our research:

1. The stories of the survivals of the war (written or oral); and
2. Land surveys (visiting the area of the former lines)

The advantage of the stories is that the local people know a small area in a detailed way. They know where bunkers were and machine-gun pits etc. The available aerial photographs can not give the same detailed information, but these stories vary in reliability. There are many examples when an active war figure

(a military commander) remembers that they fought with some specific units in an area. While mentioned units were in another country altogether!

Another disadvantage of these stories was that none of them gave an overview on the "Attila lines". Both military and civil participants of the war mentioned only a limited area of the line, where they lived, or where they fought. After the collection of all the stories and biographies our picture was like an incomplete puzzle of the "Attila lines". Some segments of "Attila line" are well described, and some are unknown.

To get more information about the unknown part of the defence system we went to the areas in question and undertook interviews with the local people who know history of the village. We visited many parts of the line Soroksár, Csömör, Újpalota etc.

According to the interviews of the local people we could identify many fire-trenches, artillery positions, concrete bunkers and, in some parts, anti-tank dikes. We made manuals, sketches and undertook land survey using GPS.

3.5 Using ArcView in reconstruction

Using primary and secondary sources we managed to achieve the reconstruction of "Attila lines" in an accurate and detailed way. The spatial distribution of the objects of the defence system was handled in a GIS system (*ArcView 3.3*).

To represent the Attila lines in *ArcView* we needed a background map that represented Budapest in 1944. We used contemporary topographic maps (1:25,000) from the Royal Hungarian Army to create a background vector map. However the topographic maps were made in the 1930's and Budapest and its neighbouring settlements have since developed and expanded. Hence we used contemporary city plans to update the topographic maps.

The background map was transformed to the current Hungarian projection (Unified National Projection) because we wanted to integrate the results of our land surveys. Furthermore, we adjusted the archive aerial photographs to the transformed vector background map using reference points. Finding reference points was not an easy task in open areas (e.g. forests, meadows).

After identifying reference points we began to digitize the defence objects of the "Attila lines" (fire-trenches, anti-tank dikes, etc.) in *ArcView*. We linked descriptions and sketches to similar defence objects. Moreover several photographs taken in 1945 were also linked to the objects. We also took many photographs of the current state of some defence objects and we linked these photographs as well.

In case of bunkers and anti-aircraft pits, also available are linked descriptions on the construction of these objects, some plans, fortification sketches and photographs as well. Besides the defence objects of the "Attila lines" we have represented the major offensives and counter-attacks of the fights in the area of the "Attila lines".

4. CONCLUSIONS

From our research we have described the situation of the Attila lines. This was a new version of the situation of the "Attila lines", in contrast to former maps made by historians. Nevertheless the result of our research was not only the detailed description of the Attila lines. There is new information about the "Attila lines":

1. Only the Attila I and Attila III were built in a horseshoe shape around Pest;
2. Attila II was only partly constructed and it joined Attila I near Maglód village; and
3. Anti-tank dikes were constructed only in Attila I and Attila III lines.

We would like to use the same approach for all defence lines in Hungary built during Second World War. Moreover we would like to create an interactive Internet version of our GIS application. Now, the "Árpád line", situated in the Carpathian Mountains, was represented in this way.

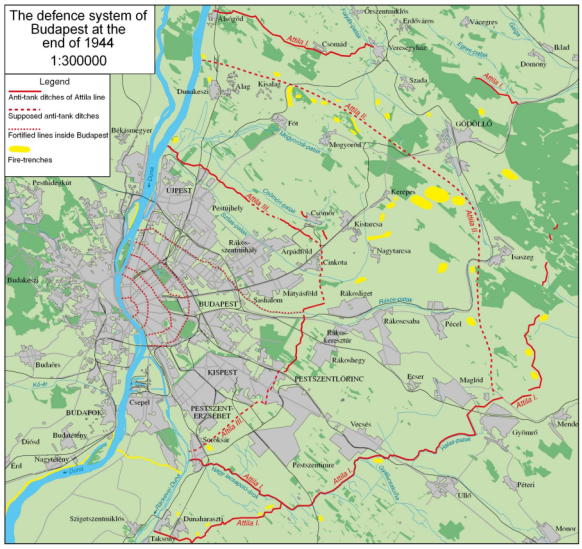

Figure 3. The defence system of Budapest at the end of 1944 (Juhász and Mihályi, 2003)

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