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CONTENT

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Literature

Chronicle

Channel regulation of Torna stream to improve environmental conditions in the vicinity of red sludge reservoirs at Ajka, Hungary

Ferenc Schweitzer[1]

Abstract

Three alumina factories have operated in Hungary, at Mosonmagyaróvár (1934–2002), Ajka (since 1942) and Almásfüzitő (1950–1997) based largely on Hungarian bauxite. In these factories bauxite was processed by the Bayer procedure. The strongly alkaline waste arising during the process was transported by hydraulic way to the depositories. The red sludge was stored in reservoirs surrounded by circular dyke at Ajka, Mosonmagyaróvár and Almásfüzitő while in Neszmély it was deposited behind a dam in a valley.

On October 4, 2010 in the north–western corner of reservoir 10th the dyke ruptured and ca 700 thousand cubic meters of watered (alkaline) red sludge flooded the low-lying parts of the settlements Kolontár, Devecser and Somlóvásárhely. The spill accident has involved casualties (ten people died and more than 120 were injured) and caused considerable material damage. Contamination soon reached the nearby Marcal river and proceeded to the Danube.

The aim of present work is to describe the geomorphologic situation in the environment of the red sludge reservoires at Ajka and to make a proposal for the regulation of the hydrographical system over the surrounding territories.

Keywords: red sludge, Ajka, geomorphological levels, alluvial cones, stream diversion

Introduction

The only alumina factory in Hungary (MAL Ltd.) operates in the neighbourhood of Ajka town, in the western part of the country. A chain of large reservoirs of caustic red sludge (by-product of the Bayer alumina production process) is to be found in the valley of Torna stream. On October 4, 2010 in the north–western corner of reservoir 10th the dam ruptured and ca 700 thousand cubic meters of watered (alkaline) red sludge flooded the low-lying parts of

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the settlements Kolontár, Devecser and Somlóvásárhely *(Figure 1)* taking toll of human lives and injuries plus causing considerable material damage. Contamination soon reached water courses Marcal, Rába, and later the Danube River. The spill has become known all over the world and once again turned the public attention to disastrous events, both natural and man-induced, to the involvement of different components of geographical environment in these catastrophes and called for the responsible behaviour to take preventive measures that would grant safe operation of large industrial projects and infrastructure.

Topography, geological, soil and hydrogeological conditions of the area affected by the disaster and its wider surroundings show a variable, mosaic-like picture. These conditions are not prone to regulation. However, surface waters as one of the most important natural components can be regulated. A major objective of interventions related to water management is the regulation of the quantity and dynamics of water resources depending on the geomorphological endowments.

Torna stream and its tributaries are important landscape forming factors in the environs of Ajka and Devecser. Regulation of their channel – with a special reference to relocation within the catchment – is promising as for the improvement of the state of environment and physical planning of the area including surface and subsurface waters and red sludge reservoirs.

The methods applied for the elimination of environmental damage and the process of landscape rehabilitation are to attract constant attention of public opinion. Once have been completed, the measures taken will positively

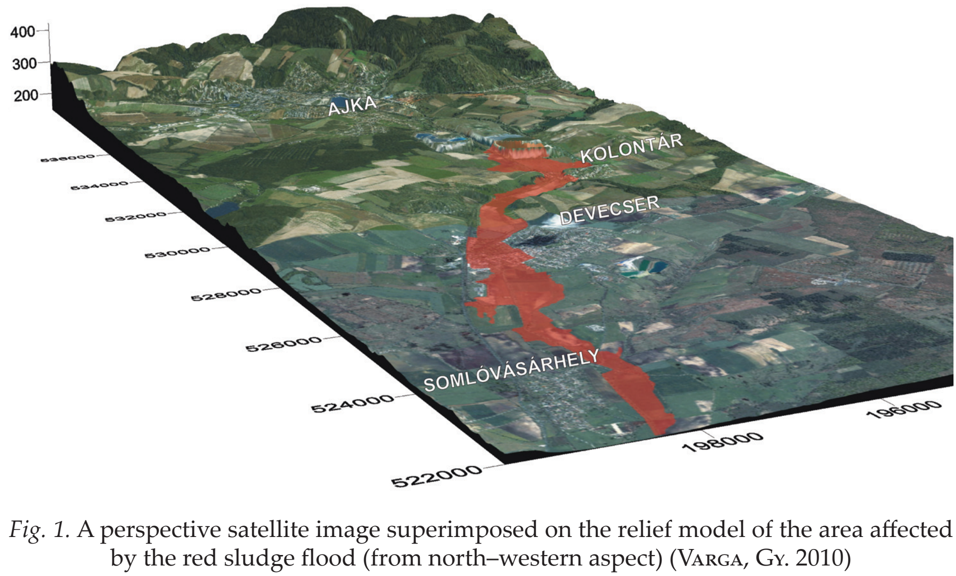


Fig. 1. A perspective satellite image superimposed on the relief model of the area affected by the red sludge flood (from north–western aspect) (Varga, Gy. 2010)

affect the security of local population and the quality of environment. No irreversible changes are expected with the relocation of the streambed section, after rehabilitation the initial channel might be used again.

In the research activities of the Geographical Reserch Institute of HAS it is a well-proven practice that different factors of the geographical environment (topography, hydrography, soils etc.) are displayed in thematic maps and the result of evaluation is also depicted in synthetic maps.

Environmental survey and mapping from the engineering aspect is a special branch of preliminary studies for large industrial establishments and projects of linear infrastructure (roads, railways) in the phase of technical planning to make a complex plan of construction perfect. Large projects of the past decades are warnings about this (Komló, Miskolc, Kazincbarcika, Salgótarján, Dunaújváros, Oroszlány; certain motorway sections; mass movements along high bluffs with adverse impact on settlements; problems related to deposition of radioactive waste; Gabčíkovo (Bős)–Nagymaros hydrocascade; flood prevention; Paks Nuclear Power Plant; and domestic red sludge reservoirs (Ajka, Mosonmagyaróvár, Almásfüzitő and Neszmély) (Balogh, J. and Lovász, Gy. 1988; Schweitzer, F. 1996; Juhász, Á. 2003; Viczián, I. 2003).

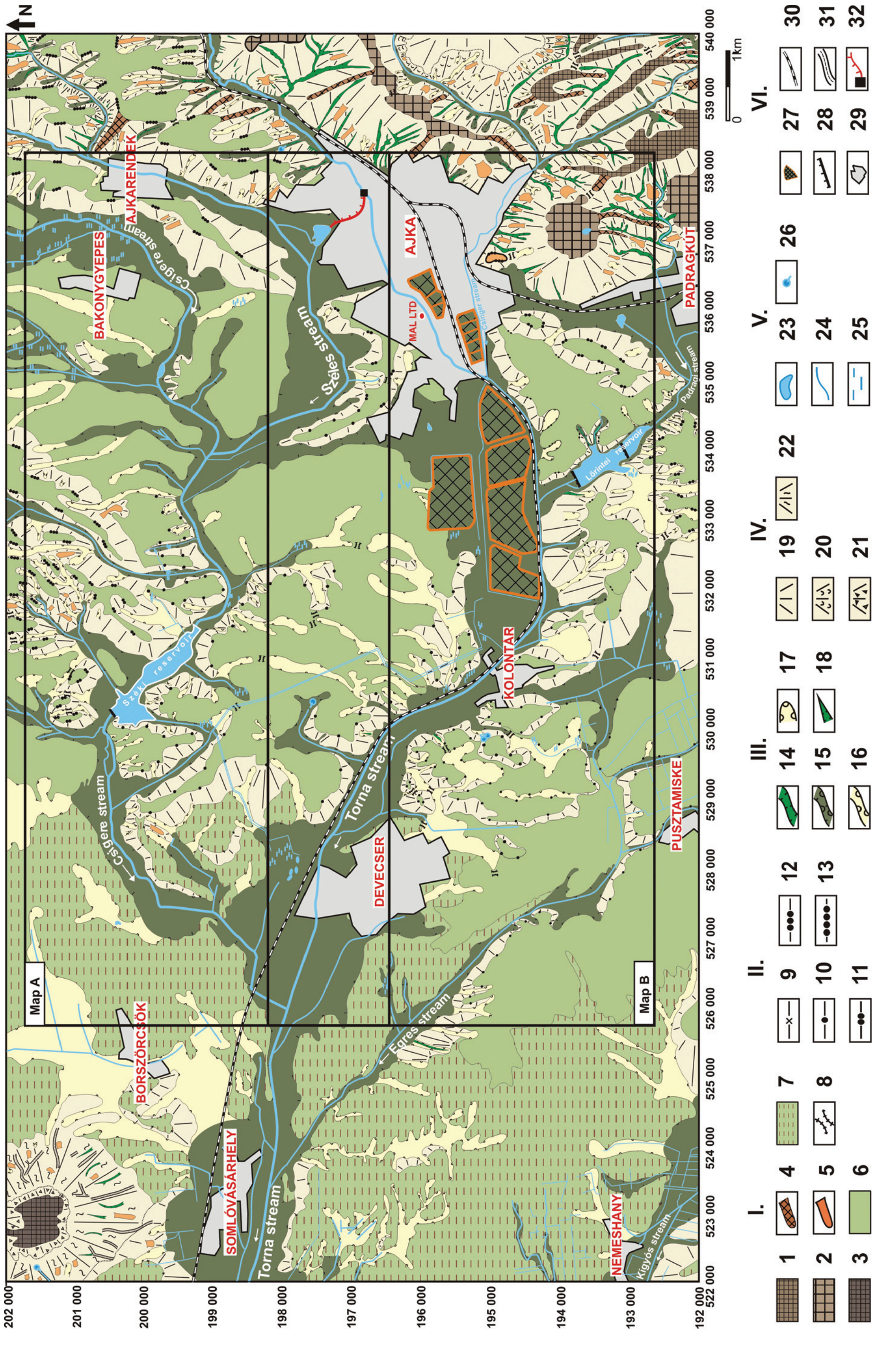
The present study was not aimed at presentation of the red sludge reservoirs and of their complex environmental impact assessment. (They are to be published in a special volume of studies.) One can find below a proposal for the regulation of Torna streambed following a brief introduction in geomorphological features in the environs of the reservoirs. Our propositions are raised for the sake of the improvement of the quality of surface and subsurface waters, and the safe operation of reservoirs.

Geographical environment, hydrographic conditions

The area with the grimmest aftermath of the disaster extending to the settlements Ajka, Kolontár, Devecser, Somlóvásárhely belongs to natural microregions North Bakony and Marcal basin. According to the landscape geographical subdivision the contact zone between these two units is part of Ajka basin on the western margin of Bakony including Veszprém–Devecser trench and at the south–eastern end of Pápa–Devecser flat belonging to Little Hungarian Plain (Kisalföld). The boundary between them can be drawn at Devecser.

The studied area is of transitional character; its geomorphological aspect is formed by series of Mesozoic horsts, foothills of the mountain rim dissected by erosional valleys and alluvial fans of the margin *(Figure 2).*

Along the axis of Veszprém–Devecser trench it is Torna stream that drains the waters infiltrating from karstic rocks of Bakony mountains into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Map A
Map B
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BAKONYGYEPES
AJKA
MAL LTD
PADRAGKÚT
PUSZTAMISKE
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DEVECSER
BORSZÖRCSÖK
SOMLÓVÁSÁRHELY
NEMESHANY
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Torna stream
Széles stream
Csigere stream
Csigere stream
Csinger stream
Egres stream
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Padragi stream
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Pannonian sandy and gravelly foothill sediments and collects surface runoff *(Figure 3).* Torna stream springs in North Bakony at Csehbánya and flows into Marcal river. Within the studied area it receives Csigere stream and Széles stream from the right side whereas Csinger stream and Padragi stream are its left-hand tributaries. Besides, minor water courses and subsurface waters also empty in it. There rise springs in the erosional and derasional valleys dissecting the extensive alluvial cone built by the stream.

In the course of valley direction analysis a definite correlation has been established between the length of the route covered by Torna stream and the dimension of the alluvial fan formed in the mountain foreland. Accordingly, the 51 km long water course with a catchment of 498 km^2 could form an extensive alluvial cone with a fan-shaped widening in a west–south-west direction of Ajka. Torna has been building its alluvium and changing its streambed configuration countinuously. The apex of the cone filling in Veszprém–Devecser trench could be immediately west of today's Ajka. The channel was wandering in north–west–south–east direction. Drainage network variations and changes in streambed position can be attributed to subsidence processes of unknown intensity in the western foreland of Bakony.

The erosional, erosional-derasional and derasional valleys of north–northwest–south-southwest orientation and the divides between them indicate the position of streambeds at the end of Pleistocene and their changes that several geomorphological levels could be associated with. In the immediate surroundings of Ajka the position of valleys refers a fan-like fluctuation of the paleo-Torna stream in the present valleys of Széles stream and Csigere stream from north–west and west to south–west up to Kígyós stream.

In the survey of the recent variations in the stream channel, archive maps and sheets of military surveys were involved as well. A map of the 2nd

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Fig. 2. Geomorphological map of the wider surroundings of red sludge reservoirs at Ajka (compiled by Balogh, J., Juhász, Á., Schweitzer, F., Szeberényi, J. and Viczián, I. 2010). – I. Complex landforms: 1 = summit level 300–350 m a.s.l.; 2 = summit level > 350 m a.s.l.; 3 = summit level of residual basalt hill; 4 = interfluvial ridge; 5 = gentle slope segment; 6 = glacial alluvial cone in intermediary position; 7 = glacial alluvial cone in low position; 8 = saddle. II. Geomorphological levels: 9 = 170–180 m a.s.l.; 10 = 180–220 m a.s.l.; 11 = 220–240 m a.s.l.; 12 = 240–270 m a.s.l.; 13 = >270 m a.s.l. III. Valleys: 14 = erosional valley; 15 = erosional-derasional valley; 16 = derasional valley; 17 = derasional niche; 18 = ravine, canyon. IV. Slopes: 19 = slopes undistinguished; 20 = slopes with landslide hazard; 21 = steep slope of rock and debris (>35%); 22 = slopes with gully erosion hazard. V. Waters: 23 = lake; 24 = stream, drainage canal; 25 = waterlogged area; 26 = spring. VI. Man-made landforms: 27 = cassettes of red sludge reservoir; 28 = valley dam; 29 = built-up area; 30 = railway; 31 = dirt road cut in loess; 32 = projected hydraulic structure with a possible new channel of Torna stream after diversion

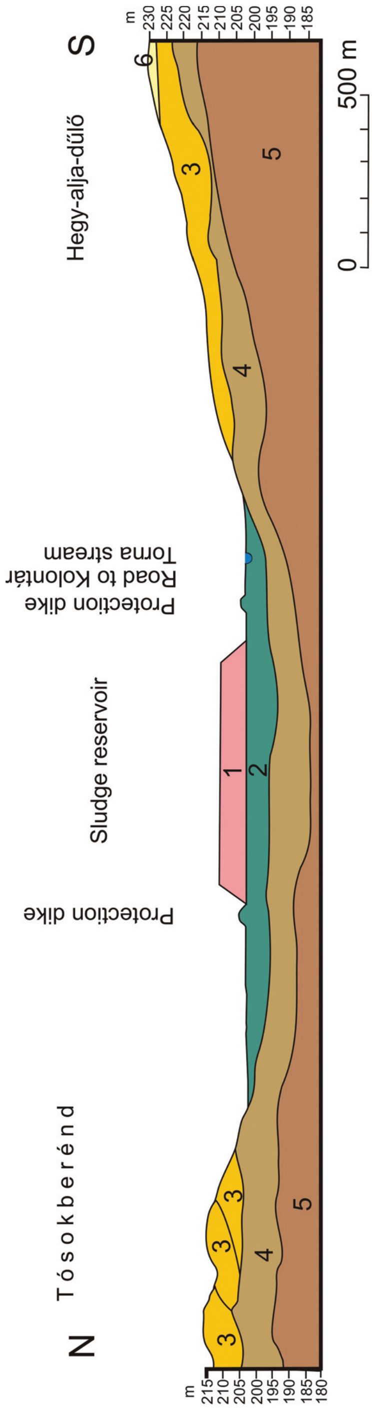

Fig. 3. Spoil heaps and sludge reservoirs upon the alluvium of Torna stream between Ajka and Tósokberénd (Juhász, Á. 2003). – 1 = sludge reservoir, spoil heap; 2 = alluvial sequence (sand, gravel, silt); 3 = terrace built of alluvium (gravel, sand) of the ancient streams (Torna, Csigere); 4 = Somló Formation (Pannonian sand, clay); 5 = Csatka Pebble Formation; 6 = slope loess, sandy loess (clastic gravel sequences)

military survey from 1852 provides a spectacular image of lower lying portions of the alluvial fan with the incising valleys. Such a depression can be viewed north of Ajka *(Figure 4)* being nowadays erosional base of Széles stream and Csigere stream. This area is separated from the current valley of Torna stream merely by a narrow strip of alluvial sediments of some metres elevation.

The formation of the alluvial cone and characteristic geomorphological levels and features show the following configuration. The valley section between Somlóvásárhely and Ajka is situated between 170 and 350 metres a.s.l. and can be subdivided into three parts geomorphically. The uppermost are the summit levels (300–350 m), lower there are foothills dissected by valleys. Within the latter an intermediary level of alluvial cones (220–300 m) and a low level of alluvial fans (170–220 m) along the mountain rim are to be distinguished. The difference between the relief energy of alluvial cones of low and intermediary position is the result of the sediment transport by and channel variation of Torna stream.

Summit levels of 300–350 m a.s.l. are composed of horsts and Mesozoic limestone formations. These areas are located east of the town, whereas their western boundary is the streambed of Torna (north–east of the town) and the southern one is the valley

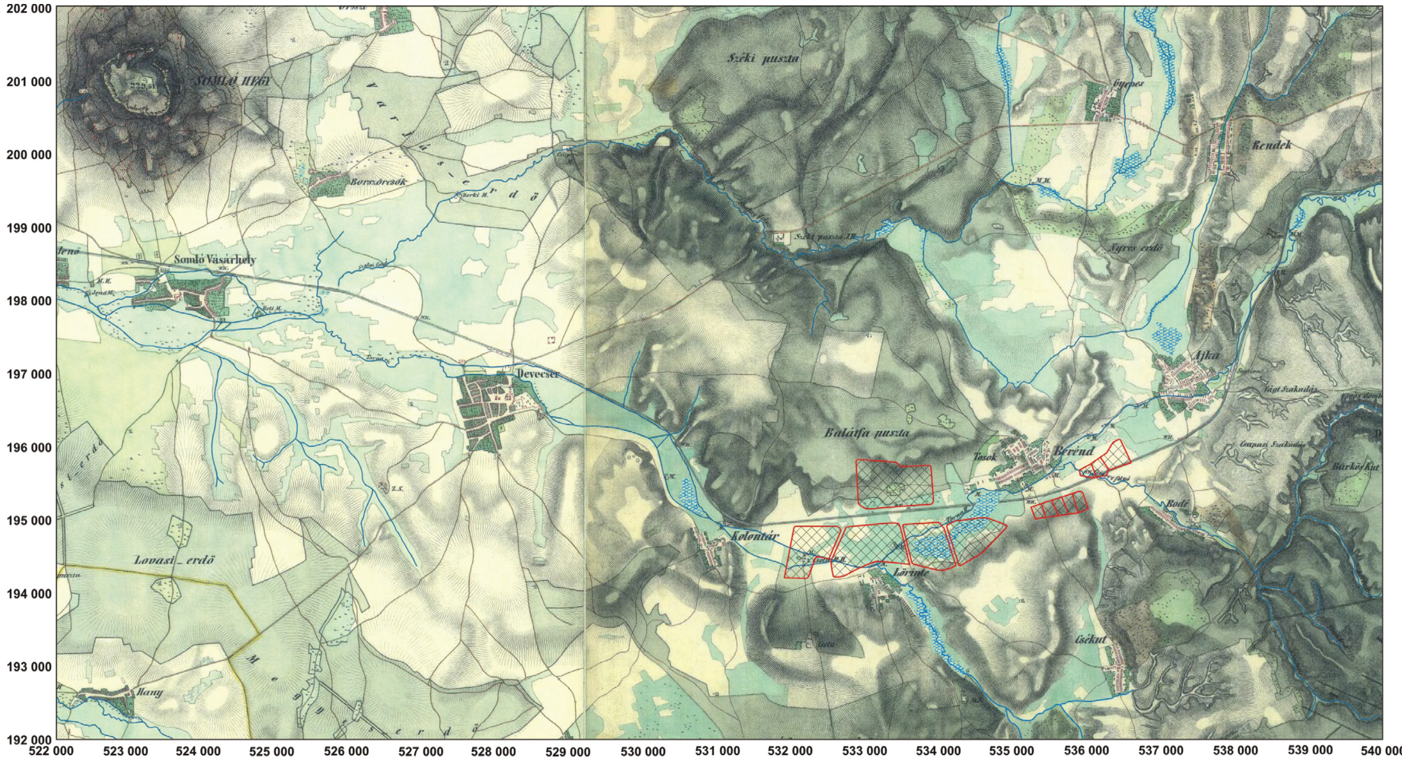

Fig. 4. A wider surroundings of Ajka prior to the construction of sludge reservoirs (2nd Military Survey, 1852) (Szeberényi, J. and Varga Gy. 2010) projected onto the map

stretching in the direction of Padragkút. The steep (25–35%) slopes are built of Pannonian clay. Such geological and landform conditions have played a key role in the formation of extensive slopes with landslide hazard along Csigere stream.

By both banks of Torna stream there are foothill surfaces strongly dissected by erosional and erosional-derasional valleys. The area below 300 m a.s.l. can be subdivided into alluvial cones, geomorphological levels. Intermediary surfaces between 220–300 m bear imprint of landform evolution under the impact of Torna stream during Pleistocene and at the end of that epoch. Lower surfaces (170–220 m) show traces of the activity of the water course related to channel fluctuations and sediment redeposition at the end of Pleistocene and during Holocene. In the talweg of Torna marshy and swampy places emerged.

An option for the channel regulation of Torna stream and diversion of its flow

Ajka town with its industrial estates and the red sludge reservoir is to be found in the valley of Torna stream with a width alternating between 1 and 3 km. Above Ajka i.e. in its middle mountain section the watercourse is natural water, but downstream it became regulated. In the course of urbanization the town has expanded from the higher geomorphological levels toward the alluvial plain. Red sludge reservoirs also were established in Torna valley *(Figure 3).* The natural valley of the stream was found initially in the place where cassettes VIII–X are placed at present, and it became diverted when the reservoir was under extension during the 1990s. Observing wells operating in monitoring system provide continuous information about subsurface water flow and quality is also checked by Middle Transdanubian Environmental and Water Management Directorate permanently *(photos 1* and *2).*

The above water course regulations have not brought about adequate changes in protection of water quality. An appropriate solution for the problem of surface and subsurface waters and especially for the safety operation of sludge reservoirs can be provided by taking a large scale but not too expensive water management measure. In accord with the paleogeographic conditions the following proposal is made.

North of Ajka town, in the valleys of Széles stream and Csigere streams (that used to form the channel of Torna stream at the end of Pleistocene) present-day discharge of the latter could be drained with relocation of a short section of the stream bed. Planning of the channel to be newly shaped requires thorough geomorphological survey as the channel is to be cut within the administrative area of the town *(figures 5* and *6).* The water of Torna stream to be

Photo 1. Observing wells monitoring water quality along the dam of red sludge reservoir (Photo by Juhász, Á. 2003)

Photo 2. Foamy alkaline water flowing out of leakage of sludge reservoir (Photo by Juhász, Á. 2003)

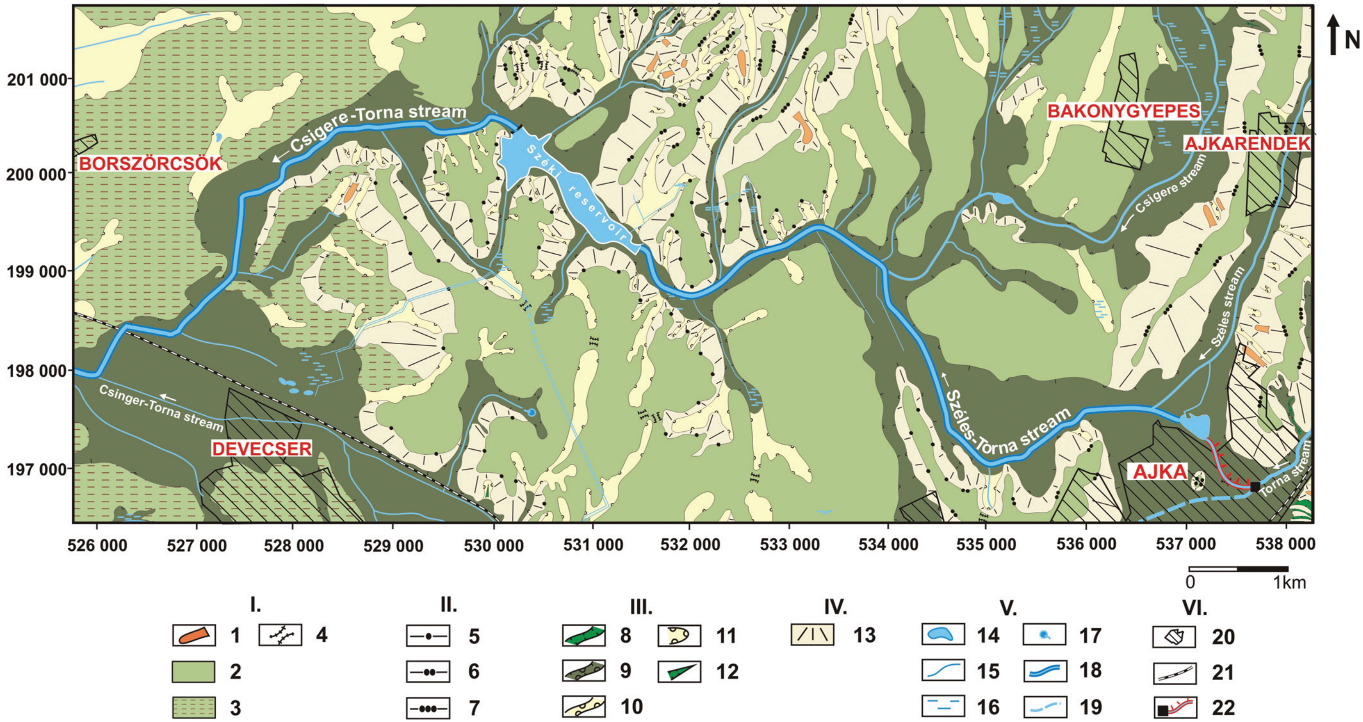

Fig. 5. State subsequent to the projected flow diversion, *map A* (compiled by BALOGH, J., JUHÁSZ, Á., SCHWEITZER, F., SZEBERÉNYI, J. and VICZIÁN, I. 2010). – I. Complex landforms: 1= gentle slope segment; 2 = glacial alluvial cone in intermediary position; 3 = glacial alluvial cone in low position 4 = saddle; II. Geomorphological levels: 5 = 180–220 m a.s.l.; 6 = 220–240 m a.s.l. 7= 240–270 m a.s.l. ; III. Valleys: 8 =erosional valley; 9 = erosional-derasional valley. 10 = derasional valley; 11 = derasional niche; 12 = ravine, canyon; IV. Slopes: 13 = slopes undistinguished; V. Waters: 14 = lake. 15 = stream, drainage canal. 16 = waterlogged area; 17 = spring; 18 = a possible solution of water diversion; 19 = desiccated channel of Torna stream; VI. Man-made landforms: 20 = built-up area; 21= railway. 22 = projected hydraulic structure with a possible new channel of Torna stream after diversion

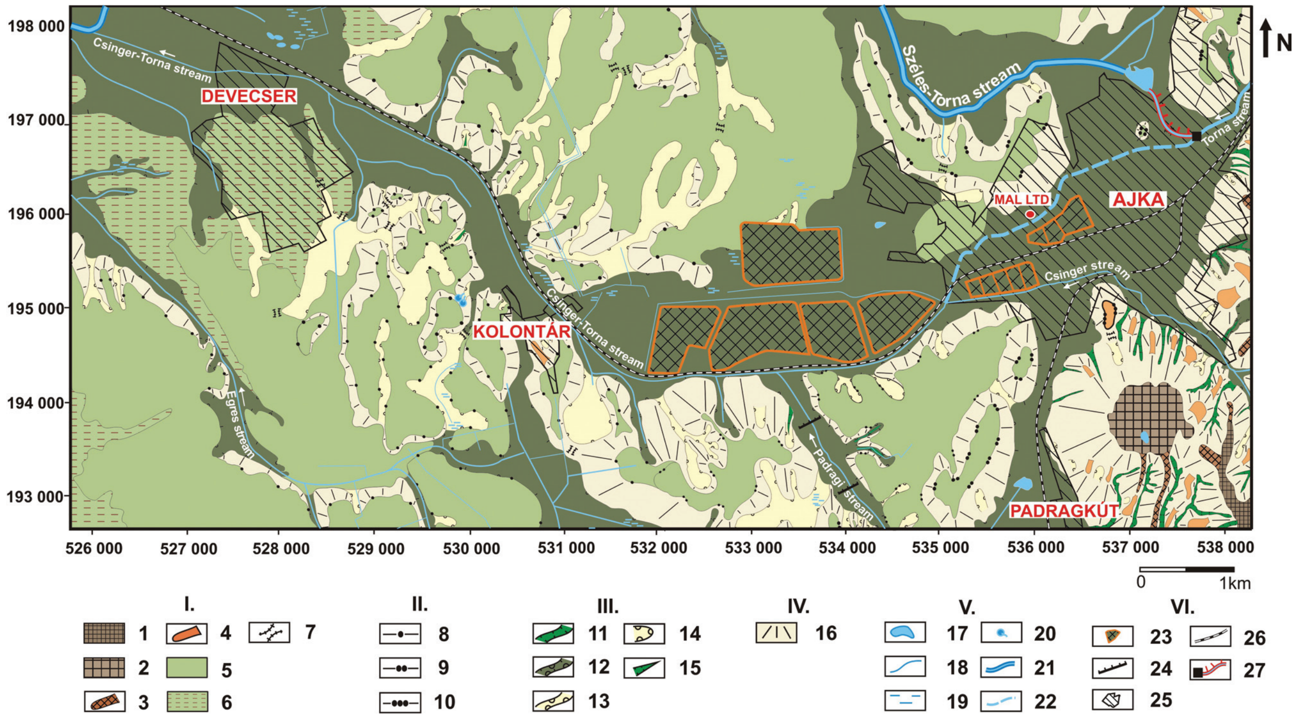

Fig. 6. State subsequent to the projected flow diversion, *map B* (compiled by Balogh, J., Juhász, Á., Schweitzer, F., Szeberényi, J. and Viczián, I. 2010). – I. Complex landforms: 1= summit level >350 m a.s.l.; 2 = summit level 300–350 m a.s.l.; 3 = interfluvial ridge; 4 = gentle slope segment; 5 = glacial alluvial cone in intermediary position; 6 = glacial alluvial cone in low position; 7 = saddle. II. Geomorphological levels: 8 = 180–220 m a.s.l.; 9 = 220–240 m a.s.l.; 10 = 240–270 m a.s.l. III. Valleys: 11 = erosional valley; 12 = erosional-derasional valley; 13 = derasional valley; 14 = derasional niche; 15 = ravine, canyon. IV. Slopes: 16 = slopes undistinguished. V. Waters: 17 = lake; 18 = stream, drainage canal; 19 = waterlogged area; 20 = spring; 21 = a possible solution of water diversion; 22= desiccated channel of Torna stream. VI. Man-made landforms: 23 = cassettes of red sludge reservoir; 24 = valley dam; 25 = built-up area; 26 = railway; 27 = projected hydraulic structure with a possible new channel of Torna stream after diversion

diverted into Széles stream and then proceeding in the streambed of Csigere could improve the quality of water in Széki reservoir, add to the capacities of storage and carry away flash floods caused by extreme precipitation events. Water of streams Torna and Csigere flowing together would return to its channel between Somlóvásárhely and Devecser.

The present section of Torna stream now in the immediate vicinity of red sludge reservoir would be eliminated, this way improving the hydrological conditions decisive for the safety of reservoirs. It would provide the opportunity for a safe reparation and reinstallation of all cassettes. A further advantage of diverting the streamflow is that contaminated wastewaters arriving from the alumina factory and sludge reservoir *(Photo 3)* could be collected in the abandoned channel and water cleaned with an adequate treatment.

Besides the improvement of the state of the environment in the area enclosing the red sludge reservoirs the objectives of channel regulation include carrying off water, ice and bed load, securing water uses, flood prevention, water distribution, protection of the existing habitats and creation of new ones and their harmonization with the landscape and specific local requirements raised during water regulation.

Photo 3. Waste water contaminated by red sludge in the drainage ditch flanking the reservoirs (Photo by Juhász, Á. 2003)

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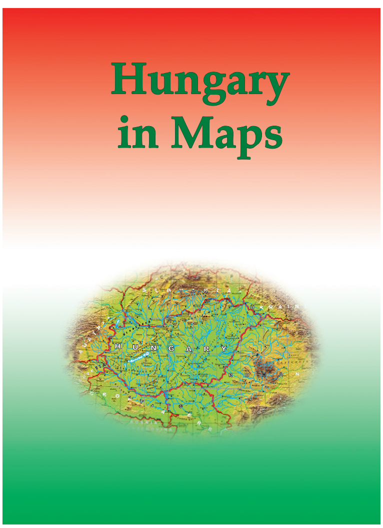
Hungary in Maps

Edited by
Károly Kocsis and Ferenc Schweitzer

Geographical Research Institute Hungarian Academy of Sciences
Budapest, 2009. 212 p.

'Hungary in Maps' is the latest volume in a series of atlases published by the Geographical Research Institute of the Hungarian Academy of Sciences. A unique publication, it combines the best features of the books and atlases that have been published in Hungary during the last decades. This work provides a clear, masterly and comprehensive overview of present-day Hungary by a distinguished team of contributors, presenting the results of research in the fields of geography, demography, economics, history, geophysics, geology, hydrology, meteorology, pedology and other earth sciences. The 172 lavish, full-colour maps and diagrams, along with 52 tables are complemented by clear, authoritative explanatory notes, revealing a fresh perspective on the anatomy of modern day Hungary. Although the emphasis is largely placed on contemporary Hungary, important sections are devoted to the historical development of the natural and human environment as well.

In its concentration and focus, this atlas was intended to act as Hungary's 'business card', as the country's résumé, to serve as an information resource for the sophisticated general reader and to inform the international scientific community about the foremost challenges facing Hungary today, both in a European context and on a global scale. Examples of such intriguing topics are: stability and change in the ethnic and state territory, natural hazards, earthquakes, urgent flood control and water management tasks, land degradation, the state of nature conservation, international environmental conflicts, the general population decline, ageing, the increase in unemployment, the Roma population at home and the situation of Hungarian minorities abroad, new trends in urban development, controversial economic and social consequences as a result of the transition to a market economy, privatisation, the massive influx of foreign direct investment, perspectives on the exploitation of mineral resources, problems in the energy supply and electricity generation, increasing spatial concentration focused on Budapest in the field of services (e.g. in banking, retail, transport and telecommunications networks), and finally the shaping of an internationally competitive tourism industry, thus making Hungary more attractive to visit.



This project serves as a preliminary study for the new, 3rd edition of the National Atlas of Hungary, that is to be co-ordinated by the Geographical Research Institute of the Hungarian Academy of Sciences.

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Tisza River Valley: future prospects

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Abstract

Hungary is among the countries in Europe most severely endangered by floods. Fourteen rivers entering Hungary from the mountainous area of the Carpathian Basin have high channel slope gradients which serve as a source of considerable flood hazard. The disastrous floods during the last decades in Hungary have been caused mainly by Tisza River and their tributaries situated on the eastern part of the Great Hungarian Plain (Alföld). These cases make necessary a thorough analysis of the extreme flood events to be carried out and the drawing of conclusions with recommendations to be made as for the immediate legal interventions. The present article outlines a river regulation program on the basis of a new concept. The purpose of this program beyond the increase of flood security is to improve the quality of life of the population concerned, extend water supply capacities, preserve natural resources and to provide flood risk management.

Keywords: flood hazard, river regulation, water management, Tisza River

Introduction

Tisza is the second largest river of Hungary. Its entire watershed (157,135 km^2) is to be found within the Carpathian Basin. Tisza rises from the Marmarosh Mountains (Ukrainian Carpathians) and flows after 1,260 km in the Danube at Titel (Serbia). From the point where the main branch of the Tisza reaches the Great Hungarian Plain 5–6 cm/km maximum gradients prevail. Along the lower stretches of the river they are reduced to 2–3 cm/km. Therefore, the river meanders lazily, forming sinuous loops, fens and oxbow lakes. The Tisza often changed course prior to its regulation, and frequent floods used at Szolnok, could be 63-fold (60 and 3,800 m^3/sec, respectively). This phenomenon is due to the 8 major tributaries of the river, namely Bodrog, Sajó, Bódva, Hernád, Szamos, Kraszna, Körös and Maros rivers *(Figure 1).*

These tributaries entering Hungary have high channel slope gradients, which serves often as a source of regular flood hazards. The regime of rivers flowing into the plains

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Fig. 1. Catchment area of the Carpathian Basin (after VITUKI)

shows extreme values. The upper reaches of tributaries are particularly wild, especially, dangerous are those of the Upper Tisza and of the Körös (the latter empties into the Lower Tisza) where the water level might rise 8–10 m within 20–30 hours following intense rainfall (Kocsis, K. and Schweitzer, F. eds. 2009).

To mitigate the extreme flood hazard, drainage regulation measures and the construction of flood control embankments started nearly 200 years ago and their alteration has been continuous ever since. With the regulation of the Tisza its section has shortened by more than 460 km on the present-day territory of Hungary. All these have resulted in increasing flood subsidence, especially on the Upper Tisza. However, it may also result in grave situations developing on the Lower Tisza, dependent on the coincidence of, or difference between high water stages of the tributaries.

A new concept for flood prevention

A detailed re-examination of the concept and regulation of the Hungarian flood prevention was carried out last time in the 1970s. In order to avoid the impending disasters the elaboration of a new strategy has become an urgent and imperative task by now *(Photo 1* and *2, Table 1).*

The catastrophic floods of the last decades in Hungary have been caused not only by the major rivers (Danube and Tisza), but by their tributaries as well. For instance, high water stages during the last 15 years in the catchment area of the Tisza River proved to be critical in 1998, 1999, 2000,

Photo 1. Siltation of 2–3 cm thickness following the flood of 2000

Table 1. Major flood waves on Tisza River since 1973 (after I. Nagy)

Year of occurrence	Actual peak stage at Szolnok (cm)	Under bed conditions of 2000		After the 30 years occurrence, if no intervention follows		
		Above the level of 1970 (909 cm)	Above design flood stage (961 cm)	Expected date of occurrence	Anticipated peak stage due to further deterioration	Above design flood stage (961 cm)
1977	880	940	–	2007	954	–
1979	904	**975**	**14**	2009	**993**	**32**
1980	873	930	–	2010	950	–
1981	885	940	–	2011	**962**	**1**
1998	897	903	–	2028	959	–
1999	974	**977**	**16**	2030*	**1,101**	140
2000	1,041	**1,041**	**80**	2050**	**1,151**	190
Occasion	*7*	*6*	*3*	*7*	*4*	*4*

* After 31 years, ** After 50 years

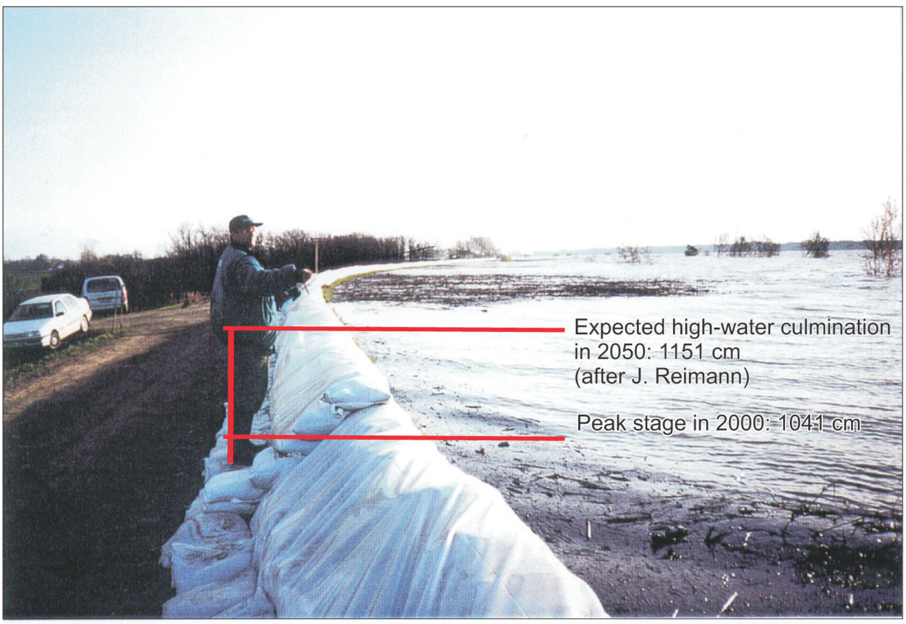

Photo 2. Change in peak stages of floods between 2000 (actual) and 2050 (anticipated)

2001, 2006 and 2010. All these cases make necessary a thorough analysis of the extreme flood events to be carried out and the drawing of conclusions with recommendations to be made as for the immediate legal interventions.

At present there is no flood security regulation, and probably this could be the cause of the absence of the systematic control and evaluation. The regulation on the design flood stages of the rivers (MÁSZ) published in 1976 can be regarded only as planning prescription. The assessments and statistics on the flood situations on the rivers do not deal with the flood security.

(Note: According to the public knowledge, in 1976 this prescription was constructed for a probability of the occurrence of the highest floods once every 100 years. It was not valid for every river even then, but nowadays it is almost impossible to find a river segment where it could be adopted. The build-up of the top level of the embankments was mostly based on the regulations for 1934 and the period before 1956. The situation, however, has changed significantly since then resulting in false concepts. According to the rules valid in the Netherlands, the embankments of rivers with high risk of flooding must be constructed for a probability of the occurrence of the highest floods once in 1,250 years.)

Before 1976 the measure of flood security was based on the difference between the height of embankments and the highest level of former floods. Since 1976 this kind of records on the rivers has not been made, only on some short segments. The recommended difference between the height of embankment and the former highest high water stage was gradually increased by 70 cm up to 100–150 cm between 1852 and 1934, and the minimum size of the embankment section was also determined *(figures 2 and 3).* In 1956 the average value was 100–120 cm along the Tisza River, but it reached +70 cm almost everywhere. At present this value is generally less than 40 cm and it does not even reach +20 cm along the river at a length of several hundred kilometers. (As a result during the flood in 2000 a temporary dike had to be built and the embankments had to be raised along a 155 km segment of Middle Tisza.)

During the last 100 years the difference between the embankment height and the highest level of floods along the Tisza River has never been as low as in the present (Schweitzer, F. 2009).

In Hungary great care was taken to the maintenance of the conditions of the high-water (flood) bed and the free throughflow of the rivers until the 1960s. In 1960 the afforestation of the floodplains, the building of inner, summer dikes and cottages, the leaving of the pastures and ploughlands, the

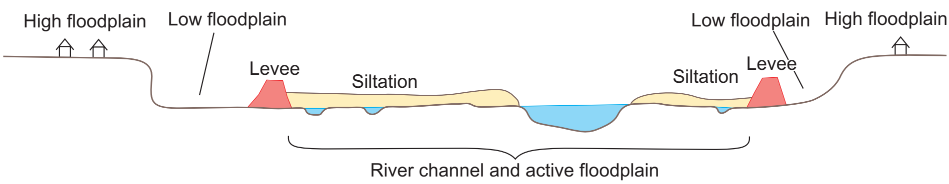

Fig. 2. Rising of the flood control embankments since river regulation (after Schweitzer, F. 2001)

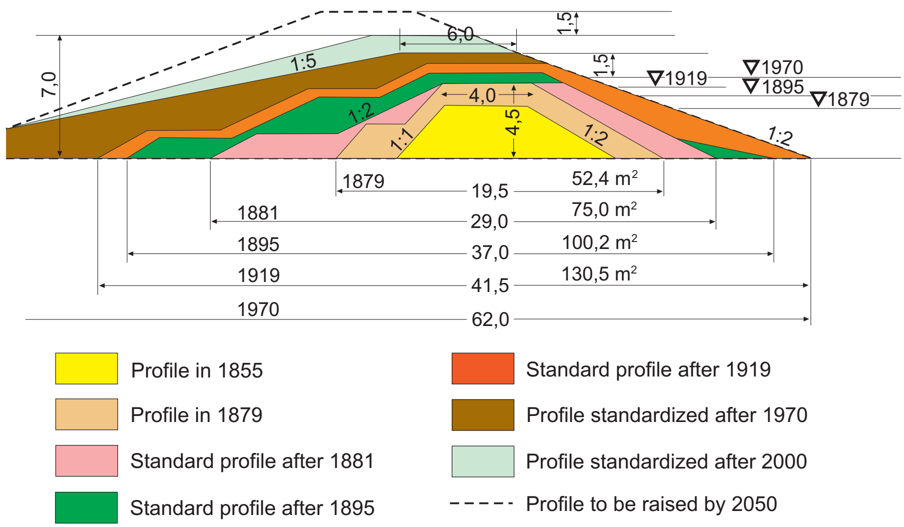

Fig. 3. Rise of the embankments (after Vágás, I.)

spreading of the invasive species (e.g. *acacia*) began, which have largely contributed to the fast rise of high-water levels and the increased accumulation of the transported sediments. It can be stated that Hungary has given up the maintenance of the transmissivity of the active floodplain, only the construction of the embankments was emphasized. Flood retention reservoirs were constructed only on the smaller streams. Hungary did not deal appropriately with the causes of the frequency, discharge, height and duration of the floods and with the probable consequences. The siltation of the river channels makes the rising of the embankments necessary, but it could be done only at some places. New storage capacities should be created, sometimes by means of sacrifying populated areas. Technical solutions are just partly able to provide remedy for the problems. A novel examination of regional development, landscape management and landscape rehabilitation are the issues to be addressed. A new land use system on cultivated areas is to promote the establishment of wetland habitats which requires the participation of local people. To avoid disasters the involvement of public-minded politicians might be instrumental. This common responsibility makes necessary to prepare the acts for legitimization, which is a national security issue *(Figure 4, Photo 3).*

The flood security of an area is determined by the state of the weakest points of the embankments. During the last two decades the number of construction objects and traverses to be renovated or replaced has been on rise due to the increased water load caused by the aging of the embankments and the rising flood levels. Owing to damages, the flood-defence scheme and its future prospects must be revaluated. Remarkable flood level rise can be

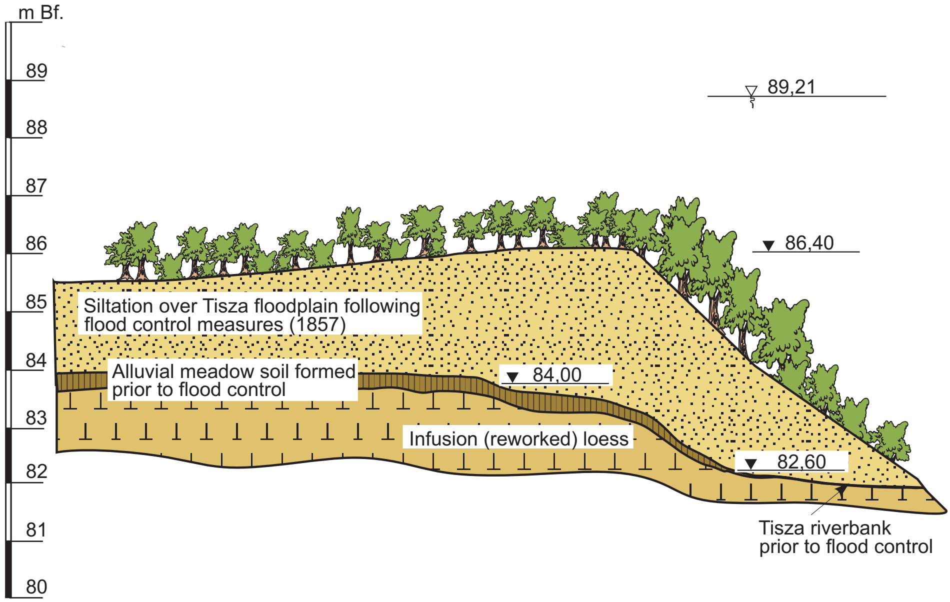

Fig. 4. Siltation over Tisza floodplain at Alcsisziget, Szolnok
(after Schweitzer, F., Nagy, L. and Alföldi, L. 2002)

Photo 3. Floodplain sediments of Tisza River near Szolnok

expected in inland catchment areas because of natural processes and economic shifts and other human interferences having taken place in the active floodplain. The conveyance capacity of the flood bed decreased by 3 cm per year along the Middle Tisza section between 1970 and 2010 (Schweitzer, F., Nagy, L. and Alföldi, L. 2002). It means that in the case of the occurrence of a flood similar to the one of 2000 the embankments could not prevent the river from overflowing even if the excess water were led into the flood-control reservoir at Tiszaroff. *(Figure 5)*

There would be a similar situation at Tiszabecs if the 2001 flood happened again. Such and similar areas are still found in great number between Khust and Titel. An immediate moratory must be declared on building up these territories which are suitable for the establishment of retention reservoirs.

The narrowing of the river channel jeopardizes vast tracts, among others within densely populated areas. This is primarily not a technical problem, but specifically an administrative and political issue. Changes in the catchments beyond the state border are also unfavourable. In Hungary little emphasis have been put on monitoring of the role and operation of foreign reservoirs. Information derived from the daily data traffic is scanty either.

The raising of the embankments in Subcarpathia, the flood-control reservoirs constructed at the meeting point of Tisza and Batár rivers as well as the restricted river bed of Tisza at the Serbian–Hungarian state border resulted in new conditions which have not been dealt with at all. During the 2006 Tisza valley flood the operation of foreign reservoirs was not reckoned with, analyzed and evaluated (Lóczy, D., Kis, É. and Schweitzer, F. 2009).

In view of the above facts it may be claimed that over the past 100 years the effectiveness of flood prevention has never been so low along the Tisza River as it is nowadays.

Similar problems can be observed in other catchment areas, too. During the last 15 years extreme flood events have become more frequent which may bring about an increase in the number of damages and even fatal accidents might occur owing to further disasters.

The Amended Vásárhelyi Plan (VTT) approved for the Tisza Valley in 2003 aimed to improve the situation of the most critical valley segments of Tisza outlining the preparation of a forthcoming program. Unfortunately, a new concept or a program garanteeing a long-term flood prevention have not been prepared yet.

(Note: several documentations under the aegis of the concept have been prepared, but none of them have informed the audience about the present and future flood prevention.

They do not refer to the level of security which can be achieved by utilizing the proposed development fund.)

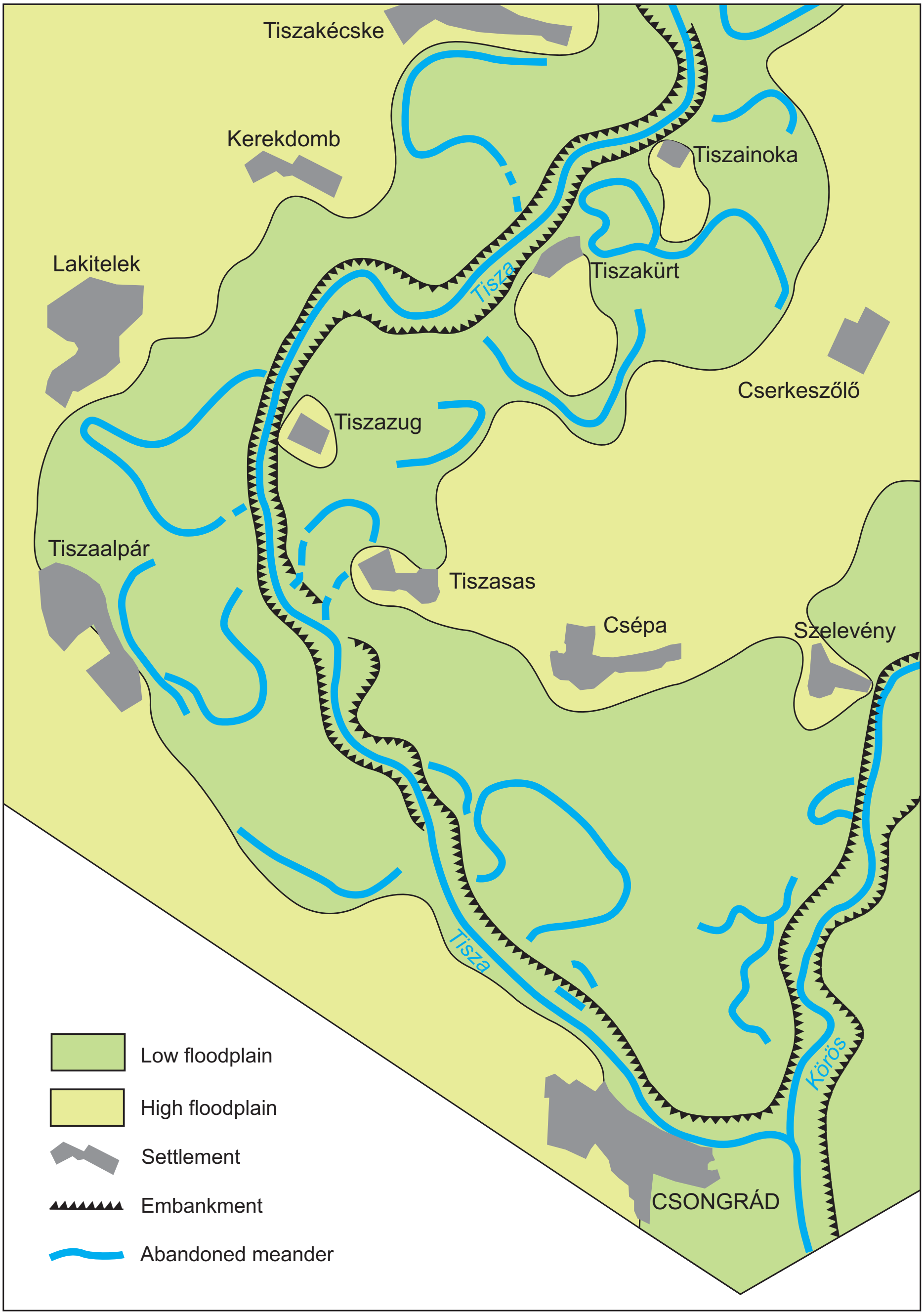

Fig 5. Tiszazug, a low-lying area, a key location for the establishment of a retention reservoir (after SCHWEITZER, F. 2001)

Conclusions

The future objective of the Hungarian flood prevention must be the creation of flood security as by law enacted. The protection of the Tisza Valley and catchment areas of other rivers is a national strategic priority.

The reform of the Hungarian flood prevention, the development of the new flood prevention concept and doctrine are crucial technical and above all political questions.

Taking into consideration the new concept, the elaboration of a program under realistic assumptions is needed to ensure a long-term flood security of protected flood areas along Tisza and other rivers to be able to inform decision makers, stakeholders as well as the inhabitants concerned and to utilise the available sources. The purpose of the new program beyond the increase of flood security is to improve the quality of life of the population concerned, extend water supply capacities, preserve natural resources and provide flood risk management.

Hungary is to undertake a similar task she did during the 1830–40s. Strategic decision for the next 100–150 years should be made for the sake of the population of our river valleys and protected flood areas.

These proposals have been made on the basis of the activity of professionals who work on the comprehensive reformation of the Hungarian flood prevention and set themselves a target of creating a new structure for the sake of river basin development and management under the EU regulations.

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Geomorphological environment of boulders and grain-size analysis of gravel sheets in the Southern Börzsöny, Hungary

József Szeberényi[1]

Abstract

Previous authors draw attention to gravel sheets in the south of Börzsöny Mountains, which are not related to Pleistocene gravels of Danube terraces. Two areas were studied: in the south-western and south-eastern parts of the mountains. These pebbles have survived in good condition. Although there are considerable horizontal distance and difference in altitudes between the two gravel sheet locations, the geomorphological and grain-size analyses have resulted in some important conclusions. The geomorphology of the two areas is very similar to each other. The correlational statistical analysis of grain size shows similarity between the samples collected from the occurrences. In the environment of both locations some boulders are found composed of quartzite. They are usually between 20 and 40 cm in diameter, but some of them are of 60 cm size. In the opinion of the author these boulders were very probably transported by floating frozen in ice floes.

Keywords: geomorphology, grain-size analysis, gravel sheets, pebbles, Börzsöny Mountains, Southern Börzsöny

Introduction

Szabó, J. (1872) was the first Hungarian researcher who dealt with cobbles up to 20 cm in diameter. He found boulders in the Mátra Mountains and considered them moraine sediment. Since then numerous studies have appeared on more or less rounded boulders. They occur mostly in the Danube Valley and in the Mátra, but were also found in the Bodrogköz and in the alluvium of the Maros River. They are mostly composed of quartz, andesite, gneiss and other metamorphites. Gravel occurrences in relation to the research of the Börzsöny volcanism and of the Visegrád Gate were mentioned in different studies published during the second third of the 20th century.

In the above mentioned studies gravels observed in the Börzsöny were not put in relation to those of Danube terraces. Former researchers wrote about

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boulders encompassed by these sediments as large as a „*head*" or a „*chair*". Nowadays these gravel sheets appear in patches isolated from each other by the terrain in certain parts of Southern Börzsöny *(Figure 1).* The dilemma is whether to distinguish between them in respect to their origin or to consider as remnants of fluvial deposits of one ancient river. In every deposit there are some large size gravels, generally between 25 and 40 cm in diameter, but in many cases well rounded quartz and quarzite boulders more than half meter in diameter can also be found. These gigantic boulders are meant to be a common feature between the isolated gravel deposits of the Southern Börzsöny.

The discipline of geomorphology examines these sediments with terrain analysis of their environs. The gravels investigated in this study were already mentioned in former articles as we will see in the chapter on history of research. Attempts were made to determine the origin and the place of provenance of gravels, but thorough terrain and geomorphological analysis of their environs have not been carried out yet. Hence in this study an analysis was to be performed from this point of view. The location of pebbles and boulders mentioned in former studies were visited and the database became expanded with new occurrences.

The history of research on boulders in the Börzsöny Mountains

Papp, F. (1933) described pebbles in the western part of the Southern Börzsöny (in the Sas Hill side and on the Koppány Saddle). He held that these gravels are older than the volcanism but did not refer to any boulders. Ferenczi I. (1935) was the first who wrote about the gravel sheets on the eastern side of the Börzsöny. They were brought into connection with ancient pebbles near Vác and Pestszentlőrinc, based on similar composition and „*roughness*". In his opinion the ancient Ipoly running along the eastern side of the Börzsöny, carried these pebbles from the Vepor Mountains (part of the Northwestern Carpathians in Slovakia) during the Late Pliocene and Early Pleistocene. He paid special attention to the boulders near Nógrád described as "yellowish brown" and as big as a "head" or a "chock".

Láng, S. (1952) wrote a comprehensive study about the geomorphology of the Börzsöny. He dealt in details with gravels found at the eastern margin of the mountains. During his research he found lots of new occurrences and plotted them on a summary map. He standardized the origin and accumulation of the pebbles around the mountains. He could not accept Papp's opinion on their genesis preceding volcanism. His stance was similar to that of Ferenczi I. instead: gravels are younger than the volcanism and they were transported by ancient rivers in the Late Pliocene. Láng, S. came across some reworked gravels in the south-western Börzsöny, and he amended Papp's work accordingly. The

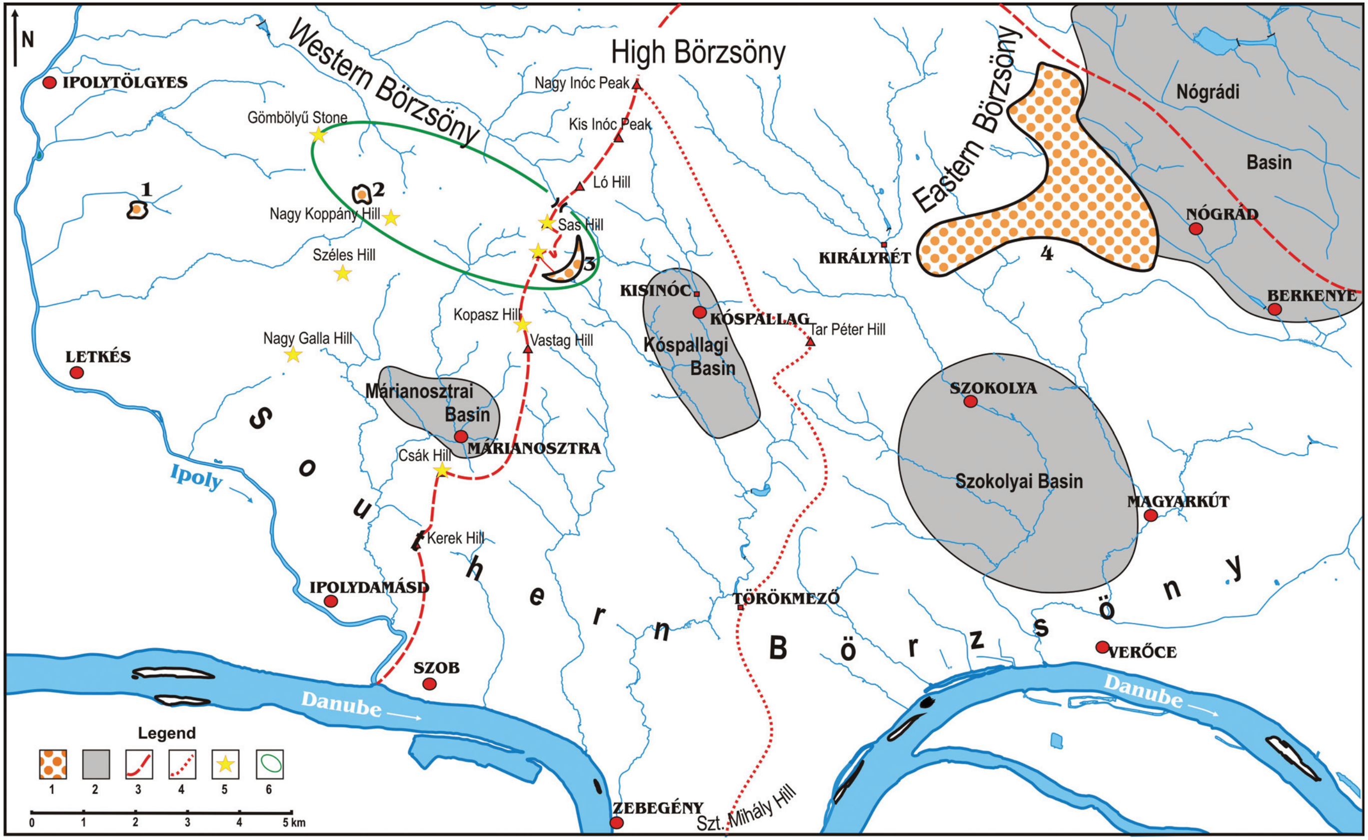

Fig. 1. Important gravel sheet occurrences in Southern Börzsöny. – 1 = Important gravel sheets; 2 = Basins; 3 = Primary drainage divide (Danube/Ipoly); 4 = Secondary drainage divide; 5 = Ancient volcanic explosion center; 6 = Headwaters of streams in south-western Börzsöny. This area is shown enlarged on *Figure 2*

gravel sheet on Koppány Saddle superimposing andesite rocks with a thickness of 2–3 meter was found very important. Characterizing the pebbles on the Sas Hill side and in the valley of Ló-hegyi Stream Láng, S. wrote: „*Grain size is varied, every size occurs in diameter between 1 and 50 cm. There are many boulders as large as the childhead or a chair.*" He agreed with Ferenczi's opinion, the gravels in south-eastern Börzsöny were transported by the ancient Ipoly, but he thought the pebbles at Pestszentlőrinc were probably transported by the Danube.

Vadász, E. (1953) studied the gravels in south-eastern Börzsöny near Nógrád, but he concentrated mostly on dreikanters. In his opinion these sediments are „*reworked tuffy gravel, terrestrial conglomerates mixed with coarse sand, which were deposited in the Sarmatian, after Tortonian (Badenian) andesite volcanism*". He believed that this pebble was transported by an ancient river in Sarmatian-Pannonian, from a Mesozoic mountain, located north of Börzsöny Mountains. The dreikanters formed from these pebbles in Würm. The author noticed some large sized boulders. He wrote about them: „*their size is between fist and half a meter in diameter*". This statement corresponds with those having been made by former authors.

Jankovich, I. and Hála, J. (1972) found an outcrop during the geological mapping located south-east of Ipolytölgyes and it shows the relations of settlement between Leitha limestone and the volcanic rocks. Authors commented: „*as it can be seen the Leitha limestone is underlain by pyroclastic rocks. There are also some andesite and quartzite boulders directly under the limestone in the agglomerate cemented by tuff. These quartzite boulders are as large as a head*". Based on the description of this outcrop it can be stated that these boulders deposited in a period between the volcanism and the Badenian transgression. We know this occurrence only from references, so we cannot decide, if there is any kinship between these boulders and those found in the mountains. In any case the approximate position of this outcrop was plotted on our map *(Figure 1, symbol 1).*

Vargáné Máthé, K. (1975–1976) dealt with pebbles found along the eastern margin of Börzsöny when she participated in the geological mapping of the mountains. She believed that the gravels were deposited during the Oligocene and Early Miocene. Accordingly these pebbles were transported from Vepor rocks, which were uplifted northward from Börzsöny Hills until the Middle Miocene. She referred to the works of Wein Gy. This standpoint is in agreement with the concepts of Ferenczi, I. 1935. and Vadász. It is surprising, that Vargáné has not mentioned boulders near Nógrád in her study.

Drainage network and basic morphology of Southern Börzsöny

Drainage network and basic morphology of Southern Börzsöny have developed since the Late Pliocene, after the Danube appeared in the Visegrád Gate.

The drainage network of the western part changed with the appearance of Ipoly River in the Pliocene *(Figure 1).* The first drainage divide is running along the border between the drainage basins of the two rivers. It starts from the mouth of Ipoly, and stretches then through Csák Hill–Sas Hill–Nagy-Inóc Peak to High Börzsöny. There it turns south-east and proceeds near Nógrád and Berkenye to the Nógrádi Basin.

The drainage pattern of the area has always been controlled by the Danube and Ipoly rivers, but it was modified significantly by the small basins of Börzsöny. The uplift of Börzsöny Mountains has been accelerating since Late Pliocene. Parallel with the general uplift there is an ongoing subsidence of small basins, but the latter is slower than the rate of downcutting of Danube. Therefore the streams running to Danube, cannot build debris cones or only accumulate those of small size. Streams are downcutting persistently thus having shaped the hilly surface of small basins. The section Csák Hill–Sas Hill of the primary drainage divide separates from each other the Márianosztrai Basin and the Kóspallagi Basin. A secondary drainage divide separates the Kóspallagi Basin and the Szokolyai Basin. It starts from Nagy-Inóc Peak and runs through Tar Péter Hill and Törökmező to Szt. Mihály Hill.

In the course of a geomorphological analysis of the areas of gravels of Southern Börzsöny, they were divided into two parts. The western occurrences of pebbles are on the boundary of High Börzsöny, Western Börzsöny and Southern Börzsöny. The gravel sheets are found on the hillsides. They have been raised up to 440–450 m above sea level by the general uplift of Börzsöny. The eastern part of the area of pebbles marks the boundary of High Börzsöny, Eastern Börzsöny, Southern Börzsöny and Nógrádi Basin. There are gravel sheets near the margin of the basin. They are located at altitudes between 290 and 310 m a.s.l. due to the uplift *(Figure 1).*

In both places some lag surfaces can be found on the valley sides. These are relics of an ancient plain that used to surround the mountains, and later it was dissected by the current drainage network. So the traces of ancient river valleys can be sought by geomorphology. In geomorphological and topographic considerations a secondary drainage divide was chosen as the border between the southwestern and southeastern locations. This boundary lies along the crest connecting Nagy-Inóc Peak–Törökmező–Szt. Mihály Hill.

Geomorphology of the environs of the gravel sheets in south-western Börzsöny

The geomorphology of south-western Börzsöny was determined mostly by channel erosion. It is interesting that the surface drainage network of this area is not controlled by through streams of High Börzsöny, but there is an independent local headwater. This is on the boundary of High Börzsöny, Western Börzsöny and Southern Börzsöny, in the vicinity of the Só Hill, Sas Hill and of a ridge starting from these hills and stretching along the crest of Nagy Gyertyános Hill–Nagy Koppány Hill–Kis Koppány Hill–Gömölyű Stone *(figures 2* and *3).*

The headwaters were developed by the unique drainage network of south-western Börzsöny. The base level of erosion forms a semicircle that follows the pattern of Danube and Ipoly rivers *(Figure 1).* The backward erosion of valleys running from the base level of erosion and converging upstream is confined to the radiuses of the semicircle. In this way a narrowing area of headwaters has been developing by the backward erosion in the course of the ongoing landform evolution. The general direction of channel erosion is shown with black arrows in the *Figure 2.* Quite logically, the backward erosion hit last these headwaters in the south-western Börzsöny, so the area was fractured least of all. In order to search some information about geomorphology of south-western Börzsöny prior to the formation of present-day drainage network, a study of these headwaters were needed. During scrutiny of headwaters there could be found two gravel sheets *(figures 2* and *3)* on andesite rocks, which are definitely fluvial deposits of an ancient river. There are some kilometers between the two occurrences, but both are on lag surfaces, at an altitude of 440–450 m a.s.l.

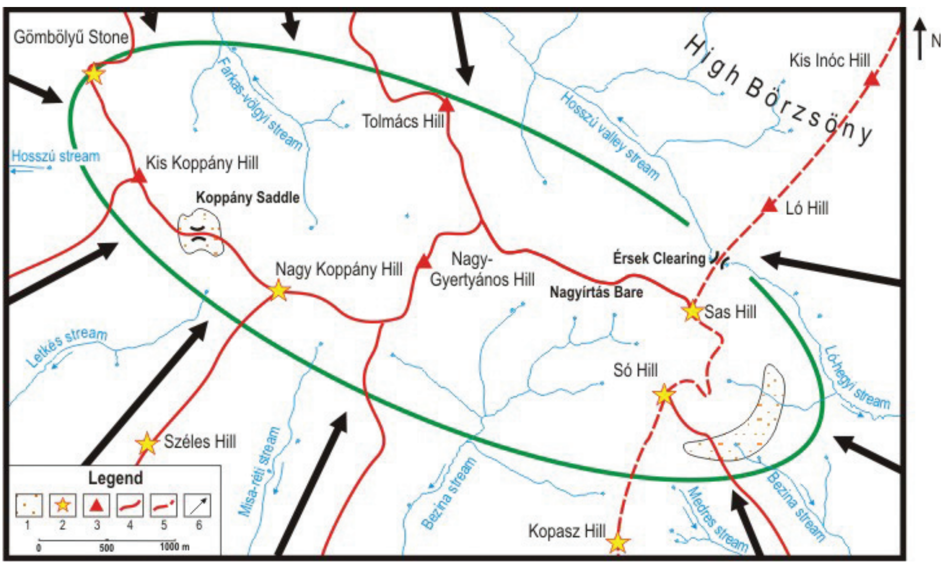

Fig. 2. The headwaters of south-western Börzsöny. – 1 = Important gravel occurrences; 2 = Ancient volcanic explosion center; 3 = Other hilltop; 4 = Secondary drainage divide; 5 = Primary drainage divide (Danube/Ipoly); 6 = General direction of backward erosion

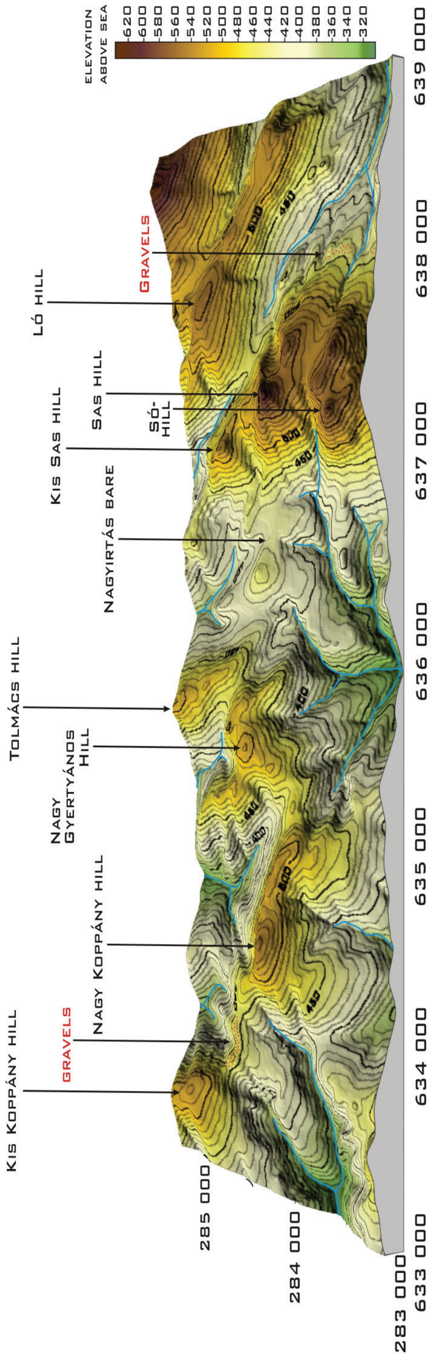

Fig. 3. Digital elevation model of the headwaters of south-western Börzsöny

The correlation of gravels is still under way, but it is conceivable that these pebbles are the remains of fluvial deposits of an ancient river. The gravels of Sas Hill and Só Hill are more important, than those of the other site on Koppány Saddle. On the Sas Hill–Só Hill and their environment the layer of pebbles is thicker than at the other site and here some boulders were found *(Photo 2).* These boulders were noticed by Láng, S. in 1952, but he did not analysed this area geomorphologically and the boulders in the surroundings of the Sas Hill has not been mentioned since then.

I would like to remedy this deficiency in the present study. The pebbles and the large sized boulders are now partially in the valley of streams in the environs, because they were moved from their original place by channel and areal erosion. The small streams could not transport far away the boulders, so it is sure that the initial place of these boulders was the lag surfaces of the Sas Hill and Só Hill, which are situated at 440–450 m a.s.l..

The Sas Hill and Só Hill are key landforms in the south-western Börzsöny. They are the ruins of two ancient volcanic explosion centers, which were one landform with four pikes by erosion. These are part of the first drainage divide between the Kóspallagi Basin and Márianosztrai Basin. There rise a lot of springs on the sides of the hills. From here some streams flow to Danube and some other ones

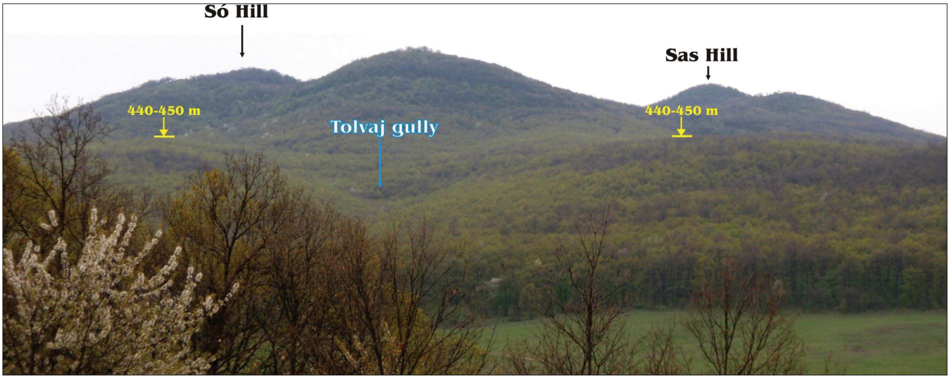

Photo 1. The Só Hill, the Sas Hill and the lag surfaces on their sides

empty to Ipoly. The Ló-hegyi Stream flows eastward, the Tolvaj Stream and Medres Stream run southeastward. These come under the drainage area of Danube. The Bezina Stream flows southwestward and the Hosszú-völgyi Stream northwestward. These streams are part of the drainage basin of Ipoly *(figures 2* and *3).* Erosional valleys of these streams have dissected the foreland of Sas Hill and Só Hill. There are some lag surfaces around the mountains at 440–450 m a.s.l. *(Photo 1).* To show them both contour lines were drawn in red on the digital elevation model *(Figure 4).*

Initially the two hills were very probably surrounded by a continuous plain surface that later became dissected by current streams. These lag surfaces are discernible nowadays. The elongated plain surface on the top of the Ló

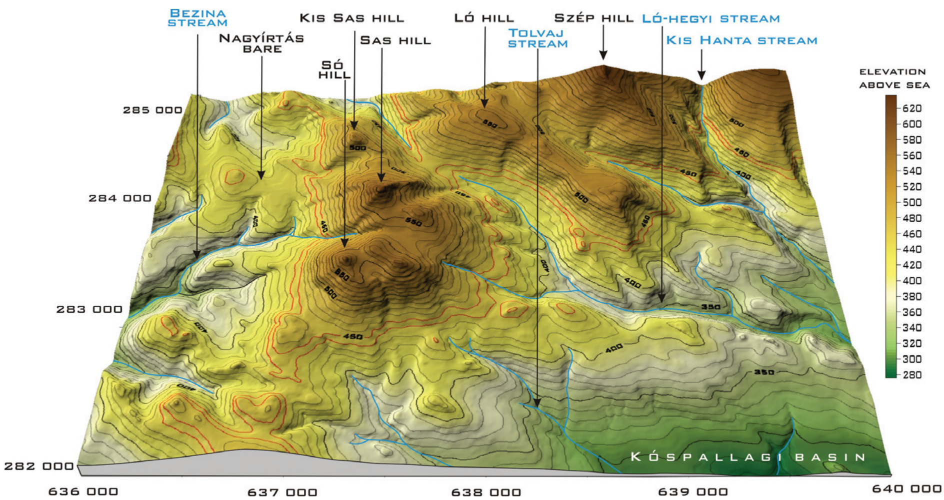

Fig. 4. Digital elevation model of the environs of Sas Hill and Só Hill

Hill is also conspicuous. Láng, S. recognized several flat summit levels in the south-western Börzsöny and Helembai Hills. In his opinion they are also lag surfaces, which were developed in the Late Miocene and Early Pliocene by etchplanation; the Ló Hill is an example. His concept has not gained adherents. In the course of our fieldwork no fluvial sediments were found. During the geomorphological mapping of Sas Hill and its environs a great amount of reworked pebbles were identified in the valleys of Ló-hegyi Stream, Tolvaj Stream and Medres Stream.

The areas of pebbles were plotted on a map *(Figure 5).* The original places of gravels are on the lag surfaces located on the eastern and southern sides of the Sas Hill and Só Hill at 440–450 m a.s.l.. The backward erosion from Kóspallagi Basin has fractured the previously contiguous plain surface and sheet erosion still keeps on destroying the superimposing gravel sheets *(Photo 2).*

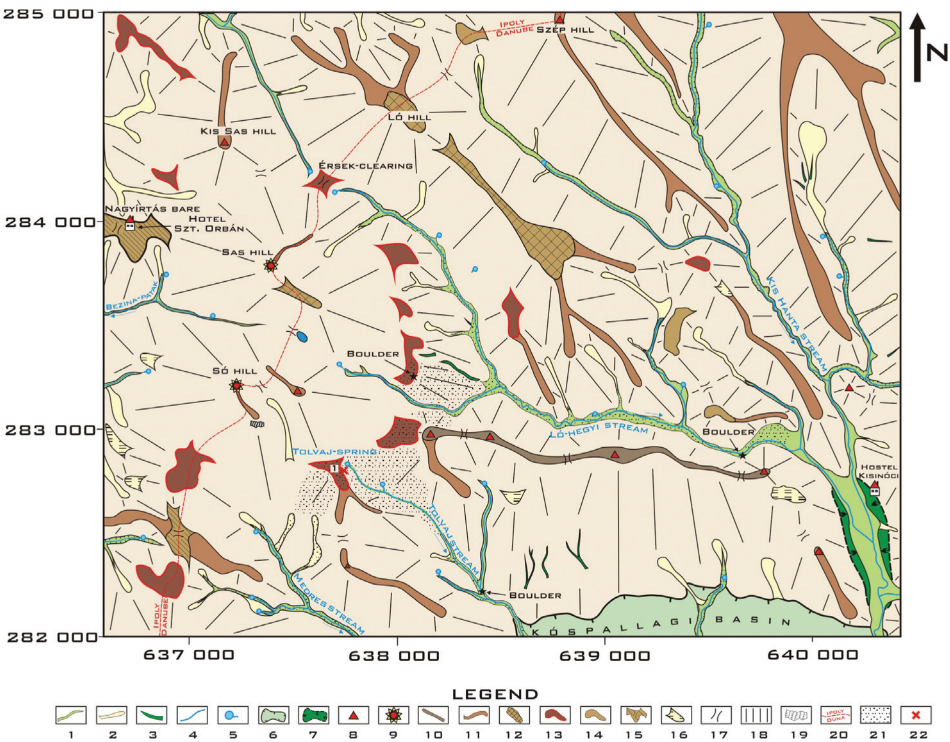

Fig. 5. Geomorphological map of environment of Sas Hill and Só Hill. – 1 = Erosional valley; 2 = Derasional valley; 3 = Rill; 4 = Stream; 5 = Spring; 6 = Basin; 7 = Local tectonic depression; 8 = Hilltop; peak; 9 = Pike (old volcanic explosion center); 10 = Crest; 11 = Interfluve; 12 = Summit level; 13 = Lag surface (440–450 m); 14 = Other lag surfaces; 15 = Wide saddle surface; 16 = Gentle slope segment; 17 = Saddle; 18 = Slope; 19 = Cliff; 20 = Primary drainage divide (Danube/Ipoly); 21 = Gravels; 22 = Outcrop

Photo 2. Boulder in the valley of Ló-hegyi Stream

Gravels of the south-western Börzsöny and their grain-size analysis

The most beautiful and intact layer of pebbles is to be found next to Tolvaj Spring on the side of the Só Hill. This place can be seen on *Photo 1*, above the Tolvaj gully, lying west of it (lag surface at an altitude of 440–450 m a.s.l.). The shape and elevation of this slightly undulating lag surface is similar to akin surfaces in the surroundings around the Sas Hill and Só Hill. The gravel layer near Tolvaj Spring is 4–5 m thick. In its upper part an outcrop was made (*Figure 5*, *Photo 3*). General colour of the profile is pale yellowish brown. The well rounded granules are mostly 0.5–1 cm in diameter. Middle-sized and well rounded granules, with grain-size of 1–5 cm in diameter also occur frequently, and there are some larger pebbles (10–15 cm in diameter.) Usually these gravels are composed of quartz and quartzite, subordinately of crystallic, metamorphite rocks and partly of local andesite. The pebbles are likely to have originated from the Alps or from the Carpathians. After sampling a grain-size analysis of the material smaller than 2 mm in diameter was made in the Geographical Research Institute of the Hungarian Academy of Sciences (GRI HAS). The results can be seen on *Figure 9*, summarized in a curve (green), which has four apices. The first apex of median curve of sample is at 11.16 μm, the second apex is at 27 μm, the third one is at 123 μm and the fourth is at 1000 μm. The average and median values can be read from *Figure 9*.

Photo 3. The outcrop of Tolvaj spring

Geomorphology of the gravel sheets of south-eastern Börzsöny and of their environs

The contour map and the relief map show the environment of gravel sheets of south-eastern Börzsöny *(Figure 6).*

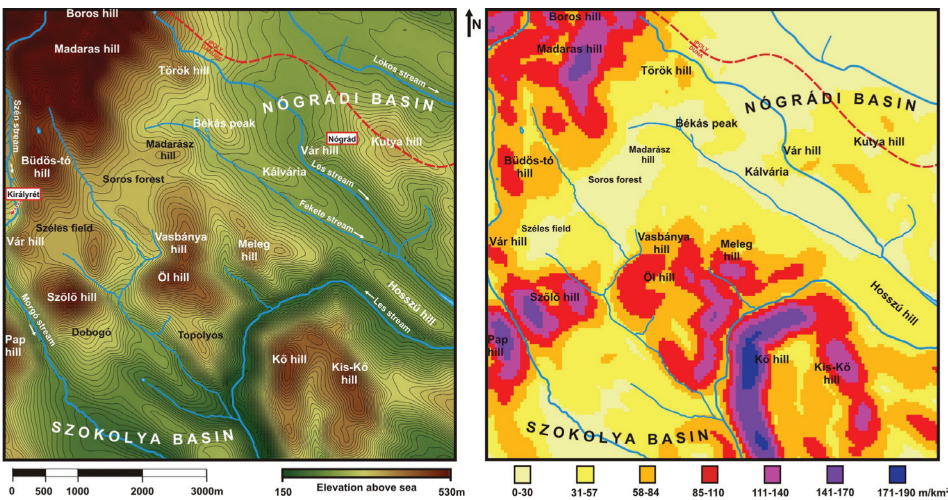

Fig. 6. The contour map and relief map of south-eastern Börzsöny

As for the drainage pattern of the area, most streams flow from north-west to south-east, but in some places the direction turns perpendicular. Tectonic predestination of this pattern seems to be quite probable. The border between the drainage basins of Danube and Ipoly runs near Nógrád settlement. North of this line lies the catchment of Ipoly River, whereas south of it is the drainage area of the Danube. The most important waters of the studied place are called Morgó Stream and Les stream, both running into the Danube. Brooks and other smaller watercourses are rising from the local springs empty into them.

There is a hilly surface between the Nógrádi Basin and the Szokolyai Basin. It is shown on the contour map. This hilly surface can be divided into two parts. The range on the north-western side of *Figure 6* is Boros Hill–Madaras Hill–Büdös-tó Hill–Vár Hill (near Királyrét); the latter is the southernmost tip of Eastern Börzsöny. The semicircle hillrange on the southern side of *Figure 6* includes the chain of Pap Hill–Szőlő Hill–Ől Hill–Kő Hill which all belong to Southern Börzsöny as the marginal elevations of Szokolyai Basin.

There are some valleys which run through this semicircle range of hills to Szokolyai Basin. As it is evident from the relief map, three gates with steep walls have developed in these places. On the same figure an area is visible enclosed by the ring of Büdös-tó Hill–Vasbánya Hill–Öl Hill–Szőlő Hill–Vár Hill (near Királyrét). This is a wide intramoutain surface with a very similar relief as the two basins, but is situated at a higher altitude *(Figure 6).* Consequently this area has to be separated from the Nógrádi Basin for geomorphological reasons. It lies between the Southern and Eastern Börzsöny and is composed tripartite of Széles Field, Soros Forest and Madarász Hill.

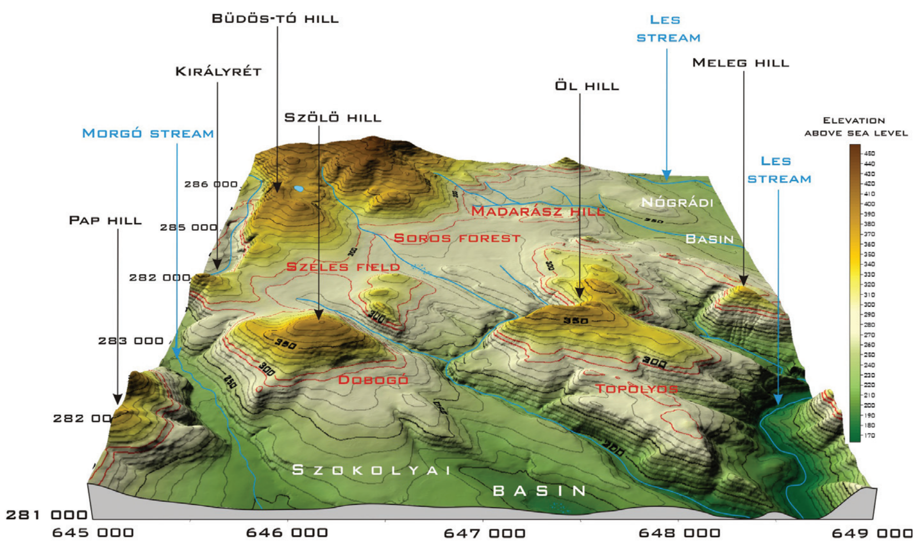

Fig. 7. Digital elevation model of the area between Nógrádi and Szokolyai basins

There are some lag surfaces on the valley sides of andesite hills. The most important ones are located at 290–300 m a.s.l. For the sake of visual perception the contours of 290 and 300 m are shown in red on the digital elevation model *(Figure 7)*. Two lag surfaces (Dobogó and Topolyos) are on the side of the Szőlő Hill and Öl Hill, above the Szokolyai basin. What is most important, the intramountain surfaces of Széles Field, Soros Forest and Madarász Hill are also at the same altitude. This area is a gently rolling surface of south-west–north-eastern extension having shaped by backward erosion, which developed from Szokolyai Basin, and it has formed three depressions in this area *(Figure 8)*. The south-western and the north-eastern depressions are derasion valleyheads, whereas the central depression is an erosional-derasional valley of a minor stream.

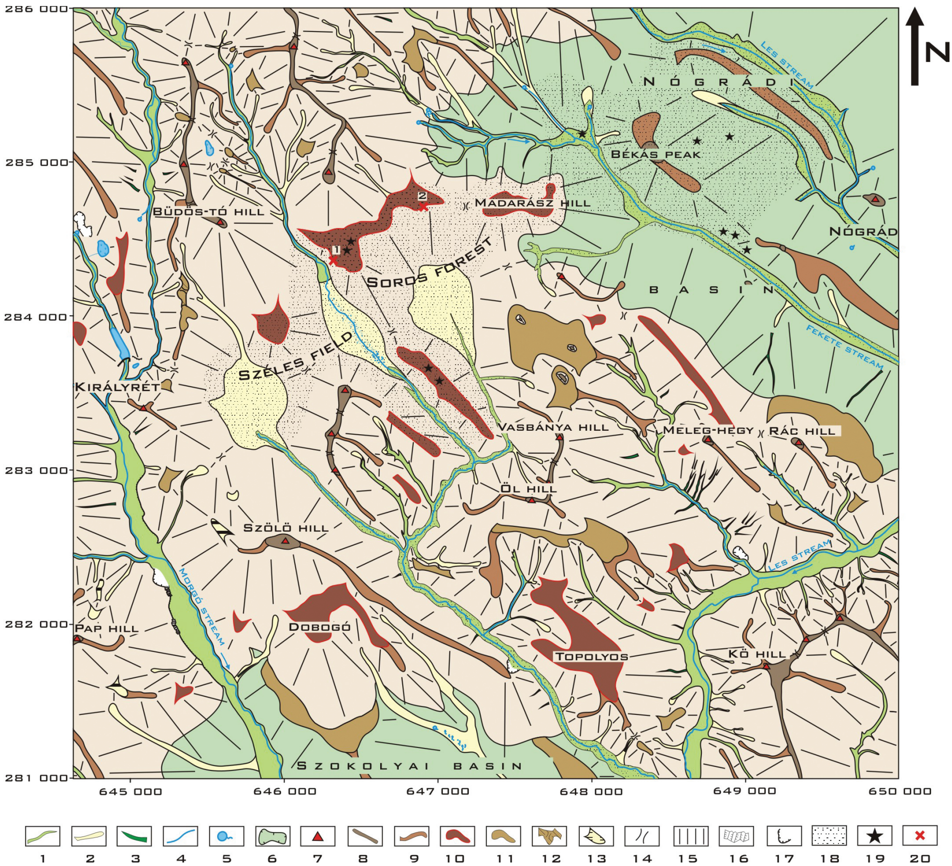

Fig. 8. Geomorphological map of the area between Nógrádi and Szokolyai basins. – Legend: 1 = Erosional valley; 2 = Derasional valley; 3 = Rill; 4 = Stream; 5 = Spring; 6 = Basin; 7 = Hilltop; peak; 8 = Crest; 9 = Interfluve; 10 = Lag surface (290–300 m); 11 = Other lag surfaces; 12 = Wide saddle surface; 13 = Gentle slope segment; 14 = Saddle; 15 = Slope; 16 = Cliff; 17 = Quarry; 18 = Gravels; 19 = Boulders; 20 = Outcrop

Before the backward erosion this area was a continous plain surface between the Eastern and Southern Börzsöny. Also very probably all the lag surfaces (Dobogó, Topolyos and the area of Széles Field–Soros Forest–Madarász Hill) used to form a large continuous plain surface around and inside the mountains built of andesite. This ancient plain was subsequently dissected by current streams.

The lag surfaces at 290–300 m altitude are especially important, because a lot of pebbles could be found on them. In these gravel deposits are also the boulders 60 cm in diameter *(Photo 4)*, which were already noticed by Ferenczi, I. (1935) and Vadász, E. (1953). These pebbles and boulders were located originally on the northern and southern sides of Széles Field and Soros Forest, and some patches of them are still found there and in summit position on the top of the plain surface of Madarász Hill *(Figure 8)*. Nowadays the original gravel sheet is affected by denudation.

Pebbles are reworked first during transport into the derasional valleys and from there to the channels of streams that take them into the Danube. The lag surfaces of gravels also extend over the Nógrádi Basin. The gravel deposits atop Békás Peak and the gentle rolling hilly surroundings are further good examples.

Photo 4. Boulder of large size near Békás Peak

The most beautiful and thickest layer of pebbles of the area lies on the lag surface in the northern part of the Soros Forest. The form and elevation of this residue is very similar to other lag surfaces between the Eastern and Southern Börzsöny. The thickness of this fractured gravel sheet is between 2 and 3 meter. It was outcropped on two occurrences. Based on the description of outcrop these sediments can be labeled as sandly pebbles *(Photo 5).*

With regard to the colour of outcrop profile of sandy pebble sheets they show an irregular alternation of brown and grey patches. The grain size of gravels is mostly fine (0.5–2 cm in diameter) and well rounded. Middle and well rounded pebbles with grain size of 2–5 cm in diameter occur frequently, but there are also some larger ones (10 and 20–25 cm in diameter). Usually these gravels are composed of quartz and quartzite, fewer of crystallic and metamorphite rocks and some of andesite locally. The most probable source areas are Alps or Carpathian Mountains. After sampling, grain-size analysis was carried out on the material smaller than pebble fraction (2 mm in diameter) in the GRI HAS. The results of laboratory analyses are shown on *Figure 9.* As a summary on the outcrop profiles two curves of median values

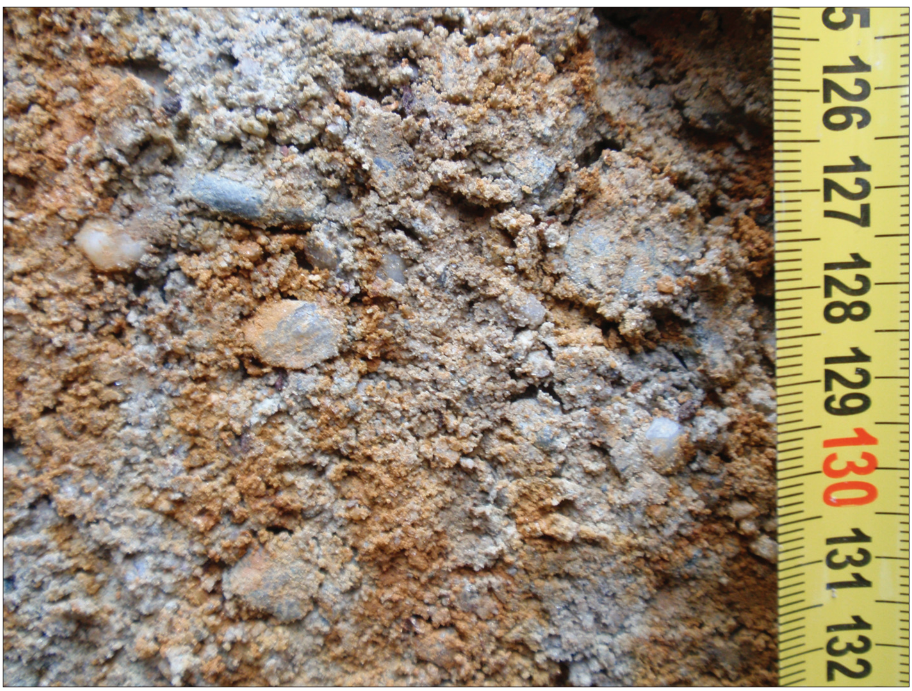

Photo 5. Outcrop profile in the Soros forest

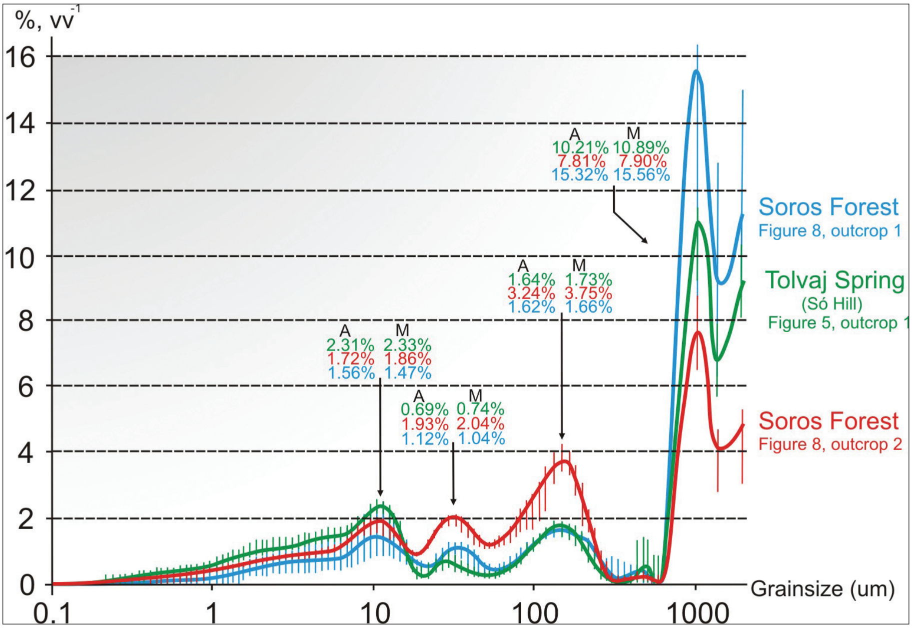

Fig. 9. Grain-size diagram (0.1–2,000 μm)

(blue and red) were drawn, which have four apices. The first apex of median curve (blue) of sample from the first outcrop is at 10.24 μm, the second apex is at 28.60 μm, the third one is at 134 μm and the fourth – at 1,000 μm. The respective apices of the median curve (red) of the other outcrop are: at 11.16 μm, 31.2 μm, 146.2 μm and 1,000 μm. The average and median values can be read from *Figure 9*.

When all is said, dreikanters should also be mentioned those spread over the surface of this area. These gravels are formed by corrasion and have developed from the original gravel layer. These dreikanters do not have any desert crust or desert varnish, but its form is the evidence of their having shaped by wind *(Photo 6)*.

Photo 6. Dreikanters

The comparison of the gravel sheets of south-western and south-eastern Börzsöny

The two occurrences of pebbles are 10 air kilometres from each other. The areas of gravels are separated topographically. The boundary is the secondary drainage divide, which lies along the line Nagy-Inóc Peak–Törökmező–Szt. Mihály Hill. Also there is a considerable vertical difference, because the pebbles of south-western Börzsöny are located at 440–450 m, and those of south-eastern Börzsöny were found at 290–300 m a.s.l. Although the two sites are far from each other, the gravels of Southern Börzsöny are intriguing, because there are a lot of common features based on the geomorphological and laboratory analyses.

1. The gravel sheets of both areas are found upon lag surfaces, which developed from an earlier continuous plain surface by backward erosion of current drainage network. These lag surfaces are on the slopes of andesite mountains. Having become fractured thoroughly, they nevertheless are correlated with each other fairly well. Thus the geomorphological analysis of the environs of pebbles dicovered some lag surfaces, which are very probably remains of an earlier river valley.

2. There are some large sized boulders at both occurrences *(photos 2* and *4)* and found in their environs, on lag surfaces or confined to them. These well rounded boulders were shaped by gravelly sand stream load.

3. The grain-size analysis provides reliable evidence of the similarity between the gravel sheets. As it is also visible on *Figure 9*, the grain-size values of less than 2 μm of the samples from the three outcrops resemble each other closely. The results of the correlation analysis (R^2) are shown on *Table 1.*

Table 1. Correlation of values of grain-size analysis

Correlation of samples (R2)			
Occurrences	Tolvaj Spring	Soros Forest 1	Soros Forest 2
Tolvaj Spring	1.000000	0.969476	0.979708
Soros Forest 1	0.969476	1.000000	0.945404
Soros Forest 2	0.979708	0.945404	1.000000

The problem of transport of large sized boulders

In the chapter on history of research some sentences were devoted to the concepts evolved by the former prominent researchers concerning the gravels and large sized boulders in the Southern Börzsöny, It is quite surprising, however, that a very important problem was missing from Ferenczi's (1935), Láng's (1952) and also Vadász's (1953) studies. The question rests with the discharge a river must have as to be capable enough to move and transport these giant boulders.

In their works they did not concentrate on any way of transport of stream load, which could explain the presence of large sized boulders, in spite of the fact that former authors had made attempts to address this problem in relation to other boulders. For example Szabó, J. (1872) identified the gigantic rocks as moraine sediments in a valley near Hasznos, Mátra foothills. According to Id. Lóczy, L. (1881) the boulders at Budafok were transported by glaciers. Schafarzik, F. and Lóczy, L. (1914) thought that the boulders of large size near Cinkota, Ács and Bábolna were transported by the extremely violent spring floods of rivers. But even larger flash floods or spring floods are not able to transport the boulders over large distances. According to Horusitzky, H. (1917) the boulders of large size near Győr were transported in an alternative way. They were frozen in ice floes and the latter floated on the water surface. The boulders are as large as those found in the Southern Börzsöny. This is a brilliant idea. *Photo 7* shows the transport of a boulder in the St. Lawrence Estuary, Canada. This photo is from a study by Dionne, J-C. (1968). The work also provided evidence about that even boulders between 1 and 1.5 meter in diameter could be transported easily. In other words for this way of transporting no giant rivers are needed. Rivers of medium discharge like Danube in the Carpathian Basin can transport large boulders from a distant land. Kriván, P. (1973) put forward this theory, when he investigated boulders of large size near Vác and Sződliget.

This case raises the question of roundness of boulders, because in this case there are not any processes (similar to the transport by glaciers), which could polish these boulders. So we can see angular blocks on *Photo 8* also taken from Dionne's (1968) study. According to Bogárdi, J. (1955) only the large eddies could keep moving these boulders. These whirls developed

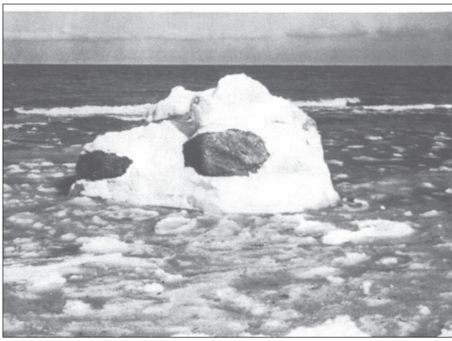

Photo 7. A large boulder transported by ice-floe in the St. Lawrence Estuary. (Dionne, J-C. 1968)

Photo 8. A large boulder in the tidal flat of the St. Lawrence River (Dionne, J-C. 1968)

during the large spring floods and polished them by sandy-gravelly channel load. Jámbor, Á. (1965, 2010) agrees with this theory, because it explains the presence of well- rounded boulders in the north-western foothills of Gerecse Mountains.

The large sized boulders of Southern Börzsöny are also well rounded *(photos 2* and *4)*. In this case there might be two alternatives. According to the first one the actors were eddies having emerged in large rivers that moved and transported the boulders. It is possible, but other important facts should also be taken into account. The Börzsöny Mountains are composed of andesite, but these boulders are built of quartzite and metamorphites. So the gravels and boulders arrived after transport from hundred or several hundred kilometer distance, supposingly from the mountains of Carpathians or Alps. It is also evident that the boulders were larger and less rounded when they fell into the river than after accumulation, reworked by attrition. There are some boulders, which are 60 cm in diameter in the Southern Börzsöny. What a size could have these boulders before transporting, and what an energy was needed to move and transport them over more than hundred kilometers! The large eddies and flash floods could move them, but only over a short distance. Was it possible that any river with such a great energy had risen from the Carpathian Mountains?

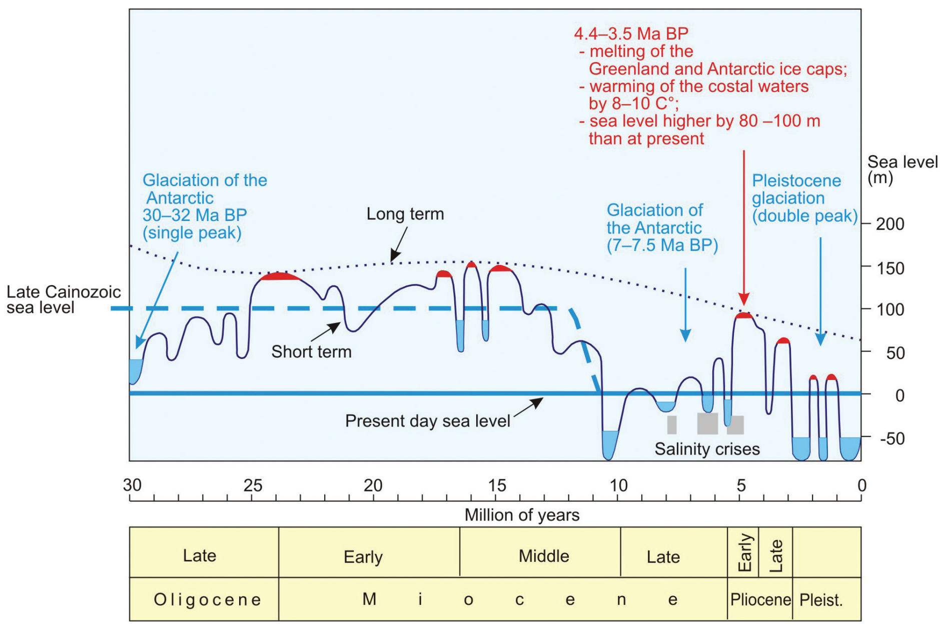

Fig. 10. The possibility of cyclic recurrence of ice ages during the Neogene (Schweitzer, F. 2004).

The other possibility is the transporting way in icefloes frozed. It provides explanation for the problem related to the capacity of the rivers, because in this case no extreme discharge is needed. At the same time the issue of roundness is raised. There is a possible solution for this problem. The angular rocks floated from the distant mountains in icefloe frozed. During the transport the icefloe was melting under a warmer climate as the river ascended from the mountains and was flowing from north to south. When the continuously melting icefloe achieved a critical size and it could not keep the blocks on the water surface, they came down into the stream bed where the rounded forms developed that is met at present. The sandy-gravelly channel load formed rounded boulders, which were transported rolling upon the bed and flowing near the bed. The bedrock-channelled rivers are developing in a similar way, the immovable things are also rounded by the channel load.

If we accept this theory we do not have to search for traces of any gigantic river, but we have to assume cold and warm periods or at least climate conditions similar to the present-day ones in Southern Canada. *Figure 10.* shows the possibility of cyclic recurrence of ice ages during the Neogene.

Summary

In the present study some gravel sheets were tackled, that are not related to the pebbles of Danube terraces. Two occurrences were selected: in the southwestern part of Börzsöny and another one in the south-eastern part of the mountains. The pebbles are relics conserved in good condition. First the studies of former authors were analyzed, then the gaps closed using the results of new investigations. For instance, these areas were characterized and new gravel occurrences found by geomorphological mapping in the environs of the gravel sheets.

The original sheets which occur on some lag surfaces were also put on the map. The sites are either at the same elevation above the sea level on the andesite hillsides, or in the surroundings, in reworked state. The above mentioned surfaces are relics of an earlier continuous river valley around the hills, fractured by recent and current drainage network, whose development began in Late Pliocene; at this time the Danube arrived in the Visegrad Gate. The western part of this drainage network altered in Pleistocene, when the Ipoly joined Danube here.

After the reconstruction of the original occurrences of pebbles by geomorphological methods, some outcrops were made. Samples were taken from these outcrops from several places and horizons. After sampling a granulometric analysis of the fraction less than 2 mm in diameter was performed in the GRI HAS. Although the spatial horizontal distance and vertical difference

between the two gravel sheets are considerable, the results of geomorphological and grain-size analyses have led to three important conclusions.

1. The geomorphological characteristics of the two areas are very similar.

2. The statistical analysis of grain size shows 94–98% correlation between samples from the two occurrences.

3. In the environs of both occurrences some boulders were found composed of quartzite.

The size of boulders is usually between 20 and 40 cm in diameter, but some of them are 60 cm. According to the authors's opinion, the route of transport of these boulders was very likely floating frozen in ice floes. After melting those boulders came down the bed of river and there had become rounded by the whirling sandy-gravelly channel load near the bed. Alternating cold and warm climate periods are assumed to have been at that time or at least a climatic environment typical of Southern Canada nowadays.

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Does sewage sludge amendment to soil enhance the development of Silver birch and Scots pine?

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Abstract

Sewage sludge can be used to improve forestry soil properties, because it is rich in phosphorus, nitrogen and organic material and, thus, can enhance the growth of tree seedlings in poor quality soils. Our study was performed on a site amended with industrial sewage sludge and afforested with birch and pine seedlings. To evaluate the growth of tree seedlings, tree dry biomass, height, diameter, root/shoot ratio, specific root length, shoot and root length were calculated. Higher concentrations of heavy metals and no significant increase in the biomass of trees on sewage sludge amended soil suggest an inhibitory effect of heavy metals on tree biomass growth.

The site treated with sewage sludge had significantly higher soil moisture content, soil pH, total copper and total lead concentrations and significantly lower exchangeable acidity. Tree tissues at the sewage sludge treated site contain significantly higher concentrations of copper and cadmium. Therefore, both positive and negative impacts of treatment are apparent. In terms of management strategies, it is recommended that the chemical quality of sewage sludge is analyzed prior to possible field applications and only sewage sludges with toxic heavy metal concentrations below accepted safety limits are applied.

Keywords: Betula pendula Roth., biomass, Pinus sylvestris L., heavy metals, root/shoot ratio, sewage sludge, specific root length.

Introduction

The potential utilization of sewage sludge as a fertilizer in forestry is much debated (Gradeckas, A. *et al.*, 1998; Bojarczuk, K. *et al.*, 2002; Bramryd, T. 2002; Katinas, V. *et al.*, 2002; Pikka, J. 2005; Hermle, S. *et al.*, 2006). Deforested

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soils usually lack nutrients and are mainly acidic, especially in exploited peat areas (Gradeckas, A. *et al.*, 1998). Sewage sludge contains components that are potentially beneficial for soils (such as organic matter, phosphorus, nitrogen, calcium and magnesium). However, sludges can have high concentrations of heavy metals (HMs), especially cadmium (Cd), lead (Pb), copper (Cu) and zinc (Zn), typically originating from industry. At high concentrations, HMs can be phytotoxic and cause reduced tree growth or even death (Kabata-Pendias, A. and Pendias, H. 2001). Toxic metal ions present in the substrate may also adversely affect trees by damaging roots, which leads to inhibition of the transport of water and nutrients to upper parts of the plant (Kupčinskienė, E. 2006).

The distribution and mobility of HMs mostly depends on soil properties, which controls their mobility within soil systems and their availability to trees. Specific soil properties (pH, exchangeable acidity (H^+ and Al^{3+}), soil moisture, soil texture and organic matter (SOM)) are the key factors that describe soil quality and tree growing conditions (ICP Forest Manual, 2005).

The level of adsorption of HMs, and associated phytotoxicity, mainly depends on tree species. For example, *Betula* and *Salix* tree species are considered as metal tolerant and accumulators (Eltrop, L. *et al.,* 1991; Kahle, H. 1993). Experiments on two *Salix* clones failed to show inhibition effects on growth for any HM treatment (max. 41.4 Cd, 655 mg·kg^{-1} Pb) (Vandecasteele, B. 2004). However, another study revealed that in acidic subsoil *Salix viminalis* displayed a significant growth reduction following the increased Zn and Cd accumulation (Hermle, S. *et al.,* 2006). In contrast, analysis of birch and pine trees in a site treated with industrial sewage sludge (The Taruškos Forest site, Lithuania) did not reveal any negative effects for either tree species (Katinas, V. *et al.,* 2002; Baltrėnaitė, E. and Butkus, D. 2007).

Other investigations have shown that birch grown in metal polluted soil decreased above-ground biomass (Bojarczuk, K. *et al.,* 2002). Silver birch *(Betula pendula Roth.)* grown in polluted substrate was characterized by high biomass allocation to roots (60% versus 30–40% in the control substrate). However, fertilization with sewage sludge, which mainly consists of nutritious organic material, can accelerate tree growth, and increase biomass allocation to foliage (Bojarczuk, K. *et al.,* 2002).

The heavy metals Cu, Cd and Pb have phytotoxic and synergistic effects (Breckle, S.W. and Kahle, H. 1991; Arduini, I. *et al.,* 1994; Kabata-Pendias, A. and Pendias, H. 2001). For example, Cu is an essential metal for normal plant growth and development. Cu participates in numerous physiological processes and is an essential cofactor for many metalloproteins. However, excess Cu inhibits plant growth and disturbs important cellular processes (*i.e.* photosynthetic electron transport) (Bojarczuk, K. 2004; Yruela, I. 2005). The determined phytotoxic concentrations of Cu in the soil was 60–125 mg·kg^{-1} (Kabata-Pendias, A. and Pendias, H. 2001).

Lead is a general protoplasmic toxic metal, which is cumulative and slow-acting (Sharma, P. and Dubey, R.S. 2005). It has a wide range of negative effects on: hormonal status, membrane structure, water potential, electron transport and enzyme activation (Sharma, P. and Dubey, R.S. 2005). However, Pb becomes harmful to plants when concentrations in the soil reaches 100–200 mg·kg^{-1} (Bergman, W. 1986; Kabata-Pendias, A. and Pendias, H. 2001). When Pb is combined with other metals, it displays synergistic effects. For example, root elongation rates of beech (*Fagus sylvatica*) seedlings were significantly reduced by ~30% by 44 mg·kg^{-1} plant-available Pb, but the same effect was observed with only 24 mg·kg^{-1} Pb when combined with 2 mg·kg^{-1} Cd (Breckle, S.W. and Kahle, H. 1991). Decrease in birch biomass was observed when Pb concentrations in soil reached 18 and Cd was 3.6 mg·kg^{-1}.

Investigations on different tree species showed that the concentration of metals in soil decreased the growth of shoots and roots by ~50% when Pb concentrations were in the range of 519 to >1280 (285–445) mg Pb kg^{-1} dry soil and Cu were 48–232 (<40–110) mg Cu kg^{-1} dry soil, respectively (An, Y.J. 2006). Typically, Cu is more toxic than Pb, and root growth is more sensitive to the toxicity endpoint than shoot growth in Cu or Pb amended soils.

Cadmium disturbs the uptake, transport and use of Ca, Mg, P and K and water uptake by plants. Cadmium decreases nitrate absorption and its transport from roots to shoots, by inhibiting nitrate reductase activity in shoots (Balestrasse, K.B. *et al.,* 2003). Arduini, I. *et al.,* (1994) found tap-root elongation of stone pine (*Pinus pinea*) and maritime pine (*Pinus pinaster*) was drastically reduced by 5 µm·kg^{-1} Cd^{2+} and Cd^{2+} + Cu^{2+} treatments. Burton, K.W. *et al.,* (1986) showed a Cd concentration of 2.5 mg·kg^{-1} significantly decreased the biomass of shoots and roots of *Picea sitchensis*.

The objectives of the investigations were to determine the influence of sewage sludge with high concentrations of heavy metals after 10 years from application on: i) the forest soil properties; ii) growth of Silver birch and Scots pine (*Pinus sylvestris L.)* trees (biomass, stem diameter, and height), iii) growth traits (root/shoot ratio, specific root length, and root/shoot maximum lengths), and iv) heavy metal concentrations in tree components (root, shoots, leaves and needles etc.).

Materials and methods

Site description

The experimental site is located in Gitėnai Forest, near Panevėžys town (Lithuania) *(Figure 1).* Panevėžys is a Mid-lowland Climatic region and is part of the Mūšos-Nevėžis subregion (Climatic regionalism 2010). The average precipitation in this subregion is 500–600 mm annually, and the prevailing winds are south-westerly.

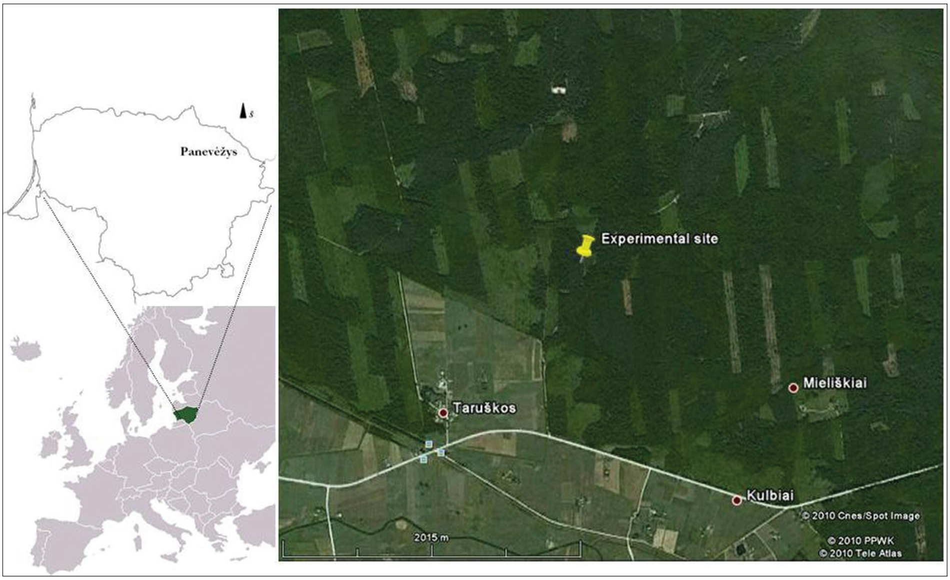

Fig. 1. Experimental site of industrial sewage sludge utilization in the Gitėnai Forest within the Taruškos Forest, located in Panevėžys region (Lithuania), (55°44′ N; 24°33′ E)

In 1998, ~300 t/ha of industrial sewage sludge was spread on the 2-ha experimental site and after one year birch (*Betula pendula*) and pine (*Pinus sylvestris*) seedlings were planted. The experiment was started in order to define the industrial sludge impact on soil chemical composition after 9–10 years of application. A more detailed experimental description is available (Katinas, V. *et al*., 2002).

Table 1 shows the HM concentrations of the industrial sludge (from Panevėžys town) and HM background concentrations of the site soil before experiment started. According to the Lithuanian regulation 'LAND 20-2005', the sewage sludge is Category II and can be used in forestry or agriculture only once every three years. High concentrations of Cu and Pb in sewage sludge were due to industrial activities in Panevėžys, typically electroplating and refrigerator manufacturing.

Table 1. Mean concentrations of HMs and phosphorus in Panevėžys industrial sewage sludge and background concentrations in experimental site before trees were planted in 1998 (published in Katinas, V. et al. 2002)

HMs	Background concentration of experimental site (mg·kg^{-1})	Concentration in industrial sewage sludge (mg·kg^{-1})
Cu	3.1–9.9	291
Pb	11.0–15.0	1,456
Cd	2.2–5.0	6.2
P	490.0–273.0	21,764

Soil sampling

Sampling was carried out in May 2007. Sites measuring 50x50 m were chosen at the site where the sewage sludge was applied (Site S) and in the adjacent forest area (~200 m from the contaminated plot), which was chosen as the background control (Site C). Before soil sampling the litter layer was removed. From both the C and S sites, six composite soil samples (mix of five subsamples) were taken (at 0–10 and 20–30 cm depths). Samples were transported at 4°C to the laboratory and then air-dried. For further analysis, soil samples were oven-dried at 105°C and fractionated through a 2.0 mm sieve *(Retsch, As 2006*).

Tree sampling

Ten year-old *Betula pendula* and *Pinus sylvestris* trees were sampled from both the C and S sites (three birch and pine trees per plot). Tree height and the diameter at 30 cm height (±1 mm) above the ground were measured. Leaves or needles, shoots, stem and roots (coarse >2.0 mm and fine <2.0 mm diameter) were shredded. Each component was weighed (±0.05 g) and measured (±1 mm).

Soil properties

Soil moisture content was determined in 15 g of each sample that was dried at 105°C to constant mass. Soil pH was measured by agitating air-dried soil in a mechanical shaker (*Gerhardt, Rotoshake RS 12*) in 0.01 M $CaCl_2$ solution for 1 hour, and waiting for another hour prior to pH measurement using a calibrated digital pH meter (pH 538 WTV). For total carbon determination, air-dried soil was fractionated through a 2.0 mm sieve *(Retsch, As 2006),* milled, homogenized and 100 mg soil samples were taken. Total C content was analyzed by dry combustion using a Total Organic Carbon Analyzer (TOC-V by SHIMADZU) at 900°C. Exchangeable acidity was determined in 0.1 $mol \cdot l^{-1}$ $BaCl_2$ soil solution. After two hours of shaking the soil extract was titrated with a 0.05 $mol \cdot l^{-1}$ NaOH solution at pH ≤7.8 (ICP Forest Manual, 2006).

Total and mobile Cd, Cu and Pb

Mobile Cd, Cu and Pb were measured in extraction of neutral salt 0.01 M $CaCl_2$, at 1:10 ratio. The solution was mixed and shaken for 16 h, at 20°C. Wet digestion was employed. Each soil sample (weighing 0.5 g, within 10 ml of HNO_3 and 2 ml of HCl solution) was digested for 31 minute in *Mileston*

ETHOS digester (Soon, Y.K. and Abboud, S. 1993). Total metal concentrations in solutions were analyzed using a *Buck Scientific 210 VGP* Atomic Absorption Spectrophotometer (FAAS and GFAAS).

Cd, Cu and Pb concentrations in tree seedlings

Each tree component (roots, stem, shoots and needles/leaves) was shredded and then incinerated at 400°C to ash. Before HM analysis, tree component ashes were powdered and pressed. Metal analysis was performed using the X-Ray Fluorescence Spectrometer in the University of Wolverhampton (UK), using pulverized samples embedded in a wax base.

Statistical analysis

Each sample was measured in duplicate. T-test analysis was performed to determine significant differences between the two investigation sites ($p<0.05$). Data analysis was carried out using *Statistica* (version 7.0) software.

Results

Soil properties

Soil moisture content was higher at Site S than at Site C *(Table 2).* At Site C soil moisture content varied significantly ($p<0.05$) and was greater in the upper soil layer than in deeper soil and the difference of moisture content values was significant between sites ($p<0.05$).

Site C was significantly ($p<0.05$) more acidic (topsoil and subsoil) than Site S *(Table 2).* Exchangeable acidity at Site S was significantly less than at Site

Table 2. Selected soil properties (n=6, mean±1SD) in the soil from the control site (C) and the soil amended with sewage sludge (S)

Site, soil depth, (cm)	Moisture % ±1SD[a]	pH ±1SD[a]	Exchang. acidity, cmol/kg ±1SD[b]	TC, $mg \cdot kg^{-1}$ ±1SD
0–10 (C)	1.87±0.79	3.15±0.07	1449±85	5.35±0.97
20–30 (C)	0.50±0.14	3.69±0.11	1199±76	1.33±0.27
0–10 (S)	3.49±0.44	6.27±0.17	61.3±22.6	5.03±0.90
20–30 (S)	6.79±0.32	6.13±0.41	73.3±39.6	3.45±0.56

significance between sites [a]$p<0.05$, [b]$p<0.01$.

C *(Table 2).* However, at Site S the difference was not significant with depth, ($p>0.05$), but it was remarkable at Site C ($p<0.05$). Between the two sites this difference was significant ($p<0.01$) in both soil layers. Total carbon (TC) variation was similar in both sites and was higher in the surface soil layer *(Table 2).* However, between the two sites a considerable difference ($p<0.05$) was only found in the 20–30 cm soil layer.

Metal contamination of soil

Total Cu concentrations were higher at Site S than at Site C *(Table 3).* Copper concentrations within sites C and S did not vary significantly between soil layers ($p>0.05$). However, between both sites, Cu concentration differences between upper soil layers were significant ($p<0.05$).

Table 3. Total concentrations and mobile fraction (mean value ±1SD, n=6) of Cu, Cd and Pb in two soil layers (0–10 cm and 20–30 cm) at the site amended with sewage sludge (S) and at the control site (C)

Site, soil depth, (cm)	Cu		Cd		Pb	
	Total [a], $mg \cdot kg^{-1}$	Mobile, %	Total [a], $mg \cdot kg^{-1}$	Mobile, %	Total [a], $mg \cdot kg^{-1}$	Mobile, %
0–10 (C)	4.00±1.04	4.4±0.8	0.85±0.11	36.1±13.1	24.78±0.63	1.6±0.1
20–30 (C)	4.53±1.92	2.5±0.37	0.75±0.07	47.5±16.5	23.00±1.18	1.6±0.5
0–10 (S)	9.9±0.07	2.1±0.3	1.33±0.18	13.8±0.8	38.83±8.72	0.7±0.2
20–30 (S)	9.35±4.41	1.5±0.2	1.15±0.24	18.7±0.8	42.92±2.42	0.6±0.2

Significance between sites [a]$p<0.05$.

Total Cd concentration was significantly less at Site C than at Site S ($p<0.05$) *(Table 3).* However, Cd concentration varied with depth insignificantly ($p>0.05$) at both sites. Pb concentrations were significantly ($p<0.05$) higher at Site S than at Site C. As was the general case with HMs, Pb did not vary significantly between soil layers ($p>0.05$).

The mobile fraction of HMs was distributed in the sequence: Cd>Cu>Pb *(Table 3).*

Contamination of tree tissue

Copper concentrations in roots and shoots of both tree species were significantly higher ($p<0.05$) at Site S than at Site C *(Figure 2).* Copper concentrations in the birch tree from Site S was 5.3±0.2 in shoots and 2.5±0.2 $mg \cdot kg^{-1}$ in roots. At Site C the concentrations of Cu in the birch tree components was 3.3±0.02 in shoots and 2.4±1.3 $mg \cdot kg^{-1}$ in roots.

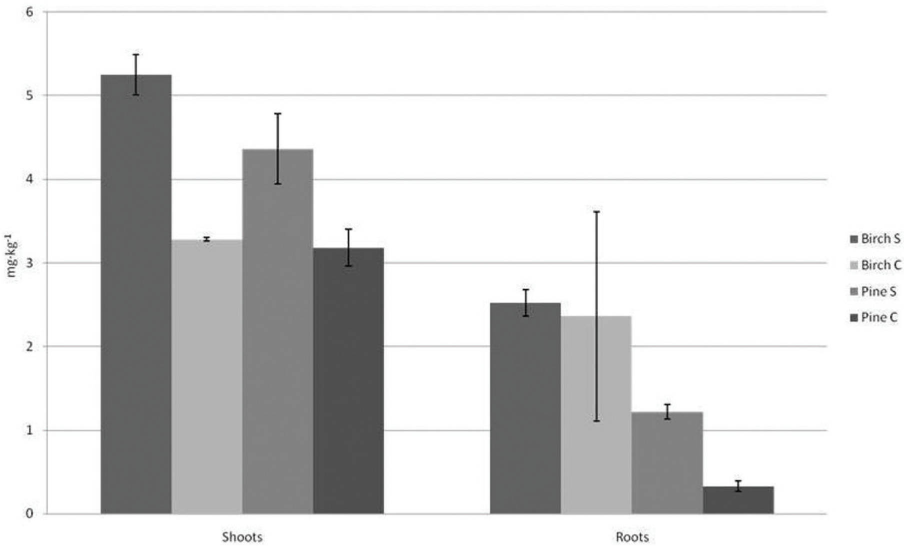

Fig. 2. Copper concentrations in roots and shoots of both tree species in the site amended with sewage sludge (Birch S; Pine S) and in the control site (Birch C; Pine C). Bars represent mean values of three samples ±1SD

In pine tree components Cu concentrations from Site S were 4.4±0.4 in shoots and 1.2±0.1 mg·kg^{-1} in roots. At Site C, higher Cu concentrations were measured in shoots (3.2±0.2 mg·kg^{-1}) than in roots (0.3 ±0.1 mg·kg^{-1}). Differences between Cu values in shoots and between Cu values in roots from both sites were significant ($p<0.05$).

In birch tree shoots and roots, Cd concentrations were lower at Site C *(Figure 3)*. In the components of birch trees from Site S, Cd concentrations were 1.7±0.2 in shoots and 1.3±0.1 mg·kg^{-1} in roots. At Site C the concentrations of Cd in birch tree components varied from 1.6±0.05 in shoots to 0.6±0.5 mg·kg^{-1} in roots. However, Cd concentration differences between trees from both investigation sites are insignificant ($p>0.05$).

In pine tree components, Cd concentrations at Site S were higher than Site C: 1±0.1 in roots and 0.7±0.01 mg·kg^{-1} in shoots. At Site C, higher Cd concentrations were also found in roots: 0.8±0.01 and in shoots 0.7±0.1 mg·kg^{-1}. Cadmium concentrations in roots between investigation sites were significantly different ($p<0.05$).

Lead concentrations in birch tree components were lower at Site S than at Site C *(Figure 4)*. At Site S the concentration was 0.6±0.03 in shoots and 0.4±0.06 mg·kg^{-1} in roots. At Site C the concentrations were 1.6±0.1 in shoots and 0.6±0.2 mg·kg^{-1} in roots. The lead concentration in shoots between investigation sites are significantly different ($p<0.05$).

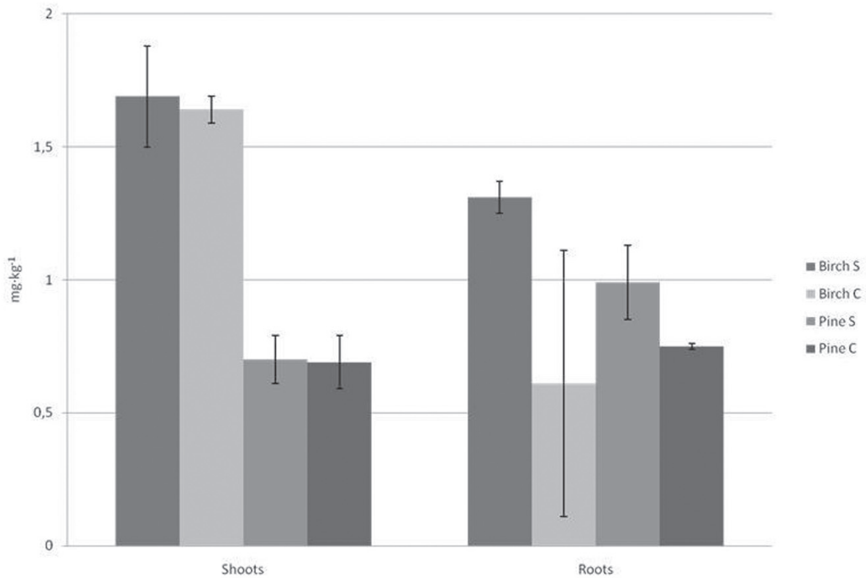

Fig. 3. Cadmium concentrations in roots and shoots of both tree species in the site amended with sewage sludge (Birch S; Pine S) and in the control site (Birch C; Pine C). Bars represent mean values of three samples ±1SD

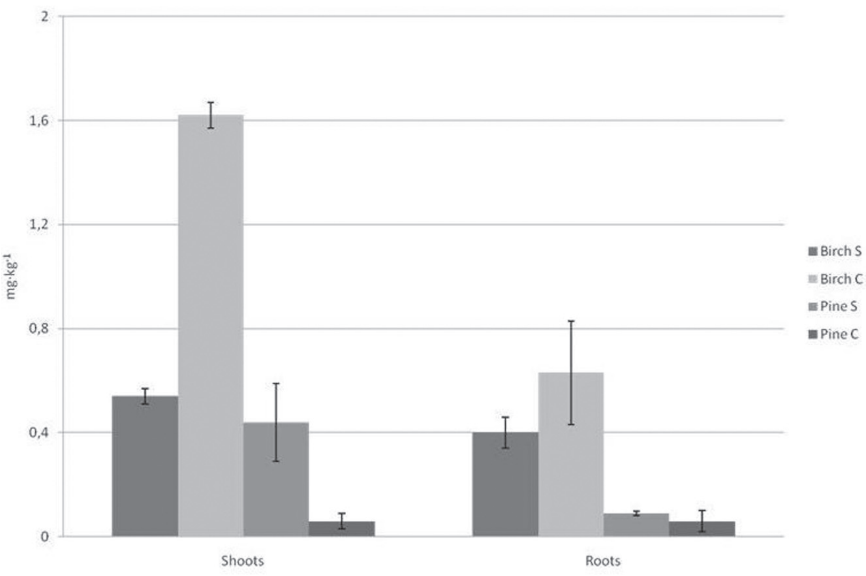

Fig. 4. Lead concentrations in roots and shoots of both tree species in the site amended with sewage sludge (Birch S; Pine S) and in the control site (Birch C; Pine C). Bars represent mean values of three samples ±1SD

In pine tree components, Pb concentrations were lower at Site C than at Site S. The concentration was 0.4±0.2 in shoots and 0.1±0.01 mg·kg^{-1} in roots at Site S, Pb concentrations were similar in shoots (0.06±0.03) and roots (0.06±0.04 mg·kg^{-1}) at Site C. Lead concentrations in shoots are significantly different between investigation sites ($p<0.05$).

Tree biomass and growth

Total and different tree components dry mass

The total biomass of birch and pine trees was less at Site S than at Site C, but these differences were not significant ($p>0.05$) *(Table 4)*. Dry mass of different trees components were greater in the control site, but these differences are insignificant ($p>0.05$). However, pine root mass was significantly ($p<0.05$) less at Site S (16±2 g) than at Site C (30±1 g).

Table 5. The diameter (cm) at 30 cm height and stem height (cm) of birch and pine trees at the site amended with sewage sludge (S) and at the control site (C), mean, ±1SD, n = 3

Tree species	Diameter	Stem height
Birch C	1.2±0.2	188±0.7
Birch S	1.4±0.4	223±13
Pine C	2.6±0.5	168± 8
Pine S	3.0±0.3	190±19

Stem diameter and height

The diameter (at 30 cm height) of birch trees varied from 1.0–1.8 cm at Site C and from 1.0–1.4 cm at Site S *(Table 5)*. The diameter of pine tree varied from 2.7–3.4 cm at Site C and from 2.0–2.9 cm at Site S and no significant differences were detected between stem diameter mean values at both sites ($p>0.05$). The stem height of both tree species was insignificant ($p>0.05$) between both sites.

Table 4. Total dry mass and mass of different components of birch and pine tree in the site amended with sewage sludge (Birch S; Pine S) and in the control (Birch C; Pine C), g/tree; mean value ±1SD, n=3

Tree species	Leaves/ needles	Shoots	Stem	Roots	Total biomass
Pine S	111±26	122±18	458±41	16±2.0*	749±156
Pine C	175± 8	144± 7	528±84	30±1.0*	821±21
Birch S	14± 4	19± 7	53± 7	12±2.5	101±12
Birch C	19± 8	28± 3	70±18	24±2.0	112± 5

*difference significant, p <0.05.

Tree development traits

The root/shoot ratio of birch tree was significantly ($p<0.05$) larger at Site C *(Table 6)*. The birch root biomass was even greater (1.78±0.07) at Site C than the mass of shoots. At Site S the ratio was also high (0.80±0.12), compared with the ratios of pine trees. These were 0.13±0.01 at Site S and 0.21±0.02 at Site C, but the difference was insignificant ($p>0.05$). The specific root length (SRL) of birch tree was significantly shorter at Site S than at Site C ($p<0.05$). In the case of pine trees, SRL was also significantly shorter at Site S than at Site C ($p<0.05$).

Table 6. Root/shoot ratio, Specific root length (SRL) ($m \cdot g^{-1}$), Shoots and roots max. length (cm) of birch (Betula pendula) and pine (Pinus sylvestris) tree at the site amended with sewage sludge (S) and at the control site (C), n=3 ±1SD

Tree species	Tree development traits			
	Root/shoot ratio	SRL	Shoot max	Root max
Birch C	1.78±0.07	0.06±0.01	47.1–77.1	20.4–81.0
Birch S	0.80±0.12	0.30±0.10	47.5–70.0	13.4–53.0
Pine C	0.21±0.02	0.19±0.04	47.5–73.5	22.0–47.5
Pine S	0.13±0.01	0.26±0.08	42.0–67.5	17.5–35.1

The maximum root and shoot lengths of birch and pine trees were longer at Site C than at Site S. The maximum lengths of pine tree seedlings roots and shoots were also less at Site S. The number (branching) of roots and shoots is an important factor that indicates environmental nutrient status *(Figure 5).* The branching of birch roots was significantly ($p<0.05$) less at Site C (11±1) than Site S (22±4). Shoot branching varied from 20±4 at Site C to 25±1 at Site S.

The branching of pine shoots and roots was not significantly greater for the pine trees at Site S. The number of roots was 23±9 at Site C and 23±3 at Site S ($p<0.05$). The number of shoots was: 27±1 and 31±6, respectively ($p<0.05$).

Discussion

More favourable growth conditions in soil amended with sewage sludge

Soil is important to plants as a source of nutrients and water and has an inherent potential to resist (stability) and recover (resilience) from environmental stresses (Griffiths, B.S. *et al.*, 2005). Plant growing conditions depend on many soil properties, including pH, texture, moisture and aeration. It is known that soil moisture, carbon content, exchangeable acidity and pH are good indicators of conditions for vegetation growth (ICP Forest Manual, 2006).

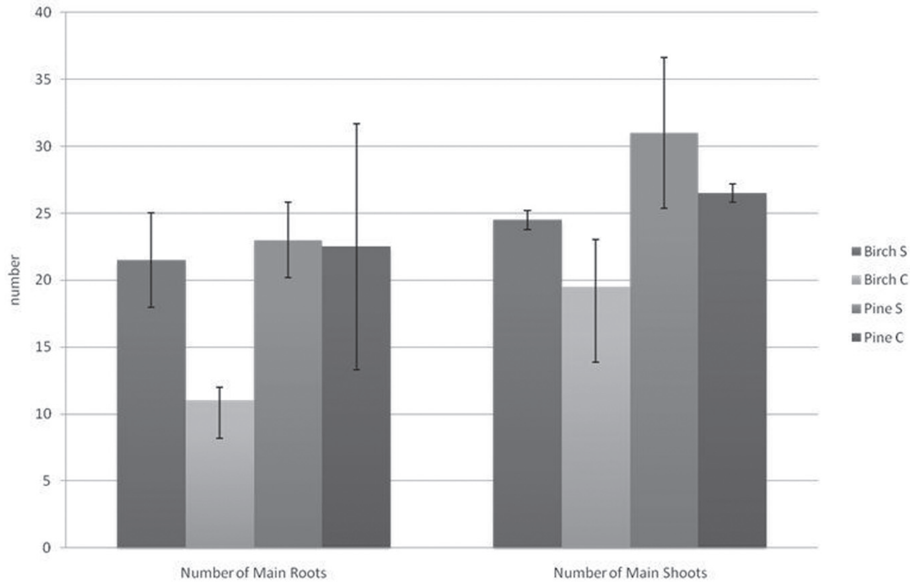

Fig. 5. Number of shoots and roots of both tree species in the site amended with sewage sludge (Birch S; Pine S) and in the control site (Birch C; Pine C). Bars represent mean values of three samples, ±1SD.0

Soil moisture influences the transportation of soil solutions through roots. Lower moisture content can also indicate suppression of the diffusion and the mass flow from soil to plants. Moisture content was higher in soil amended with sewage sludge. These results reveal better moisture capacity in the site amended with sewage sludge.

Changes in soil carbon influence physical properties (Denef, K. *et al.*, 2001) and due to higher soil carbon contents soils are physically more stable than non-amended soils (Sort, X. and Alcaniz, J.M. 1999). Soil carbon content was higher at Site S than at Site C. Carbon content of the upper layer was approximately equal at both sites, as it was the case with organic compounds too. However, in deeper layers carbon content was significantly greater at Site S.

More acidic soil conditions can increase Al^{+3} availability, which in turn can disturb the normal development of tree roots and minimize the uptake of macro-nutrients, such as Ca^{2+} or Mg^{2+} (Kupčinskienė, E. 2006). Low pH also increases the mobility of toxic HMs, which can be taken up more easily by plants (Kabata-Pendias, A. and Pendias, H. 2001). As soil in the control site is more acidic, it could inhibit the growth of tree seedling.

Exchangeable acidity (Al^{+3}, H^{+}) indicates soil disturbances due to high Al^{+3} concentrations which, as discussed previously, are toxic to plants and soil organisms (Sparks, D. 1995). Toxic effects of aluminium (acidic, pH <5.5) increase the thickness and stunt root fibres, leading to decreased assimilation of nutrients from the soil and slowing down plant development (Göransson, A. and Eldhuset, T.D. 1995; Bojarczuk, K. *et al.* 2002).

The results illustrate significant differences between the two investigated sites indicating 1.60–1.99 times higher pH values, 2.59 times more SOM in deeper soil layers and 1.9–13.5 times higher moisture content. Exchangeable acidity (Al^{+3}, H^{+}) was 23.7 times less in the upper and 16.35 times less in the lower layers of sewage sludge amended soil. This reveals that in the latter the conditions for the trees are better than in that of the control site.

Variation of Cu, Cd and Pb in soil

Our results reveal Pb is the least mobile heavy metal and Cd tends to eluviate to deeper soil. Furthermore, the mobile fraction of HMs is strongly related to soil pH, as it is one of the main factors influencing HM migration (Eckert, D. and Sims, J.T. 1995; Kabata-Pendias, A. and Pendias, H. 2001).

HMs in sewage sludge can inhibit tree biomass development. For example, only 0.005 $mg \cdot kg^{-1}$ Cd reduced spruce tree root elongation (Arduini, I. *et al.*, 1994) and 0.005 $mg \cdot kg^{-1}$ Cu in solution can reduce pine biomass (Arduini, I. *et al.*, 1998). In our study plant available Cd was 0.16 $mg \cdot kg^{-1}$ in soil amended with sewage sludge, which may have had a negative influence on pine root elongation, as 0.22 $mg \cdot kg^{-1}$ Cu have in pine biomass. Furthermore, possible synergistic effects should be considered (Arduini, I. *et al.* 1994).

The influence of Pb is hard to predict, because it is very stable in the soil and is probably only available in the very acidic soil of the control site. In addition, plant available Pb in the site amended with sewage sludge was ≤0.3 $mg \cdot kg^{-1}$, which is much lower than the 18 $mg \cdot kg^{-1}$ that is known to inhibit tree growth (Breckle, S.W. and Kahle, H. 1991).

Variation of Cu, Cd and Pb in tree

Higher metal concentrations were determined in birch trees than in pine trees, which accords with the hypothesis that birch tends to extract more HMs from soil than pine (Eltrop, L. *et al.*, 1991; Kahle, H. 1993). However, there were minor differences between their concentration in trees from sites both C and S. Normal contents of Cd and Cu in plants are 0.1–1.0 and 1–10 $mg \cdot kg^{-1}$, respectively (Kabata-Pendias, A. and Pendias, H. 2001; Kupčinskienė, E. 2006. Copper toxicity in plants may occur when the tissue concentration is >20–30 Cu $mg \cdot kg^{-1}$. Decreased rates of plant growth occur at tissue concentrations of

>3 Cd mg·kg^{-1} (Pais, I., and Jones, J.B. Jr. 1997). In our study, the concentration in birch tree tissues at Site S was >5 Cd and >4.9 mg·kg^{-1} Cu and these concentration in pine tree were ~3.9 and 7.0 mg·kg^{-1}, respectively. In addition, no significant relationship between tree growth and HMs accumulation in tree tissues was observed. However, some tendencies were highlighted. For example, higher Cd and Cu concentrations were determined in shoots and roots in trees from Site S, these differences being particularly evident in the Cd content of birch roots and in the Cu content of birch shoots. In the case of pine trees, concentrations of both of these HMs were higher in shoots and roots, more significantly in roots. Copper and Cd are inhibitors of tree biomass development, especially tree root systems (Arduini, I. *et al.* 1994).

Tree biomass indications

Tree biomass was expected to be less in the control site considering positive influence of sewage sludge on soil properties (Pikka, J. 2005). Tree biomass is strongly related to root systems, because poor soil conditions (low pH and high exchangeable acidity (Al^{+3}, H^{+})) have a negative influence on the development of the root system (Kupčinskienė, E. 2006).

In our study, biomass did not significantly change by the application of sewage sludge with the exception of reduced pine root mass (by 50.0%) without significant change of root/shoot ratio, which is in contrast to a significant reduction of the latter in birch. Better root system development at Site C is associated with the relatively poor nutritional environment and this tendency is remarkable for birch trees (Påhlsson, A.B. 1991; Bojarczuk, K. *et al.* 2002; Gradeckas, A. *et al.* 1998; Katinas, V. *et al.* 2002; Pikka, J. 2005).

Tree growth traits

Specific root length (SRL) is an important indicator to determine carbon allocation into the root system and indicate a nutritious soil environment. In our study, the roots at Site C had greater mass density, as their SRL value was lower (Eissenstat, D.M. 1991), which indicates the decreased ability of plants to uptake nutrients (Hartikainen, H. *et al.* 2001). Higher SRL values indicate soils richer in nutrients (Ryser, P. 1996) and exhibits high hydraulic conductivity of roots (Eissenstat, D.M. 1997). The larger the SRL the more effective is the strategy of allocation of assimilates to the development of short roots (Lõhmus, K. *et al* 1989; Ostonen, I. *et al.* 1999; Wahl, S., and Ryser, P. 2000). However, the length and branching of roots and shoots of birch trees were greater at Site S than at Site C. In addition, roots at Site C tended to elongate more than branches, for example, the maximum length of birch root varied from 20–80 cm and at Site S comparative values were 13–54 cm. Moreover, infertile soils produce root systems with long, poorly branched surface roots; whereas, fertile soils produce well-branched roots that may penetrate deeper into the soil (Crow, P. 2005). In the case of pine trees the branching of roots and shoots was slightly longer at Site S, but their mean length was shorter than at Site C.

These differences among species can be explained by differences in root physiology, for example, the highest concentration of birch coarse roots accumulates in deeper layers (13–16 cm) than pine trees (5–15 cm) (Laitakari, E. 1934). In fertile soil, roots penetrate easier into deeper layers. The spread sewage sludge was contaminated with HMs, but the leaching of HMs into deeper layers may have been suppressed by organic matter from sewage sludge, the surface peat layer and the Fe-Mn geochemical barrier (Katinas, V. *et al.* 2002).

The production of longer, thinner roots may be an important mechanism to compensate for reduced carbon allocation to, and dry matter accumulation by, roots of trees exposed to pollution. These factors may also help explain differences of root/shoot ratio between sites. To adapt to less favourable conditions at Site C, trees had greater propensity to develop root systems at the expense of above-ground biomass. The roots at Site S, which have greater absorptive surfaces, could more easily transport nutrients and water to surface parts and expand above-ground biomass. However, the roots were thin and long, and carbon accumulation was less. This could lead to weaker root systems and increased risk of mechanical disturbance (e.g. by strong winds and floods). The production of longer, thinner roots may be an important mechanism to compensate for reduced carbon allocation to, and dry matter accumulation by, roots of trees exposed to pollution.

Site S had more favourable conditions for tree growth. However, plant biomass and tree growth trends (except root branching) did not support this tendency. This suggests that sewage sludge might have additional constituents (e.g. heavy metals) that inhibited tree development.

Conclusions

The results reveal that soil amended with sewage improves soil quality. However, higher concentrations of metals and no significant increase in the biomass of trees in soil amended with sewage sludge suggest an inhibitory effect of heavy metals on tree biomass growth.

During a 10 year period, pine trees produced 87% more biomass and accumulated ~60% more heavy metals (Cu, Cd and Pb) than birch trees.

For indication of soil nutritious environment it is recommended to use the following tree functional traits: specific root length (SRL), root/shoot ratio, root branching; and for possible toxicity effect of heavy metals or other harmful compounds: tree height and stem diameter (if trees are of the same age) and tree biomass (dry mass).

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Homogenized classification of developing economies: different countries behind general indices

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Abstract

Countries in the world can be classified into different groups regarding their geographical location, historical background, economic and social environments, and even demographic conditions. It is obvious that decision makers need exact and general indices in order to identify country groups. On the basis of the evaluations by some international organizations (e.g. International Monetary Fund, the World Bank, United Nations) countries in Southeast Asia and in Eastern Europe belong to the same group – to that of developing countries – however they are quite different regarding their fundamental characteristics. The key elements of the comparison of countries are different indicators and indices (GDP, GDP PPS, HDI and HPI) and those used to form groups of nations. But do these indicators have sufficient validity? The main aim of this article is to compare the fundamental characteristics of the Philippines (Southeast Asia) and Hungary (Eastern Europe) to answer this question.

Keywords: developing countries, Eastern Europe, Southeast Asia, economic indices

Introduction

The sole objective by writing this article has been to answer the question: whether the category of developing countries can be regarded as a homogeneous group or certain differentiation within this category is needed with respect to the factors examined by various organizations. Two completely different countries were selected that are categorized by some international organizations – for reasons to be detailed hereunder – as developing countries: the Philippines and Hungary.

There is quite a distance between Hungary and the Philippines not only in view of the nearly 10,000 km in between the two countries, but due to their fundamental geographic, economic, social and cultural characteristics as well. The 93,030 sq km Hungary lies in the middle of continental Europe,

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whereas the 300,000 sq km Philippines, consisting of 7,107 smaller and bigger islands, are situated in Southeast Asia. Even larger differences can be seen between the populations of the two countries: according to the 2007 census, 88.57 million people live in the Philippines, while the population of Hungary is 10.05 million. These differences in population are well characterized by the differences of the respective capitals and major cities. Situated on Luzon Island and consisting of altogether 17 cities, Metro Manila has a population of 11.55 million, making it the 16th largest metropolis of the world; the number of her inhabitants is larger than that of the whole Hungary. On the other hand, Hungary's capital, Budapest has a population of only 1.7 million, i.e. less than the number of inhabitants in Quezon City. According to the figures of the World Bank, the growth rate of the population in the Philippines was 1.9% in 2007, while in Hungary the rate of natural decrease has reached 0.2% (The World Bank, 2009). UN estimates that by 2015 the population of the Philippines will have become 100 million, and by 2050 140 million, whereas the population of Hungary will have dropped under 10 million by 2010, and will have remained under 8.5 million by 2050 (UN, 2008a).

Therefore, it is reasonable to raise the question what characteristics serve as the basis for the comparison between the two countries featuring completely different geographic situations, population and cultural history, and whether there is any rationale to make such a comparison. Naturally the number of differences outweighs that of similarities, yet in some important aspects clear parallelisms can be detected. The Philippines is a full founding member of Association of Southeast Asian Nations (ASEAN) established in Bangkok in 1967 (Sachs, J. 1989), while Hungary has been a member state of the European Union (EU) since 2004, i.e. both counties belong to significant economic (and political) organizations. The political regimes of the two countries also show parallel features: the Philippines got rid of the dictatorship of the Marcos era in 1986 (Schirmer, D.B. and Rosskamm Shalom, S. 1987), while Hungary witnessed the change of the political-economic regime in 1989. Today, both countries can be regarded democratic political regimes, though in the light of the corruption perception by Transparency International a considerable difference exists between the two countries: in 2009, Hungary's Corruption Perceptions Index (CPI) was 5.1, and thus ranked 46th of the 180 examined countries, while the Philippines was only the 139th with 2.4. It is to be noted, however, that Hungary is lagging behind most European states, meaning that, in its own surroundings the country is among the lowest ranking countries with respect to corruption.

In spite of the foregoing, in Hungary the Philippines is a frequently referred example of developing countries or newly industrialized countries, and one should find the basis of this view in the differences of social characteristics (e.g. rate of population growth, level of schooling) and economic indices (e.g. per capita GDP, role of agriculture) (Probáld, F. and Horváth, G. 1998). Our article has its points of reference in the analyses of International Monetary Fund (IMF) and Grant Thornton International Ltd., because both these organizations have categorized Hungary and the Philippines as developing countries (IMF, 2009; Grant Thorton, 2008). In this respect, no difference between the two countries can be observed in international judgement, meaning that the use of the term "developing country" seems to be just a matter of perspective.

In spite of the fact that each country has unique characteristics, they can be categorised in view of a number of aspects, as international organizations generally do so. In their book entitled Developing countries: definitions, concepts and comparisons, Sanford, E.J. and Sandhu, A. (2003) take political, economic and social relations as the basis, and highlight principally the per capita incomes of the countries, which can be measured in the simplest manner with respect to purchasing power parity. Similar ideas are suggested in Éprime Eshang's (1983) work entitled Fiscal and monetary policies and problems in developing countries. He opines that economic development is a fairly complex concept that should focus on social, political, technological and cultural changes in addition to economic characteristics. According to John Weiss beside the above-mentioned factors it is the low share of industrial production within the economic structure that describes developing countries (Weiss, J. 1990). The discrepancy between developing and developed countries became pronounced in the second half of the 20th century and in the early 21st century, in parallel with the strengthening processes of globalization. Thomas M. Leonard (2006) thinks that the express differences in the fundamental economic, social, political and cultural factors may lead to the distinction of a country from another even if there are several such countries regarded to be developed that could also be considered to be developing countries due to the poor qualities of some of the above characteristics. A common approach of the sources mentioned in the foregoing is that when highlighting the importance of economic factors all of them attribute some influence to social, cultural and political attitudes as well.

The list of articles and books describing the differences between developing and developed countries seems to have no end, and therefore one has to rely on the relevant definition of UN.

"The designations "developed" and "developing" are intended for statistical convenience and do not necessarily express a judgement about the stage reached by a particular country or area in the development process" (UN: Standard Country or Area Codes for Statistical Use).

"There is no established convention for the designation of "developed" and "developing" countries or areas in the United Nations system. In common practice, Japan in Asia, Canada and the United States in northern America, Australia and New Zealand in Oceania, and Europe are considered “developed” regions or areas. In international trade statistics, the Southern African Customs Union is also treated as a developed region and Israel as a developed country; countries emerging from the former Yugoslavia are treated as developing countries; and countries of Eastern Europe and of the Commonwealth of Independent States (code 172) in Europe are not included under either developed or developing regions” (UN: Composition of macro geographical (continental) regions, geographical sub-regions, and selected economic and other groupings).

According to the classification from IMF before April 2004, the countries of Eastern Europe (including Slovenia which still belongs to "Eastern Europe Group" in the UN institutions) as well as the former member republics of the Soviet Union (U.S.S.R., including those in Asia) and Mongolia, were not included under either developed or developing regions, but rather were referred to as “countries in transition”; however they are now widely regarded (in the international reports) as “developing countries”.

This article studies and compares the fundamental characteristics of Hungary and the Philippines in view of three main aspects:

- demographic characteristics and urbanization,
- economic performance and economic structure,
- social relations, social conditions.

Along this line of thinking, we are in search of an answer to the question whether there actually exist some parallelism between the two countries in the context that IMF applies, and if it is possible at all to categorize countries regarded to be developing, but having different characteristics in the same group. This analysis has been based on the summary reports of national and international organizations, such as Central Intelligence Agency (CIA), FTSE Group, Grant Thornton International Ltd, Hungarian Central Statistical Office, International Monetary Fund (IMF), National Statistics Office (Philippines), PriceWaterHouseCoopers, The World Bank, Transparency International, United Nations (UN) and United Nations Conference on Trade and Development.

Demographic characteristics and urbanization

One of the most characteristic demographic factors of developing countries is the growth rates of these countries over the average rate, i.e. population boom (Ghatak, S. 2003). In comparison with other continents, Europe witnessed her population boom relatively early, between 1800 and 1900, and the process peaked at the beginning of the 20^{th} century (Roupp, H. 1996). In 1900, 25% of the world’s population lived in Europe (408 million people) and 57.5% in Asia (946 million people). In Asia, the most intensive period of the population boom was the 20^{th} century, while by this time the growth of Europe’s population had

Table 1. Demographical trends in the Philippines and in Hungary between 1950 and 2050

Region, city	1950	1970	1990	2000	2010	2020	2030	2040	2050
	Population (million)								
World	2,535.00	3,698.00	5,295.00	6,124.00	6,906.00	7,667.00	8,318.00	8,823.00	9,191.00
Asia	1,411.00	2,139.00	3,181.00	3,705.00	4,166.00	4,596.00	4,931.00	5,148.00	5,266.00
Philippines	19.99	36.55	61.23	76.21	93.00	108.75	122.39	132.86	140.47
Urban population	5.43	12.05	29.86	44.62	61.73	78.59	93.86	107.01	117.83
Metro Manila	1.54	3.53	7.97	9.96	11.66	13.89	14.81*	–	–
Europe	548.00	657.00	721.00	728.00	730.00	722.00	707.00	687.00	664.00
Hungary	9.34	10.34	10.37	10.21	9.94	9.62	9.26	8.85	8.46
Urban population	4.95	6.21	6.82	6.60	6.79	6.95	7.05	7.04	6.99
Budapest	1.62	1.95	2.01	1.79	1.66	1.66	1.66*	–	–

*2025 *Source:* UN, 2008a

slowed down considerably (Embree, A.T. and Gluck, C. 1997). According to UN's data, in 1950 the population of Asia was 1,411 million, in 2000 3,705 million, and it is estimated that by 2050 – with respect to the tendency of population growth – it might reach 5,266 million (UN, 2008a). *Table 1* shows that the population of Asia is still on an intensive growth, while the population of Europe will increase only until 2010, and thereafter continuous decrease is forecast.

A similarly dynamic growth rate of the population is characteristic of the Philippines, whose population will have become seven times larger from 1950 to 2050 in contrast with Hungary, where the decrease of the population is foreseen to be 1.1-fold in the same period. This difference is the most clearly reflected in the fact that in 1950 the population of the Philippines was hardly twice as many as that of Hungary, and by 2000 and 2050 the gap is expected to be 7-fold and nearly 17-fold, respectively.

Another characteristic figure is that in 1950 0.79 of the world's population lived in the Philippines, in 2000 – 1.24%, while in 2050 – 1.53%. In contrast, the corresponding data for Hungary show considerable decrease: in 1950 the country had a share of 0.37%, which dropped to 0.17% by 2000, and is going to remain under 0.1% in 2050. In his book entitled World population: a reference handbook and published in 2006, Geoffrey Gilbert has arrived at the conclusion in the light of the current demographic trends that those regions are considered to be developing where the growth rate of the population is over the average (Africa, Asia and Latin-America), while those countries are claimed developed where this growth rate has become decelerated or stopped

(Europe, Japan, Australia, New Zealand and North America). It is obvious that this approach largely simplifies a fairly complex issue, and therefore fails to offer absolute certitude.

In developing countries, due to the population boom huge demographic pressure is shouldered by the cities, in comparison with the rural population the growth rate of the urban population will be three times larger from 2000 to 2030 (Ruel, M.T. *et al.*, 2008; Bassam, E.N. and Maegaard, P. 2004). In parallel with the growth of the population, the urbanization rate is also on the rise, which is primarily reflected in the increasing number of urban population, while the emergence of urban lifestyles is less pronounced (Gilbert, G. 2006). *Figure 1* shows that the urbanization processes being characteristic of developing countries have left Hungary practically unaffected, unlike the Philippines, where within 80 years the proportion of urban population has nearly tripled. In Europe, urbanization processes accelerated in the 18–19th century, while Hungary witnessed the same tendencies just a century later, in the 19–20th century. In the 1950s, only 50% of the population lived in towns and cities, yet the growth rate in this respect has been rather slow, and therefore even by 2030 the ratio of urban inhabitants will have just exceeded 75% of the total population. In contrast, the Philippines saw the acceleration of urbanization processes in the second half of the 20th century; as a result by 2010 the ratio

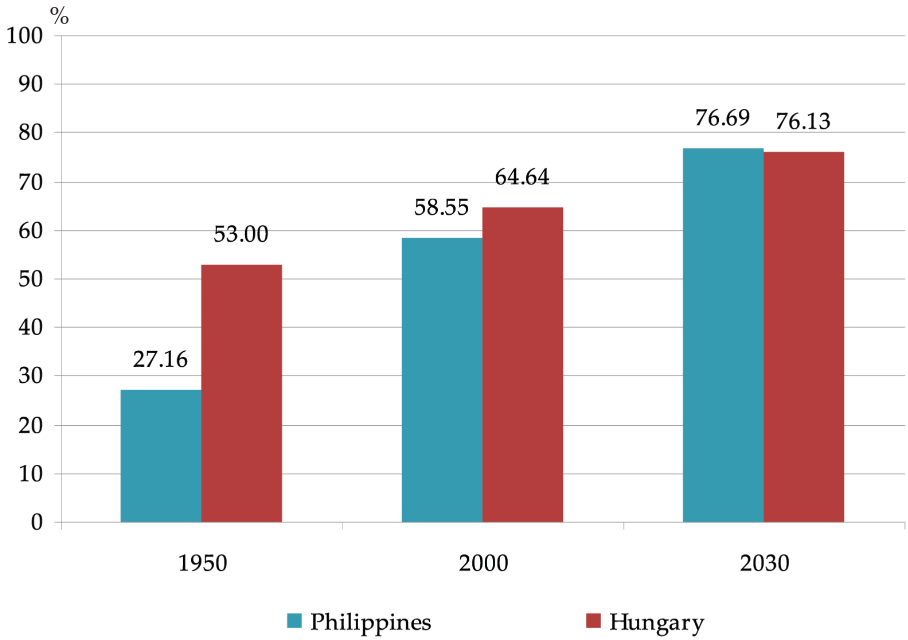

Fig. 1. Change in urban population in the Philippines and in Hungary between 1950 and 2030. *Source:* UN, 2008a

of urban population has become similar to that of Hungary, while by 2030 it will have passed the corresponding Hungarian ratio. Thus, the urbanization rate tends to be rather similar, and reflects little difference.

An adequate indicator of the above mentioned demographic and urbanization processes is the difference between the population growth of Metro Manila and Budapest. The only period was the 1950s, when the populations of the two cities were comparable. *Figure 2* clearly shows that by 2030 the population of Budapest will have been in fact identical to the population back in the 1950s, whereas Metro Manila will have experienced a tenfold increase within the same 80 years.

According to Aprodicio A. Laquian (2005), the fundamental problem is that the infrastructure network of the agglomeration is not capable of handling such a large-scale growth of urban population that is witnessed in the developing countries. The underlying reason is that the development of the infrastructure is slower than demographic changes, which impacts life quality in these megacities.

Consequently, in the light of the demographic and urbanization characteristics Hungary and the Philippines cannot belong to the same category. On the basis of the results of demographic analyses, instead of IMF's definition of developing countries it seems to be worth relying on UN's similar categorization stating that Hungary means a transitional stage in between developing and developed countries.

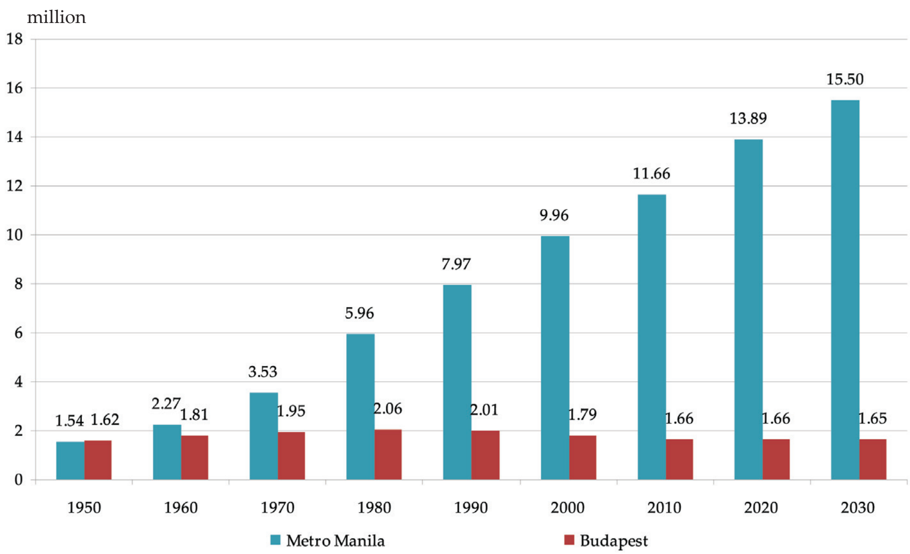

Fig. 2. Change in population number of Budapest and Metro Manila between 1950 and 2030 (estimated). *Source:* UN, 2008a

Economic performance and economic structure

In addition to demographic processes, it is generally the economic performance of countries that serves as the basis of categorization of developed and developing countries. Most of the associated sources take the gross domestic product and per capita gross domestic product of countries – measured nominally or at purchasing power parity – as the basis of comparison (Adams, F. G. 2002; Epstein, G.A. 2005; Eshang, É. 1983; Krugman, P.R. 2000). In this economy-oriented analysis, the various forms of GDP were also regarded to serve as grounds for comparison; one reason for this approach is the fact that it is generally measured in all countries. The present analysis has relied on the figures of three organizations (IMF, The World Bank, CIA), and special significance has been attributed to the IMF analysis. *Table 3* shows that on the basis of the nominal GDP values for 2008 the GDP values of the Philippines and Hungary are nearly identical, yet at purchasing power parity there is almost a 1.5-fold difference in favour of the Philippines. Obviously, GDP data in themselves are not too significant (the GDP of Sweden with a population of 9 million corresponds to the GDP of Indonesia inhabited by 230 million people), and therefore it is more effective to present per capita data. As *Table 2* shows considerable differences can be found in per capita nominal GDP figures. In Hungary, the per capita nominal GDP is USD 15,542, which is 8.3 times larger than in the Philippines, and nearly 1.7 times larger than the global

Table 2. Nominal GDP and GDP PPS in Hungary and in the Philippines

Region	IMF (2008)	Rank	The World Bank (2008)	Rank	CIA (2008)	Rank
	Nominal GDP (millions of USD)					
World	60,689,812	–	60,587,016	–	62,250,000	–
Philippines	168,580	47	166,908	47	172,300	46
Hungary	156,284	52	154,668	50	164,300	48
	Purchasing power parity GDP (millions of USD)					
World	68,996,849	–	69,697,646	–	69,490,000	–
Philippines	320,384	36	317,110	36	320,600	37
Hungary	196,074	51	194,023	52	203,900	51
	Nominal GDP per capita (USD)					
World	9,048	–	8,103	–	9,281	–
Philippines	1,866	121	1,848	115	1,755	132
Hungary	15,542	45	15,409	37	13,231	55
	Purchasing power parity GDP per capita (USD)					
World	10,287	–	9,760	–	10,361	–
Philippines	3,546	123	3,510	111	3,300	132
Hungary	19,499	45	19,329	35	19,800	47

Sources: IMF 2009, The World Bank database 2008 (www.worldbank.org), CIA 2008 average. Naturally, GDP values at purchasing power parity do not carry such large differences. Hungary's per capita GDP value at purchasing power parity is twice as large as the global average, but it is only 5.5 times higher than the corresponding value of the Philippines.

With respect to the differences in per capita GDP measured for nominal and purchasing power parities, we opine that the two countries cannot belong to the same category. This view has been reinforced by the report of FTSE Group Global Equity Index Series (Country Classification) monitoring stock markets where Hungary has been classified to be an advanced emerging country, while the Philippines belong to secondary emerging countries. This categorization is rather similar to the UN standard, and not IMF's categorization.

Concerning urbanization, it is worth comparing the data of Metro Manila and Budapest, as well, because in both countries the capitals are the agglomerations with the strongest economic performance. In its 2007 publication entitled Economic Outlook, PriceWaterHouseCoopers analyzes the characteristic GDP figures of 151 metropolises (PWHC, 2008). In the light of GDP data at purchasing power parity, in 2005 Metro Manila contributed to the gross domestic product of the Philippines with 36%, whereas Budapest gave 23% of Hungary's gross domestic product. Consequently, the distribution of the GDP has a more polycentric nature in Hungary, yet in view of the demographic tendencies the Philippines is foreseen to see the concentration of GDP in Metro Manila in the future. *Table 3* shows that Metro Manila enjoys a dynamic GDP growth in contrast to Budapest, which ranked 151st and thus last among the examined cities. In view of the trends anticipated the weight of Metro Manila is going to increase by 2020, and it will grow into one of the leading cities of Southeast Asia, while Budapest will lose a considerable part of her global (and continental) influence. Similar changes can be detected in per capita GDP values of these cities: per capita GDP of Metro Manila at purchasing power parity will have become 1.8 times larger within 15 years to reach USD 18,500, unlike Budapest, which will have only a 1.2-fold growth, and its per capita GDP will not hit USD 30,000. In their publication entitled A Roster

Table 3. Urban agglomerations GDP rankings in 2005 and illustrative projection to 2020 (using UN definitions and population estimates)

City	Estimated GDP (million USD at PPPs)		Ranks		Real GDP growth rate (% 2006–2020)	GDP growth ranking (out of 151)
	2005	2020	2005	2020		
Metro Manila	108,000	257,000	42	30	5.9	36
Budapest	43,000	49,000	92	126	0.9	151

Source: UN, 2008a

of World Cities, Beaverstock, J.V. *et al.* (1999) rely on various calculations to assume that at the present both Metro Manila and Budapest can be regarded gamma world cities, yet the characteristic tendencies promise the increase of Metro Manila's global weight.

In our opinion, the GDP value for economic performance does not lead to any accurate conclusion whether to regard a country to be developing or developed. Per capita GDP (either nominal, or at purchasing power parity) offers a more realistic view on countries, yet on the basis of these values neither Hungary, nor the Philippines can be considered as developed. In fact, the definition of FTSE Group Global Equity Index can be regarded to be acceptable with Hungary classified as an advanced emerging country, while the Philippines as a secondary emerging country. In view of economic growth, the dividing line between the two countries cannot be regarded to be so sharp that one would assume the above-described tendencies to remain permanent.

Unlike economic performance, economic structures are much differing. A general characteristic of developing countries is that the majority of the added value to the gross domestic product originates from industry, and a smaller proportion comes from agriculture, while the tertiary sector is less developed (Narula, R. 1996). In the case of the Philippines, 14% of the GDP originates from agriculture, and industry and services have contributions of 32% and 54%, respectively; in Hungary, 4% comes from agriculture, 30% from industry and 66% from services (The World Bank: World Development Indicators database, 2009). In our comparison, the point of reference has been Germany belonging to the most developed countries: here the agricultural sector contributes to the GDP only with 1%, while industry and services have shares of 30% and 69%, respectively. When compared to Germany in terms of the structure of economy, Hungary should clearly belong to the group of developed countries, while the evaluation of the situation of the Philippines is rather doubtful. The relatively large proportion of the added value from agriculture is an obvious consequence of the broad-scaling rural population, yet with respect to the given tendencies of urbanization it may become considerably smaller in perspective. With the increasing regional and global significance of the Philippines – especially Metro Manila –, people forced to leave the agricultural sector would primarily flow to the service sector, and to industry to a lesser extent, meaning that the economic structure of the country would become similar to that of the developed countries.

In the light of The World Bank's figures, there is still an important factor to be highlighted: the value of foreign direct investment (FDI). FDI has a crucial role in determining how much foreign investors consider a given country to be worth hosting investments. Obviously, with respect to FDI it is difficult to see any parallelism in between the emerging markets of Southeast Asia and the post-communist countries of Europe, because they are target areas of investments for different types of countries from various geographical locations (Athukorala, P. and Hill, H. 2002; Nicholas, S. and Maitland, E. 2002). In addition to the Philippines and Hungary, the FDI value has also been established for Germany as a country of reference on the basis of the figures of United Nations Conference on Trade and Development (UNCTAD) and CIA. *Figure 3* shows that foreign investors channel the largest investments to Germany featuring the strongest economic performance among the countries mentioned; the corresponding ratios for Hungary and the Philippines in comparison with the overall value for Germany are 16% and 3%, respectively.

In Hungary, the aggregate amount of foreign direct investments was dynamically increasing to become 171 times larger in 2007 than in 1990, while in the case of the Philippines the overall growth was 4.2-fold in the same period. A characteristic figure for Hungary's FDI growth rate is that since 1990 even China's total amount of foreign direct investments has risen only to a 15-fold value. It is also important to mention the other side of FDI that is the sum invested in foreign countries. According to UNCTAD data, in 2006 Hungary's foreign investments totalled up to USD 12,693 million, making her the largest capital investor among the former Communist countries. Obviously, the above-mentioned amount is far smaller than the corresponding values of Western European countries, yet the underlying growth rate is not insignificant. In the period from 1990 to 2006, nearly USD 40 billion foreign investments were associated with Hungary, which meant a 65-fold growth. The Philippines had USD 20 billion foreign investments in 1990–2006, and thus the given growth rate was 14-fold.

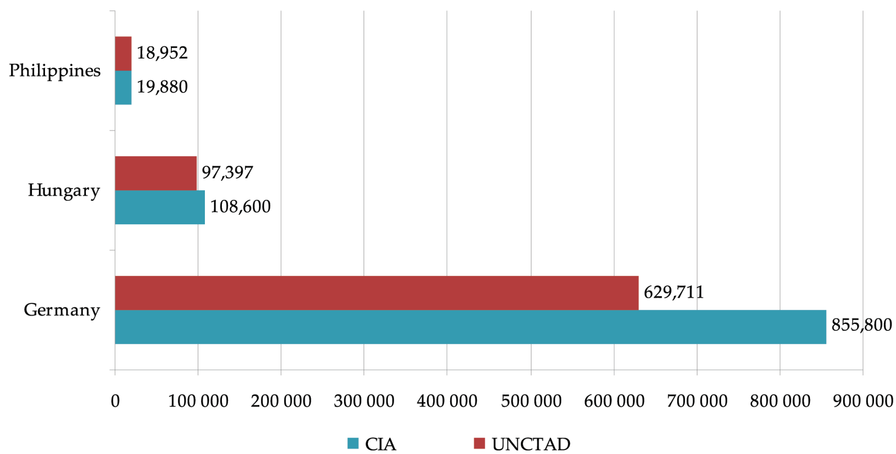

Fig. 3. Foreign direct investment (million USD) arriving in the Philippines, Hungary and Germany between 1990 and 2006. *Source:* UNCTAD, 2008; CIA, 2008

According to UNCTAD's analysis in relation to economic performance, Hungary belongs to the developed European countries, while the Philippines are one of the developing Asian countries. It is to be noted, however, that Hungary has suffered much more from the global economic crisis of 2008–2009 (and expectedly 2010) than the Philippines. IMF claims that in 2008 the GDP of the Philippines increased by 3.8%, and in 2009 the growth rate decelerated to 1% due to the crisis, yet is foreseen to grow again by 3.2% in 2010. In contrast, in 2008 Hungary's GDP had a growth rate of only 0.6%, and is expected to drop by 6.7% in 2009 and stagnation is going to follow into 2010 (-0.9%). Another key factor that makes Hungarian economy more vulnerable is that her USD 126 billion external debt reaches up to 80% of the annual GDP, whereas the external debt of the Philippines totals up to only USD 62 billion, remaining under 21% of the GDP (CIA, 2008). It is to be noted, however, that the external debts of countries regarded to be developed tend to be far larger than that of Hungary or the Philippines. For instance, the corresponding value for Switzerland is 442%, 375% for Great Britain, 160% for Germany and 100% for the United States.

Social relations, social conditions

The evaluation of social relations and social conditions has been chosen as the last aspect of the comparative analysis, because – in our opinion – this is the area where the sharpest contrasts can be detected between the two countries, and on the other hand that seems to be the most critical point of the analysis. The social conditions, circumstances of life in a given society are largely dependent on the growth rate of the population and the economic conditions, i.e. they are the essence of the factors examined in the foregoing. Naturally, the history, culture and political life of the two countries determine social conditions to a certain degree, but not to an extent that would make comparison impossible.

The colonization of the Philippines by the Spanish started in the 16th century, and then at the turn of the 20th century the years of American influence followed until 1946. In the 1960s and 1970s, the Philippines had the second quickest economic growth in Asia after Japan. In 1960, Ferdinand Marcos was elected, but no democratic changes took place; moreover, in 1972 Marcos declared martial law, and exercised dictatorship until 1986. Announced as a consequence of the People Power Revolution, the general elections of 1986 were won by María Corazón Cojuangco-Aquino, who thus became the first woman president not only in the Philippines, but in whole Asia (Schirmer, D.B. and Rosskamm Shalom, S. 1987). Since 1986, the Philippines have been walking the way of democracy more or less successfully (Lambertson, D.F. 1987).

Until 1918, Hungary was dependent on Austria within the dualist confederation of the Austro–Hungarian Monarchy. As a result of the Peace Treaty of Trianon closing the First World War (1920), as a country defeated in the war Hungary saw the shrinking of her territory from the former 325,000 sq km to 93,000 sq km, and a major loss of population from 20.9 million to 7.6 million inhabitants. Hungary was again among the defeated countries of the Second World War, yet the subsequent change in her territory was not considerable in comparison with the outcomes of the Trianon Peace Treaty. Save for a very short period of democracy from 1945 to 1949, until 1989 Hungary was a part of the sphere of influence of the Soviet Union, and therefore the first democratic elections took place as late as in 1990 (Molnár, M. and Magyar, A. 2001).

With respect to the historical characteristics, it can be claimed that the democratic processes rooted in western traditions arrived in both countries only in the second half of the 1980s, meaning that any comparison between the Philippines and Hungary is realistic only for the period since the 1990s.

Beside per capita gross domestic product examined above, it is Human Development Index (HDI) that is suitable for the description of the social relations and conditions of these countries, also with respect to the available data of international organizations serving as the basis of the analysis (UN, 2007). On the basis of HDI, UN proposes three basic categories of countries: countries with high, medium and low HDI values. In this respect, Hungary is ranking 43rd, and although she belongs to the middling group of countries featuring high HDI values, she has lost some positions in recent years. The Philippines is ranking the 105th, and therefore is in the medium HDI category. *Table 4* shows the various components of HDI in relation to 2006. The largest difference between the two countries is existent between the values of the GDP index, but no significant discrepancies can be found in the life expectancy index and education index. Life expectancy at birth is to be highlighted separately, because in this respect the values for the Philippines and Hungary are nearly identical, while Hungary is at the tail-ends in Europe.

Table 4. Human Development Index by components (2006)

Coutries	HDI value	Life expectancy at birth (years)	Combined gross enrolment ratio in education (%)	GDP per capita (PPP USD)	Life expectancy index	Education index	GDP index	GDP per capita rank minus HDI rank
	2006							
Hungary	0.877	73.1	90.2	18.154	0.802	0.960	0.868	5
Philippines	0.745	71.3	79.6	3.153	0.722	0.887	0.576	20

Source: UN, 2008b.

It is reasonable to compare changes in HDI. For Hungary, the HDI value was 0.811 in 1990, and reached 0.877 by 2006, thus the growth rate came to be 0.066 points. The HDI value of the Philippines was 0.694 in 1990, and then 0.745 in 2006 with an underlying positive change of 0.095 points. The growth rate of HDI can be regarded to be averaging in both countries, but in the period of 2000–2006 the increase of HDI considerably flagged in the Philippines. Similarly, material differences can be detected in the education index of the two countries: Hungary ranks 26th, while the Philippines rank 66th. It has been mentioned above that in the life expectancy index no similar difference can be observed between the two countries, because Hungary is in position 78, while the Philippines rank 100th. Obviously, the underlying reason is not the better ranking of the Philippines, but rather reflects Hungary's poor value.

Finally, a new indicator has been introduced for the purpose of comparison. In addition to HDI, UN examines countries with respect to their Human Poverty Index (HPI) values (UN, 2009b). It is an indicator that indeed echoes the differences in the social conditions of countries, distinguishes developed and developing countries on the basis of their social conditions. Countries regarded to be developed have not been included in the group of countries studied in UN's HPI survey, and therefore altogether only 135 countries have formed the relevant sample. From among the 135 countries, Hungary has become third in ranking (2% of the population lives under USD 1.25 a day, and another 2% under USD 2 a day), while the Philippines ranks 54th (22.6% of the population lives under USD 1.25 a day, and another 45% under USD 2 a day).

There are a number of other indices to express social conditions (Subjective Well-being Index, Quality of Human Conditions Index), and they look at the countries from various perspectives. On the basis of HDI and HPI, it has become apparent that quite a wide gap is open within the group of countries regarded to be developing.

Conclusion

The above-listed indicators (GDP, GDP, PPS) and indexes (HDI, HPI) consider only the current social-economic conditions of the countries with no reference to the future. According to the analyses and databases of various international organizations, the post-communist European states (e.g. Hungary) and the Southeast Asian emerging countries (e.g. the Philippines) can be grouped in the same category in spite of their apparently differing attitudes: they are all developing countries. In fact, the historic past determines today's circumstances and conditions in countries that are situated in different continents, and therefore such categorization has a rationale only within broad bounds.

We opine that the category of "developing countries" means an excessively homogeneous group where it is hard to fit countries when they are examined from various perspectives. Our initial objective has been to compare the Philippines and Hungary with respect to the fact that IMF deems both states to be developing countries. We have drawn the conclusion that these two countries can be classified in no single global group, while it is obvious – even in the light of the analyses of international organizations – that Hungary is a developing country in Europe similarly to the situation of the Philippines in Southeast Asia (at least when compared with Germany or Japan).

What is to be foreseen for the future?

We have no reason to think that the futures of countries are fixed and determined. Although today the differences between Hungary and the Philippines are fairly large, we should rely on the opinion of the well-known American scholar of political science, Samuel P. Huntington. In his presumably most famous book, The Clash of Civilizations and Remaking of the World Order published in 1996, he called the attention to the decline of the Western Civilization headed by the USA and Europe, and the strengthening economies of Eastern Asia. It will wake the self-conscience of the Eastern Asian countries, as their civilization will be founded on strong economies.

According to Huntington, by just after the middle of the 21st century the balance of powers between Asia and the Western world will have changed substantially, and even as early as today we can witness the signs of the process. Møller, J.Ø. (2007) thinks that the focus of global economy is gradually being shifted towards Southeast Asia, while Kerr, D. (2004) points out that nowadays the Southeast Asian economic competition between China and Japan (also affecting the Philippines) is just as determinant as the former economic rivalry between Japan and the USA.

A new economic global regime is being shaped where the future of developed and developing, European and Asian countries seems to be a still open question (Fox, J., 2009).

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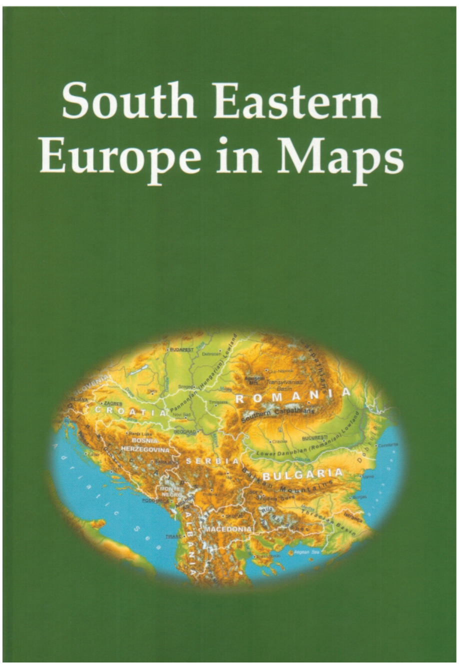
Károly Kocsis (ed.): South Eastern Europe in Maps

2nd, Revised and Expanded Edition

Geographical Research Institute Hungarian Academy of Sciences. Budapest, 2007. 136 p.

Over the past fifteen years the explosion of the "Balkan powder-barrel" shocking the European continent deeply i.e. the fanning of ethnic-religious tensions (suppressed for several decades) into regional conflicts and warfare renewed traditional interests of the Hungarian public towards the countries of South Eastern Europe (the former member republics of Yugoslavia, Albania, Bulgaria and Romania).

There has emerged a necessity to publish an atlas in the form of a book or a book combined with an atlas in which a large number of attractive thematic (political, ethnic, religious, economic) maps, charts, tables completed by concise textual analyses provide explanation for the up-to-date societal and economic issues of South Eastern Europe and the most characteristic segments of the region's development in the 20th century. The present publication produced in the Geographical Research Institute of the Hungarian Academy of Sciences serves as a brief account for public and scientific audiences and political decision makers on the region which largely belongs to the Balkans, with some countries as the primary targets of the enlargement of the European Union. The chapters are entitled by the main topics figuring in the book: the concept of South Eastern Europe and the Balkans; territorial distribution by states; ethnic and religious patterns; urbanisation and town network; the standard of economic development; spatial disparities; industry; transport; and tourism.



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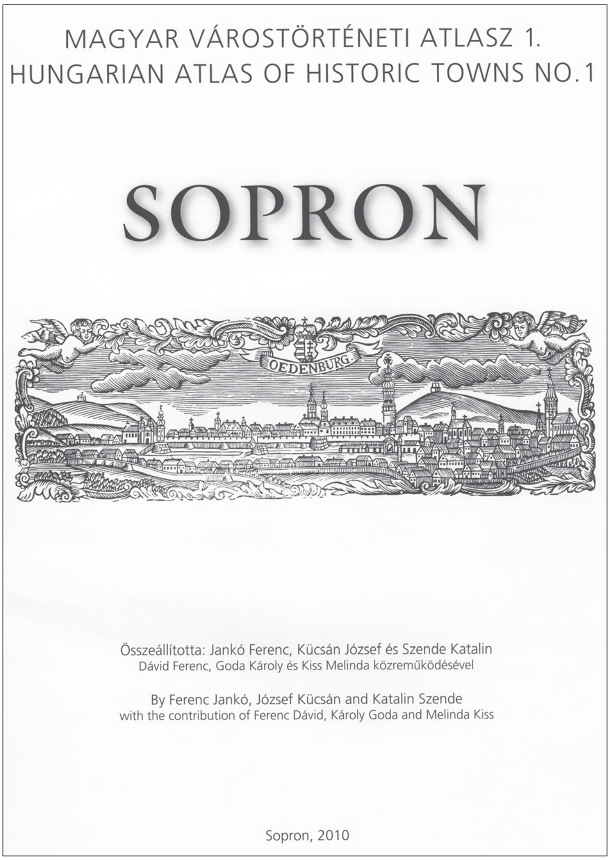
Jankó, F., Kücsán, J. and Szende, K. (eds.): Hungarian Atlas of Historic Towns No. 1 – Sopron. Győr-Moson-Sopron Megye Soproni Levéltára. Sopron, 2010. 87 p., 23 maps & images.

The year 1955 marked the founding of the International Commission of Urban History (Commission Internationale pour l'Histoire des Villes), the organization that later initiated the edition of historic town atlases in Europe. In 1968, a group of specialists in urban topography and history led by Heinz Stoob set up general guidelines for the edition of the series of town atlases. The focus in this period was very much on the Middle Ages but from the 1990s new principles were established and since then modern history has become equally important in the volumes. Over the last four decades more than 450 folios have been published in the series of historical town atlases, all of which have, more or less, the same structure and editing principles. The main maps use identical scales. The atlas series is organized on a national basis. Thus, the volumes follow the present-day borders of the countries. Although the current volume is the first to be published within the modern borders of Hungary, there are a few atlases published in Croatia (Varaždin, Bjelovar, Sisak, Koprivnica, Hrvatska Kostajnica), Austria (Rust, Eisenstadt) and Romania (Sebeş, Sighişoara) which represent towns that once belonged to the Hungarian Kingdom. Research on historic town atlases were already proposed in Hungary by Jenő Szűcs in the 1960s but the work itself has only been ongoing in the last six years. Under the supervision of András Kubinyi and after his death led by Katalin Szende, a



research group has been working on the edition of the first four volumes of the series with the financial support of a Hungarian Scientific Research Fund grant (OTKA) since 2004. The first four atlases all represent different types of towns in historical Hungary. Sopron (Western Hungary) as one of the eight medieval free royal towns was one of the few highly urbanized centers in medieval Hungary. The study of Buda is also of key importance as from the late 14th century it became the royal center and capital of the country. Kecskemét represents a different type in the group of market towns (*oppidum*). Kecskemét itself is a typical example of urban settlements from the Great Hungarian Plain. It had huge borders and a large population from the Ottoman Period onwards. However, the population was not significant before the sixteenth century. The fourth choice fell on another market town: Sátoraljaújhely (north-eastern Hungary), which is in a rather different location and topographic setup at the feet of the hill region in Hungary.

The focus of this review is on the historical topography of the town of Sopron. The present volume – the first one in the Hungarian series in print – consists of two parts: a booklet, which provides a detailed description of the town and a section of loose-leaf maps which includes twenty-three maps and images showing the topographical, structural and social changes in the town. Although the primary focus is on the maps themselves, as the publication under review is an atlas, the descriptive part is also worth some discussion as this is the most recent scholarly summary of one of the most important towns of Hungary from experts in urban geography, ethnography and the local history of Sopron.

Sopron has the richest archive among the medieval towns of Hungary. Many excavations were also carried out in the town, making it possible to provide a detailed analysis of the structure of the town since antique times. The town of Scarbantia (Sopron), established next to one of the most important trading routes (the Amber Road) in the Roman Empire, was a significant settlement. The authors provide topography of the town based on a previous research by János Gömöri, combined with the results of more recent excavations. From the turn of the sixth century, the town was abandoned; still this was an important period in its history because, as Katalin Szende convincingly argues, the German name Ödenburg (meaning 'desolate castle') the name given the town during the Carolingian Times. After the Hungarian Conquest, the remains of the town were still visible and because of its strategic location a wood-and-earthwork bailiff's castle had been built along the line of the Roman walls. During the early Arpadian age a new fortification wall was constructed which still followed the path of the Roman walls. This is the reason for its larger territory than parallels from the medieval times.

In the eleventh and twelfth centuries the commercial role of the castle area was limited, something that changed from the mid-thirteenth century onwards. New houses were built within the walls of the town, which fundamentally changed the structure of Sopron. Katalin Szende provides a thorough analysis of the parceling-up of the new downtown of the city and the restructuring of the suburbs. From the fourteenth century, several urban farms were built in the suburbs. These farms greatly influenced the later development of the town. The author gives an account of the urbanization in the late medieval period and discusses the construction of ecclesiastical institutions (religious and military orders, chapels) and administrative buildings (especially the town hall). The analysis also includes data on the territories outside the built-up area of the town. The chapter about the medieval period of the town also refers to the demographic trends in the town although this subchapter does not fit in the structure of the work logically.

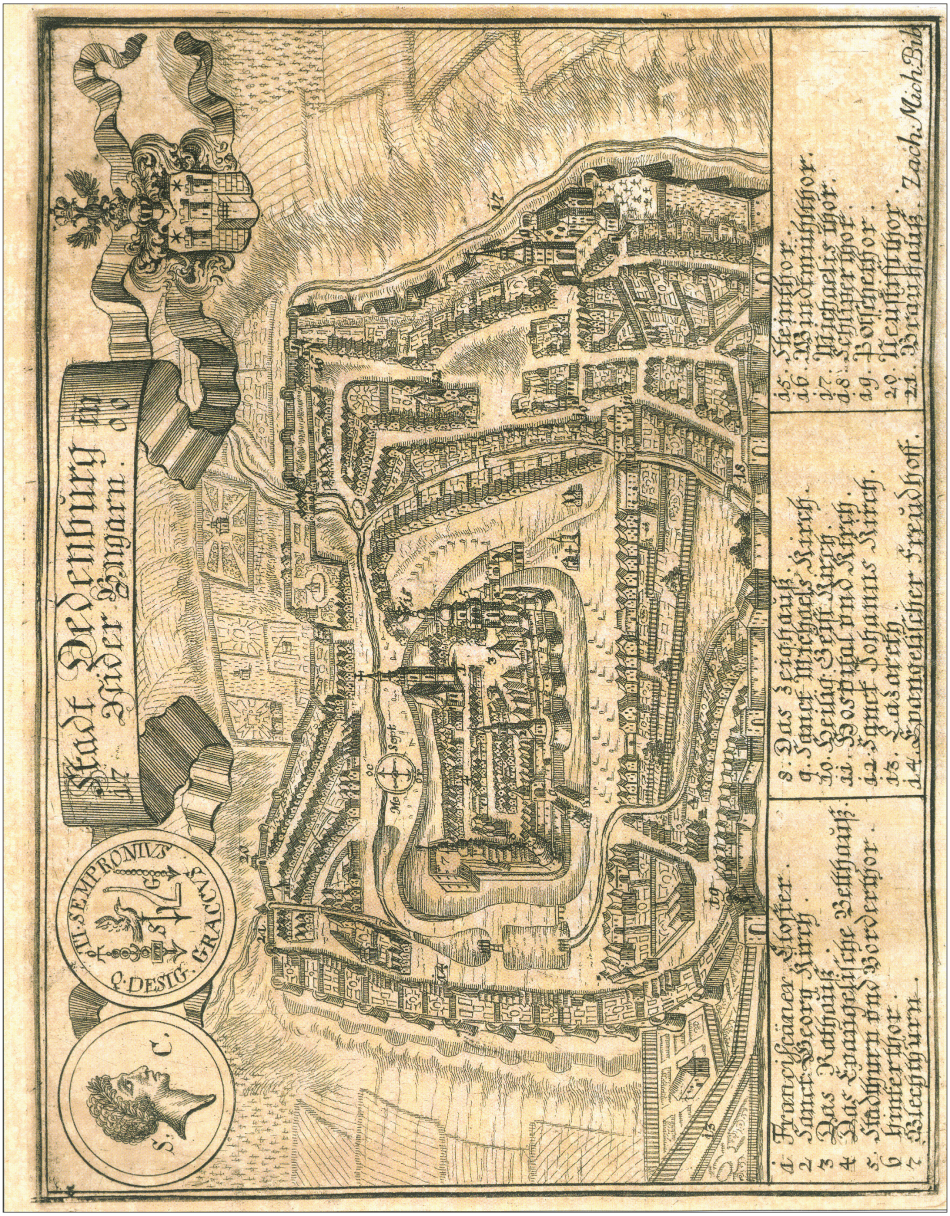
In the early modern period, discussed by ethnographer József Kücsán, the view of the town changed again as a consequence of the major fortification works, which was an obvious response to the growing pressure on the town during the Fifteen Years War.

Not only were the inner walls strengthened but another wall was built which surrounded the suburban territories as well. The historical sources in this period can be supplemented by landscape paintings and other visual evidence that the editors used carefully. In the sixteenth and seventeenth centuries, the medieval center of the town and the road network remained the same. Numerous houses were rebuilt but there were no fundamental changes. In the eighteenth century many houses were rebuilt in the Baroque style, which have remained the most important element of the townscape. Major changes took place in the Várkerület Zone in the eighteenth and early nineteenth century. The previously open zone of the ditch began to be built-up as the protective role of this area decreased. The population grew rapidly in the suburbs during the eighteenth century as the outer walls restricted growth within the old boundaries until the early nineteenth century but did not limit the expansion of the town beyond them.

The last chapter of the historical overview contains information on the modern development and morphological changes of the town. The author of this part, Ferenc Jankó, focuses on the growth around and outside the historical center of Sopron. Although before the Austro-Hungarian Compromise (1867) the historical suburban area was very much urbanized, the most fundamental change in the modern times was the growth of the town itself as the surrounding settlements accreted with the town. The author puts an emphasis on the development of the Lőver, which is the historical villa district in the hills south of the town. In the late-nineteenth – early-twentieth century the most important new feature of the town was the growth of industry which resulted in the construction of new residential areas. After the Second World War during the socialist era, and especially in the 1970s and '80s, a wave of housing estate construction started in the town. However, as it is emphasized in the study, the historical center was saved and became one of the most important areas of monument protection in Hungary. As a consequence, the town preserved its medieval milieu. In the last subchapter, Ferenc Jankó refers to the changes over the last twenty years. During these years the decline of industry and the growth of commercial and shopping centers marks the most significant change and as the population did not stop growing, the structure of the town still is in a dynamic change.

Apart from the comprehensive description of the development of the town of Sopron, the booklet contains two more sections. In the first one, Károly Goda analyses the number of taxpayers and the amount of tax paid by them in the late medieval and early modern times, the other short treatise contains a discussion of house-ownership of the prominent members of the town in this period. Although both subchapters contribute to the social and economic history of Sopron, they are not embedded in the structure of the historic atlas. Apart from the maps, which are indeed the most important part of the atlas, the last main section of the booklet is also very valuable as the editors of the atlas compiled a database which includes all the topographic objects that appear in the maps (features not only in the town itself but also those related to the surrounding agricultural area) until the late nineteenth century. This topographical gazetteer follows the example set by the Irish Historic Towns Atlas.

Although the booklet in itself is already a noteworthy overview of the town of Sopron, the plates it contains make it even more important. The main principles of the historic atlas are the same for all of Europe. The editors respected these principles and made only slight modifications to help the readers understand the topographic changes of the town. The first plate (A.1) shows the topography of Sopron based on the cadastral survey of 1856. The scale of this map (1:2500) provides a detailed overview of the parcel structure of the town. The atlas also includes a sheet representing Sopron and its environs in the first (1765–1785) and second (1819–1869) military surveys (A.2). A.3 through A.6 is


Stadt Oedenburg in Nider Ungarn.
TI. SEMPRONIVS GRACCVS Q. DESIG.
S. C.
1. Franciscaner Closter.
2. Sanct Georg Kirch.
3. Das Rathauß.
4. Das Evangelische Betthauß.
5. Stadthurn und Vorderthor.
6. Hinterthor.
7. Blechthurn.
8. Das Zeughauß.
9. Sanct Michaels Kirch.
10. Heilig Geist Kirch.
11. Hospital und Kirch.
12. Sanct Johannis Kirch.
13. Lazareth.
14. Evangelischer Freudhoff.
15. Steinthor.
16. Windmühlthor.
17. Michaelis thor.
18. Schlipperthor.
19. Poschenthor.
20. Neustifftthor.
21. Branthauß.
Zach. Mich. Bib

a series of plates which illustrates the development of the town from the Roman period until recent times. Here the editors deviated from the basic principles of the series which provides a single summary map of growth phases, and represented the stages of development in different periods on different maps instead. This makes it easier to compare the stages of development by time period.

The next major group of plates is an addition to the compulsory requirements set by the International Commission for the History of Towns. Plates B.1 and B.2 represent some aspects of social, ecclesiastic and economic structures of Sopron town in medieval and early modern times. The ones on the estate values and the valuation of houses in early modern Sopron says a lot about social stratification and the real estate of burghers in the town. The plates designed by József Kücsán concerning the early nineteenth century are also worth closer examination. This series of maps is essential for understanding the relationship between professions, wealth and urban space in Sopron. The maps by Ferenc Jankó (B.5 and B.6) on nineteenth- and twentieth-century Sopron visualize the morphological changes of the town over the last 200 years. The main focus, apart from the display of territorial expansion, is on the change in how many multi-storied buildings the town had. One of the main lessons to be learned here is that the buildings (especially those in the historic center) remained very similar in height during this period.

The last section in the plates (C.1 through C.11) is an important aid both for scholars and the interested public, as it brings together the most important visual representations of the town from early modern times. Apart from recent artists' reconstructions of the Roman and Arpadian age early lithographs, aquarelles, copper cuts and maps of Sopron from the eighteenth and nineteenth-century are included. One of the earliest representations of the town of Sopron is a copper cut from 1681 by Daniel Suttinger. It was a very reasonable decision to show this picture together with the lithography of Zsigmond Hárosy from 1841 because of the obvious parallels but it is not easy to connect the explanation of these two plates in the booklet with the images themselves.

The first volume of the Hungarian Atlas of Historic Towns is a very ambitious attempt to summarize the urban development and the morphology of an urban settlement in Hungary over the last millennia. The volume succeeded in this ambition in that this compilation will be a useful tool for scholars of urban, social and economic history, urban and historical geography, historical demography and so on. Both the study of the urban development of Sopron and the maps were edited with care and precision. All the pictures and graphs are of high quality. The maps also have a fine design in most cases, except perhaps for the ones on the twentieth-century development of the town. This problem may be attributed to the fact that these maps were adopted without alteration from the country-wide mapping system of the Institute for Geodesy, Cartography and Remote Sensing (FÖMI). The volume includes a CD as well containing all the maps and the text of the booklet. The atlas with all its parts is bilingual (Hungarian–English) which allows international scholars to become acquainted with the results of this work, to compare Sopron with other towns in the region as well as with more distant towns of Europe.

András Vadas

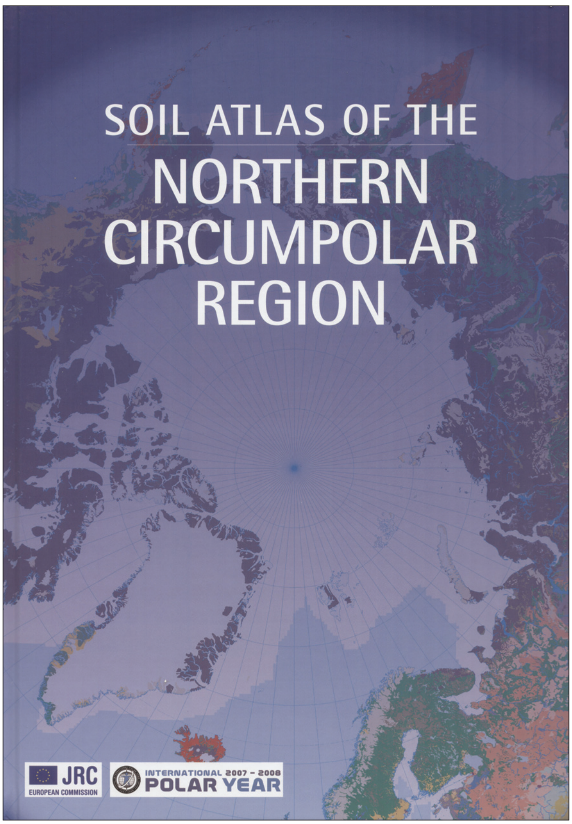
←
Zacharias Michel: Bird's eye view of Sopron, 1700

Jones, A. *et al.* **(eds): An introduction to the „Soil Atlas of the Northern Circumpolar Region".** European Commission, Publication Office of the European Union, Luxemburg. 2010.

The Joint Research Center of the European Commission has recently published a new atlas summarizing the soil resources of the Northern Circumpolar region. This atlas is the second in the Soil Atlas series, which was launched three years ago with the Soil Atlas of Europe and will continue soon with the Atlas on Soil biodiversity, and the Soil Atlas of Africa. Both of them are in the final stage of editing and will be published very soon. The work is ongoing, the organization of the scientific and editorial team for the Soil Atlas of Southern America has just recently started.

The initiative of publishing this Atlas series has been started with the compilation of the 1:1 million scale harmonized European Soil database, which was the first harmonized thematic database for the EU member states. The Atlas on the European soils is one of the presentation forms of this database with two major aims behind it. The first one is to provide a comprehensive view on the soil resources of Europe for teaching and educational purposes, while the second one is to raise awareness of soil protection over Europe.

The topic of the most recent Atlas on the soils of the Northern Circumpolar region was decided in 2007, as an EU contribution to the international polar year 2007–2008. Soil plays a critical role in the global carbon cycle processes thus being one of the most important factors in global warming. The thawing of soils in the arctic regions will result in the thawing of the currently frozen organic matter of the peat and meadow soils formed in this temporarily wet environment.



The reactivation of the surface and the soil forming processes can impact the global carbon cycle in two opposite ways. The warming and drying scenario may increase the decomposition rate of the soil organic matter and thus produce significant amount of extra carbon load to the atmosphere.

On the other hand, the warming and wetting scenario is bound to increase the hydromorphic impact and to decrease the decomposition rate of the fresh biomass and therefore to increase the carbon sequestration ratio in the soil. It is very likely, that both scenarios will happen in the same time depending on the environmental conditions. The important thing in forecasting the impact of the soil systems on global warming is to know the spatial extent of the two processes. Any modeling effort requires hard and harmonized data on soil for the potentially affected regions, which did not exist till recently. This gap was filled by this atlas.

More than 20 soil specialists of the arctic regions were involved into the project from each of the corresponding countries of Europe, Asia and North America, which ensured the high scientific quality of the work. Besides being a traditional atlas with 28 A/2 sized soil map plates classified in accordance with the World Reference Base 2006, the book is an attempt to describe the physical endowments and human environment of the Arctic and their impact on soil formation and the soil types. It summarizes the major soil types and soil properties of the regions and their role in the global processes, like the carbon cycle and global warming/climate change issues, and the local perspectives/uses of the soils in the contributing areas and countries.

The book is rich in illustrating photos, figures and maps, and provides a unique opportunity to obtain an insight into the Arctic environment. It is very useful for teaching or self educating purposes and provides a pleasant reading for the interested audience.

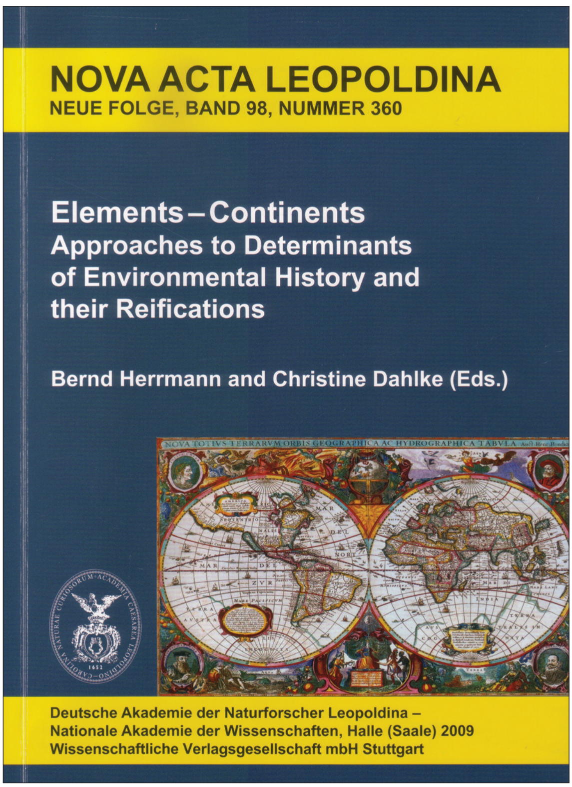
Endre Dobos

Herrmann, B. and Dahlke, C. (eds.): Elements – Continents. Approaches to Determinants of Environmental History and their Reifications. Nova Acta Leopoldina, Band 98, Nummer 360. Deutsche Akademie der Naturforscher Leopoldina – Nationale Akademie der Wissenschaften, Halle, 2009, 304 p.

A universally accepted definition of environmental history has yet to to be formulated. In simple terms it is a history that tries to explain why our environment is like it is and how humankind has influenced its current configuration, as well as elucidating the problems and opportunities of tomorrow. The American historian Donald Worster's definition is widely quoted, it states: "*Environmental history is the interaction between human cultures and the environment in the past*."

In 2007, the German National Academy of Sciences Leopoldina organized a workshop at Georg August University Göttingen in co-operation with the Research Training Program “Interdisciplinary Environmental History”. This publication contains both lectures of prominent scientists and abstracts of doctoral (PhD) students. The first part of the book is devoted to the lectures related to “Elements” of nature. Britta Allgöwer’s study (University of Zurich) is dealing with the role of fire in landscape and forest evolution in the Swiss National Park using high resolution remote sensing investigations.

Petra van Damm’s article (Free University of Amsterdam) analyzes different states of water from the viewpoint of environmental history and she gives an insight into transformations of the aggregate states and their impact on the countryside and lives of people in the Netherlands and other European regions. She concludes that water in its different states (ice, steam) became a commodity very early in densely populated Northwestern Europe. The benchmarks of water transitions in the environment history seem closely connected with those of economic, social and technological history.



Wolfgang Lucht’s study (Potsdam Institute for Climate Impact Research) focuses on the air, which can be seen as a planetary hybrid. The author provides a holistic view of the air as a joint product of geosphere and biosphere co-evolving throughout the Earth’s history. He introduces a new scientific approach called geophysiology which aims at analyzing the planetary body changes.

Professor Bork, R. (Christian Albrechts University in Kiel) and his co-authors investigates soil formation in the geological and human history. Since the rise of agriculture, human activities determine processes of soil formation and soil degradation. In urban areas former natural soils are nearly totally lost and replaced by anthropogenic deposits. Humans are using soils not only for agriculture and forestry but for several other purposes. One of the oldest techniques of soil use are construction techniques such as adobe brick or pottery production. Early figures made of soil more than 20,000 years ago were found. Some of the oldest pots date back to 11,000 B. C., were found in Fukui Cave, Japan.

Von Tilzer, M. (University of Konstanz) analyses the fifth element, the emergence and proliferation of life on Earth. Life formation around 3.5–3.8 billion years ago is seen as a succession of steps of self-organization that were only possible in the absence of oxygen in the atmosphere. The greatest breakthrough during the evolution was the emergence of oxygen photosynthesis at least 2.7 billion years ago. The next major evolutionary change was the development of multi-cellular plants and animals. After the termination of the last glaciation ca 10,000 years ago, biological evolution of humanity came to a halt and was replaced by cultural evolution. The past 200 years have been considered a new geological era which is characterized by significant impacts at global scale and called anthropocene.

The second part of the publication touches upon the environmental history of different "Continents". Professor Sieferle, R. (St. Gallen University) explores specific natural environmental conditions in Europe, with special regard to population, productive agriculture and natural disasters (e.g. volcanic eruptions, earthquakes, extreme weather events) in different historical contexts.

Beinart, W. (University of Oxford) deals with historical aspects of plant transfers to South Africa. Africans welcomed and absorbed many plants including as maize and prickly pear. The author argues that someone needs to be cautious in specifying asymmetrical plant flows and also in applying the concept of ecological imperialism.

Elvin, M. (Australian National University in Canberra) focuses on two main features of late-imperial pre-modern Chinese economy that created strongest pressures on the environment. These were garden-building (horticulture style farming) and distinctive dual style of agricultural management that combined land farming with collective management of water. Since the medieval economic revolution good farmland rather than labor force became the factor of production in shortest supply.

Professor Bargatzky, T. (Bayreuth University) in his study addresses iconic quality of land in Australia and Oceania. The land has been of paramount practical and symbolic importance to the aboriginal population. Land as an icon is interpreted as occurrences of gods. In Oceania land is transformed into iconic landscape through institutions like kinship group and the sacred community center in Polynesia.

Professor McNeill, J.R. (Georgetown University, Washington) touches on environmental history of American continent. American ecosystems have been buffeted by two main invasions. The first invasion began perhaps 15,000 years ago when wanderers crossed the bridge connecting Siberia with Alaska. The second invasion started more than 500 years ago when Columbus arrived in American waters followed by millions of Europeans, enslaved Africans and a growing stream from the rest of the world. The study provides an interesting overview of the environmental consequences if this twin invasions. It gives attention to the themes of earth, air, water and fire. The second part of the paper is devoted to the industrialization, oil exploration, forestry and land use and urbanization in 19th and 20th centuries.

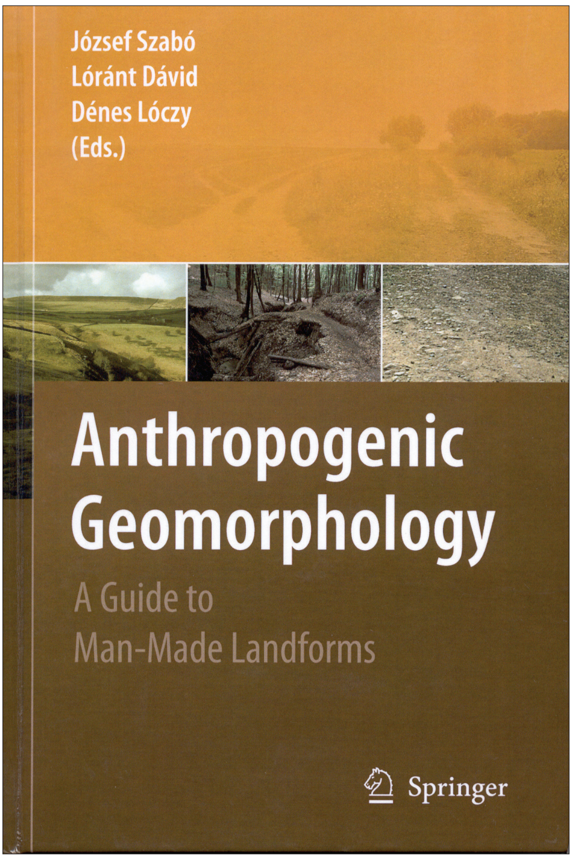
I recommend this book those readers who are interested in interdisciplinary studies like environmental history addressing the changing interactions between man and nature which is also a central theme of the geography since its existence.

István Pomázi

Szabó, J., Dávid, L. and Lóczy, D. (eds.) 2010. Anthropogenic Geomorphology: A Guide to Man-Made Landforms. SPRINGER Science+Business Media B.V., Dordrecht-Heidelberg-London–New York, 298 p. ISBN 978-90-481-3057-3

In the past few decades interest in the environment has reached a peak as popular opinion has become aware of the extent of the human impact on natural systems. A proliferation of degrees has followed this wave of 'environmentalism', their focus has been on natural areas and the damage caused by human impacts. Anthropogenic geomorphology deals with the special interaction between humans and the geographical environment which includes not only the physical constituents of the Earth, but also the surface of the Earth, its landforms and in particular the processes which operate to change it through time.

Since the 1970s in the research of the physical environment two, frequently intertwining trends are prominent. One of them investigates the changes in the natural environment induced by human economic intervention (which are often undesirable) along with their counter effects. The other aims at the quantitative and qualitative survey of the resources and potentials of the physical environment and the evaluation of also regionally varying geographical potentials. Researchers reviewing the geomorphological literature of the last 40 years will gain the impression that the perception of Man as a geomorphological agent is a fairly recent development. Anthropogenic geomorphology is a new approach and practice to investigate our physical environment, because in the eighties the increasingly urgent demands from society against geography – ever more manifest due to the scientific-technical revolution – underlined the tasks to promote efficiently the rational utilization of natural resources and potentials, to achieve an environmental management satisfying social requirements and using opportunities. At the same time, anthropogenic geomorphology is a new challenge for geomorphologists, since environmental problems have an effect on several branches of science.



Anthropogenic geomorphology studies the huge – and an ever increasing – number of landform associations of extreme variety depending on the actual way and purpose of their creation by the human activity. The discipline also studies the surface changes induced by these forms; moreover, predicts the consequences of disturbance of the natural equilibrium, and makes recommendations for preventing damages. Therefore, anthropogenic geomorphology can also be regarded as an applied discipline, which helps to solve both social-economic issues and environmental protection and natural conservation problems.

The editors and authors of the new Hungarian text-book on anthropogenic geomorphology hold that mankind must be regarded as a direct geomorphological agent, for it has increasingly altered the conditions of denudation and aggradation of the Earth's surface, and it has been becoming the major landscape sculpturing factor. Anthropogenic geomorphology is regarded as an activity system and taught as such, therefore, it is believed that the various fields of science in environmental protection rank equal and an important part is assigned to anthropogenic geomorphology in the structure of our education. The organisation of the book follows this concept. After a general introduction into the aims and scope of this discipline, the individual chapters focus on the different sectors of the human activity. The final chapter intends to give a qualitative and quantitative summary of the human impact on the Earth's surface.

Professor Andrew Goudie has written in the book's preface: 'This valuable book written by 14 Hungarian researchers provides an overview of impacts from most types of human activity, demonstrates the value of an historical approach, and although it has a special emphasis on Hungarian research, it provides examples from all over the world.'

László Rétvári

AVAILABLE!

Ukraine in Maps

Edited by

KOCSIS, K.–RUDENKO, L. and SCHWEITZER, F.

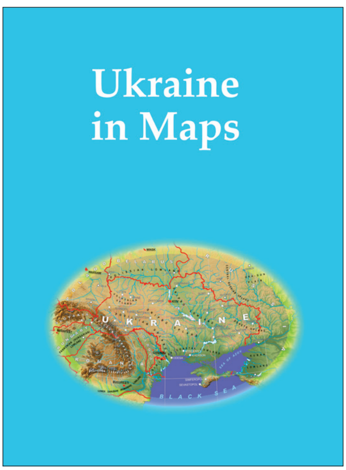
Institute of Geography National Academy of Sciences of Ukraine

Geographical Research Institute Hungarian Academy of Sciences. Budapest, 148 p.

Kyiv–Budapest, 2008

Since the disintegration of the USSR, the Western world has shown an ever-growing interest in Ukraine, its people and its economy. As the second-largest country in Europe, Ukraine has a strategic geographical position at the crossroads between Europe and Asia. It is a key country for the transit of energy resources from Russia and Central Asia to the European Union, which is one reason why Ukraine has become a priority partner in the neighbourhood policy of the EU. Ukraine has pursued a path towards the democratic consolidation of statehood, which encompasses vigorous economic changes, the development of institutions and integration into European and global political and economic structures. In a complex and controversial world, Ukraine is building collaboration with other countries upon the principles of mutual understanding and trust, and is establishing initiatives aimed at the creation of a system that bestows international security.

This recognition has prompted the Institute of Geography of the National Academy of Sciences of Ukraine (Kyiv) and the Geographical Research Institute of the Hungarian Academy of Sciences (Budapest) to initiate cooperation, and the volume entitled "Ukraine in Maps" is the outcome of their joint effort. The intention of this publication is to make available the results of research conducted by Ukrainian and Hungarian geographers, to the English-speaking public. This atlas follows in the footsteps of previous publications from the Geographical Research Institute of the Hungarian Academy of Sciences. Similar to the work entitled South Eastern Europe in Maps (2005, 2007), it includes 64 maps, dozens of figures and tables accompanied by an explanatory text, written in a popular, scientific manner. The book is an attempt to outline the geographical setting and geopolitical context of Ukraine, as well as its history, natural environment, population, settlements and economy. The authors greatly hope that this joint venture will bring Ukraine closer to the reader and make this neighbouring country to the European Union more familiar, and consequently, more appealing.



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CHRONICLE

Hungarian Geographical Bulletin 59 (4) (2010) pp. 441–445.

Hungarian Conference of Soil Science

Szeged, Hungary, September 3–4, 2010

A conference entitled *"Soils under changing physical and social impacts"* was organized jointly by Hungarian Soil Science Society, Committee for Soil Science and Agricultural Chemistry of Hungarian Academy of Sciences and Department of Physical Geography and Geoinformatics at University of Szeged. The meeting was. organized by a committee composed of Barta, K., Bidló, A., Farsang, A., Fuchs, M., László, P., Pirkó, B., Puskás, I., Szabóné Kele, G. The scientific committee included members Stefanovits, P., Várallyay, Gy., Máté, F., Michéli, E., Farsang, A., Mezősi, G. and Rajkai, K. More than 140 specialists took part at the conference both from research and educational institutions and from agricultural agencies and firms. The plenary session was proceeded by oral and poster presentations on the first day and a whole day field trip followed on the second day.

Szabó, G., rector of the University of Szeged opened the conference, then Mezősi, G., head of Department of Physical Geography and Geoinformatics welcomed the participants. In the course of the plenary session Farsang, A. from the host department showed the status of the soil science at the University of Szeged, and talked about education, research and services related to soil science. The second plenary lecture was given by Michéli, E., professor of Szent István University. She talked about the actual tendencies in the international and domestic soil science and in the activities of the organizations. In the afternoon 23 lectures were delivered in 4 oral sessions and 41 poster was shown.

In the session entitled *"Processes and evaluation of soil data"* lectures were given about the Hungarian soil data bases (e.g. the new soil physical data base combined with agrogeological data base, application possibilities of "MARTHA" data base), the potential development of national land evaluation and the connection between the newly developed Hungarian classification and WRB.

The *"Changing soils"* session included various topics. There were lectures about the long-time monitoring systems in Hungary: about "BIOSOIL" program for the observation of soils under Hungarian forests and about changes of brown forest soils in Somogy County based on "TIM" (Soil Information Monitoring) data. Besides, some serious soil degradation processes (water erosion, changes in soil moisture regime, etc.) were shown and changes in individual soil profiles from different parts of the country presented.

Participants heard 6 lectures in session *"Biological activity and soil use under changing climate and agricultural practice"*. There were tackled the new challenges (soil fertility, renewable ability, multifunctionality), problems of sewage sludge disposal, determination the optimum of forest society based on changing soils and improvement of salt affected soils in the Great Hungarian Plain.

The opening ceremony and its public

The last oral session was entitled *"Element traffic in soils"*. There were reports on field experiments with sewage sludge, different composts, energy plants, phosphorus movement by water erosion and lectures about vertical movement of copper and the selenium content in Hungarian soils.

The field excursion on the day after took place under the label *"At the contact of different natural microregions"*. Participants had the opportunity to visit 5 soil profiles typical of neighbouring landscapes (South Tisza Valley and Dorozsma–Majsa Sand Ridge) or transitional ones on their border. The first of them is found in the city of Szeged, it is a typical Technosol in the archeological excavation of the museum garden. The second one is part of the Soil Information Monitoring. This Chernozem is located west of Szeged on an

Participants of the meeting and discussion in the Arenosol profile

arable land. The third one is confined to the landscape border where sandy soil has been formed on the buried Chernozem. This profile is only 3 km away from the second profile and WRB can classify it as Arenosol. The next profile has formed in a flat depression near Zsombó village. This sandy Gleysol has a very high carbonate content (70–85%) and it is quite unique in Hungary because of its petrocalcic horizon. The last profile was that of a thin Gleyic Solonetz near Sándorfalva. Attractive benches completed the salty morphology in this area. The proceedings of the conference would be read in a special issue of journal *Talajvédelem* (Soil Conservation) to be published in spring 2011.

Károly Barta, Andrea Farsang

Scientific Conference ″Geographical Research and Cross-Border Cooperation within the Lower Basin of the Danube″

(Craiova, Romania, 23–26 September, 2010)

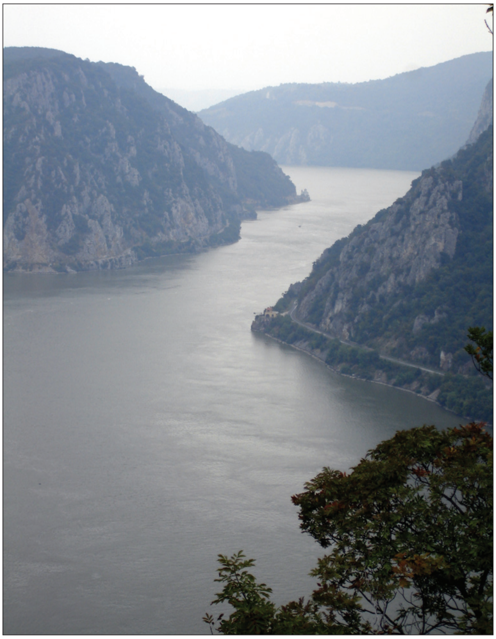
The Department of Geography at the University of Craiova (established in the centre of Oltenia in 1966) has been organizing meetings for geographers since 1992. The conference topics are mostly general but there have been some most specialized occasions too. At the beginning, the conferences had only attracted geographers from all parts of Romania but later colleagues from Bulgaria and Yugoslavia were also involved. In 2010 the fifth such meeting was organized and within the framework of collaboration in the Lower Danubian basins, researchers from Hungary were also invited. The coordination of geographical research activities in the Lower Danubian region acquires special significance in the light of the Water Framework Directive and the Hungarian presidency of the European Union, which put great emphasis on the broadening of cooperation between the Danubian countries and on the renewal of cooperation documents relating to the Danube drainage basin. Hungary was widely represented in Craiova: by four young lecturers and two Geology students from the Eötvös Loránd University of Budapest as well as two members of the staff of the University of Szeged and one from the University of Pécs.

The papers presented covered various fields of physical and human geography and also important topics from the related disciplines (including political sciences and demography). The first plenary lecture was held by Dénes Lóczy entitled ″Floodplains – links between countries and landscapes″, followed by Serbian, Bulgarian and Romanian

Craiova Town Hall

papers, one from each country. The conference continued in sections. The physical geographical section included particularly interesting presentations by researchers of the Geographical Institute of the Romanian Academy of Sciences on the application of GIS techniques to the solution of various geomorphological problems. Thanks to the publication opportunity offered by the hosting institution, the papers of the conference will appear in the forthcoming issues of Forum Geografic, a journal edited at the Univesity of Craiova, in English, in 2011.

The successful conference was complemented by a field trip to the Iron Gate reservoir, including a boat trip, fish meal and some hiking (to the Great Csukár, Ciucarul Mare Plateau). The explanations during the field trip focused on problems of nature conservation in the area.



Iron Gate Reservoir

For the organization of the conference gratitude is due to Professor Sandu Boengiu and his enthusiastic helpers, first of all, to Liliana Popescu and Cristiana Vâlcea. This was a very useful opportunity to revive the contacts between neighbouring countries, which used to be much more intensive decades ago, and provided young scientists an insight into research trends in participating countries as well as a chance to build new contacts between each other. We were happy to notice that the series of meetings would not be interrupted: the next meeting is planned to take place at the University of Szeged in 2012.

Dénes Lóczy

Cazanele Mare Cave

Hungarian Geographical Bulletin

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