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Faculty of Sciences
Doctoral School of Earth Sciences

**The historical change of human impact on the
environment in the Komárom-Esztergom Plain and
Western Gerecse Mts.**

PhD thesis abstract

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Introduction

In my doctoral thesis I am looking for the answer for the question in what way the view of the landscape has transformed and the condition of the environment has changed by the influence of human activity in two sub-regions of the Komárom–Esztergom Plain: the Győr–Tata terrace area and the the Almás–Tát–Danube valley combined with marginal areas of the Western–Gerecse Mts. I mainly focus on the area determined by the „triangle” of the Komárom, Tata and Neszmély settlements (*Figure 1*).

Human-environment interaction has been changing throughout history. The people of different ages adapted to environmental conditions in different manners, as well as they took use of its inherent facilities in various ways. In my thesis I intend to show how the landscape has been forming according to the different military, economic and power interests of different ages.

During my researches I have come to the realisation that the strongest forming impact on the landscape was left by the Romans. They dammed the waters arriving from Tata by an embankment – running West from today’s Almásfüzitő railway station –, producing a huge marsh and lake among Tata, Komárom and Dunaalmás by this. The marshy nature of the landscape was determining until 1747, Mikoviny’s big water regulation and arrangement works. While the investigated area emptied during the Turkish era, and it got slowly populated again and regained its economic importance only after World War II, owing to the foundation of the Almásfüzitő alumina factory. Moreover, alumina production became a new impact factor on the environment. Red mud as a dangerous by-product of alumina production has arisen in great volume. Out of this 12 million tons were laid down behind the flood protection dams of the Danube on the low and high flood plains of the river, spread over an area of cca. 200 ha.

In my dissertation after introducing the area’s environmental and geomorphological conditions – enriched with new findings – I deal with the landscape forming impact of human activity in the different historical eras, I try to reconstruct the landscape of all era as well as interpret the role of human activity in each one of them. I intend to introduce the history of the mapping of the area, especially via the representations of the times before 1747. In the last chapters I deal with the results of my environmental researches regarding the red mud depositories.

In my thesis I investigate different topics which are related to each other by the common plot and by the investigation of the – historically ever-changing – human-environment relation. Just as the different water regulations works of each historical era pop up questions different from the ones regarding the environmental effect of red mud depositories, the methodology of the investigations was varying topic by topic. This latter condition made it possible for me to work together with researchers of different branches of science, as well as to make investigations in different topics and on various fields.



Figure 1. The map of the investigated area (VICZIÁN I.)

Source: Corrected version of the EOTR 1:10 000 scale maps from the DDM-50 database with the help of digitalised contour lines

Aims

The aim of my thesis is to reveal the historical change of human impact on the environment in the territory of the Komárom-Esztergom Plain and the Western-Gerecse. According to this I set myself the following targets:

1. Revealing the *geomorphological, hydrological and geological conditions* of the investigated area. Distinguishing different geomorphological forms formed by different natural and anthropogenic factors, explaining their formation, interpreting the change of the running directions of water channels, preparing detailed geomorphological map of the sample areas. Preparing digital relief model and thematic map to demonstrate the relief conditions and to support geomorphological analysis and mapping.
2. Recognising and interpreting the different *factors forming the environment typical of the different historical eras*. Establishing the role and the origin of the different relief forms shaped by anthropogenic impact. Establishing different *periods* in the *human-environment relation* and in the *landscape development*, reconstructing the *environmental conditions of the different periods* by geographical methods and by historical and archaeological sources. Geographical interpretation and correction of archaeological explorations and historical data.
3. *Collecting the related detailed county and country maps* on the investigated area from different collections, especially for the sake of exploring conditions before 1747. Introducing the *landscape history of the area and the history of its mapping* based on the knowledge of map sources.
4. The *environmental-geomorphological investigation of the red mud depositories* of Almásfüzitő. Revealing the *factors endangering the safety of the depositories* (old channels, earthquake, flood, etc.). Evaluating the choice of plot for the depositories.
5. Evaluating the *effects of the Almásfüzitő red mud depositories* causing *environmental pollution*. Analysing the environment of the depositories from environmental point of view. Evaluating the radioactive nature of red mud, measuring the radon concentration in dwellings in the vicinity of the depositories.

Research methods

I applied the MTA-FKI-established geomorphological map-compiling methods in the course of the investigation of the area's relief conditions and natural processes and conditions. To compile the maps I also took use of the relevant military air photos, satellite records and old maps.

I prepared the area's maps of slope exposure and slope category as well as its digital relief model. The digital processing of the relief was based on the data of the relief model of horizontal 50 m resolution of the Hungarian Military Cartographic Co. (DDM-50), which was specified by the contour lines taken from the 1:10 000 scale EOTR map-leaves (typically on the flood plains and on the lower lying terraces). I used the ArcGIS program pack Version 9 – applying its Arcview program Spatial Analyst and its 3D Analyst extensions – to generate the primary relief attributes coming from the digital relief model.

I used the Corel 13 program to prepare the figures and the maps.

For the better understanding of the relief-shaping impact of human activity and for the reconstruction of the landscape's formation I collected old maps depicting the area from the material of several libraries, archives, museums, collections and second-hand bookshops. When it was needed, - after identifying the typical map points – I compared the maps by geographical referencing with the help of ArcGIS.

Besides the old maps I endeavoured to get familiar with all the related historical, local historical and archaeological works, as well as to get into contact with the researchers of these fields. I conducted common researches about the reconstruction of the area's environmental conditions in the Roman era with dr. Friderika Horváth, coordinator of the excavations performed in the area. The exploration of the environment-shaping impact of the Roman era was conducted, on the one hand, by fieldwork observation, and on the other, by the geographical interpretation of both the published and the hand-written archeological literature.

For the environmental evaluation of the Almásfüzitő red mud depositories I made familiar with the depositories' construction and extension plans as well as previous impact studies in the Construction Geotechnical Data Archive of the Hungarian Geological Survey: today: Office for Mining and Geology.

I studied environmental expert opinions and permissions regarding the depositories in the Northern-Transdanubian Environmental Protection Inspectorate, and in the database of the Tata Environmental Protection Ltd. and other companies and authorities.

I prepared a detailed geomorphological map on the environment of the depositories. I also deal with the hydrological conditions of the environment of the depositories by having used the geographical and geological maps and literature on the area.

Throughout years I regularly performed field-observations on the environment of the depositories in times of low water, middle water and flood. I was especially paying attention to the changes occurring in the depositories' dams as well as to the spring-waters coming out

in the dams' sides and in the channels of the Danube and the Szöny-Füzitő-canal surrounding the depositories.

I endeavoured to get familiar with the professional literature dealing with the origin of red mud, the possibilities of its further utilisation and its radioactive characteristics.

I cooperated with Rad Labor (residing at 48 Budakeszi road, Budapest at that time) to reveal the possible radioactive overflow affecting dwellers in the vicinity of the red mud depositories by individually measuring the level of radon in dwelling places. I conducted the measurements in 2002-2003 near the Red mud Depository VII in Béke street in Almásfüzitő. We carried out the measurements by solid state nuclear track detectors (from CR39 polycarbonate). The principle of this method is that alpha-particles originating from the decomposition of the radon impact on the detector and cause damages in it. The number of the damages is directly proportional with the time of irradiation and with the activity-concentration of the sample near the detector. From the number of the damages (tracks) occurring on the detector we can make conclusions about the sample's activity and activity-concentration. After appropriate preparations the tracks on the detector-flakes are counted by a pattern-recognising computer program.

Results

In my dissertation I investigated the impact of human activity on the area among Komárom, Tata and Neszmély. Besides revealing the changes of the investigated landscape, I also contributed to the better knowledge of the geomorphological and hydrological conditions of the area.

I compiled a *detailed geomorphological map* on the sample areas, as well as a *digital relief model* and a *slope exposure* and a *slope category map* on the investigated area. I applied a critical analysis on the topic's and the area's literature in light of my individual geomorphological and landscape-historical investigations.

I have established that the anthropogene factors have significantly reshaped the landscape, I have found filled up areas as well as waterflows of either fully artificial origin or at least strongly modified by human activity. Earlier investigations in Earth Sciences did not count with the fact that landscape and hydrogeological conditions can be historically affected, therefore many false or defaulty establishments might have been made about the area's

sedimentological or geomorphological conditions, or about the change of rivers' and streams' flow direction.

In the course of my geomorphological investigations I tried to reveal the changes of the landscape and the area's hydrogeology. Based on Schweitzer's observations, I divided the flow change of the rivers and streams in the Quaternary Period into sections according to geomorphological criteria. We have found that at the terrace boundaries they regularly turn to the West by 45 °.

I have proved the artificial origin of the below Tata section of *Által-ér*, as well as presented the consequences of human impact affecting other water flows. I prepared a detailed geomorphological map on the area between Dunaalmás and Komárom. By investigating the history of the area I have managed to distinguish between forms and waters of natural and of artificial origin.

The greatest change in the landscape was caused by a *Roman-built embankment and dam* which created a huge marsh and lake among Tata, Komárom and Dunaalmás by damming the waters of the area. This water filled both the early Holocene Danube-channel (Szöny-Füzitő-canal) and the channel and flood plain of the old Fényes-stream (Mikoviny-canal). The dam was at the common section of the two waters. I also managed to point out the exact place of the dam and the sluices built into it by geomorphological, cartographical and historical methods. I have found that the place of the old dam overlaps with one section of the railway embankment East of the the Almásfüzitő railway station, and that the sluice must have been at the railway bridge above the Szöny-Füzitő-canal. The dammed water reached the Danube in three ways. On the one hand, through both the Almásfüzitő and Szöny ends of the early Holocene Danube-channel at Almásfüzitő, on the other hand, at the intermission of the Roman embankment across the marsh directing the water into the other early Holocene Danube-channel between Almásfüzitő and Dunaalmás.

The landscape conditions and the marsh created in them had significant role in the life of settlements around the area. Brigetio (at today's Szöny), one of the most important military centres of Pannonia, was surrounded and protected by the marsh and the Danube. In the Middle Ages a toll place was established on the narrow road through the marsh, in the wartimes of the Turkish occupation the border line was also set here for a long time, while the watery areas provided protection for the castles of Tata and Komárom too. The significance of the marsh and the lake-system in the landscape, however, was not recognised or was not dealt with enough care in the historical sources – in absence of the landscape reconstruction of different eras.

Based on my *researches on local history* I found that the area's marshy condition was prevalent until 1747, Samuel Mikoviny's drainage work. By *collecting* and interpreting different well-known and less-known *historical sources* I can make statements about the high probability of the *marsh's more than one-and-a-half-thousand-year-long existence*. I managed to demonstrate the process of the marsh's and its environment's filling up as well as the *actual state of the change of the hydrogeology* with the help of *contemporary maps* over a several centuries long period.

By comparing the maps I managed to follow the filling up process of some – today hardly recognisable – inherited channel remainders deepening into the high flood plain of the Danube at Almásfüzitő. In the same way, I presented the change (and the effect of the change) of water flows between Tata and the Danube and that of the early Holocene Danube-channel running parallel with today's Danube.

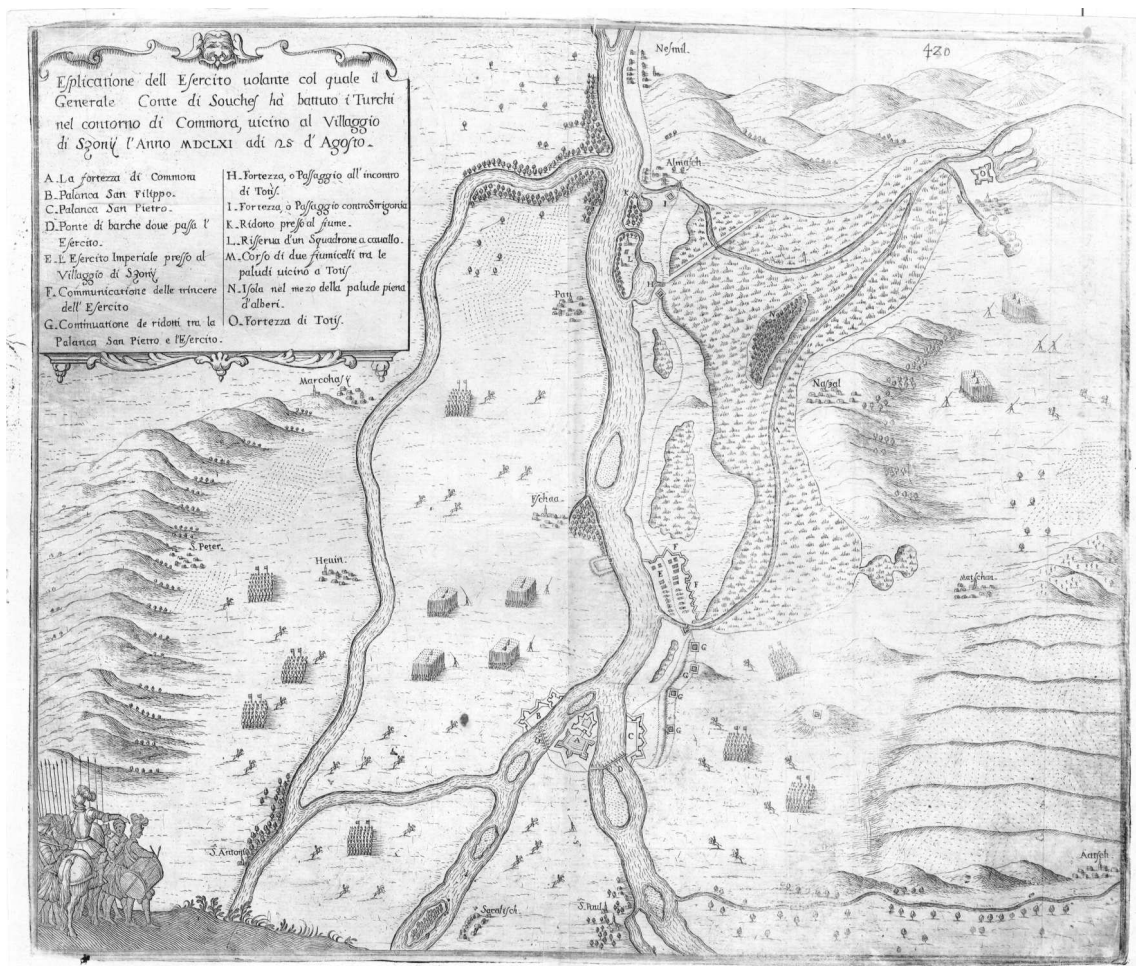


Figure 2. Komárom's map of siege (PRIORATO, G. G. 1672)

Besides the historical sources and the results of geomorphological researches my primary help with landscape reconstruction were those country, part of country, county and local maps which include the investigated area. In the course of processing these maps I could introduce the area's cartographical history (and landscape history) until 1747. Regarding the topic's literature I could find and interpret many maps never mentioned or never published before (Coronelli, Priorato (*Figure 2*), Marsigli, country and county maps, etc.).

Considering several factors, I prepared a detailed landscape reconstruction of the Roman era. The water level of the rivers could be lower according to contemporary climate and hydrogeological conditions, therefore present flood plains could be much better utilised. I found proof of this by interpreting the archaeological findings referring to the area. I made investigations on the location and role of Roman constructions, roads and aqueducts in light of the reconstructed geomorphological conditions. I found that these adapted well to the area's landscape and hydrogeological conditions, moreover, the Roman took good use of the inherent possibilities.

Along the majority of the *limes* the road and the river was densely followed by different edifices (military fort, castellum, etc.), while along this section sporadically. In the frame of my landscape reconstruction I could interpret the location of Roman buildings and the track of roads. It can well be spotted on the below geomorphological map (*Figure 3*) too that they were placed well considering the conditions given by channels, marshes, lakes and islands, as well as using the possibilities of these facilities. The lake / marsh having formed behind the embankment of the *limes* – crossing the early Holocene Danube channel – was not only the necessary consequence of road construction, but at the same time a tool of defense – with controllable water level – protecting the legion camp from possible attacks.

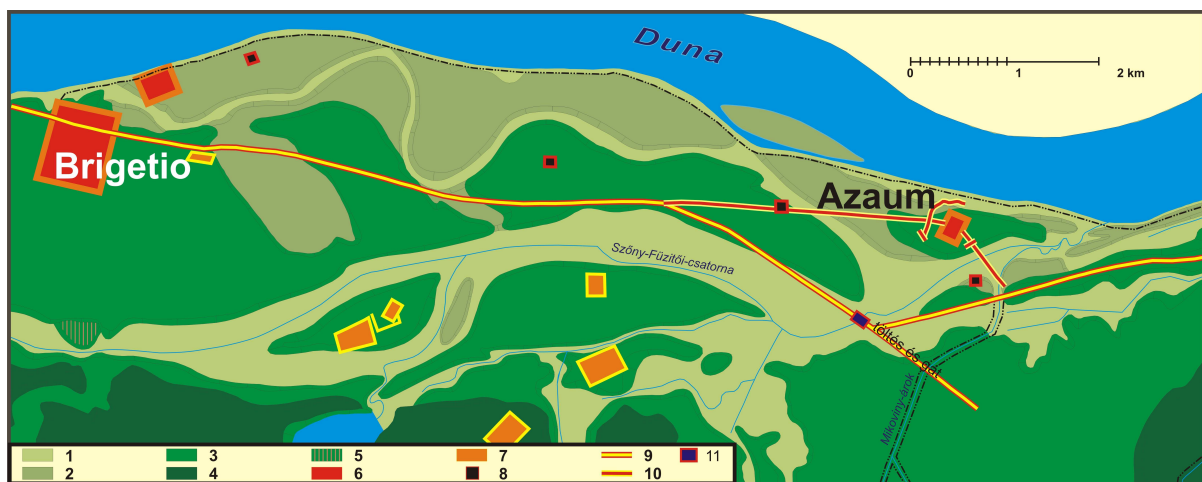


Figure 3. Geomorphological map of the area between Brigetio and Azaum (VICZIÁN I.)

1.= low flood plain, 2.= high flood plain, 3.= II/a terrace, 4.= II/b terrace, 5.= filled up area, 6.= Roman castellum, 7.= Roman burgus, 8.= Roman military fort, 9.= limes junction assumed by Visy Zs.,
10.= the offset of lime according to Fülep F. and Bíró E., 11. sluice

Knowing the Roman landscape, I think that the *Azaum* auxiliary troop camp (catellum) must have played a *crucial role* in the defence of the embankment and marsh, both of great strategical importance. It can seem an obvious statement nowadays, but before my researches the archeologists who had been conducting reserahces for years in the area did not have any knowledge of the existence of the marsh, neither of its role.

My landscape reconstruction of the Roman era greatly contributed to the interpretation of *excavations in Almásfüzitő* as well as to the choice of further directions of research. My archaeologist colleague (Dr. Horváth Friderika) also found the remains of the Roman sluice and Roman aquaduct in Almásfüzitő with the help of my landscape reconstruction. Also, new archeological/historical results have sprung from it in identifying earlier Roman *bridges* in the area, defining the earlier track of the *limes* around Azaum, and the track of the Roman aqueduct as well.

Besides that of the marsh behind the embankment, I demonstrated the *impact* of *Roman landscape formation* reaching till nowadays in other areas too. I hold it likely that while building the aqueduct in the Roman era they partly filled up the early Holocene Danube channel near Szöny (Brigetio), as well as the fact that the Boldogasszonyi Lake (earlier Kereki Lake) – North of Mocsá – had formed owing to the construction of the aqueduct by damming the Kocs-Mocsá water flow.

In the course of my *map research* I discovered several new, earlier not published or not interpreted maps. I called the attention of the diver archaeologists to a map which suggests a much lower water level of the Danube, most probably referring to the Roman era. By interpreting Mikoviny's maps I called the attention to the results of earlier impacts forming the landscape. I could make statements about times before his works regarding the lowering of the marsh's water level and other *hydrogeological changes*, while discovering the traces of anthropogene filling-up too. I performed a *comparative map analysis* of contemporary maps as well as of maps of the same author (Mikoviny, Marsigli) published at different times.

I dealt with the Mikoviny drainage works from a geographical and a geomorphological point of view, I investigated the consequences of the water regulation and the most important impacts on the landscape in the period since then.

The most significant environmental load in the past 6 decades and the most serious landscape shaping impact in the area have been the alumina factory of Almásfüzitő and its by-product, red mud. Red mud is classified as II category dangerous waste because of its high heavy metal contents and strongly alkaline character. In Almásfüzitő 12 million tons of red mud was laid behind the flood protection dams of the Danube over an area of 200 ha.

I conducted a detailed *environmental-geomorphological examination* of the vicinity of the cassettes containing red mud, and I reviewed the whole technical literature of the cassettes and red mud. I found that the depositories were built without proper technical embankments, therefore the polluted waters getting out of them can easily communicate with the underground waters of the area and with the Danube.

The placement of the depositories is also unfavourable from a geomorphologic point of view, as they were mostly placed on the river's low and high flood plains (Figure 4), moreover, earlier river and stream channels are running under them. These channels are favoured zones of groundwater's flow, and those sections of the depositories' embankments which are built above these are all damaged, slides and collapses are forming on them, red mud springs pour out of their sides.

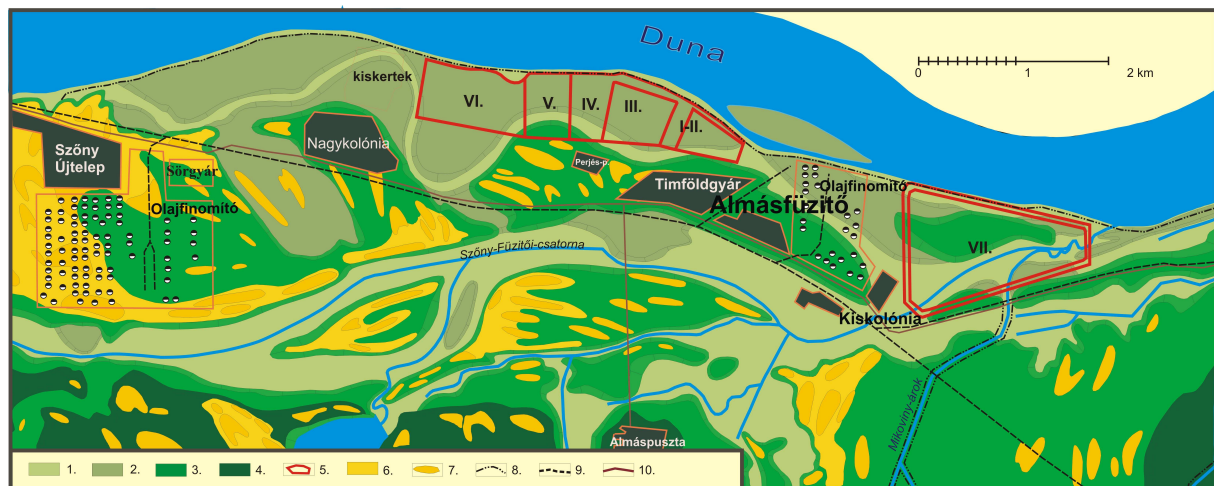


Figure 4. The geomorphological map of Almásfüzitő (VICZIÁN I.)

- 1= low flood plain, 2= high flood plain, 3= II/a. terrace, 4= II/b. terrace, 5= red mud depository,
 6= surface elevated by drift sand, 7= drift sand forms, 8= flood protection dam,
 9= railway, 10= road

The depositories were set up on the 15-20 m thick highly permeable alluvial sediments of the Danube, polluted waters flow into the river – according to its actual water level – in the majority of the year, moreover, in case of high water they even pollute the areas beyond.

However, the depositories' location – nearby the river – makes the necessary dilution of the pollution possible.

The dust of the red mud transported by the wind from the uncovered mud space endangers the health of inhabitants of the surrounding settlements. The cassettes containing the red mud are covered by various other dangerous waste.

The water and dust load of the depositories' environment are continually checked by the green authorities. However, radon level in dwelling places had not been examined before. I conducted measurements of interior radon level by solid state nuclear track detectors in 2002–2003 in Béke street, the immediate vicinity of the depositories. Red mud has a high concentration of radioactive elements, 10-20 times higher than in any standard Hungarian soil. The results of the measurements show that the radon load of dwelling places is mostly tolerable, only high in one or two cases, however, the dust of red mud transported by the wind and breathed in by inhabitants can have more serious radioactive effects than this.

At the end of my dissertation I deal with the possibility of the occurrence of different natural disasters (flood, earthquake) and their potential environmental impact. As the surroundings of Almásfüzitő is highly exposed to the danger of earthquakes – lying at the crossing of faults –, it is necessary to count with the possible effect of such catastrophe on the red mud depositories. The break of the dams would cause serious environmental damage, polluting the water and the gravel bed of the Danube, destroying by this the drinking-water base of the settlements situated along the Danube, and causing serious damage for the living organisms too.

Ways of utilising the results

My dissertation containing critical review of the literature on the area's natural conditions as well as new research results can be a survey well utilisable for further researches in earth sciences and contains interesting propositions regarding directions of further research.

The interdisciplinary approach of my anthropogene geomorphological research can serve as example to and contribute to the improvement of methods of other similar researches.

My landscape reconstruction embracing several historical eras can help the more exact understanding or revision of the area's changing role through history. It can also serve as guideline for selecting new areas for archaeological excavations, while it can also give inspiration for choosing new topics of archaeological research.

Besides the scientific use of my historical landscape reconstruction and my cartographic collection work regarding the area can serve as source for museum exhibitions, publications and works on local history.

The exploration of the geomorphological and hydrological conditions can give new earth science perspectives to the regional planning and settlement development.

My environmental geomorphological researches on the red mud depositories point to the potential and real environmental risk, but also present specific tasks regarding prevention.

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