Riverbank erosion in Hungary – with an outlook on environmental consequences

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Abstract

In the 19th century deforestation in the Carpathians and the growing population made flood control and river regulation an urgent task in the Carpathian Basin. As a result of shrinking active floodplains and cut-offs, the natural sedimentation/erosion equilibrium have been upset over the Hungarian Plain. The modified conditions have also changed the erosion patterns on minor floodplains. The present paper will outline the necessity for flood control, its effects and consequences for bank erosion. The present conditions and forms of bank erosion along the Hungarian rivers are considered and an overview is provided on the most important factors affecting bank protection with their socio-economic consequences in Hungary.

Keywords: riverbank erosion, floodplain, flood control, flood wave, heavy metals, remobilisation, Danube, Tisza

Introduction

The Danube and Tisza rivers have always played an essential role both in natural landscape evolution and in national life in the Carpathian Basin. These rivers and their tributaries wandered across the major part of this basin during the past 500,000 years (Borsy, Z. 1991). Both rivers and their tributaries have often altered their channels (although the Danube less frequently), so the river meanders have a relatively short evolution from their emergence till natural cut-off (Borsy, Z. 1991; Somogyi, S. 2001). In the 19th century socio-economic development called for effective flood control. While the deforestation of Carpathians caused higher and higher flood waves, the growing popula-

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tion required more and more protection for settlements and farming. Parallel with these the industrial development also demanded waterways providing safe navigation.

Flood control and water regulation measures started in the middle of the 19th century along the Tisza and Danube rivers and subsequently were extended to their tributaries. These activities have continued up to our days and can be classified into three groups:

1. building of dyke system and implementing cut-offs,
2. bank protection;
3. construction of hydraulic power plant systems (Erdélyi, M. 1994; Fejér, L. 2001; Somogyi, S. 2001).

The dyke system had been completed along the most important rivers by the early of 20th century parallel with cutting off meanders (*Figure 1*). Rivers have been shortened and their stream gradient increased (*Table 1*).

Although the early phase of channel regulation protected the settlements against the rising flood peaks and provided new (previously not cultivated) fields for agriculture, it did not reduce bank erosion (Julian, J. and Torres, R. 2006). On the contrary, bank erosion rates and meander evolution increased and undercut the existing dykes and abutments along the Tisza River and its tributaries (Károlyi, Z. 1960). The construction of new dykes continued in the late 20th century, but by now the strengthening and rising of

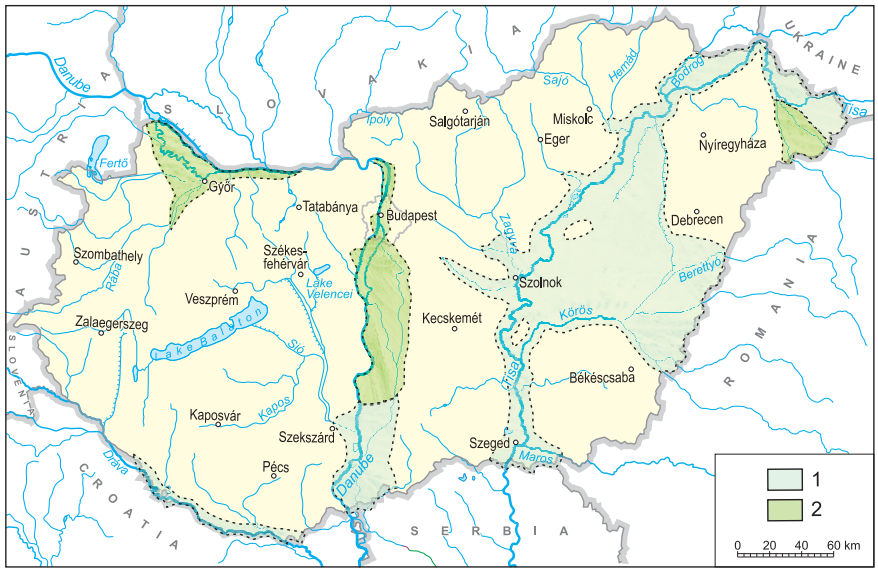

Fig. 1. Inundated areas before flood control in Hungary. – 1 = inundated areas during floods; 2 = inundation period was longer than three months per year (On the basis of National Atlas of Hungary)

Table 1. Properties of the most important rivers in Hungary before and after flood regulation (after Somogyi, S. 1974)

River	Length, km		Average stream gradient, cm/km	
	before	after	before	after
	flood regulation			
Danube	494	417	5.0	8
Tisza	1,419	966	3.7	6
Dráva	409	232	7.5	12
Maros	191	121	14.0	28
Hármas-Körös	234	91	2.0	5
Rába	132	84	32.0	47

the already existing embankments had become the most important activity in the field of flood control.

In order to reduce bank erosion building of protection works have been started along the endangered bank reaches. Four methods have been used mostly: 1. groynes, 2. revetments, 3. retaining walls, 4. bluff reinforcement. The first and second is of common use along all big rivers for maintaining the shipping and protecting bridges and hydraulic works. The third method is used along river sections in the cities (Bariteau, L. *et al.* 2013) and the fourth one is widespread along the Danubian loess bluffs (Kleb, B. and Schweitzer, F. 2001; Stancikova, A. 2001). Adequate bank protection is capable of reducing bank erosion to a considerable extent.

The reduced floodplains and protected riverbanks have accelerated alluvial processes (e.g. sedimentation on sensitive areas) and changed the quality, amount and pattern of riverbank erosion.

Riverbank erosion: forms and processes

In convex and flat floodplains different processes control riverbank erosion (Butzer, K.W. 1976). These variations between the processes result in various erosion forms and patterns. A convex floodplain is typical of the majority of Danube sections. Under natural conditions channel shifting is slower over convex than flat floodplains. Thus the amount of the transported sediments is also lower in general. The most important erosion forms can be found on the natural levees both along riverbanks and the banks of islands. Erosion forms on natural levees depend mainly on vegetation structure and land use pattern. Under geomorphic conditions close to natural two kinds of bank erosion processes prevail: piping, which results in a spongyform structure in the near-surface part of natural levee and transverse crevasses across natural levees.

Piping is typical along those natural levees where the sediment is sandy loam or finer sediments. Pipe formation occurs on the falling limb of the flood hydrograph and it is driven by water escape. When water levels are falling, the external pressure is decreasing until it is equal to atmospheric pressure, i.e. lower than the internal (groundwater) pressure. The outflow of groundwater on the bank face is freed from this pressure difference and it starts on the bank face. These flows mostly emerge along lines where the sandy layers are exposed on the natural levee. The outflow partly runs on the bank surface and partly flows in a pipe network near to the surface (*Figure 2*).

The pipe network is enlarged by outflowing groundwater and mostly formed along the root network (Hubble, T.C.T. *et al.* 2010) and thus parts of the bank face where the interparticle force of cohesion is less than the average. The mean diameter of these pipes is around 5–9 cm (*Photo 1*). The majority of pipes collapse during subsidence. The rate of collapse depends on that of drying and rewetting. Finally, this process causes a very slow bank retreat and 100–200 m^3/km/year material losses from natural levees in the Hungarian Danube sections. Kiss, T. *et al.* (2002) reported higher bank erosion rate (9.2–44.5 cm/year) along the Tisza River (between 212 and 216 river kms), which approximately means 140–700 m^3/km/year material losses from natural levees.

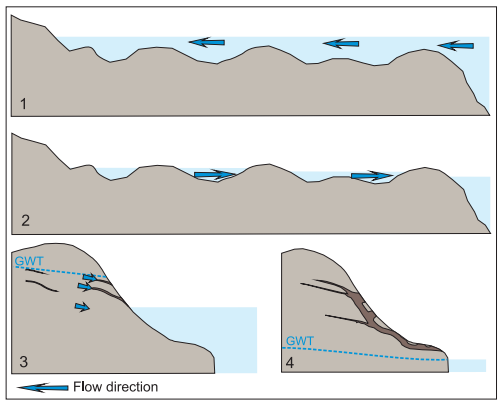

Fig. 2. Pipe forming in natural levee. – 1 = inundation of active floodplain, natural levee saturated during the flooding; 2 = the level of the floodwater on the floodplain is higher than the water level during falling; 3 = initial phase of pipe forming: the outflow starts to cave pipes in the natural levee due to the pressure of floodwater; 4 = after flood-wave pipe system starts to collapse; GWT = ground water table

The crevasses on the natural levee are developed during of 6–10-year floods. These crevasses play an essential role in the inundation of floodplains, stretching beyond the levees because flood water should not overtop the natural levee during inundation (Pizutto, J. *et al.* 2010). Crevasses can be attributed to both natural and anthropogenic processes. A crevasse can form at sites where the bank face is lower than the average. Along some river sections the dredged and dumped sediments can raise natural levees. These raised banks also accentuate the crevasses. Crevasses across the natural levees have an ambivalent role in bank erosion because they contribute to accretion behind the levees during floods (crevasse splays) and locally intensify bank erosion (*Figure 3*).

Photo 1. Pipe outflow (the Danube River, Háros Isle) (Photo by Szalai, Z.)

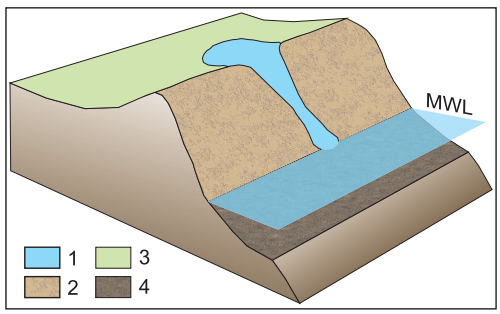

Fig. 3. Transverse crevasses in natural levees. – 1 = crevasse; 2 = natural levee; 3 = floodplain; 4 = storage bar; MWL = mean water level

During inundation a large amount of suspended load can reach the floodplains behind the levees where normally there is no sedimentation. During the retreat of floods the drop of the water level is much more rapid in the channel than over the floodplain and the difference between the water level in the channel and the floodplain can reach 5–10 m. The retreating water on the floodplain is less turbid than during flooding because the vegetation adsorbs suspended sediments. This filtration is accelerated by micro-topography. The water outflow from the floodplain has high energy because the suspended sediment concentration is low and the relative relief is high. This temporary high-energy flow forms V-shaped crevasses (Anderson, M.G. *et al*. 1996).

The amount of material eroded from the riverbank can be high locally, while the total amount of material loss from crevasse on riverbank remains low. The bank-derived sediment is moved into a temporary storage and thus material becomes available for transport during the following flood. In the adjacent and dead channels the crevasses incise into this bar. The dredging in adjacent channels accelerates the bank erosion processes, because the temporary storage bars are destroyed and finally the bank slope angle increases. Moreover, near-bank dredging results in bluffs caving in along these sections (*Photo 2*).

The willow groves might reduce bluff instability temporarily. After three-four flood events undercutting can cause 1–2 m bank retreat and a new

Photo 2. Near-bank dredging caused caving bluff along the Danube (Photo by Szalai, Z.)

storage bar forms simultaneously. During a repeated near-bank dredging the material of renewed temporary storage disposed again into the natural levee.

In the Middle Danube Valley the convex floodplain and its landforms are combined with loess bluffs. Karácsonyi, S. and Scheuer, Gy. (1972) identified three types of loess bluff (*Figure 4*) along the Hungarian sections of Danube:

– The first type is where the Danube washes away the debris from the foreland of bluffs during the floods groundwater is released from the loess without completely saturating it (*Figure 4, A*). The loess becomes saturated only during the flood events and this can cause landslides, but the alluvium accumulated in the foreland protects it against undercutting. This kind of bluff is relatively stable, landslides and gully incision are the most important bank erosion processes.

– The second type a directly undercut bluff, where lateral erosion of the river is the main agent (*Figure 4, B*). Along these sections it is the caving in that can lead primarily to erosion processes and forms (Schweitzer, F. 1999).

– The third type of bluff is characterised by debris slopes and, as a rule, it is situated in the foreland of a steep bank (*Figure 4, C*). It is typical in some river sections of the Middle Danube Valley. This debris protects the bluff against the lateral erosion of Danube as a buttress, but it also impounds groundwater in the loess (Lóczy, D. *et al*. 2008). The backwater level can reach the top of the debris slope and it is one of the most important reasons of landslides along this section of the Danube (Schweitzer, F. 2001).

Human activities (e.g. inflow of municipal and industrial wastewater in lack of a sophisticated sewerage system) cause serious problems along loess bluffs through increasing bluff instability and landslide hazard Growing population and industrial development impose a positive feedback on these processes. Visy, Zs. (1988) estimated bank retreat between 1778 and present. He reported 2.5–12.5 m/100 years retreat (*Figure 5*).

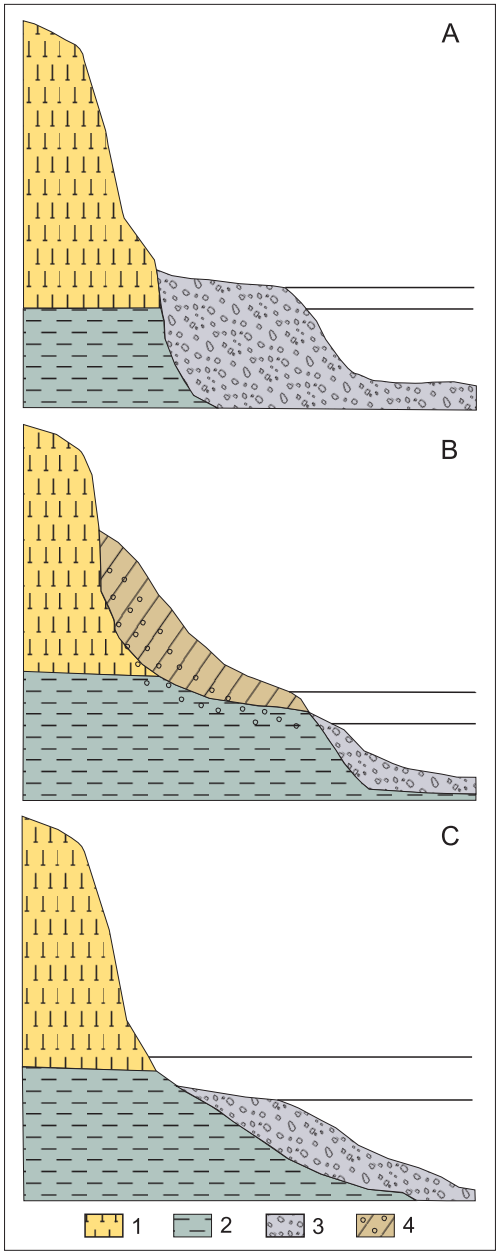

Fig. 4. Loess bluff types in the Middle Danube Valley (after Karácsonyi, S. and Scheuer, Gy. 1972). – 1 = loess; 2 = pannonian clay; 3 = gravel bed; 4 = debris slope

Lóczy, D. *et al.* (1989) determined erosion rates due to various agents. They have identified three bank retreat rates: 1. an overall rate on a geological timescale (1–2 m/100 years); 2. periods of active undercutting (2–10 m/100 years); 3. natural retreat enhanced by human intervention during the last hundred years (10–100 m/100 years). This means that the human activities of the last hundred years have multiplied the rate and the amount of bank retreat in comparison with the active undercutting periods (*Figure 6*).

The amount of the removed material per landslide event has increased as well. Landslides along the Danubian loess bluff affect 10,000,000 m^3/km sediment per on an average event during the second half of 20th century (Lóczy, D. 1997; Schweitzer, F. 1999).

One of the most important man-induced impacts on riverbank evolution in convex floodplains is bank accretion with industrial hazardous waste. The most important embankments can be found in the river sections of the Danube near Mosonmagyaróvár and Almásfüzitő (Northwest Hungary), where red mud reservoirs are found behind natural levees. The riverside dykes of the reservoir have been built upon the natural levees from slag. There is virtually no vegetation cover on the red mud and the dykes of reservoir and when it rains (especially during rainstorm events) huge

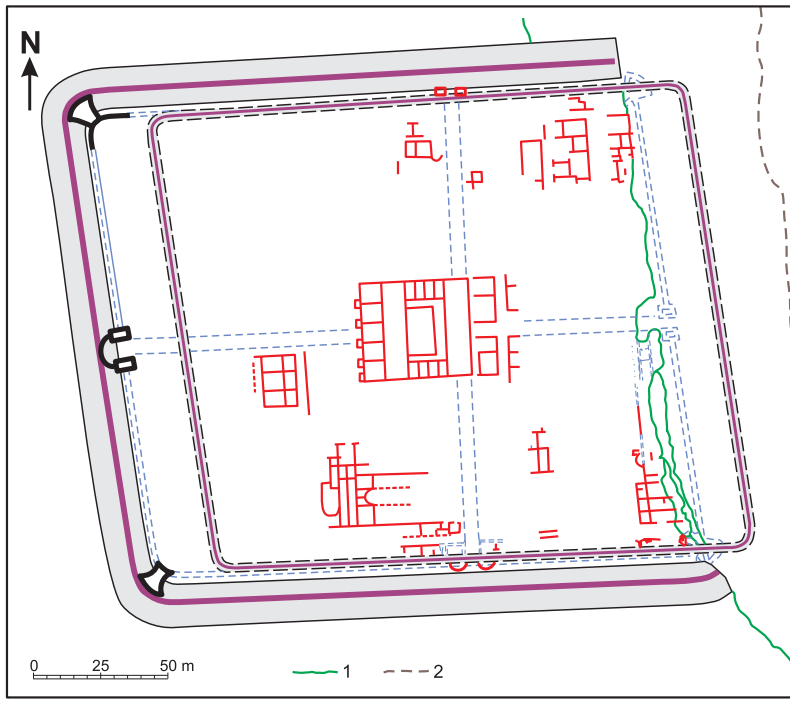

Fig. 5. Bank retreat along the Dunaújváros section of the Danube River on the basis of the Roman castrum Intercisa (Dunaújváros). – 1 = recent loess bluff; 2 = hypothetic line of the loess bluff (495 AD)

amounts of hazardous material are eroded into the channel. Piping here is replaced by rill erosion features. During the 6–10-year floods the floodwater surrounds the reservoirs and washes hazardous materials into the channel (Viczián, I. 2004; Schweitzer, F. and Szeberényi, J. 2011).

Flat floodplains are typical for most of the reaches of the Tisza River and for the majority of its tributaries. There are also some reaches of flat floodplain along the Danube near to the southern national border as well. The most important erosion process of flat floodplains is the lateral erosion of meandering rivers. The rate of meander evolution and lateral erosion has been changed fundamentally by cutoffs, reducing active floodplains and by channelization (Somogyi, S. 2001). The cut-offs with a bank protection have decelerated bank erosion dramatically. In some places lateral erosion has been reduced by 75% *(Table 2)*.

Recently, 1 m^3 water washes out ca. 1 kg sediment from the riverbank along whole length of the Hungarian section of the Tisza (Károlyi, Z. 1960; Rátóti, B. 1964). Along the reaches of Danube flanked by flat floodplains lateral channel shifting has removed much more material from its bank than from that

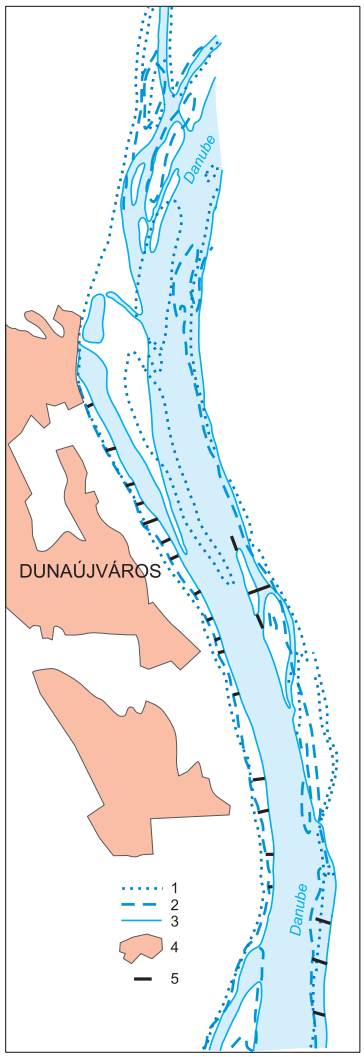

Fig. 6. Changes in riverbanks due to the channel regulation (from the Map Series of Hidrology, 11. Danube 2. – VITUKI, 1970). – 1 = riverbank on the 1884.1829 map (by Huszár, M.); 2 = riverbank after the 1899–1904 survey by the Hydrographic Department of the National Water Construction Authority; 3 = recent riverbank; 4 = built up area; 5 = groyne

Table 2. Bank erosion rates along the Hungarian sections of the Tisza River (after Károlyi, Z. 1960)

River sections along the Tisza	Number of shifting meanders	Amount of eroded riverbank	
		before	after
		bank protection, m^3/km/year	
Upper Tisza Valley	109	32,590	11,500
Middle Tisza Valley	21	10,633	2,450
Lower Tisza Valley	12	4,785	3,090

of Tisza. Somogyi, S. (2000) reported on 5–10 times higher values for lateral erosion than along the sections of Tisza River *(Table 3)*.

Table 3. Amount of riverbank erosion along the Danube (after Somogyi, S. 1974. and the measurements of the authors)

River sections along the Danube	Amount of eroded riverbank	
	before	after
	flood regulation, m^3/km/year	
Sárköz	138,460	70,000
Fajsz-Baja	82,000	53,330
Middle Danube	–	1,200

High bank erosion rates of temporary character can also result from channel regulation. Several cutoffs with an initial channel width around 20 m (Lászlóffy, W. 1982) have widened up to 100–200 m. Thus, after cutoff the sediment yield of bank erosion could reach 40,000 m^3/km for the initial period.

Economic and environmental consequences of riverbank erosion

Although riverbank erosion has decreased, farming, industrial and municipal assets are still imperiled. After channel regulation and bank protection more than 95% of previously endangered

settlements are still to be protected. At present the most endangered riverbank section is the Middle Danubian loess bluff. More than 10 settlements are at risk and the highest amount of municipal and industrial infrastructure damage have been recorded there. The total amount of damaged assets and the expenditure on bank protection has not been summarized until now. In Hungary the value of dykes and other hydraulic works is around 1.932 billion EUR. The total value of hydraulic works, for bank protection directly, is estimated around 728 million EUR. Considering the settlements and areas endangered by bank erosion prior to flood control the value of protected assets can reach 20 billion EUR in 2001 (Láng, I. 2001).

A less considered aspect of riverbank erosion is the remobilization of the deposited pollutants. Environmental consequences of this phenomenon have not been investigated yet and now it poses an immense hazard (Vonk, J.E. and Gustafsson, Ö. 2013). The rivers in the Carpathian Basin transport a huge amount of inorganic pollutants. The majority of the emitted non-biodegradable inorganic pollutants (e.g. heavy metals) derive from the neighbouring countries. The main source of these pollutants is the slag and sludge reservoirs of mines, slag reservoirs of non-ferrous metal plants, and the oil refineries (Kerényi, A. and Szabó, Gy. 2002; Kerényi, A. *et al.* 2003; Szabó, Gy. 2002; Szalai, Z. 1998b). These elements accumulated in well-identifiable floodplain sections (Szalai, Z. 1998c; Szabó, Sz. *et al.* 2008). The site of the accumulation mainly depends on the physical form of pollutants and on the shape of the floodplain (Szabó, Sz. and Posta, J. 2008).

On convex floodplains the majority of particulate pollutants accumulated on natural levees, because the waves of pollution usually coincide with flood waves. Along Danube Zn concentration in sediments ranges between 150–250 ppm, cadmium is around 1 ppm and lead between 50–70 ppm DW (Szalai, Z. 1998a). In the Middle Danube Valley piping remobilizes around 10.5–35 kg/km/year zinc, 0.8–1.4 kg/km/year cadmium, and 3.5–10 kg/km/year lead. Most of the remobilized heavy metals move into the temporary storage and is washed into the bedload of the adjacent channels and dead arms. Since the material transport is minimal in these channels, the pollutants accumulate there, thus becoming available for the aquatic ecosystems.

In the main channels (of gravel-bed rivers) the overwhelming part of remobilized heavy metals remains in suspended load. The eroded material results in 0.1 mg/litre zinc concentration increase per kilometre. The growth of lead concentration remains of the order of μg/litre. In the case of the Tisza, Gosztonyi, Gy. *et al.* (2011) analyzed the remobilization of zinc and iron with DW and HNO_3 treatment. They found that zinc was mobilizable with distilled water in small amount (0.014±0.001 mg/kg) applying 1 week extraction, while iron was not. Furthermore, 0.001M HNO_3 mobilized 2.9±1.4 mg/kg Zn; in the case of iron they experienced rebounding after one week. Heavy metal remobilization from other rivers has not been estimated yet.

Conclusion

Channel regulation and flood control have changed riverbank erosion conditions completely. Bank erosion has been generally reduced along the rivers of the Carpathian Basin. Before flood regulation and bank protection it was the lateral channel shifting that eroded the highest amount of material. Recently these river curves are protected, and, consequently, the share of erosion of natural levees has increased.

While important results have been achieved in the field of bank protection, other human activities are expanding (e.g. near-bank dredging, inadequate land use system on active floodplains) (Lóczy, D. and Dezső, J. 2013).

Riverbank erosion and associated human activities have made an essential impact on economy. The endangered and damaged assets and the maintenance of flood control systems and of bank protection related structures belong to the measurable values of these objects and activities. The remobilised hazardous elements pose immeasurable environmental and public health risk and damage to economy.

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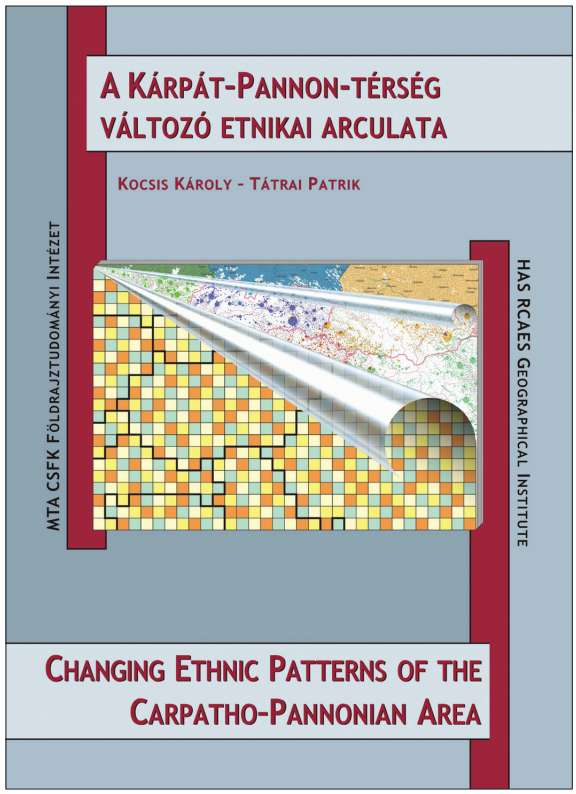
Changing Ethnic Patterns of the Carpatho–Pannonian Area from the Late 15th until the Early 21st Century

Edited by
Károly KOCSIS and Patrik TÁTRAI

Hungarian Academy of Sciences, Research Centre for Astronomy and Earth Sciences
Budapest, 2012.

This is a collection of maps that visually introduces the changing ethnic patterns of the ethnically, religiously, culturally unique and diverse Carpathian Basin and its neighbourhood, the Carpatho-Pannonian area.

The Hungarian and English volume consist of three structural units. On the main map, pie charts depict the ethnic structure of the settlements in proportion to the population based on census data et the millennium. In the supplementary maps, changes of the ethnic structure can be seen at nine dates (in 1495, 1784, 1880, 1910, 1930, 1941, 1960, 1990 and 2001). The third unit of the work is the accompanying text, which outlines the ethnic trends of the past five hundred years in the studied area.



The antecedent of this publication is the „series of ethnic maps" published by the Geographical Research Institute of the Hungarian Academy of Sciences from the middle of the 1990's, which displayed each of the regions of the Carpathian Basin (in order of publication: Transylvania, Slovakia, Transcarpathia, Pannonian Croatica, Vojvodina, Transmura Region, Burgenland, Hungary). This work represents, on the one hand, the updated and revised version of these areas, and, on the other hand, regions beyond the Carpathian Basin not included on previous maps. Thus, the reader can browse ethnic data of some thirty thousand settlements in different maps.

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Regeneration process of the karst water springs in Transdanubian Mountains, Hungary

Krisztina BABÁK[1], Ibolya KISS[2], Zsanett KOPECSKÓ[3], István Péter KOVÁCS[4] and Ferenc SCHWEITZER[5]

Abstract

Since the 1940s and 50s, there have been several researches dealing with karst water springs and the mapping of the continuous karst water level of the Transdanubian Mountains. The karst water level sank because of the intense bauxite and coal mining between the 1950s and 1980s and it started to increase after the decrease of mining activity. However, only a few authors investigated and modelled the water level changes and the rejuvenation of karst springs in the karst reservoir. Our paper is about the mineral contents and geomorphic properties of karst water springs near a chosen reservoir and our aim was to get some information about the regeneration process of the karst water reservoir. The geomorphic properties of karst water springs were mapped, using detailed field survey (DGPS) and geomorphic mapping. The mineral contents of spring waters were analysed to prove their origin. GIS results show that the karst water level in the karst reservoir reached 180–190 m a.s.l.

Keywords:, karst water spring, karst water level, mineral contents, geomorphological mapping, Transdanubian Mountains

Introduction

The term of karst water stems from Grund, A. (1903) who applied it to karst water accumulated in the holes of dolomite and limestone mountains (Schréter,

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Z. 1940). Höfer, H. (1912) classifies the subsurface waters of the karst areas as the subset of rock-moving waters (*Felswasser*), cave waters (*Höhlenwasser*) called Triassic water by the Hungarian mining engineer Szádeczky-Kardoss, E. (1941) who used this term, too.

According to Kállai, G. (1927), the term mentioned above can be thanked to Jex, S. who was a former mining director in Tatabánya and who first applied the term Triassic water to vadose water streaming in the Triassic limestone bed. In the respect of karst water research dealing with karst phenomenon, the work of Cvijič, J. (1893) is also worth mentioning.

At the beginning of the 1940s heated discussion evolved among the Hungarian and the foreign hydrologists about the continuous interconnected karst water level of karst water reservoir of Transdanubian Mountains. The theory of Katzer, F. (1909) was accepted by some researchers (Höfer, H. 1912; Keilhack, K. 1912; Lehmann, O. 1932) who believed that continuous karst water level can be observed very rarely and their regular distribution of karst water is more frequent (Schréter, Z. 1940). In contrast, others adopted the continuous interconnected karst water level theory by Grund, A. (1903) to the area of mountains (Schréter Z. 1940).

Grund (1903) suggested a continuous interconnected karst water level in the limestone of the karst region in a way which able the accumulated, mustered waters to run on and communicate with each other in every direction in the fracture network of limestone mountain hereby the continuous subsurface water level evolves similarly to the phreatic water. According to the opinion of Szádeczky-Kardoss, E. (1948), the theory of Grund can be accepted in case of deeper karst (for example Transdanubian Mountains) while in case of shallower karst, the theory of Katzer can be applied.

Szádeczky-Kardoss started his research to create the first Hungarian karst water map on the South part of the Transdanubian Mountains in the second half of the 1930s. He determined that the karst water level stands out well at 109–146 m a.s.l. in the area of Keszthely Mountains, below that height, water abundance and above that height, a shortage of water can be experienced. The theory of the continuous interconnected karst water reservoir was accepted around the 1940s and 1950s (Szádeczky-Kardoss, E. 1941, 1948) which is due to the hydrogeological researches related to the bauxite and coal mining below the karst water level.

At the same time the karst water level maps were illustrated with izohypses were born concerning the area of the surface karst water level and its wider environment (Szádeczky-Kardoss, E. 1941, 1948). Alföldi, L. (2007) put the modern knowledge of the geological and hydrogeological background of the karst water reservoir into a unified framework.

After World War II the increased industrialisation demanded more and more raw materials, but that demand couldn't be satisfied with surface

and near surface mines because of their depletion, which affected deep mining endangering the subsurface and karst water inrush. It went hand in hand with the active and later the passive anhydrous of the mine tunnels. Later its amount – Csepregi, A. (2007) calculated (estimated) an amount of 10 billion m^3 exploited karst water between 1951 and 1990 – exceeded the average amount of 500 m^3/s infiltration being necessary for the natural regeneration of the karst water reservoir (Csepregi, A. 2007). The water removals on spots or in smaller areas had an impact on the whole area because of the connected water level in the Széki Reservoir (3 km NW from Ajka). Apart from some exceptions, almost all karst springs of the Transdanubian Mountains have dried up or their yields have decreased significantly (*Figure 1*).

Since the 1990s, the karst water level has begun to rise (*Figure 2*) as a result of mine closures and the dewatering works, however, at the beginning, very different and often exaggerated calculations related to the entire period of the regeneration of the reservoir emerged. According to the latest model calculations, the almost total refill of the reservoir can be expected by mid- or second half of the 2020s (Csepregi, A. 2007).

On 4th October 2010, while examining the possibilities of the dewatering of the reservoir of MAL Zrt. (Hungarian Aluminium Corporation), following its tailings

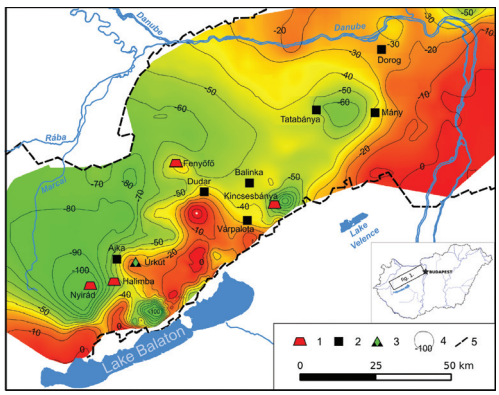

Fig. 1. Karst water level in 1990 comparing to the original karst reservoir conditions (based on Csepregi, A. 2007). – 1 = bauxite mine; 2 = coal mine; 3 = manganese mine; 4 = relative karst water level; 5 = border of the karst water reservoir

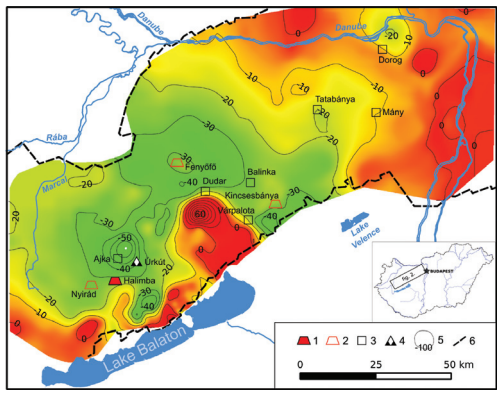

Fig. 2. Karst water level in 2006 comparing to the original karst reservoir conditions (based on Csepregi, A. 2007). – 1 = bauxite mine; 2 = closed bauxite mine; 3 = closed coal mine; 4 = closed manganese mine; 5 = relative karst water level; 6 = border of the karst water reservoir

rupture, sludge disaster (Schweitzer, F. 2010), we noticed intensive spring works on the surface around the Széki Reservoir (Schweitzer, F. and Viczián, I. 2011). Investigating the causes of the sludge disaster, the engineer report (Mecsi, J. 2012; Turi, D. *et al.* 2013) highlighted the role of ground water in the disaster which can be closely related to the recovery of the resources tapping the increasingly restored karst water.

The aim of our study is to identify the sources, the origin of spring water found near the Széki Reservoir in 2010 and their relationship with the karst water reservoir. Besides, as a subgoal, we will define the source areas and the sketching of their geomorphological situation.

Site description

Our investigation area is situated in Pápai-Bakonyalja physical geographical microregion, in the valley of Csigere Creek (*Figure 3*). From the geomorphic point of view, it covers the lower, Southwestern part of the hillslope of the Bakony

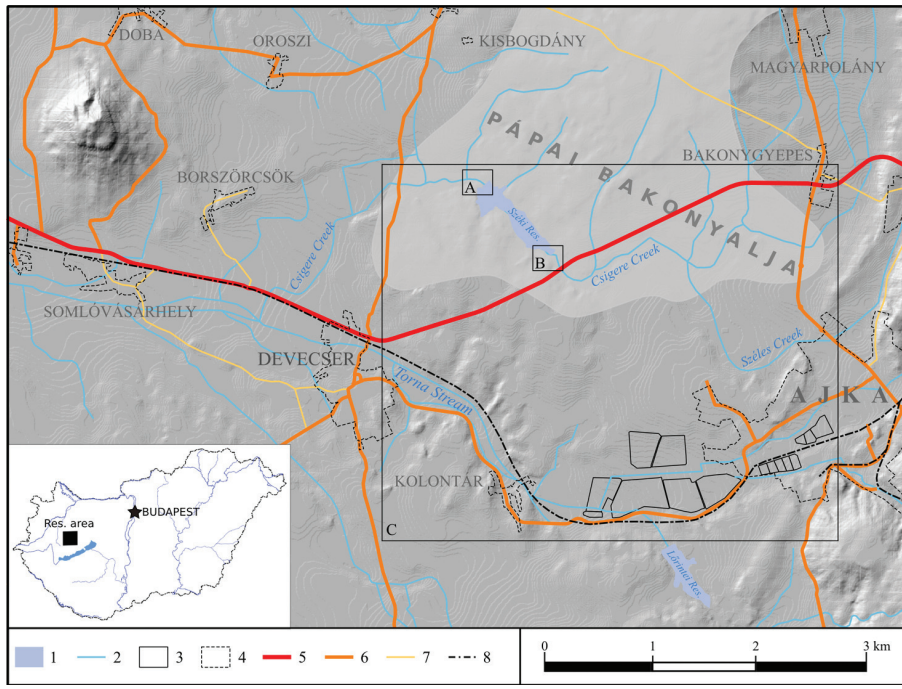

Fig. 3. Sketch of the investigated area. – 1 = water reservoir; 2 = water course; 3 = sludge reservoir; 4 = residential area; 5 = primary road; 6 = secondary road; 7 = tertiary road; 8 = railroad; A, B, C = detailed sketches (See *Figs 4–7)*

Mountains (Dövényi, Z. ed. 2010). The higher parts of the Bakony Mountains in the East and the lower Quaternary alluvial fan system in the West are connected by the Csigere Creek Valley. Detailed field mapping was done West and Southwest from the Széki Reservoir created by the dam construction at the Csigere Creek.

The area is built up from up to 1,000 m thick Cretaceous calcareous sediments covered by 250 m thick clay, conglomerate, marl and limestone layers of Eocene transgression (Bohn, P. 1983). The bedrock in the areas North and Northwest from the reservoir contains the Eocene limestone layers. Thick layers of Oligocene and Miocene conglomerates are superimposed on limestone, they cover the surface in the Western part of the reservoir.

Methods

Detailed geomorphic mapping based on 1:10,000 scale topographic and orthophoto maps published in 2005 was done to clear the position and the geomorphic properties of karst springs and their surroundings. The 2.5 m vertical resolution of the topographical map and the vegetation cover on the orthophoto map impeded the identification of the exact altitudinal and horizontal positions of karst springs. Hence, karst springs and their surroundings were surveyed by Topcon FC-250 differential GPS (DGPS). The survey was hindered by the dense vegetation, accordingly, the accuracy of the measurements was maximum 50 cm (horizontal) and 20 cm (vertical). The unequivocally identified karst spring outlets were measured more precisely, with subcentimeter accuracy. The surveyed data were processed with Grass GIS 6.4.2., Qgis 1.6.0. and Inkscape 0.48 was used to draw the detailed geomorphic sketch.

The height values of karst spring outlets were compared to the "original" (before the 1950s) karst water level of the izohypse maps (Jaskó, S. 1959; Csepregi, A. 2007) to identify the karstic origin of the springs. The izohypses were digitised using v.digit module of Grass GIS 6.4.2. and they were interpolated with v.surf.rst module using spline interpolation (Mitasova, H. *et al.* 2005) and 100 m horizontal resolution was applied. The DEM of the "original" karst water level was smoothed using 33×33 convolution matrix and an averaging technique. r.resap was used to increase the horizontal resolution of the DEM of karst water level to 10 m. The DEM of the „original" karst water level was compared to the DEM of the land surface using r.mapcalculator. The map clearly shows the place where the „original" karst water level crosses the surface and it also demonstrates if the areas are under karst water pressure or not. The mineral content of water samples taken from springs were analysed to clear their origin. Results were compared to the mineral contents of karst waters published by former authors. 1.5 litre spring waters were sampled from springs 3 times during the observation period (*Figures 4* and *5*).

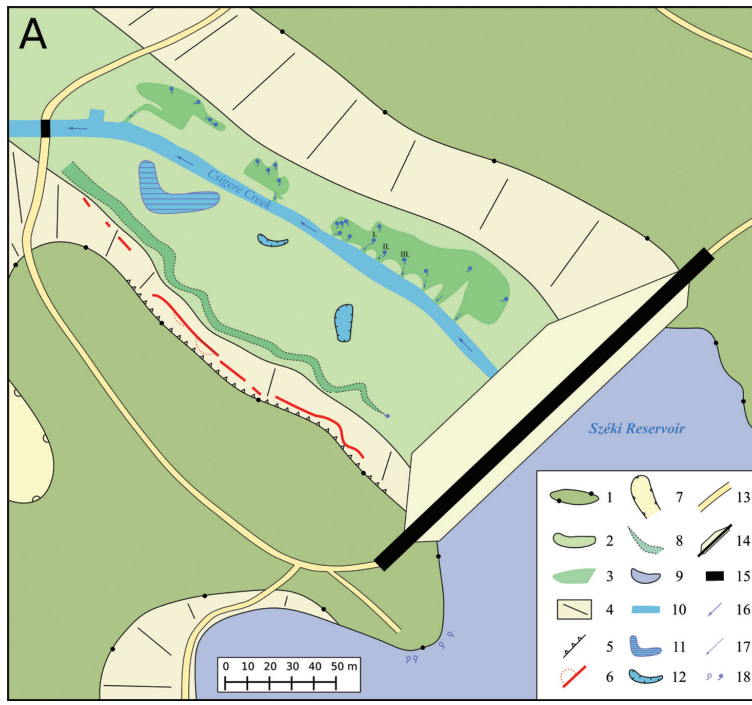

Fig. 4. Geomorphic sketch of the karst spring area, NW from the Széki Reservoir (area 'A' inside *Fig. 3*). – 1 = hillslope; 2 = flood plain; 3 = waterlogged surface pach; 4 = slope; 5 = high bluff; 6 = travertine with overhanging slope; 7 = dry valley; 8 = ephemeral channel; 9 = water reservoir; 10 = channel; 11 = oxbow lake; 12 = artificial lake; 13 = unpaved road; 14 = dam; 15 = bridge; 16 = waterflow direction (in the channel); 17 = water flow direction (on waterlogged area); 18 = karst springs

As a result of the environmental analyses, mostly very low concentrations of materials were established. The results of the measurements are usually expressed in the unit of "gram per litre," (g/l). Water analyses can be done by several methods. The most common and oldest type of measurement is titration. Instrumental methods are becoming more and more popular. Our measurements were made according to the Hungarian Standards (MSz).

Titration depends on using a well-defined chemical reaction to measure the amount of a standard solution needed to react with a defined amount of the sample. A known volume of sample is placed into a beaker and the standard reagent is dispensed from a burette to the sample (thus the volume of standard reagent can be measured). The "endpoint" of the reaction is determined by observing the colour change using an indicator or by observing the physical-chemical change in the solution using an instrument. Knowing the amount of the standard reagent, the amount of the analysis can be calculated in the sample.

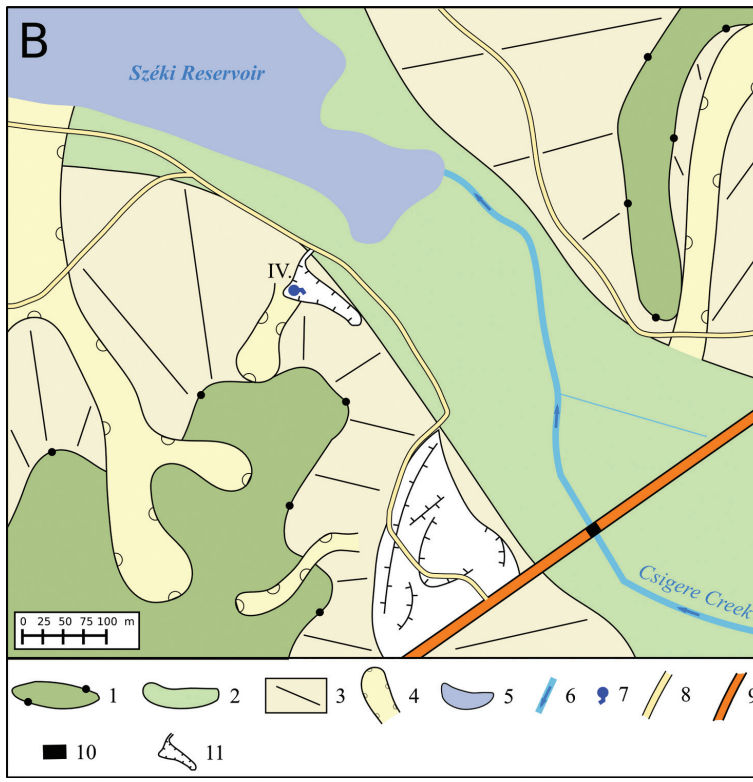

Fig. 5. Geomorphic sketch of the karst spring area, W from the Széki Reservoir (area 'B' inside *Fig. 3*). 1 = hillslope; 2 = flood plain; 3 = slope; 4 = dry valley; 5 = water reservoir; 6 = water course; 7 = spring; 8 = unpaved road; 9 = primary road; 10 = bridge; 11 = quarry

Alkalinity is a measure of water's ability to neutralize acids. Bicarbonate, carbonate and hydroxide ions are the most common causes of alkalinity. The alkalinity of water is determined by end-point titration with a strong acid solution (HCl). Titration to pH 8.3 (decolourisation of phenolphthalein indicator) will indicate the complete neutralization of OH^- and half of CO_3^{2-} while titration to pH 4.5 (sharp change from yellow to orange of methyl orange indicator) will indicate total alkalinity {MSz 448-11 and ISO 9963-1}.

Hardness is determined by the concentration of cations, Ca^{2+} and Mg^{2+} are common cations in hard water. The water runs through the rocks containing minerals such as gypsum ($CaSO_4 \bullet 2H_2O$), calcite ($CaCO_3$), dolomite ($CaMg(CO_3)_2$).

Temporary or bicarbonate hardness is caused by the presence of dissolved bicarbonates of calcium, magnesium and other heavy metals. It's determined by end point titration with a strong acid solution (HCl) using methyl orange as indicator {MSZ 448-21}. Ca^{2+} and Mg^{2+} can be combined with chlorides and

sulphates resulting in *permanent hardness of water* which can't be removed by boiling. The permanent hardness of water is determined by complexometric titration using EDTA (ethylene-diamine-tetraacetic acid) at pH 10 (both Ca^{2+} and Mg^{2+} will complex with EDTA at that pH value) {MSZ 448-3 and MSZ 448-21}. Standard laboratory glasware such as burettes, volumetric flasks and beakers [Beakers (100 ml), Burette (25 ml), Graduated cylinder or pipette (100 ml), Whatman filters (only for suspended materials)] were used during the analysis.

Results

The geomorphic position of karst springs

The construction of the ~10 m high dam of Széki Reservoir at the Csigere Creek was finished in 1978 and it also involved the channel regulation of the creek. The outflow water leaves the dam and flows in an artificial, 4 m wide channel towards west (*Figure 4*). The channel bisects the former, 70–90 m wide alluvial flat of Csigere Creek which cut a 7–10 m deep valley into the sediments on the hillslope of Bakony Mountains. The Western part of the planar surface of the floodplain (179–181 m a.s.l.) is dissected by two small, artificial lakes, a former meander of Csigere Creek and an ephemeral channel of a karst spring.

The alluvial plain is connected to the hillslope being a result of the lateral erosion of Csigere Creek with a steep slope. The Eocene bedrock and the superimposed travertine structure are clearly visible along a 195 m long section of the steep slope. The identification of the Eocene limestone and the young travertine junction is quite difficult, because the travertine contains a lot of reworked fossils (*Nummulites sp.*) from Eocene layers. However, their mass is lower in the travertine structure than in the Eocene bedrock. In addition, the typical overhanging slopes of travertines rimstone barriers also prove their karst water origin.

Two – 1.8 m high, 1 m deep and 1 m high, 0.5 m deep – overhanging slope hollows (*Photo 1*) were also observed close to each other in the travertine structure. All of the observations prove a former, intense period of spring activity.

The Eastern part of the floodplain is connected to the hillslope with a gentle slope. There is no travertine, only Eocene limestone is exposed along a short, 1 m long section between the slope and the floodplain. The Eastern part of the floodplain is covered by waterlogged surface patches. They occur in an area of 200 m long and 20–30 m wide along the floodplain and their areas are ~1,400 m^2, 180 m^2 and 420 m^2, respectively, extending from Southeast to Northwest. They are separated from the floodplain with a 20–50 cm high berm. 12 clearly visible karst water springs were identified on the most extensive waterlogged surface patch and 8 others on the smaller patches at 180.6 m a.s.l.

Photo 1. Typical fossil travertine structure on the steep slope of the Csigere Creek (Photo by Kovács, I.P.)

The number of the identified karst water springs is lower than their real number due to their difficult-to-reach location and the dense vegetation cover. The vegetation indicates the temperature of the karst water springs (10–12 °C). Vegetation covered the waterlogged surface patches during our fieldtrips in February (*Photo 2*).

The outflow waters run in small, 0.5–1.5 deep erosional channels to the Csigere Creek, however, measuring the discharge was impossible. The rejuvenation of the karst spring activity is shown by the recent yellow and reddish, calcareous mud and the lack of travertines in the surrounding of the springs (*Photo 3*). The calcareous mud coats leaves and boughs and it forms low rimstone barriers (*Photo 4)*.

Underwater karst spring outlets were observed in the Northern part of the reservoir, South from the dam. The frozen underwater karst springs being warmer than the water of the reservoir melted and broke through the ice on the reservoir (*Photo 5*).

There is a quarry, 40 m southwest from the reservoir on Oligocene-Miocene gravels (*Figure 5*). Reed (*Poaceae australis*) patches and willows (*Salix alba*) indicates the karst water springs at the northern end of the mining claim. The spring activity is not so intense here the water leaks and fills up the mining claim. 0.5 m thick calcareous mud was deposited at the mouth of the spring, however, it's colour is lighter comparing to the mud mentioned above, probably due to the lower concentration of iron compounds.

Photo 2. Warm (12 °C) karst water of waterlogged surfaces around the springs with greenery in February 2013. (Photo by Kopecskó, Zs.)

Photo 3. Leaves covered by recent calcareous mud near the springs (Photo by Kovács, I.P.)

Photo 4. Approx. 3 cm high recent rimmstone dams near karst springs (Photo by Kovács, I.P.)

Photo 5. Underwater karst springs brake trough the ice of the water reservoir in February 2013. (Photo by Kovács, I.P.)

The results of the chemical analysis of water

The content included in the analysis of water samples mineral follows a common pattern (*Table 1* and *2).* The HCO^- from 345.5 to 394 mg/l Ca^{2+} were measured from 99.5 to 146.7, and Mg^{2+} is between mg/l 33.6 and 41.4. The Ca^{2+} and Mg^{2+} ratio is between 2.7–2.8. The hardness of the samples varied from 15.9 to 18.1, while permanent hardness is somewhere between 22 and 29.9.

Three springs of the Széki Reservoir in the Northwest part provided very similar data, while some parameters (of the springs) showed significant differences in the southwest part of Széki Reservoir. The resulting Ca^{2+} in water compared to 30–40 Mg^{2+} content of 3–4 mg/l is greater than that of the average of other sources. It affects all of the permanent hardness of which more than 7 units of other sources of water. The measured results collected and published by Szádeczky-Kardoss, E. (1940, 1941) represent highland karst water mineral content and temperature (*Table 2*).

Table 1. Measured chemical parameters of water samples

Parameter	Amount
Temperature	10–14°C
Ca^{2+}	70–110 mg/l
Mg^{2+}	30–50 mg/l
Ca^{2+} : Mg^{2+}	2.1–2.7
HCO^-	dominance
Temporary hardness	15–23
Permanent hardness	20–25

GIS results

According to the results of the comparison of the "original" karst water level (Csepregi, A. 2007) and the height values of the mapped karst water springs (*Figure 6*), it is proved that the recent spring activity is under the "original" karst water level. Karst springs being Northwest from the reservoir are 4.2–5.6 m below the “original” level on average, but the karst spring west from the reservoir is just 0.5–1.5 m below it. At the red mud reservoir No. 10, the values are between 7 and 6 m, furthermore, the older sludge reservoirs are 4–6 m deeper than the "original" karst water level.

Using the "original" karst water level by Jaskó, S. (1959), the results are quite different (*Figure 7*). The Northwestern karst springs are situated 3.5–5.6 m higher than the "original" karst water level, whereas the South-Western springs, reservoir No. 10 and the older sludge reservoirs are located 15–16 m, 15–20 m and 20–35 m higher, respectively, than the “original” karst water level.

Discussion and conclusion

The comparison of the mineral content and the temperature of the water samples from the examined springs and the comparison of the obtained results

Table 2. Chemical and physical parameters of water samples of karst springs and their comparison with the standard karst water parameters (Szádeczky–Kardoss, E. 1940, 1941)

Standard solution	HCl					EDTA				
Indicator			Phenolph–thalein	Methyl orange		Murexid		Eriochromeblack T		
V (mL)	100.00	–	100.00	–	–	100.00	–	100.00	–	–
c (N)	0.10	–	0.1	–	–	0.05	–	0.05	–	–
f	1.0024	–	1.0043	–	–	1.0638	–	1.0638	–	–
E(g/gekv)	61.01	–	61.0	–	–	40.08	–	24.32	–	–
	6.12	–	6.13	–	–	2.13	–	1.29	–	–
HCO_3			Phenolph–thalein alkalinity	Total alkalinity	Temporary hardness	Ca^{2+}		Mg^{2+}		Total hardness
Date	*11.01.2013*					*11.01.2013*				
	V(mL)	c (mg/L)			dGHo	V(mL)	c (mg/L)	V(mL)	c (mg/L)	dGHo
I.	6.45	394.5	0.0	6.5	18.1	4.90	104.5	2.60	33.6	22.3
II.	6.35	388.3	0.0	6.5	17.8	4.85	103.4	2.60	33.6	22.3
III.	6.35	388.3	0.0	6.4	17.8	4.85	103.4	2.95	38.2	23.2
IV.	5.65	345.5	0.0	5.7	15.9	6.40	136.4	3.20	41.4	28.6

Table 2. (Continued)

Date	*18.01.2013*					*18.01.2013*				
I.	6.20	3792	0.0	6.2	17.4	4.65	99.1	2.80	36.2	22.2
	6.35	388.3	0.0	6.4	17.8	4.80	102.3	2.75	35.6	22.5
	6.30	385.3	0.0	6.3	17.7	4.70	100.2	2.90	37.5	22.6
	6.28	*384.3*	*0.0*	*6.3*	*17.6*	4.72	100.6	2.82	36.42	*22.4*
II.	6.15	376.1	0.0	6.2	17.3	4.75	101.3	3.30	42.7	24.0
	6.15	376.1	0.0	6.2	17.3	4.75	101.3	2.80	36.2	22.5
	6.15	376.1	0.0	6.2	17.3	4.75	101.3	2.95	38.2	22.9
	6.15	*376.1*	*0.0*	*6.2*	*17.3*	4.75	101.3	3.02	39.0	*23.1*
III.	6.45	394.5	0.0	6.5	18.1	4.80	102.3	2.85	36.9	22.8
	6.40	391.4	0.0	6.4	18.0	4.80	102.3	2.85	36.9	22.8
	6.40	391.4	0.0	6.4	18.0	4.75	101.3	2.90	37.5	22.8
	6.42	*392.4*	*0.0*	*6.4*	*18.0*	4.78	102.0	2.87	37.1	*22.8*
IV.	6.25	388.3	0.0	6.4	17.8	6.85	146.0	3.20	41.4	29.9
	6.20	379.2	0.0	6.2	17.4	6.90	147.1	3.15	40.7	29.9
	6.30	385.3	0.0	6.3	17.7	6.90	147.1	3.15	40.7	29.9
	6.28	384.3	*0.0*	*6.3*	*17.6*	6.88	146.7	3.17	41.0	*29.9*
Date	15.02.2013					15.02.2013				
I.	5.80	355.4	0.0	5.8	16.3	4.70	100.2	2.95	38.2	22.8
	5.80	355.4	0.0	5.8	16.3	4.65	99.1	3.00	38.8	22.8
	5.85	358.4	0.0	5.9	16.5	4.65	99.1	3.00	38.8	22.8
	5.82	*356.4*	*0.0*	*5.8*	*16.4*	4.67	*99.5*	2.98	*38.6*	*22.8*
II.	5.90	361.5	0.0	5.9	16.6	4.60	98.12	2.75	35.6	21.9
	5.95	364.6	0.0	6.0	16.7	4.75	101.3	2.70	34.9	22.2
	5.95	364.6	0.0	6.0	16.7	4.75	101.3	2.60	33.6	21.9
	5.93	*363.5*	*0.0*	*5.9*	*16.7*	4.70	*100.2*	2.68	*34.7*	*22.0*
III.	6.00	367.6	0.0	6.0	16.9	4.85	103.4	2.80	36.2	22.8
	5.95	364.6	0.0	6.0	16.7	4.70	100.2	2.80	36.2	22.3
	5.95	364.6	0.0	6.0	16.7	4.65	99.1	2.85	36.9	22.3
	5.97	*365.6*	*0.0*	*6.0*	*16.8*	4.73	*100.9*	2.82	*36.4*	*22.5*

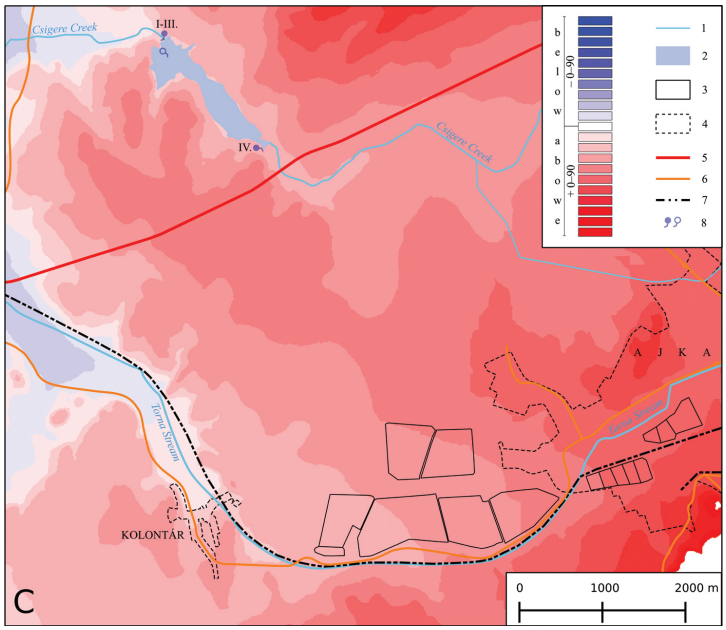

Fig 6. The height of the original karst water level (Jaskó, S. 1959) comparing to the DEM of the surface (area 'C' inside *Fig. 3*). – 1 = water course; 2 = water reservoir; 3 = sludge reservoir; 4 = residential area; 5 = primary road; 6 = secondary road; 7 = rail road; 8 = karst spring (Coloured chart: the height values of the original karst water level comparing to the DEM.)

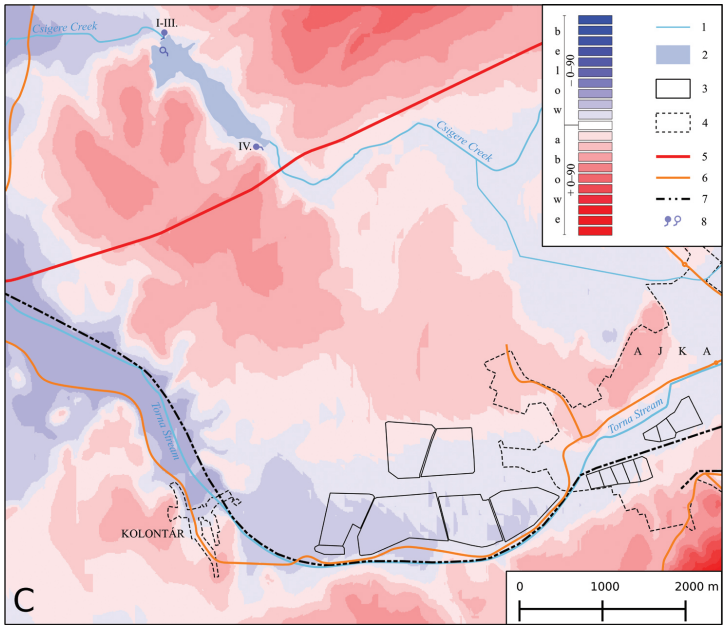

Fig 7. The height of the original karst water level (Csepregi, A. 2007) comparing to the DEM of the surface (area 'C' inside *Fig. 3*). – 1–8: For explanation see *Fig. 6.*

with earlier data undoubtedly prove the deep, karstic origins of the springs. It is even more obvious if we compare the obtained data to the low mineral content of the shallow springs in the Tatra Mountains (Żelazny, M. *et al.* 2012). The mineral properties of spring Nr. IV also underline that some of its properties being different from those of other springs can be explained by the different bedrocks.

The water chemistry results match the observations made during geomorphologic mapping and field measurements. Earlier spring activity is proven by the spring limestone visible on the sides of the valley of Csigere Creek. When the bed of the stream deepened, spring activity might have relocated to lower areas. The lowering of karst water level due to mining must have played a significant role in the drying up of the springs, however, it is impossible to determine the location of the old springs. The geomorphological situation of the recent springs and the sinter barriers all suggest that spring activity in the examined area is only a few years old. We must note, however, that Northwest from the Széki Reservoir, the leaking of water is extensive but sampling and measuring are not possible due to the conditions of the area at the moment.

To provide some data on the topic of refilling karst water system, we used a map comparing the prior karst water level and DDM. The 10 m or larger height difference between Jaskó (1959) and Csepregi (2007) type karst water isohypses posed a problem. Scientific knowledge about the hydro-geological conditions of the karst water system between the creation of the two models has greatly increased in the almost 50 years, so the later map is probably more accurate than the previous one. It is proven by the position of the springs of the Széki Reservoir.

As all the springs originate multiple meters below the calculated original karst water level, we can claim that the karst water system has been refilled up to the height of the springs (180–190 m a.s.l.) or even higher. We can only extrapolate that value to the entire karst water reservoir only with restrictions, there is a poor availability of research data concerning the area.

Outlook

The refill of the karst water system and the rejuvenation of the dried up karst springs will have an increasingly intense effect on the rest of the mountain range, so their investigation is a national economic interest. Another reason is that the rise of the water level can have some unexpected negative or even catastrophic consequences besides the positive ones. The potential negative effects will take place rather along the lines of the increased number of sinkholes and the valleys of sudden floods caused by the rise of the karst water levels (Waele, J.D. *et. al.* 2011) and not in the human-made surroundings causing damages in the built environment.

One of the already affected areas is the town of Tata where the return of 30–40 karst springs, which was significant before the drop in water level, is endangering the residential buildings of an area populated during the decrease of water level (Ballabás, G. 2004).

The volume of the springs and the rejuvenation of springs in higher locations (Tóth, M. 2002; Horváthy, L. and Lénárt, L. 2009) further increase the size of flooded areas and the number of damaged buildings. The general rise of karst water level will affect many towns in the mountains, therefore the re-examination of buildings and the review of flood prevention measures created during the time of lower water levels is more and more important.

The study was not aimed to reveal the reasons of the catastrophic events at the Ajka mud-reservoir, however, the partial refill of the karst water reservoir and the rejuvenation of karst springs can explain the high levels of underground water and the increased water supply in the reservoir and in its surroundings (Mecsi, J. 2012; Turi, D. *et al.* 2013). Since the compartments storing the mud are in the valley of the Torna Stream, below the „original" karst water level, more springs can be expected to appear. Due to the fact that there are no effective defences, the surface water removal system created by Schweitzer, F. (2010) should be used again. It could help relieve the burden caused by the leaking surface water in the area.

A positive effect of the rise in karst water levels is the stabilization of the spring volume of Hévíz lake, the refill of the cave lake in Tapolca, the rejuvenation of the Fényes springs in Tata and many others, and the increase in the volume for the hot water springs of Buda. All these provide economic benefits through tourism.

The water level of Lake Balaton has dropped considerably, approximately by 70 cm, due to the dry years between 2000 and 2003 (Somlyódy, L. 2005). Our research was conducted in the Transdanubian Mountains to apply the results of the investigation of karst water in case of Lake Balaton, namely, in respect of the raise of water level. However, that idea was rejected mainly because of the natural refill of the lake and also because of the small amount of available karst water and the potential negative side effects of the process (Somlyódy, L. and Honti, M. 2005; Tombácz, E. *et al.* 2005).

The studies have discovered, though that karst water does not influence the water quality of the lake negatively (Simonffy, Z. 2005). During the lowering of karst water level related to mining, streams carried water to the lake draining the water in mines. The travertine in Balatonfüred, the hot springs at the ship factory in Balatonfűzfő and the aforementioned streams prove that Lake Balaton was the base level of erosion for karst springs. The volume of the springs will rise with the karst water level which will influence the water level and the quality of Lake Balaton positively.

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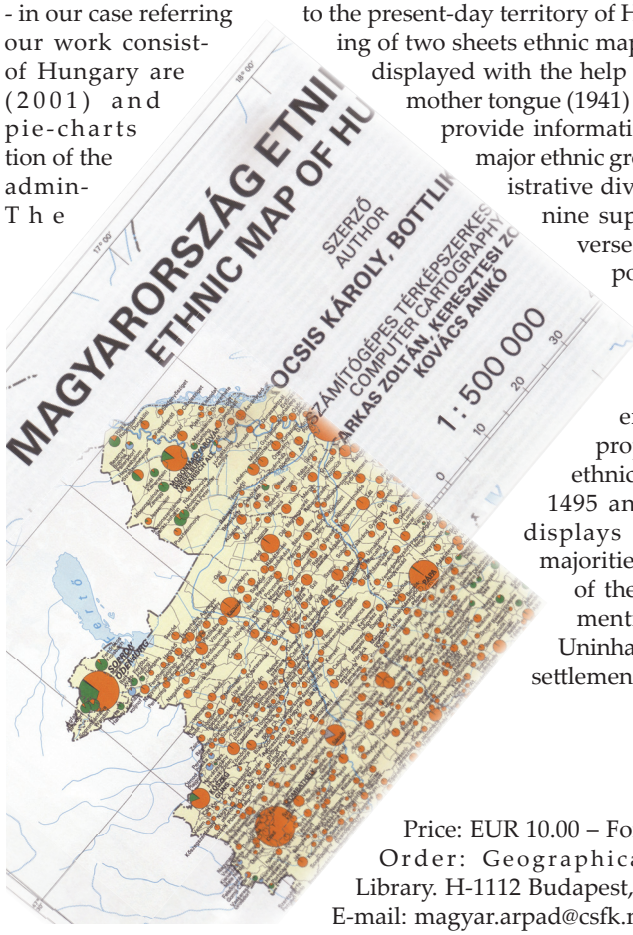

The nine supplementary maps on the reverse show the lingual-ethnic composition of the present-day territory of Hungary in 1495, 1715, 1784, 1880, 1910, 1930, 1941, 1990 and 2001 respectively. The chart here explores the quantitative and proportional changes of the main ethnic groups' population between 1495 and 2001. The series of maps displays absolute or relative ethnic majorities only in the inhabited areas of the settlements which had been mentioned in the source referred. Uninhabited areas with no permanent settlements are shown as blank spots.

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The demographic role of religion in Hungary

Fertility of denominations at the beginning of the 20th century

Gabe HARRACH[1]

Abstract

Could it be possible that religious ties determine demographic behaviour, including fertility? If so, how can we arrange this factor with other variables in the same causal hierarchy? The raised problems were drafted at the beginning of modern demography already. In this paper we examine the mutual relations of religion, ethnicity and fertility in the territory of the former Hungarian Kingdom at the beginning of the 20th century. This period is interesting for the fact that fertility rate in Hungary decreased by an extraordinary proportion, 40% between 1910 and 1930. The Carpathian Basin had a unique ethnic and religious character at that time: seven main ethnic groups and seven relevant denominations had been registered by the 1910 Hungarian Census, thus the region is suitable for the empirical examinations of the mentioned coherences.

Keywords: fertility; marriage; religion; demographic regions

Theoretical background

During the 20th century, the explanation theories on fertility could be devided into two parts: economic and social paradigms. Dudley Kirk (1996) named altogether seven kinds of fertility explanation theories. In our case the validity of explanations on fertility reduction is delimited by the fact that the demographic transition took place in a different way in the Carpathian Basin compared to the description of this theory (Notestein, F.W. 1945): in certain areas the fertility rate began to decrease roughly before the industrialization already, and at the beginning of the 20th century some agricultural regions, especially the Banat, showed similar fertility rates to the strongly industrialized French and Belgian provinces, which had the lowest values on continental level (Tekse, K. 1969; Demeny, P. 1972).

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Hungary was one of the first countries where intellectual and widespread dispute, the so-called only-child debate began on fertility reduction because of the extraordinary low regional levels of childbearing. The interpretations of the phenomenon can be categorized into four groups.

1. Economical viewpoint. Small landed properties were not able to spread because of the dominance of large estates, and as its consequence, the sharing of small estates among descendants could result in wealth-disintegration. This is the reason why families, in order to avoid pauperisation, were forced to decide to limit the number of their offspring. Rudolf Andorka (1989), who proved by his family-reconstitution researches the application of contraceptive methods in some regions since the middle of the 18th century, supposed that the owners of small lands chose this alternative solution in order to avoid to become agricultural workers on large estates.

2. Ethnical aspect. In South Transdanubia, one of the least fertile regions in Hungary, Germans produced higher rates than Hungarians (Kovács, A. 1923), moreover, fatal visions were published on the forthcoming population-change of Hungarians and Germans in the region (Illyés, Gy. 1933). The deviate demographic behaviours could be based on unwritten legal differences: among Germans the firstborn was the only inheritor, hence in the latter case the higher number of children could not cause the devaluation of estates.

*3. Denominational approach***.** The imaginary shape of the Reformed person with only-child became the symbol of a beginning demographic crise. It was certainly a simplification, but not without any basis: connections between religious ties and childbearing, or in other words, Calvinists' lower fertility was observed at the beginning of the 20th century (Kovács, A. 1913; Pezenhoffer, A. 1922), although the conclusions usually offended Protestants.

4. Moral interpretation. 'The only-child world is a separated moral universe. (…) Its base is the selfishness, the lack of faith, (…) the desire to live in comfort, in luxury, carefree' (Fülep, L. 1997, p. 22).

Dezső Dányi (1994), who analysed the employment and demographic statistics based on the 1930 Census, refuted the hypothesis on correlation between estate-size and fertility, pointing out that (1) in this term the fertility level of peasantry decreased in other European countries also, including those which had more balanced estate-conditions; (2) in Hungary the phenomenon of only-child or childlessness was more frequent among members of the rural middle classe than the small-holders. According to Dányi the level of fertility reduction depended firstly on the geographical position of the given regions, secondly, in accordance with the results of researches emphasizing the significance of age-specific fertility (Acsádi, Gy. and Klinger, A. 1965; Kamarás, F. 1991), on the intensity of contraception at the end of child-bearing life-period.

It occurred that both economical and cultural (i.e. religious and ethnic) circumstances influenced the formation of fertility on local level (Kósa, L.990). At the turn of the 19–20th century a more rational agriculture became general in some Calvinist and ethnic Hungarian villages of the Drava region (Somogy county), which led achieving a kind of middle-class status and spread of new values among the inhabitants. The common wish for keeping the reached level of living standard led to general practice of contraception. The harder it was to keep it, the more radical methods were applied by them. The reason why this process could be observed only in the Reformed Hungarian villages, but not in the neighbouring Catholic Croat settlements, raises the possibility of determining role of religion. According to Max Weber 'the Protestants (…) both as majority and as minority, have shown a special tendency to develop economic rationalism which cannot be observed to the same extent among Catholics either in the one situation or in the other' (Weber, M. 1930, p. 39).

Beside Weber's interpretation, there is another approach to explain the demographic role of Protestantism, according to which, birth control would rather be regarded as a moral than an economical personal decision, and the measure of its application depends on the different levels of religious control upon individual. As Durkheim wrote: 'The only essential difference between Catholicism and Protestantism is that the second permits free inquiry to a far greater degree than the first. (…) The Protestant is far more the author of his faith. (…) If Protestantism concedes a greater freedom to individual thought than Catholicism, it is because it has fewer common beliefs and practices. (…) The greater concessions a confessional group makes to individual judgment, the less is dominant lives, the less is cohesion and vitality' (Durkheim, E. 1996, pp. 157–159).

On the basis of the results of a research on Vaud, a Reformed canton in Switzerland, Praz attributes the Calvinists' lower fertility to the fact that the church, reacting to external ideological offensives, launched a plain-spoken and taboo-free inner dispute on marriage, sexuality and birth control at the beginning of the 20th century, which resulted in the definition of a specific Protestant marriage and family behaviour pattern, which included the idea of a considerate father and husband, as well as, even a kind of the practice of birth control based on husband's self-restraint (Praz, A.F. 2009). Besides, as a direct consequence of this new family model, more and more young women began to attend school, which increased the expenses of upbringing, making the families reduce their fertility, which was commented by parochial reports in a tolerant tone. This connection between the church attitude and demography could not be imagined in the Carpathian Basin: first of all in Hungary there were not such open debates as it was arranged in Switzerland, second of all the Hungarian Calvinist clergy and intelligentsia, together with Roman Catholics, regarded the birth-reduction as one of the most serious social and moral problems.

Methodology

We examine three indices on each ethnic and religious group:

- nupciality of married women aged 15–49, henceforth: nupciality;
- marital fertility rate (concerning married women aged 15–49);
- overall fertility rate (concerning all women aged 15–49).

There is a logical connection between these rates: by the method of Coale, A.J. and Watkins, S.C. (1986), the overall fertility – in this case the total fertility rate (TFR) – should be calculated by the next formula, if I_f means TFR, I_m is nupciality, I_g is total marital fertility rate (TMFR) and I_h means total extra-marital fertility rate.[2]

$$I_f = I_m \cdot I_g + (1 - I_m) \cdot I_h$$

Considering the fact that extra-marital births amounted to almost 90% of the all births of the Hungarian Kingdom in the examined period, the TFR was determined essentially by I_m and I_g. The product of them converges to the real value of TFR: the less the proportion of births out of wedlock is, the less is the deviation between the mentioned product and the real TFR on a local level. This mathematical fact is the reason why we examine henceforth only two indicators: the nupciality and the marital fertility rate.

The statistical database in the examined period does not allow us to calculate TFR/TMFR related to the religious groups, thus during our research we prefer general (marital) fertility rate instead of the mentioned indices (except the local TMFR values). It means that we do not use the index expressing the average number of births per one woman (concerned, of course, to a given year), but apply the rate of every births per every fertile women in a given year. However, it needs to be emphasized that the use of general (marital) fertility rate instead of TFR/TMFR does not change the validity of the formula above.

In order to count nupciality and marital fertility rate of the different ethnic groups and denominations, country-wide or in the counties, first of all we should know the number of married women aged 15–49 belonging to each religious group. It is obvious that these data, in fact being the combinations of three basic variables (age, religion, family status), can not be found in any census databases or they can only be estimated, not computed. In our case only certain cross-data are published, composed any way by two of the mentioned variables, from which we can calculate the elements of the estimation-formula.

[2] As a matter of fact, this formula consists of the Princeton indices, i.e. the proportional numbers which indicate the relations to the nupciality and fertility of marital hutterites (Henry, L. 1961; Coale, A.J., Anderson, B. and Harm, E. 1979; Coale, A.J. and Watkins, S. 1986). In our case the demographic rates are expressed by traditional calculation, thus Princeton indices are not applied in this paper.

To create this formula, initially we consider the number of 15–49 years old women from *d* religion as a starting datum $(w^d_{15\text{-}49})$, and then we try to define the number of married ones within this group. It is expedient to multiply the $w^d_{15\text{-}49}$ with the quotient of the married women aged 15–49 $(m_{15\text{-}49})$ and the total number of women from the same age-group $(w_{15\text{-}49})$. However, we know the fact from the census-statistics that each of denomination has different nupciality level, consequently the product mentioned before should be multiplied with that proportional number also which shows the relation between the nupciality of adult women from *d* religion (w^d_{15+}) and of every adult women (w_{15+}). Namely, because the nupciality means a proportion too (married women to total women), as a matter of fact the latter relation is a quotient of two other quotients. In consequence of all, we can get the next formula:

$$m^d_{15\text{-}49} \approx w^d_{15\text{-}49} \cdot \frac{m_{15\text{-}49}}{w_{15\text{-}49}} \cdot \frac{\frac{m^d_{15+}}{w^d_{15+}}}{\frac{m_{15+}}{w_{15+}}} = \frac{w^d_{15\text{-}49} \cdot m_{15\text{-}49} \cdot m^d_{15+} \cdot w_{15+}}{w_{15\text{-}49} \cdot w^d_{15+} \cdot m_{15+}}$$

In theory, the total sum of the different $m^d_{15\text{-}49}$ indices (which stand for the married women in a given denomination, aged between 15–49) should be equal to the whole number of married women in the same age-group (and in the same area, of course). Because the latter number can be calculated directly from census-statistics, it is possible to control the validity of the above estimation formula. We have completed this simple calculation on national level: the result was only 0,2 thousandts proportion-deviation between the real and the estimated numbers.

As a methodological notion, we defined a representation limit for denominations. In those counties and cities where the number of fertile women, belonging to a given religious group, was less than 100% or did not reach 1% of every productive woman living in the same area, their data are shown neither in the statistics, nor on the maps, because in this case the affected group would not be regarded representative. By our own database, established related to this research, it is proved by many examples that under-representation could cause extremely high or low demographic values.

The adjective 'country-wide' which we use many times, refers to different areas and population before and after World War I. For the sake of mutual comparability, only in case of chronological analyses, we tried to reduce the country-wide data of 1910 to the territory of Hungary after the Trianon Treaty. It was not an absolutely exact procedure indeed, because most of the demographic statistics from 1910 were published only on county level, and

the new frontiers tore apart many counties into two or three parts. Thus these modified data on country-level, from 1910, were counted to a heap of counties, the total territory and population of which approximately covered, as much as possible, the territory/population of Hungary after 1920.

The main demographic features of denominations in the Carpathian Basin

Before World War I.

Related to the 1910 census, the Hungarian Central Statistical Office published comprehensive data on eight relevant denominations (including the category of 'other'), ranking them as it can be seen below (*Figure 1.*) On the next table the population and proportional numbers are extracted directly from the official statictical database, while the nupciality, marital and general fertility are calculated by the upper estimation formula (*Table 1).*

The formation of nupciality does not refer to the possible role of religious cultures. The values of neither of the indices show significant differences, except for Jews and the category of others. The outstanding marital proportion of the 'others' can be explained by strong inner cohesion of small church communities, which might be an urge for believers to be married; Jews are discussed in details below. The general fertility rates of Catholic and Orthodox churches exceeded the country-wide average, while those of Protestants (Reformed, Evangelist, Unitarian) were lower. Differences between Catholics and Protestants are more evident concerning marital fertility, even though in this case Orthodox believers present lower values, close to Protestants. (The reason of the latter fact is that almost 30% of Orthodox believers, lived in counties which had generally low fertility rates.)

Table 1. Main demographic rates of denominations in 1910

Religion	Population		Nupciality, %	Marital	General
	number	%		fertility, ‰	
Roman Catholic	10,888,138	52.1	64.5	210.6	148.1
Greek Catholic	2,025,508	9.7	66.6	221.2	161.3
Reformed	2,621,329	12.6	65.8	191.0	138.1
Evangelist	1,340,143	6.4	66.1	187.8	132.0
Orthodox	2,987,163	14.3	66.9	189.4	148.1
Unitarian	74,296	0.4	64.2	184.5	137.7
Jewish	932,458	4.5	60.1	156.3	104.9
Other	17,452	0.1	73.9	180.7	139.5
Together	*20,886,487*	*100.0*	*65.1*	*201.9*	*144.9*

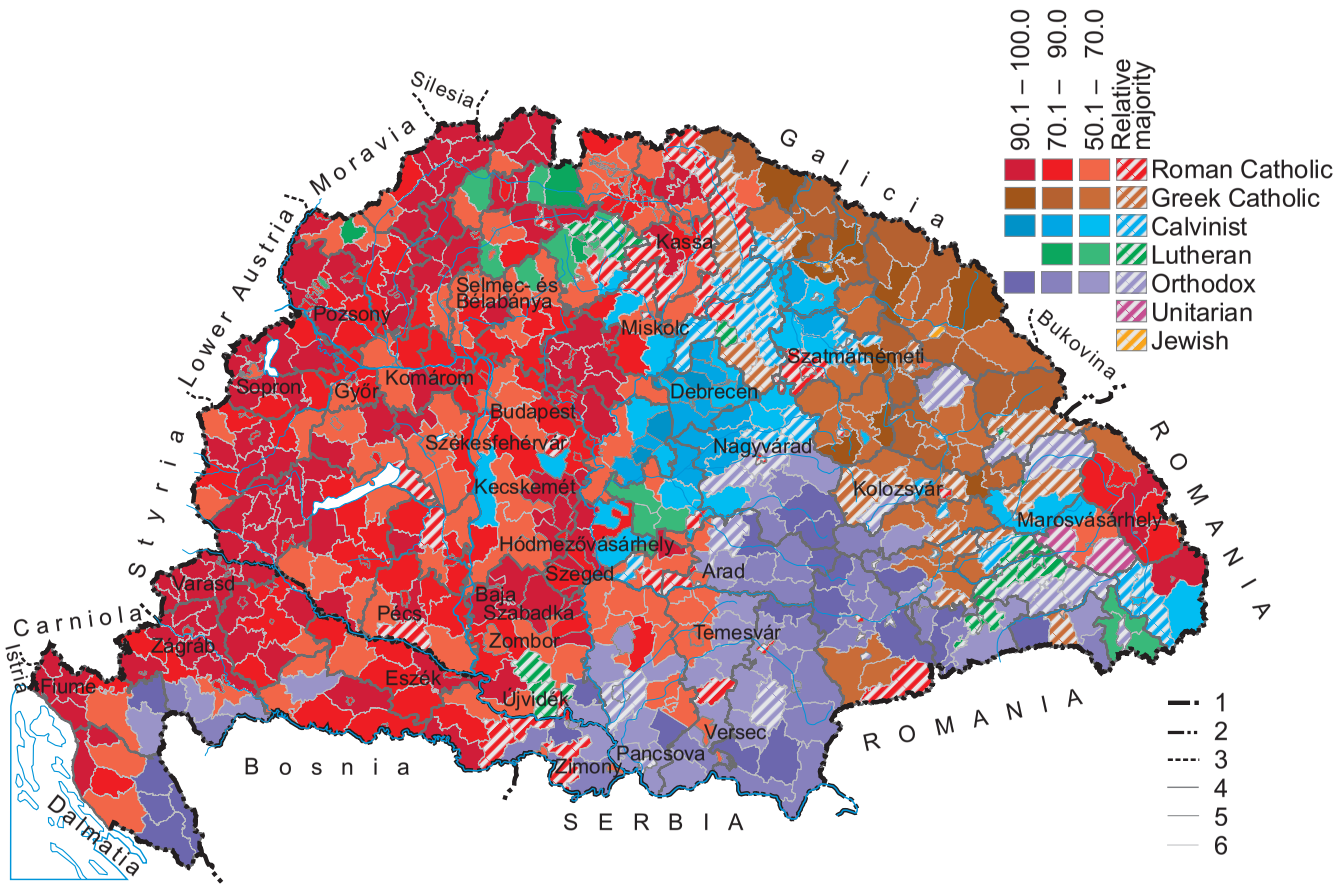


Fig. 1. Denominational majority in the subregions and cities in 1910 (%). – 1 = border of the Hungarian Kingdom; 2 = Hungarian–Croatian border; 3 = country border; 4 = city boundary; 5 = town boundary; 6 = border of the subregion

Previously we mentioned that overall fertility is determined firstly by nuptiality and marital fertility. The next matrix and point-diagram can make the mutual relation of both indices visible. If each value of them above the national mean number is regarded as high and below it as low.[3] We can get four categories of the demographic behaviour patterns *(Table 2)*.

Table 2. General scheme of the demographic behaviour patterns

Indicator		Nupciality	
		Low level	High level
Marital fertility	Low level	Modern	Neo-Malthusian
	High level	Malthusian	Traditional

Societies or communities, who aimed their fertility reduction by limitation rather of marriages than childbearing, are called Malthusian. Where fertility reduction was achieved in an opposite manner – high marital rate and birth control at the same time – we can speak about neo-Malthusian groups. A society with high nupciality and marital fertility is traditional, and if both of the components are low, it is simply called modern. The latter pattern is not equal with the post-modern demographic behaviour, of which is described in the theory of second demographic transition (Van De Kaa, D.J. 2002).

The mean values of nupciality and marital fertility are changing spatially and temporally. For example people who lived in the Hungarian Kingdom before World War I, followed the Eastern European marriage pattern, which meant marriage at young age and generally high proportion of married people at the same time (Hajnal, J. 1965), because 'the society expected its members to be married after a certain age' and 'singles, divorcees or separated married couple were condemned' (Csernák, J. Mrs. 1997, pp. 341–342). Consequently the classification of elements in the scheme of demographic behaviours depends on the examined region and era *(Figure 2)*.

In the Carparhian Basin the total population of Roman Catholics followed the Malthusian, Calvinist, Lutheran and Orthodox believers the neo-Malthusian and Greek Catholics the traditional pattern, while Jews and Unitarians had modern demographic behaviour (Ájus, F. 2010). However the demographic values of each church are influenced very much by urbanization levels: the higher is the rate of citizens, probably the lower are the values of nupciality and marital (and thus also general) fertility. This rule is evident in case of Greek Catholics, who lived mostly in rural environment, and in case of Jews, whose very low demographic rates can be explained by their highly urbanized character: 38% of productive aged Jew women lived in cities (in contrast to the national value, 13%), moreover, their county population lived rather in small and medium sized towns than in villages.

[3] Nupciality: 65.1%; general marital fertility: 201.9‰.

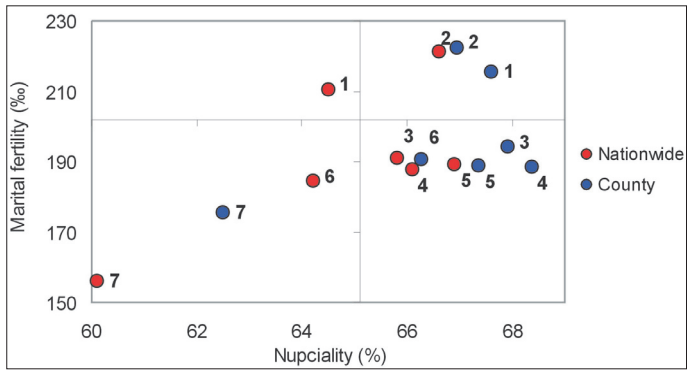


Fig. 2. Nupciality and general marital fertility rate of denominations on country-level in 1910. – 1 = Roman Catholics; 2 = Greek Catholics; 3 = Reformed; 4 = Evangelists; 5 = Orthodoxes; 6 = Unitarians; 7 = Jews

Beside levels of urbanization several social facts could influence the fertility such as educational level, employment structures, the low level of infant and child mortality which could influence the willingness to childbearing. Some of these facts will be discussed below. Although we need to emphasize, first of all, according to the upper figure the urbanization seems to be the most influential factor in demographic sense, second of all, urbanization is a complex notion, namely the above-mentioned causal variables had special, fertility reducing values in urban areas. On the upper figure we have marked also the data of aggregated population of each church in the counties. The distance between a red and a blue diagram element of the same denomination is closely related to the urbanization level: both values are varying linearly.

Between the two World Wars

We analyse six churches altogether in a chronological approach. (The Unitarian Church became insignificant in Hungary after World War I because of the occupation of Transylvania by Romania.) In the following tables and figures the data from 1910 are reduced to the new territory of Hungary, as we mentioned it in the chapter on methodology, and the aggregated county and urban values are also indicated *(Table 3).*

The general fertility rate of Hungary decreased by 40% between 1910 and 1930, thus a downward tendency can be observed, regardless of the normal annual fluctuations in fertility rates.[4] The process was influenced by different demographic

[4] It is observed that the annual agricultural rate of return and the birth rate have a positive correlation with each other (Ájus, F. and Henye, I. 1992).

Table 3. Nupciality, marital and general fertility rate of denominations between 1910–1930

Religion	Nupciality			Marital fertility			General fertility		
	%			‰					
	1910	1920	1930	1910	1920	1930	1910	1920	1930
Roman Catholic	63.8	57.9	59.6	212.7	196.2	137.2	148.6	123.4	90.2
Greek Catholic	62.0	59.1	61.2	236.2	251.8	201.1	162.5	159.5	132.9
Reformed	66.3	59.2	60.2	183.3	181.0	139.3	131.8	116.2	92.9
Evangelist	66.7	58.0	60.4	186.0	179.1	118.6	132.3	111.2	77.1
Orthodox	64.6	60.8	62.7	173.5	185.4	111.2	133.0	129.0	86.5
Jewish	58.0	52.0	54.0	134.8	106.0	71.2	82.8	57.1	39.6
Counties (aggr.)	*68.7*	*60.6*	*62.8*	*210.4*	*198.1*	*143.4*	*154.5*	*128.7*	*97.5*
Cities (aggr.)	*48.6*	*48.3*	*48.6*	*154.5*	*126.9*	*96.3*	*92.5*	*72.0*	*56.3*
Total	*64.0*	*57.8*	*59.5*	*200.7*	*184.5*	*134.5*	*140.3*	*115.5*	*88.0*

factors in each decades and administrative category: decreasing nupciality between 1910 and 1920 on county level (as a consequence of the men's casualties during World War I), marital fertility reduction between 1920 and 1930 on county level also, as well as, in the cities during both decades. In total the most important statistical cause of the general fertility reduction was the fall of marital fertility between 1920 and 1930. Between 1910 and 1920 most of the denominations, and in the next decade all of them can be characterized by a uniform decrease of general fertility rate[5] (*Figure 3*).

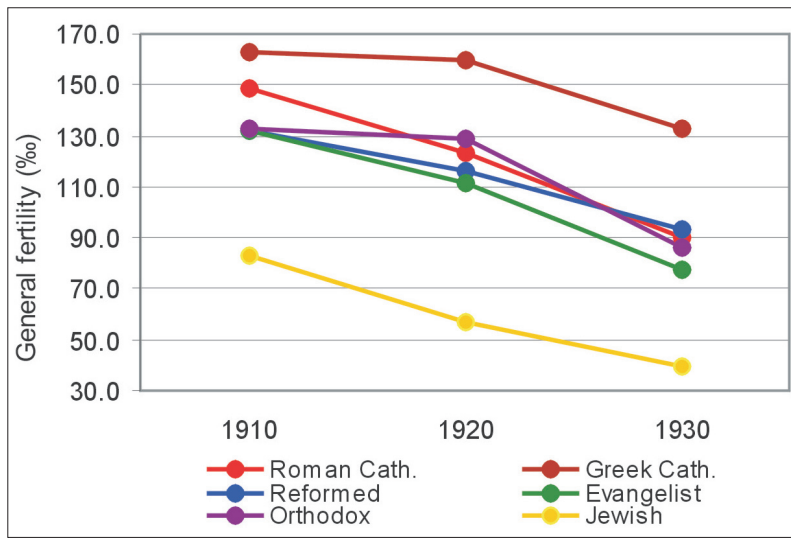


Fig. 3. General fertility rate of denominations between 1910 and 1930

[5] It can not be perceived on the figure that fertility rate fell down to an extraordinary degree during World War I, then it was almost entirely re-corrected by 1920.

Until 1930 a special order of values was formed, in which both of the extreme (highest and lowest) rates were significantly separated from other values which were relatively close to each other. Therefore Greek Catholics, having outstanding general fertility, were followed by Roman Catholic, Protestant and Orthodox believers, and finally Jews took place on the diagram, deviated very much from the others. Because of the various proportions of infant and child mortality by churches, differences among their net reproduction rates are smaller than the observed ones on the upper graph.

As a result of an earlier comparative study (Thirring, L. 1936)[6] an average married Greek Catholic woman had 3.98 births and 2.25 living children in 1930. The same indices in case of Jews were 2.40 and 1.88. Therefore the difference between the two denominations is 1.58 to births, but only 0.37 to living children, which refers to the fact that infant and child mortality was higher at Greek Catholics and lower at Jews. All things considered there is a positive correlation between fertility and child mortality rates of denominations, chronologically resulting in a mitigation of the original differences among churches on childbearing.

Denominations in the hierarchy of causes

Henceforth we analyse only the marital fertility, because this component playes more important role in formation of general fertility. The following map shows the most relevant and accurate index, the TMFR in the counties and the cities in 1910 (*Figure 4*).

Counties, whether their marital fertility rates are high or low, made demographic regions. According to our definition a demographic region is an area where a demographic index (1.) shows similar values, or (2.) changes in the same direction, hereby in both cases differs from the surrounding ones. In other words, the notion of demographic region has both static and dynamic interpretation. In our case a demographic region means an area consisting of counties with similar marital fertility rates. It is characteristic in the Carpathian Basin that neither of them covers the economical, ethnic and religious regions. Moreover the highest marital fertility rates, unusually, can be observed in the most developed and underdeveloped areas at the same time, as others have already raised attention to it (Katus, L. 2011). The next task is to investigate how religion could influence the level of marital fertility.

[6] These rates, by the fertility-definition of that time, were calculated for adult women, without the reduction to those aged 15–49. Because of the higher mean number of births/children of elder generations, values become higher by this calculation.

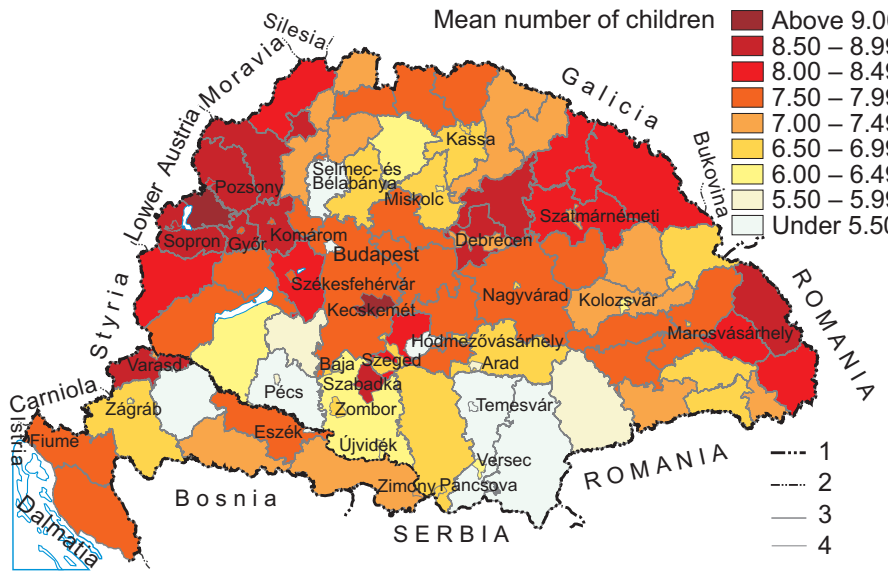


Fig. 4. Total marital fertility rate in the counties and the cities in 1910. – 1–4 = For explanation see *Fig. 1.*

Religion as the third demographic factor

As we have seen from the above data series, the urban social existence, strongly connected to such relevant variables as industrialisation, infant survival rate, proportion of literates, educational level, secularization, etc., had a greater impact on overall fertility than other factors. If we aspire to define a hierarchy of causes, the level of urbanization should be named as the primary demographic factor. In order to be able to rank the other causal factors, hereinafter we examine only the county data, omitting the cities.

Suppose that religion determines marital fertility rates in all counties. In this imaginary case a given denomination would show similar values everywhere, and childbearing of total population would depend on religious composition in each county. In fact, the county values of marital fertility of denominations and of total population have positive correlation with each other. (Therefore denominational values do the same generally also.)

It means that not the religion but a geographical factor determines the level of marital fertility in the counties. It is important to emphasize that the use of the adjective 'geographical' is a compelled solution because we do not know exactly the concrete variables causing the formation of demographic regions on county level in the Carpathian Basin; the fact we know is that

the development of them is 'probably the result of a mutual impact on each other by very complicated demographic and socio-economic factors', and 'it could not be succeeded to explore the economic, social, political, psychological and, supposed, other movers of the fertility reduction in Hungary so far' (Dányi, D. 1977, p. 61; 1994, p. 111).

On our following maps we compare the *general* marital fertility rates of the total population, of Roman Catholics and of Calvinists in the counties and the cities in 1930, in the post-Trianon territory of Hungary[7] *(figures 5, 6* and *7)*.

The cartograms reinforce the fact of correlation between the county values of the involved groups. In some counties we do not experience the parallel territorial formation of the values, therefore the correlation is not an absolute phenomenon. However, it is evident that marital fertility of Roman Catholics is higher everywhere than that of Calvinists.[8] It means that the religious component is relevant also behind the geographical factor.

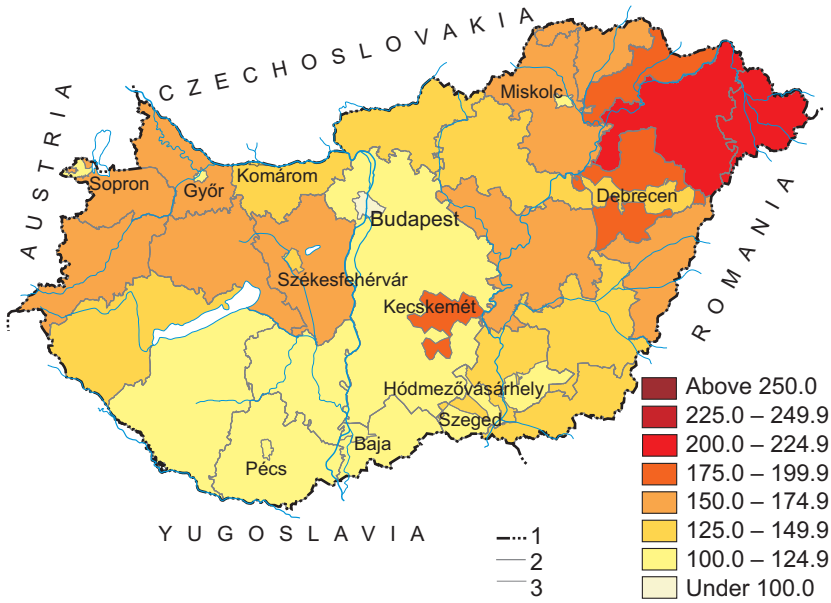
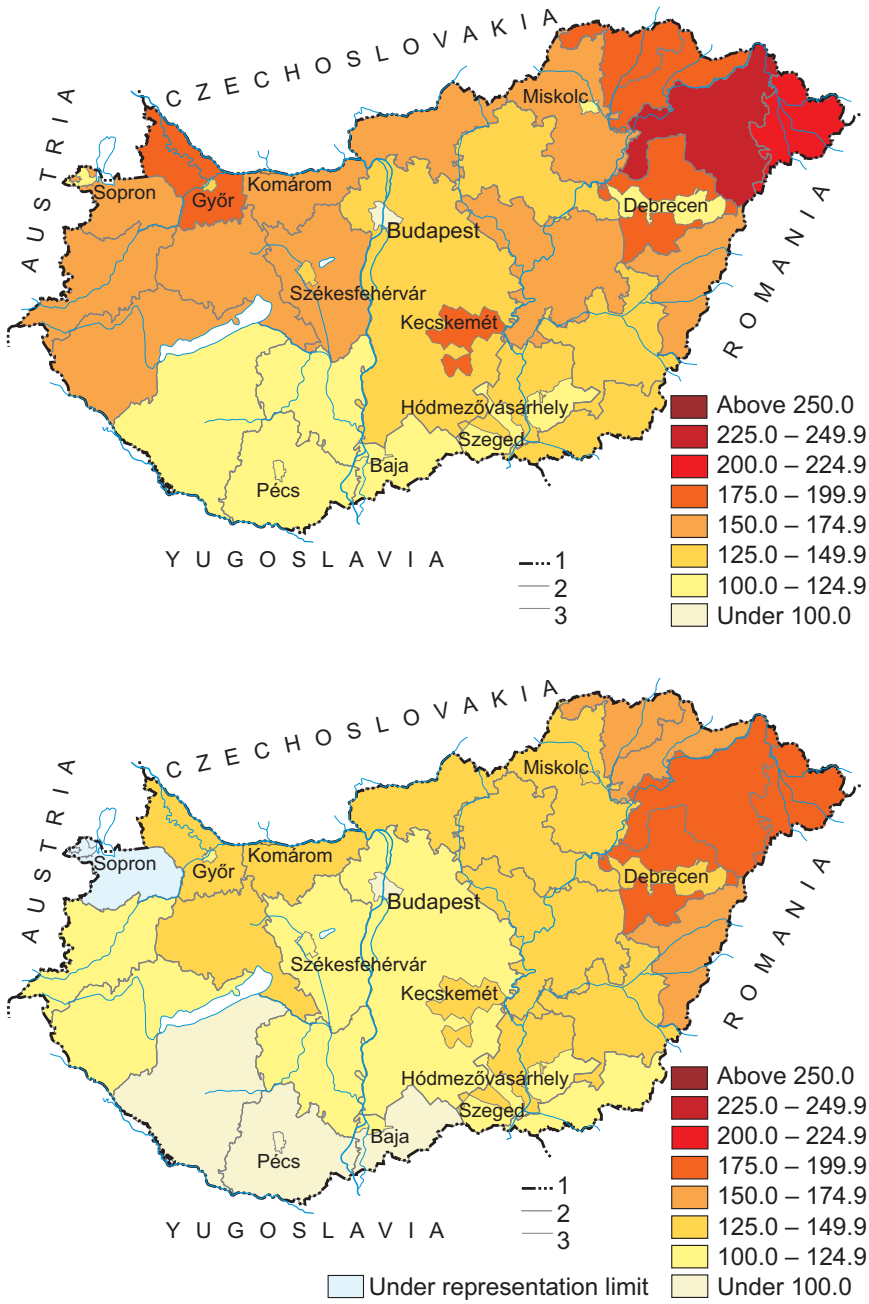


Fig. 5. General marital fertility rate of the total population in the counties and the cities in 1930 (‰). – 1 = state border; 2 = county border; 3 = city boundary

[7] The values can not be compared totally with each other only in Sopron county where Calvinists did not reach the representation limit mentioned in the chapter on methodology.

[8] As *Table 3* shows, even Calvinists had higher marital fertility, compared to the Roman Catholics, on country-wide level in 1930. The reason of this apparent inconsistence arises from the different distribution of both denominations: the majority of Calvinists concentrated in the most fertile region, while Roman Catholics are scattered almost equally all over the county.



Figs. 6, 7. General marital fertility rate of the Roman Catholics (above) and Calvinists (down) in the counties and the cities in 1930 (‰). 1–3 = For explanation see *Fig. 5.*

Our purpose, by the following figure, is to get a common, exact and clear picture on mutual relations among the geographical and denominational factors. The point-diagram, by its regression lines, shows the correlation between the general marital fertility rates of the total population and those of each denomination on county level. Therefore the vertical rows of diagram elements, which can be perceived hardly because of the large quantity of the points, mark the religious groups of each county (*Figure 8*). (Denominational groups of the cities, as it was mentioned before, are not implicated into the diagram.)

The positive regressions prove that the 'geographical' cause determines the fertility level of the counties (of which the demographic regions are made), while the the parallel lines indicate another rule: the religious fact determines the standard sequence of fertility rates among some denominations, independently of their territorial positions. (The above correlations can be observed related to the other demographic component, the nupciality, however in this case the role religion, in absence of parallel lines, can not be demonstrated.) Considering the previously mentioned fact that in total the level of urbanization is the most influential social factor, the geographical cause should be called as secondary, and the religious one is as third demographic factor.

A question arises as to how detectable is the demographic role of religion exactly. The effect on fertility by a given denomination can be defined by calculating the county general marital fertility without the involved church, that is by subtracting the absolut numbers of corresponding legitimate births and 15–49 year old married women. The difference between the original and the resulting rates shows that to what extent the given denomination strength-

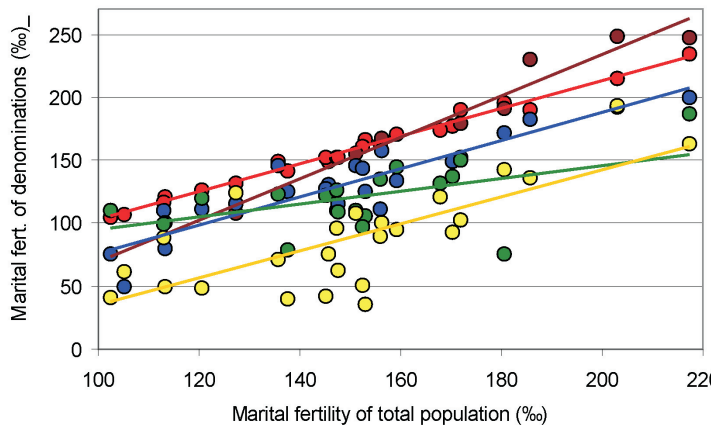
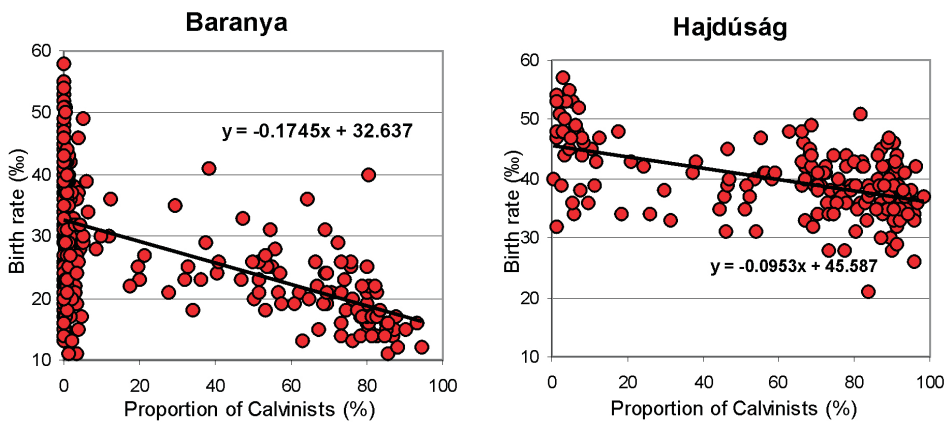


Fig. 8. General marital fertility rate of denominations compared with the same index of affected counties in 1930. – Coloured balls: Red = Roman Catholics; Brown = Greek catholics; Blue = Calvinists; Green = Evangelists; Yellow = Jews (No data for Orthodoxes)

ened or weakened the childbearing of the total county. A 1910 example of two counties, belonging to the same demographic region: while the marital fertility would be lower by 7.1 perthousand points in Hajdú county, and by 11 perthousand points in Szabolcs county without Catholics, the same rates would be higher by 21.7 perthousand points in Hajdú, and by 6.5 perthousand points in Szabolcs county without Calvinists. The marital fertility of the total county population is determined more by Calvinists in Hajdú county, and more by Catholics in Szabolcs county. So in fact not only fertility values, but the residential rate of churches also plays a role in demographic processes.

The manifestation of the religious factor at the beginning of the 20th century will be illustrated by a comparative example on Baranya county and Hajdúság region. Main parameters of these areas are deviated absolutely from each other, including topography, dominant type of settlements, total fertility rate and religious character. The purpose of the comparison is to demonstrate, first of all, the correlations between the proportions of Calvinists and the birth rates in the localities, second of all, the similarity of the correlations in the two areas, which are different in almost every aspect. (Birth rate is 'weaker' than fertility rates we use here, but related to the local administrative level only this kind of demographic index is published in the corresponding census database.) The diagram elements indicate, of course, the settlements of the examined counties *(figures 9, 10).*

As it is reflected in the negative correlations, the bigger the proportion of Calvinists, the smaller the birth rate is in a settlement. The graphs illustrate spectacularly the second and the third factor alike: most of the elements are distributed within different domains along the y-axes in each diagram, but the



*Figs. 9, 10***.** The coherence between the proportions of Calvinists and the birth rates in the settlements of Baranya county and Hajdúság region between 1901 and 1910

regression lines close similar angles. Within the $y = ax + b$ function the b means the second, and the a means the third demographic factor, thus the previous one determines the position of regression line along the y-axis, and the latter one determines its angle.

Religious or ethnic determination? The case of South Transdanubia

So far we have not taken into consideration the so-called cover-variables. In the Carpathian Basin denominations had significant overlaps with the ethnic groups at that time (which means, according to the early statistical standard, native groups), and automatically raises the necessity to examine the possible demographic role of ethnic groups. Regions with lowest fertility are suitable fields to find the appropriate variable being more responsible for fertility reduction.

According to Paul Demeny 'we can isolate at least three "leading" groups. In the Transdanubian region, the nucleus of change is found among the Protestant (Calvinist) Hungarian population. In the Banat region, the leaders were Roman Catholic and German. Further to the east, in Krassó-Szörény, early fertility decline is a characteristic of the Greek Orthodox Rumanian population' (Demeny, P. 1972, pp. 170–171). As Demeny added, we can speak about diffusion of birth control in the affected areas: the attitude-transfer in South Transdanubia took place through denominational channels – Roman Catholics imitated Calvinists' demographic behaviour three decades later –, while in the Banat region the process of fertility reduction was led by ethnic groups: Hungarians and Serbs followed the German and Rumanian pattern with delay.[9]

In the following we try to concretize the real demographic impact of religions and ethnics in Baranya, the least fertile county of South Transdanubia. The population here, in religious and ethnic aspects, can be divided essentially into two groups: Roman Catholics and Calvinists, as well as, Hungarians and Germans. Comparing their marital fertility rates, it becomes apparent that which was the more appropriate observations during the only-child debate in connection with the demographic deficit of Hungarians and Calvinists (*Table 4).*

Table 4. Marital fertility rates of the relevant South Transdanubian denominations and ethnics in 1910

Territory	Roman Catholic	Reformed	Hungarian	German	*Together*
	‰				
Baranya	149.3	79.5	125.1	165.6	*138.5*
Hungarian K.	210.6	191.0	204.8	177.9	*201.9*

[9] One should note that diffusion was not only a sociological but also a cultural and a geographical notion at that time, as it was regarded as a flow of information on contraception among the social strata (Becker, G.S. 1960).

According to data of the 1910 census, Germans were Catholics, Hungarians belonged to both churches, and Calvinists were Hungarians in Baranya; the total county proportion of other overslap was very slight. Essentially we can separate three big groups of inhabitants in the county: Roman Catholic Hungarians, Reformed Hungarians and Roman Catholic Germans, but in statistical sense we can regard, considering the above-mentioned cross data, Calvinist Hungarians simply as "the" Calvinists, and Catholic Germans as "the" Germans, therefore both latter groups' marital fertility rate can be calculated by the estimation formula discussed in the methodology chapter. The same index of the third group, Roman Catholic Hungarians, can be computed in an easy way.[10] According to the final results, the marital fertility rates were as follow: Calvinists: 79.5‰; Germans: 165.5‰; Roman Catholic Hungarians: 137.1‰.

The difference between the rates is higher in case of groups belonging to different churches than among groups of different ethnicities (58 and 29 thousandth points). Therefore in Baranya county, the religion played more significant role in the development of marital fertility than the ethnicity did. We can draw the same conclusion in other South Transdanubian counties, but an opposite causal hierarchy prevails in the Banat and South Transylvania, where marital fertility was formed mainly by the ethnic ties, as Demeny stated first,[11] and the differences of denominational fertility rates were determined by ethnic compositions of the local religious groups.

[10] As a first step we need to calculate the two elements of the marital fertility rate, the numbers of legitimate births and married women within the Roman Catholic Hungarian population. It can be done in two ways: taking the given number of Calvinists from the total number of Hungarians, or repeating the same procedure in case of Germans and Roman Catholics. The difference between the results is very small (legitimate births: 2,996 and 2,995, married women aged 15–49: 21,379 and 22,300), and when the quotient is formed from them, we use the mean values of the corresponding figures. Due to methodological aspects, during our procedure in theory we need to suppose that the proportions of the religious and ethnic overlaps are same in case of total county population, legitimate newborn babies and married women aged 15–49.

[11] We would complete Demeny's statements about the Banat region: in religious context it were not the Roman Catholics but the Orthodox, in ethnic respect it were not the Germans but the Rumanians, who were leaders in fertility decline, similarly to the neighbour county, Krassó–Szörény (calculating only with the relevant religious and ethnic groups). Using our estimation formula, we can describe the general marital fertility rates of the ethnic and religious groups in the Banat region, accurately in Temes county from 1910, i.e. Hungarians: 217‰, Germans: 158‰, Rumanians: 106‰, Serbs: 184‰, Roman Catholics: 169‰, Orthodoxes: 127‰.

Summary and conclusions

The general fertility rate was reduced by 40% in Hungary between 1910 and 1930. The main reason of the strong decrease was primarily the tumble of marital fertility between 1920 and 1930. The general fertility of most of the denominations declined in similar degrees between 1910 and 1930, except for Orthodox and Greek Catholic believers, whose rates began to decrease only in the second decade. Denominational values showed significant deviations: Greek Catholics' fertility values moved in an outstandingly high, while that of Jews in especially low domain, while the others produced average rates being close to each other.

Several reasons could cause differences between the demographic characters of denominations, such as proportions of urbanized and rural population, educational level, employment structure, infant and child mortality, religious and ethnical overlapping and, last but not least, the denominational culture itself.

In the Carpathian Basin the marital fertility could be characterized by geographical differences of the values, hereby different sized demographic regions formed, each of them extended onto many counties. These areas, being either high or low, could not be connected with the economical, ethnic and denominational regions. The county values of nupciality and marital fertility were primarily determined not by the religion, but by the so-called geographical factor. However, it can be observed that denominational marital fertility values showed the same or similar sequence in several counties.

The geographical cause, which fundamentally determines the marital fertility level of a given region, is called secondary demography factor (considering that urbanization can be regarded as primary one), and the religious/cultural cause, which can be connected to the sequence of the same indices of denominations, is called third secondary demographic factor. The latter one could also have a limited influence on the overall fertility in the counties, but its degrees depended on the religious complexion of the affected area.

Because of the significant overlaps between denominational and ethnic groups, it is ambiguous that the secondary demographic factor can be interpreted religious or ethnic phenomenon. As it is proved by the examinations, the causal role of denominations and ethnics was different in the regions. For instance, religion was a more determining factor than ethnicity in South Transdanubia, and the reverse was true for the Banat and South Transylvania.

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Delimiting the "Balaton Riviera" tourist destination by using network analysis

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Abstract

Recently the recognition of the role, potential within, and analysis of networks has been increasing in business and academic areasl. Network analysis has also been applied widely in tourism, as numerous researchers are studying connections among elements of tourism, with the main focus on destinations, cooperation and the efficiency of cooperation among players of destination management organisations. The methodology applied in those researches has reinvented social network analyis, which has noteable historical roots in mathematics, sociology, and anthropology. As identified in the title, the subject of this study aims to delimit destinations which have been researched in a micro-region (Felsőörs, Lovas, Paloznak, Alsóörs, Csopak) of a Balaton Region, Hungary's number one tourist destination as well as the local destination management organisation "Balaton Riviera". Analyzing the data we can conclude that our hypothesis posed at the beginning of the research is verified, namely in the case of this micro region the connections among the actors mark the boundaries of the destination. For the time being, the scope of this research is limited to pilot research only, but thanks to sophisticated methodology and softwares it can be upscaled to manage huge databases as well, and therefore the results achieved herein can be tested elsewhere and generalized.

Keywords: tourist destination, social network analysis, destination management organisation, Balaton Region

Introduction

In the last two decades destination competitiveness has emerged as a major focus of tourism research (Barbosa, L.G.M. *et al*. 2010; Croes, R. 2011; Papp, Zs. and Raffay, Á. 2011) – mainly when it became evident that spatial competition (that is competition among tourist destinations) was decisive in tourism, due

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to the globalisation and the development of international tourism (Kozak, M. 2004). Because of destination competitiveness, it has become urgent to find the definition of the destination for effective tourism management. It is essential to be able to outline the territory, which means the place of experience for tourists.

According to Jancsik and Mayer the role of networks is about to become more and more important. Beside comparative and competitive advantages they argue that *network advantage* can be defined and used as nowadays network competes against network (Jancsik, A. and Mayer, P. 2010). According to this network advantage those destinations will be more successful in competition, where the actors have more and stronger linkages inside the destination. However, the tourism destination as a place is difficult to outline (as its borders depend on the visiting tourists) and is difficult to define. For one tourist a whole country can be a destination, while for another even a little village can be attractive enough to set off on a journey. Therefore we move back one step in effect and suppose that the territory, which has actors in tourism with many and strong inside linkages – can be defined as tourism destination.

Our research is bulit on the hypothesis that social networking analysis could provide a tool to resolve the issue so far uncleared in the relevant literature, namely how to define and delimitate destinations. We investigate by the help of type and rate of in- and outbound connections whether participation in a *destination management organisation* (*DMO*) defines a destination indeed or the connections show that linkages outside the organisation are typical and the membership does not delimit a real destination.

Research background

Need for destination management

Lately tourist demand has changed. The main emphasis is now the *experience*, which can be available in a destination – that means that competition concentrates on destinations (Ritchie, J.R.B. and Crouch, G.I. 2000). But a tourist destination is often not cleared. In more countries there are minimal criteria such as number of guest nights, local or community tourist bureaus or the size of the budget (Aubert, A. *et al.* 2010). But the main characteristic is that the whole territory means one unit for the tourist, and at the end of the travel all the things build up into one complex experience. Therefore it is important to look at destinations as the scenes of available experiences – where the product (that is the destination) is lived through instead of being consumed by tourists (Stamboulis, Y. 2008).

Tourists' experiences can be of all kind however – and also the scope of the destination is observed differently. That is the main difficulty of destination research: the 'district' cannot be easily defined. Following Nemes Nagy who says: "as many people – so many scopes" (Nemes Nagy, J. 2009, p. 101) it can also be said: as many people – so many destinations.

Among terms used in economics, a tourist destination can be seen as the equivalent of a traditional nodal region. This type of region is usually regarded as related areas of several neighbouring settlements – with one or some bigger city in the middle, as a node (Lengyel, I. 2009). Nodal regions mean the spatial concentration of an economic activity, mainly of processing industry (Lengyel, I. 2010). Nevertheless a destination is usually organized around an *attraction* not a town or village – it is similar to a nodal region. In addition a destination is also open and cannot easily be defined by administrative boundaries.

Yet, in the scientific literature many of the authors examine regions (Cracolici, M.F. and Nijkamp, P. 2008) or mostly countries (Gomezelj, D.O. and Mihalic, T. 2008; Dwyer, L., Kim, C. 2003) as destinations because it is easy to handle and research – just because of the existing boundaries. They usually also emphasise that considering geographical and/or administrative boundaries as definers of a destination is not always eligible, because tourists' choices do not rely on administrative boundaries. Klepers and Rozite say the same drawing on their research; they found that travellers do not notice administrative borders in general (Klepers, A. and Rozite, M. 2010).

Leiper says that a destination is the place towards which people travel and where they choose to stay for a while in order to have experiences (Leiper, N. 1995). This definition makes research difficult, because the territory and the boundaries of the place regarded as their 'destination' can vary according to the tourists' expectations and motivations.

Taking the supply-side approach, Buhalis defined a destination as a region where all the supply elements (attractions, services, etc.), which a tourist would need are available (Buhalis, D. 2000). It seems easy to delimitate the destination like this, but considering the various services that various tourists need – it also fails to give a good basis.

We propose to consider the issue from a management view. We presume, that destinations may be considered as collaborating networks of complementary organizations (Gunn, C.A. 1997) and it is also evident that a destination with a management organisation is more effective and competitive and able to react more rapidly on market changes than without it (Raffay, Á. *et al.* 2010). Nowadays more and more DMOs are founded in Hungary as well, however we couldn't find such an organisation in every Hungarian destination, so we aren't able to compare the destinations just based on this definition.

Many studies (de Araujo, L.M. and Bramwell, B. 2002; Pavlovich, K. 2003; Dredge, D. 2006a, b; Plummer, R. *et al*. 2006; Wang, Y. and Fesenmaier, D.R. 2007) have indicated the importance of inter-organizational networks in destinations and the importance of collaboration among organizations. Because of the latter statement and the development of the DMOs' network in Hungary our research is based on the management approach as we try to describe the boundaries of a destination with the help of the bottom-up relationships between the actors and the connecting DMO.

Development of DMOs in Hungary

In destination development Hungary has a notable basis: with a strong national marketing organisation which operates with the help of wide network of Tourinform offices throughout the country; and the regional organisations were established several years ago. Because of the successful structural development it is important to take into account both opportunities (effective tourist strategy of the government; activity of NGOs) and threats (instability in the government; destination managers not recognizing their role) as well (Jancsik, A. *et al.* 2008).

Nowadays destination management is of growing importance and a key element of Hungarian tourism policy, since it became one of the five main priorities in the National Tourism Development Strategy for the period of 2005–2013 (worked out by Ministry of National Economy in 2011). Tourist destinations in Hungary have not been bottom-up units thinking together, but small regions formulated by the central government (Hanusz, Á. 2010). No other administrative region can, however, respond as quickly to market changes as a destination based on close cooperation (Kovács, M. 2008). Regional tourism supply and the formulation and strengthening of tourism destinations are some of the most significant instruments to increase competitiveness (Hanusz, Á. 2010).

This is the main reason why destination management is so important (not only in Hungary). Destination competitiveness is a fashionable term, but also a key factor influencing the long-term survival of a destination. It follows that the Secretariat for Tourism within the Ministry of Local Authorities decided to foster the formation of DMOs throughout the country (Raffay, Á. *et al.* 2010) – to maximize its advantages like:

– possibility of conscious development with the interest of all the stakeholders;
– financial basis and competence for independent actions;
– effective marketing;
– effective image-formation for the area;

– increasing tourism performance, more tourists and income;
– delegating tourism-like tasks by local governments to the DMO (yet have more tax-income);
– new work places, migration can stop (Hanusz, Á. 2010).

The first organisations which worked like a DMO were established at the beginning of the previous decade. For instance, the success of the Gyenesdiás Tourism Association, founded in 2003, proved that building from below is effective indeed, and only cooperation leads to development.

According to this model of tourist administration, the government tried further bottom-up initiatives and helped the local and regional participants of tourism to organize DMOs for improving destination management performance. In 2005–2006 within the frame of Lake Balaton Partnership Programme training was organised and tourism professionals were teaching about the importance of cooperation in the tourism sector. They presented international best practices and sketched out the planned Hungarian system. As a result of this training the Balaton DMO Booklets came into existence (Clarke, A. and Raffay, Á. 2011). For example, in 2008 a handbook of organizational and professional DMO development was published. This offers easy-to-follow guidelines for the tourism sector to build up these organisations and in addition more and more invitations to tender became available to achieve these aims (Jancsik, A. *et al*. 2008).

The handbook also stated the main characteristics of the Hungarian DMO-system, like its structure. DMO-system in Hungary consists of three levels:

1. local level (settlement),
2. middle level (micro-region),
3. regional level (region).

Local level – as the basis of the whole DMO-network – is usually formulated by a settlement, if the conditions for effective operation are insured. If conditions are not given in one settlement – that has the possibility to cooperate other settlements, yet formulating a local level DMO system or the local enterprises can join in the geographically nearest local (maybe micro-regional) organisation (Nyirádi, Á. and Semsei, S. 2007). Destination management organisations can exist at all the levels – but with slightly different functions. Tasks are shown in *Table 1.*

Some expectations are common (at all levels), like development cooperations, research activity or information management (Lengyel, M. 2007), which are stated in the handbook – and appear as basic requirements in the series of tenders.

Since 2010 the new DMOs have to be registered at the Secretariat for Tourism within the Ministry of National Economy (it's a prerequisite of a tendering activity). At the time of the research 75 registered DMOs were working in Hungary (http://www.tdmszovetseg.eu/).

Table 1. DMO tasks at different levels

List of tasks	Local	Middle	Regional
	level tasks		
Planning	occasional	main	main
Development	main	main	occasional
Destination marketing	occasional	main	main
Attraction and visitor management	main	main	occasional
Quality management	occasional	occasional	main
Monitoring	occasional	occasional	main
Professional training	occasional	occasional	main
Advocacy	occasional	occasional	main

Source: Lengyel, M. 2007.

In 2011 a new tendering period began and with the help of this invitation to tender the government wanted to support the formation of not only the local but the regional DMOs as well. At the end of last year the first regional DMO of Hungary, the Balaton Regional DMO, was established.

The SNA methodology

In the last decade social network analysis – used also in our research – became the scientific focus of economists. The reason why it turned out to be important is the appreciation of the role of connections among the actors in economic life and competition. It follows that it comes to the front of scientific interest of economists in last decades. The significance lies in that SNA collects a new type of data (relational data), it asks new type of research questions (structural analysis of whole or ego networks) and it uses new types of methods for analysis (matrix and graph theory) (Letenyei, L. 2005). Although the SNA represents a new approach applied just for some decades in economical researches, the method goes back a long way thanks to the mathematical (e.g. Euler – Bridges of Königsberg, 1736), sociological and anthropological roots (Simmel, Radcliffe-Brown, Moreno, Milgram, etc. – cit. Gerő, M. 2006).

The SNA enables explorations of the formal and/or informal connections, furthermore linkages with different content (information, knowledge, commercial, etc.) of a community (e.g. actors of a destination). With the help of extensive indicator systems (e.g. density, centrality, mean distance, etc.) it is possible to characterize the role of the actors involved to the network or the stability of the whole network. Furthermore the network maps produced by various softwares underpin the graphic presentation of a network structure. In many cases these maps give enough information for example for the determination of central actors or the identification of isolated elements. Besides, there

are various indices introduced and available to map networks structure more deeply and thoroughly and, for example, to examine network position, success, and correlation of economic output (Bencze, Sz. 2010). According to the literature, the most important indices to characterize topology and behaviors of a complex network are as follows: density, degree/degree centrality, average path length, clustering coefficient, efficiency (Baggio, R. 2008, 2009, 2010; Baggio, R. and Cooper, C. 2008; Baggio, R., Scott, N. and Cooper, C. 2008).

These possibilities mean it is an excellent starting point for network development (e.g. regional development), namely if we know the social network of the given destination, a conscious network development can begin and specific arrangements can be determined for involvement of isolated actors or more efficient information flow (Letenyei, L. 2005; Bencze, Sz. 2010).

Our investigation is just a pilot research with a small number of participants, but sophisticated computerised analysis techniques could elevate this study to higher levels (regional or national) of much higher volume, which would open space for testing, comparison, and generalisation. Bencze studied a large area, as she studied connections (5404 connections) among Small Region Coordinators and their partners in the Central Hungarian region by analysing the database of Small Region Coordination Network with the help of social network analysis (Bencze, Sz. 2010). At the international level larger areas, regions (and therefore more elements) have already been studied with relevance to tourism: Baggio studied dynamics and efficiency of connections among touristic destination players within the Elba region of Italy (Baggio, R. 2008).

SNA in tourism

The SNA appears in Hungarian tourism literature only tangentially. It means that certainly the Hungarian researchers have been interested in destination networks and cooperation and network of different tourism enterprises (Jancsik, A. and Mayer, P. 2010; Jancsik, A. 2010; Rátz, T. and Kátay, Á. 2009), have until now – except for this project - have not carried out specific SNA research in the field of tourism. Therefore we can review just the international tourism related SNA literature and examples.

In the course of his literature review Baggio collects articles concerning social networks based on three respectable journals (Tourism Management, Annals of Tourism Research, Current Issues in Tourism). These were selected from the period 2000 to 2006 which concerned three main areas: inter-organisational networks (majority of studies), policy networks and individual social networks (Baggio, R. 2010).

Table 2 shows our own article collection made during the period 2005 to 2012 based on the most significant tourism related journals and confer-

Table 2. SNA methodology in tourism related literature

Authors	Year	Keywords
Hwang, Gretzel and Fesenmaier	2006	multi-destination travel, city tourism, destination bundling; network analysis, international tourism
Baggio, Scott and Arcodia	2008	co-authorship, events literature
Hu and Racherla	2008	co-authorship, hospitality research, knowledge domain, knowledge networks, social network analysis
McKercher	2008	citation, citation count, impact analysis
Benckendorff	2009	bibliometrics, social network analysis, Australia, New Zealand, research, trends
Benckendorff	2010	collaboration, co-authorship, bibliometrics, social network analysis, Australia, New Zealand
Rachela and Hu	2010	co-authorship, knowledge networks, scientific collaborations, social network analysis, tourism research
Ye, Li and Law	2011	co-authorship, social network analysis, tourism and hospitality, journals, research collaboration
Ying, Xiao	2011	knowledge network, scientific community, social network analysis
Ye, Song and Li	2012	co-authorship, cross-institutional collaboration, tourism, hospitality, weighted social networks
Schaffer, Lawley	2012	knowledge transfer, artificial reefs, network analysis, social value, tourism
Baggio, Scott, Wang	2007	destination, collaboration, network analysis, websites, Fiji, Elba
Baggio, Corigliano, Tallinucci	2007	tourism destination, internet, web, cooperation, economic and social integration, complex networks
Baggio, Marzano	2007	tourism destination, power, content analysis, network analysis, marketing plan, Queensland
Baggio	2008	complex networks, tourism systems, web, internet
Baggio, Cooper	2008	innovation, knowledge transfer, network analysis, tourism destinations
Baggio, Scott, Cooper	2008	complex systems, network science, tourism destination, destination management
Scott, Cooper, Baggio	2008	network analysis, destination structure, cohesion
Baggio	2009	network science, complex systems, tourism destination, destination management, qualitative and quantitative methods
Baggio, Corigliano	2009	web navigation, hyperlinks, complex networks, random walks
Cooper, Scott, Baggio	2009	networks, stakeholder, tourism destination, destination management
Baggio, Cooper	2010	epidemic diffusion models, knowledge transfer, network analysis, tourism destinations
Baggio	2010	tourism destinations, collaboration, network analysis, modularity
Romeiro, Costa	2010	rural tourism, co-management, cooperation, innovation, social network analysis, Spain
Lee, Choi, Yoo and Oh	2012	integrated tourism management, centrality, network analysis, spatial interaction, Korea
Pforr	2005	tourism policy process, tourism development master plan, policy cycle and network approach, systems model, Australia
Dredge	2005	regional tourism system, networks, innovation
Dredge	2006a	collaborative planning, tourism, networks, conflict, policy communities, community, local government
Dredge	2006b	public–private partnerships, local tourism association; local government, tourism, networks
Pforr	2006	policy making, network approach, Northern Territory, Australia

Source: Own compilation on the basis of references

ences. Two research fields are dominant in the literature: co-authorship among tourism researchers and destination management appears in most cases as a background in SNA analysis

General introduction of the study area

The importance of Balaton Region

Traditionally lakes are a vital part of recreation and tourism in many parts of the world (Hall, C.M. and Härkönen, T. 2006) – and 'lake tourism' is an important sector of Hungarian tourism as well. As one of the largest lakes of the Central European region, Balaton, the "Hungarian Sea" (as the lake is often called by Hungarians) can be mentioned together with Lake Geneva in Switzerland or Lake Constance (Bodensee) in Germany. As *Table 3* shows, Balaton differs from the others mostly in its average depth – the lake is shallow enough to follow the temperature of the air quickly (the temperature of the water is usually over 20 degrees in the summer).

It confirms that Balaton destination (the lake and its surroundings) is the most popular holiday resort of Hungary, both for domestic and international tourists: lakeside holidays, historical monuments, special natural values and very good opportunities for trips are available for visitors. Although the Balaton area has been an agricultural area with average conditions, from the end of the 19th century it is clear that the development of the lake and its area can only be based on tourism, and tourist services (Buday-Sántha, A. 2008) (*Table 3).*

Today tourism is the most important economic sector by the lake. On the southern part of the lake there is a wide band of shallow water, which is exceedingly suitable for families with little children to have a lakeside holiday. On the other, northern part the water deepens closer to the bank, but there are plenty of safe beaches here as well.

Table 3. Main data of Lake Balaton – compared to similar European lakes

Indicator	Lake Geneva	Lake Constance (Bodensee)	Lake Balaton
Water surface, km^2	580	536	594
Length, km	72	63	77
Average depth, m	153	90	3,6
Climate	mediteranean	continental with oceanic effects	temperate continental
High season	summer and winter	summer and winter	summer

Source: Horváth, Z. 2011.

Beside classical holidays (with swimming and sun bathing) active holidays are also more and more popular. Water sports like sailing date back to long time ago, while bicycle tourism is rather popular now that the bicycle route is ready around the lake. In the Balaton region 6 official wine regions can be found, that is why the region is famous for its wine, wine tourism and wine festivals.

Balaton destination is classified as one of the 9 tourism development regions (Balaton Region) in Hungary (*Figure 1). Balaton Region* and the *Balaton Resort Area of High Priority* have almost the same territory – and they are usually regarded as synonyms. As mentioned it is the most popular holiday destination of the country – yet it is the second best destination (after the capital and its surroundings) regarding the number of visitors and guest nights. *Figure 1* shows the quantity of guest nights per regions.

The management of Balaton Region is undertaken by relevant organisations. One is the Balaton Development Council, which is responsible for appointing development directions and for supporting development projects. Marketing management is the responsibility of the Balaton Regional Marketing Directory.

At the end of 2011 the Balaton Regional DMO was formed – as the association of local DMOs in the region. This organisation is the only one which can join the forces of the stakeholders. The objectives of this DMO serve the development of the region by market research, effective marketing activities and professional support.

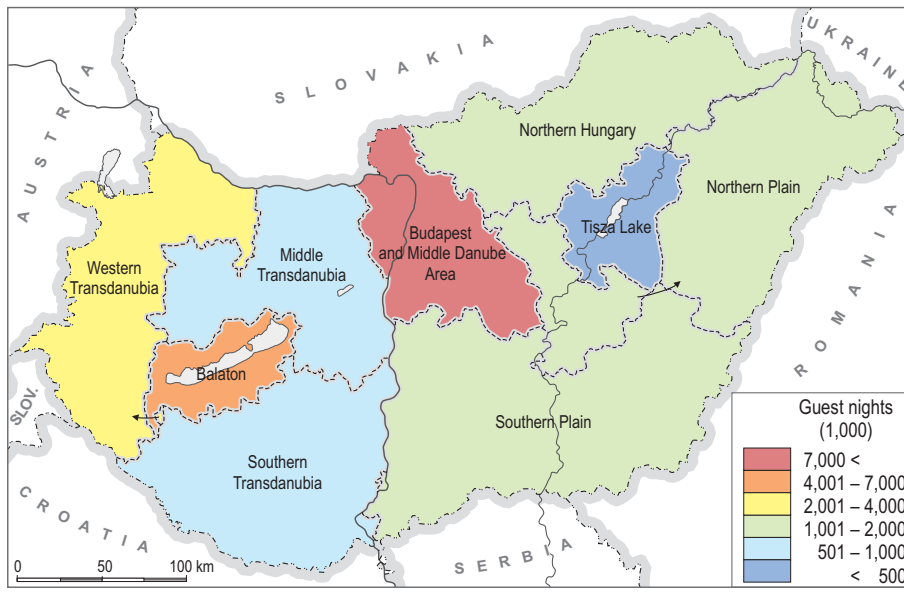

Fig. 1. Guest nights in different tourist regions of Hungary, 2011.

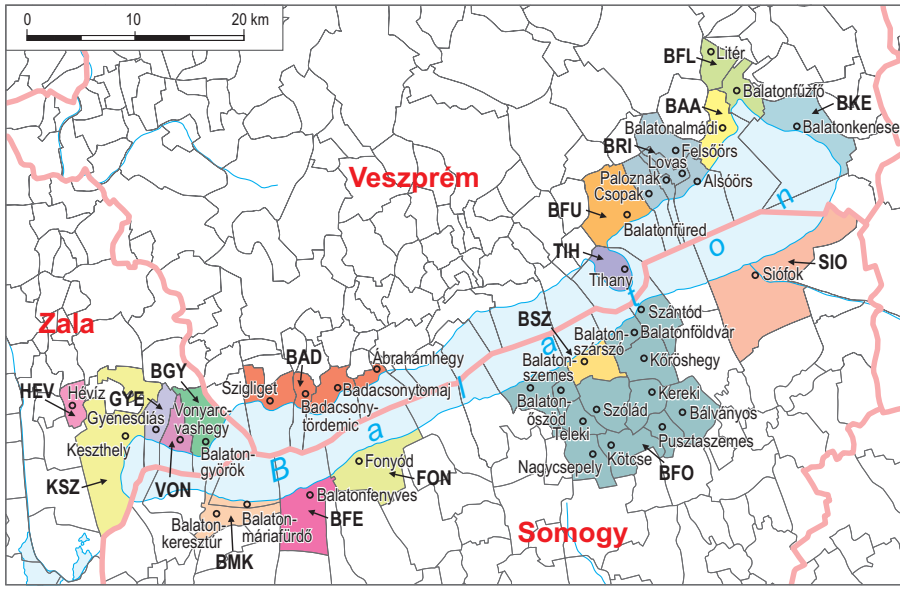

Fig. 2. Local destination management organisations (DMOs) in Balaton Region (with member settlements). – BAA = Balatonalmádi DMO; BAD = Badacsony DMO; BFE = Balatonfenyves DMO; BFL = Balatonfűzfő-Litér DMO; BFO = Balatonföldvár DMO; BFU = Balatonfüred DMO; BGY = Balatongyörök DMO; BKE = East Gate of Balaton DMO; BMK = Balatonmáriafürdő-Balatonkeresztúr DMO; BRI = Balaton Riviera DMO; BSZ = Balatonszárszó DMO; FON = Fonyód DMO; GYE = Gyenesdiás DMO; HEV = Hévíz DMO; KSZ = Keszthely DMO; SIO = Siófok DMO; TIH = Legend of Tihany DMO; VON = Vonyarcvashegy DMO

Regarding the number of local DMOs this region "is the best": almost 30 per cent of all the Hungarian local DMOs can be found in Balaton Region. *Figure* 2 shows the DMOs in the region – it can be seen in the map that there are DMOs working for only one settlement, and others covering 2 or more settlements.

Beside the significance of the region in tourism, the choice of it as a research field is also reasonable because (a) this region has a special tourism milieu (Rátz, T. and Michalkó, G. 2007); and (b) Lake Balaton destination is an internationally known tourist destination (Jordan, P. 2006), and is a region, which consists of smaller destinations.

The Balaton Riviera DMO as tourist destination

The 'Balaton Riviera' as a tourist destination is situated on the Northeastern part of the lake, between the towns Balatonfüred and Balatonalmádi (BRI as

seen in *Figure 2*). It consists of 5 villages; 3 at the lakeside and 2 off the shore in the hinterland. It means relative closeness; these 2 villages are only 3-4 kilometres away from the lakeside villages. That is important to note, because the tourism pattern changes even some more kilometres further from the lake (Pénzes, E. 2002).

Regarding its tourism infrastructure and supply the Balaton Riviera can be defined as a homogenous, average subregion of the Balaton Region: beside the traditional lakeside holiday the tourism potential consists of horse-riding and sailing facilities, and there is a good basis for wine tourism and bicycle tourism.

Recently a significant alteration has occurred in the tourism demand. As it can be seen in *Figure 3* foreign (mainly of German origin) guests were previously predominant – with an infinitesimal proportion of domestic tourists. By the end of the year 2000 this position turned and since then the number of foreign guests has been continuously decreasing – while the number of domestic tourists has been increasing.

The main target group of the micro region (as well as of the whole Balaton region) used to consist mainly of East- and West-German tourists, who used to travel to the lake so as to meet each other. The Balaton offered not only cheap recreation, but also served as a meeting point. After the transition in 1989–1990 this function broke off and it led to a rapid decline first and a slower one afterwards (Buday-Sántha, A. 2008). It became evident that the Balaton destination has to compete in an international market – and inevitable that the tourism supply of the region should be drastically renewed.

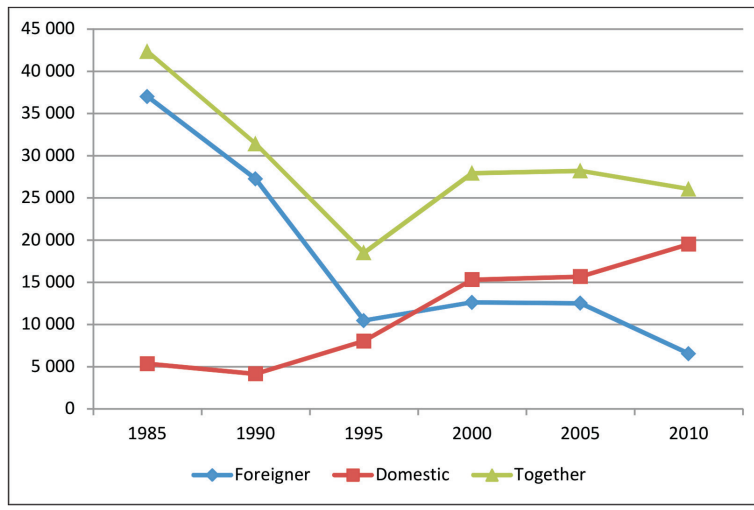

Fig. 3. The number of foreign and domestic visitors at the Balaton Riviera between 1985 and 2010.

As European consumers want complex experiences and want to look at a destination thoroughly, and from the most possible aspects – complex products are needed. The willingness to cooperate is the most mentioned objection of the development (Buday-Sántha, A. 2008). The Balaton Riviéra destination was among the first destinations to formulate a DMO so as to achieve effective cooperation of the suppliers of the tourism market – and also to attract more tourists (*Figure 3).*

The Balaton Riviera Tourism Association was founded in October 2005, initiated by the mayors of the five villages. In those days, few similar organizations existed in the Balaton region, but the participants involved in tourism had the opportunity to meet a number of best practices even back then. These were mainly Austrian and Italian examples, which were seen due to their geographical closeness. It was easy to pay visits and gather personal experiences. There were also exemplary initiatives in Hungary, even in the Balaton area. For instance, the Gyenesdiás Tourism Association, which was an important stimulus in this process – mainly because foreign examples are often difficult to adapt to Hungarian circumstances (Clarke, A. and Raffay, Á. 2011).

Balaton Riviéra DMO has been fairly successful – even if it realised only 3.5 per cent of guest nights of the Balaton Region in 2010. With this result, however, Balaton Riviera was among the top 10 DMOs (exactly the 7th best), in the wake of such successful DMOs like Hévíz, Siófok, Balatonfüred, Keszthely etc. – as seen in *Table 4.*

Hévíz is the absolute leader in the region. The objective of the research, however was not to test the most successful DMO destination – but a self-organised small destination preferably with more than one settlement.

In this DMO five settlements (mainly villages) together represent the special features of settlements in the Balaton region – regarding for example their location: three of the villages are lakeside settlements (Alsóörs, Csopak

Table 4. 'Top' DMOs of Balaton Region in figures, 2010

DMO	Number of guest nights	Average number of employed in tourism	Income from tourism in 1,000 HUF	Number of DMO members
BAA	62,228	145	470,225	60
HEV	934,385	1,422	8,363,661	94
SIO	58,104	624	4,236,477	295
BFU	458,797	464	3,312,007	170
BFO	241,889	361	1,059,772	130
KSZ	163,137	133	601,443	no data
BRI	102,766	42	293,374	130
TIH	101,028	148	803,644	20
FON	97,380	39	224,591	51

Source: Own compilation.

and Paloznak), while two of them have no lakeside and are situated some kilometres away from the lake (Felsőörs and Lovas).

In the case of these five villages, action was initiated by the local governments, as it was clear that inhabitants and local enterprises were not yet ready to act on their own behalf. However it was urgent to start the process of cooperation immediately, prompted by the reactions needed to changes in demand and the time factor.

The association, founded in 2005 with 40 members, now has 130 members, as *Table 4* shows. This indicates that regional participants have accepted the necessity of a complex supply and a unified image, which are built up by their own cooperation. This is the way they can offer complex experiences to tourists visiting the area.

Research design

Hypotheses

Investigating the DMOs two hypotheses can be outlined.

H1: Tourist destinations can be delimited by the methodology of SNA.

The starting point of our research was the question: if the methodology of SNA can delimit a destination by mapping connections among service providers. Assuming that tourism service providers would cooperate with those in the same destination (serving mainly the same guests), our main hypothesis was that the methodology is an appropriate tool to draw the borders of a tourist destination.

H2: Only one settlement is not enough in all cases to form a local level DMO.

We also wondered if a destination next to the Balaton should consist of one settlement only – or whether a few settlements can cooperate and formulate a 'real' destination. Regulations and recommendations could not help, as the DMO handbook said: a local DMO is established by the settlement itself, although if it is necessary and possible, the settlement can cooperate with others and set up even a local DMO together as well. We had the question: if Balaton Riviera, which consists of 5 settlements is a real destination – whether it was 2–3, even 5 destinations together, maybe together with other nearby settlements.

Sampling

In our research we used quantitative methods because of the type of information needed to undertake the analysis; we needed answers from the actors of what we supposed to be the destination of the Balaton Riviera about the

number and nature of the links they have established and to identify from those actions the resultant structural characteristics. We planned to investigate the whole network, in this small region of the 5 settlements. Due to the lack of time we could not ask every member of the DMO, so we asked the destination manager to identify the key stakeholders of the micro region. Some of the 35 proposed respondents were not available (our research was carried out after the high season, but during the grape harvest period), so at the end we could ask 24 members from the 35, which is also a fair sample. We applied researcher-administrated structured questionnaires (the respondents had to make a list about partners whose services they recommend), and at the end of the questionnaire we had some open ended questions about the membership and relationships in the DMO.

The enterprises of the villages with direct lakeside access represent a somewhat higher proportion amongst the respondents (Csopak and Alsóörs – 14 respondents, Felsőörs, Lovas, Paloznak – 10 respondents). It must be noted that there are more service providers in the villages with direct lakeside access. (Although Paloznak has a direct lakeside, but tourism services are limited to one campsite and an open access beach. It means that the service supply is less significant than in Csopak or Alsóörs, where paying beaches are working.

The type of business of the enterprises can be described as follows: 11 actors deal with accommodations, 6 of the respondents work in hospitality and catering and 6 enterprises operate in the winery sector. 3 offices – 2 of them are accommodation providers as well - deal with inspected and recommended accommodation services for tourists visiting the micro region, two of them have important and stable foreign partnerships. Suppliers offering additional services can also be found in our sample (5 enterprises); for example a folk-dance group, an association for preserving local traditions, event-organisers and sailboat-rental also occur among the respondents. Some of the enterprises run more businesses which is the reason why the sum of the suppliers does not match the sample size.

Three enterprises started their business before 1990, 10 actors began their activity between 1990 and 2000 and 9 respondents launched out on their enterprises. In 2 cases we do not have these answers from the questionnaire.

The accommodation suppliers carry out their business as private accommodation providers or individual enterprises, catering service providers and wineries are mainly limited companies and in some cases limited partnership companies. Furthermore we are talking about family enterprises in every case.

We asked the actors about their income resulting from their business activity. To reach the highest response willingness they had to estimate the sum with the help of an income-scale, but we could not collect all the answers using this method either (6 respondents did not given us answer). *Table 5* shows the categories and the sample pattern as well.

Table 5. Enterprises in the sample by income categories

Categories of incomes in million HUF	Number of enterprises in the sample
under 0.5	1
0.5–1.0	3
1.0–2.0	3
2.0–5.0	4
5.0–10.0	3
above 10.0*	4

*The standard deviation of incomes varies between 12 and 80.

Considering the demographic data we can characterise the respondents as follows:

– in 15 cases we asked men as the leader of the enterprise and in 9 occasions women were interviewed;

– the average age of the respondents is near to 53;

– regarding the qualification the rate of respondents having secondary certificate is slightly higher (10 higher education certificate, 13 secondary certificate, 1 skilled worker).

Results

At the beginning of the interviews we asked the respondents to make a list of the partners whose services they recommend. The respondents and their answers were encoded with a combination of a letter and a number:

– *accommodation – SZ* (because in Hungarian we call them "*SZálláshely*");

– *offices offering inspected and recommended accommodation services* for tourists visiting the micro region, a *type of travel agency – UK* (because in Hungarian travel agency means "*UtazásKözvetítő*");

– hospitality and *catering suppliers – V* (because in Hungarian we call them "*Vendéglátóhely*");

– *other service providers – E* (because in Hungarian we call them "*Egyéb szolgáltató"*).

In the figures different colours designate the five villages (Felsőörs – yellow, Alsóörs – orange, Csopak – green, Lovas – red, Paloznak- pink, out of micro region – grey). The circle sign is for actors who are members of the DMO and are situated in the region as well. The square means that the actor works in the micro region but is not a member of the DMO.

In *Figure 4* the relationships among the accommodation suppliers can be seen. The five villages are signed by five different colours, and the sign SZ19 and SZ20 are summarized categories. These are neighbourhoods

of the other nodes. It is easy to read that just few relationships exist (the density is low), usually we can see micro ego networks (an example is circled within *Figure 4).*

It is not an unexpected result, because probably the visitors would like to stay nearby and because of the development of the local economy service providers recommend destination-members. In this case the DMO-membership is not a primary reason, closeness is more important. (The relationships illustrated in this figure have been existing for a long time, the evolution of them was separate from the founding of the DMO.)

Figure 5 shows the relationships among accommodation and hospitality suppliers. Here we can see more connections pointing outside the micro region, where these are concentrated at 3 nodes: 2 wineries and 1 accommodation supplier. The wineries offer other wineries often and accommodation providers outside the micro region send guests to high quality wineries regularly. The external relationships of this accommodation arise from family ties. In the diagram below you can see a remarkable growth regarding the number of connections among the villages. The closeness is less important, they offer restaurants of other villages more frequently.

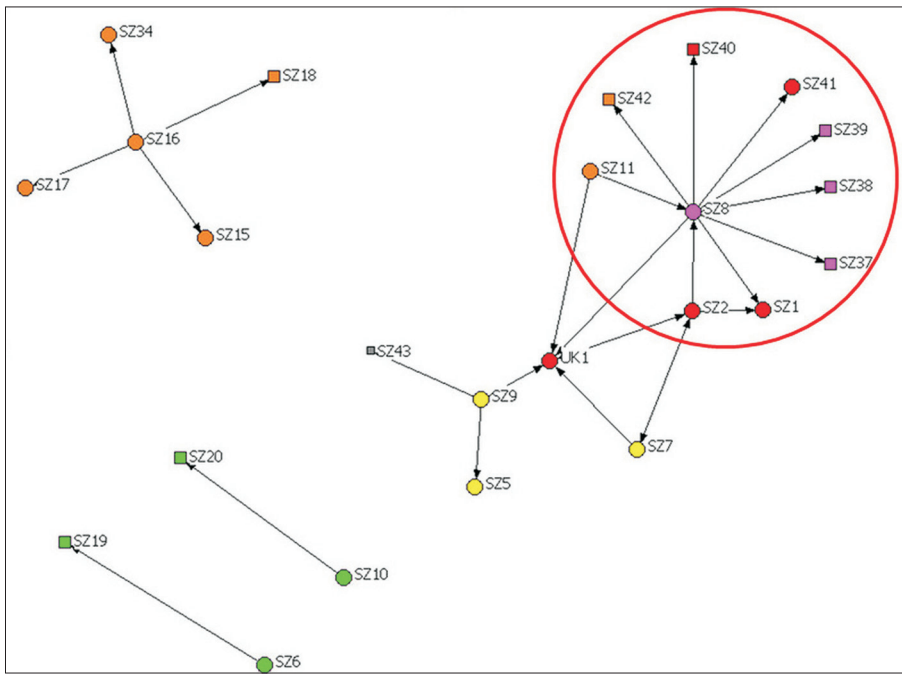

Fig. 4. Partnerships among accommodation providers (Explanation of codes is in the text)

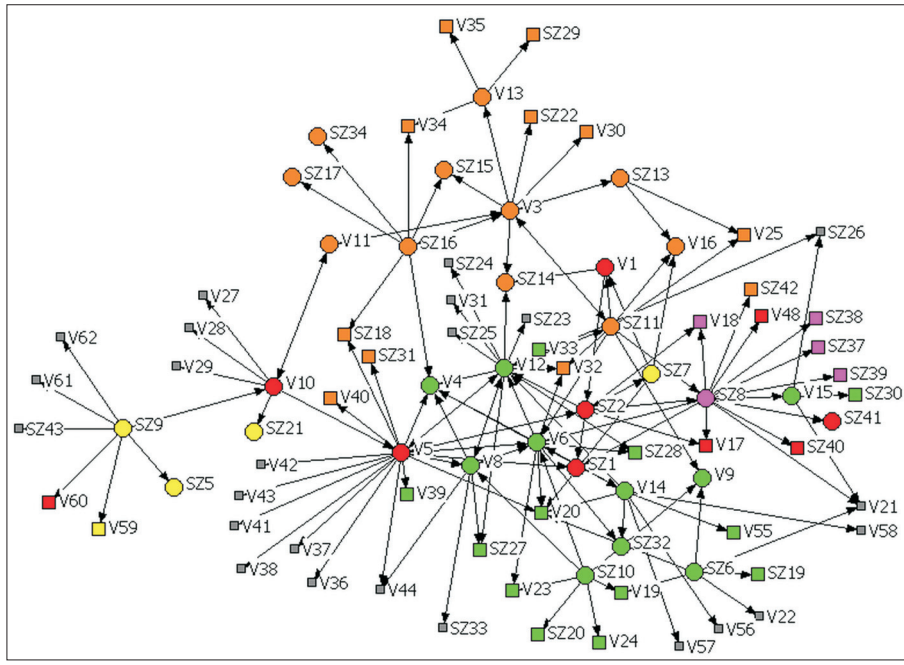

Fig. 5. Partnerships among accommodation and catering providers (Explanation of codes is in the text)

Looking at the whole network we can see numerous outside-oriented relationships, but these are concentrated around the three players mentioned previously. The majority of the remaining outer relations are to travel agencies operating outside the micro region. This is a typical phenomenon, as the task of these agencies is to bring visitors into the region from outside. According to the responses collected, this task cannot be solved by Balaton Riviera so far – and that is why these partnerships with travel agencies are still alive.

The existence (and importance) of the internal relationships are shown clearly in *Figure 6*, but we also have to stress that many respondents told us they could not mention any partners by name because usually they just opened the BR brochure to recommend a proper service for the visitor. Therefore it must be noted that even more relationships exist than denoted by the *Figure 6*. (On *Figure 5* and *6* smaller squares mean that the actor works out of the micro region.)

It can be seen clearly in this (and also the previous) figure(s), that the partnerships between the lakeside settlements (Alsóörs and Csopak) dominate. This is mainly because the lakeside territory attracts more visitors, than those without beaches. That is why there are also more service providers and respondents in the lakeside territory.

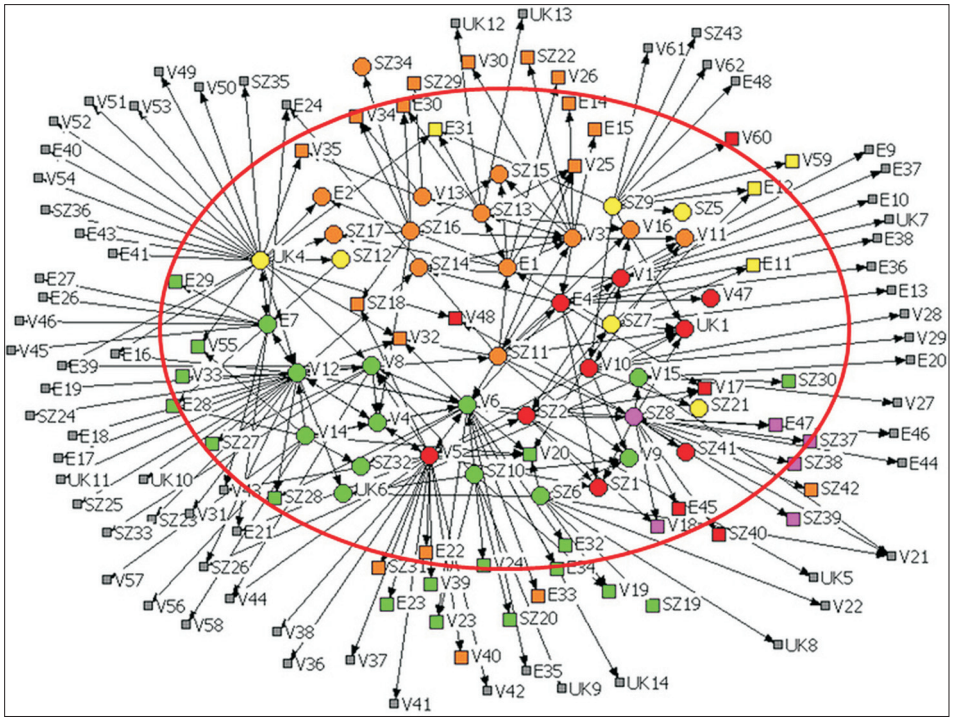

Fig. 6. The complete network of providers (Explanation of codes is in the text)

Conclusions

Dealing with destination competitiveness it is indispensable to outline clearly what a destination is. According to the relevant literature the delimitation of tourist destinations can be done in many ways – from insisting on applying geographical/administrative boundaries to the abstract theories of tourists' choices. However, much more realistic approaches are needed in practice, when trying to develop and/or manage a tourist destination.

We presumed that a spatial unit with existing networks among tourism suppliers can be effective enough to offer complex tourism products and experiences – which can be clever enough to retain tourists at the location, namely at the destination.

Looking at the operating DMOs in Hungary we chose the DMO of Balaton Riviera and the SNA methodology to test our hypothesis: Tourist destination can be delimitated by the methodology of SNA (*H1*).

Asking the players of the DMO we mapped the connections and the network. Analysing the data we can conclude that the hypothesis can be accepted: the linkages determine the boundary of the destination rather obviously – at least in the case of this micro region.

We also hypothesised that only one settlement may not be enough in all cases to form a local level DMO (*H2*). We can accept this hypothesis as well, because the figures above show that beside the inner connections of the settlements the actors possess a number of outside linkages oriented to actors of other villages in Balaton Riviera destination. Along the hypothesis the results of the research let phrase the further conclusions and suggestions:

1. Recommendations for Balaton Riviera DMO.

It turned out that this methodology is suitable to find existing connections, formal and informal partnerships, which makes it possible to find those players, who have many connections – but are not members of the DMO or it shows the isolated actors as well.

2. Useful suggestions for all DMOs in Hungary.

We found out that a local DMO destination can consist of many settlements. DMOs should not be afraid of cooperation among settlements; they should be brave enough to involve the surroundings – especially where the SNA method shows living and strong connections. Based on the SNA methodology the DMOs can improve their management tools and compete on a higher level in a constantly changing economic environment. In case of systematic SNA research the DMOs will be able to show the dynamic of the linkages, so it can be a useful tool to represent their activity to foster the cooperation among the members of destination.

3. Lessons learned about the methodology.

We have to remark that the SNA method is expensive and long to implement. Yet it is worth to learn more about the DMO's connection because of the above mentioned benefits. In our research we asked the members about the partners whom they recommend to the tourists. But SNA enables to explore linkages with different content (formal/informal, information- and knowledge-flow, etc.) of a community (e.g. actors of a destination), so this method can give us a complex picture (in literally and a figurative sense as well) about the destination.

Our research is considered as a pilot research, but it confirmed that this method can be suitable to determine the boundaries of the destination and further research is needed to declare this as a statement.

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ValiDat.DSM, a new soil data validation dataset for Central Europe

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Abstract

Digital soil maps are often derived using digital soil mapping tools, satellite imageries and digital terrain models as environmental covariates. Therefore several new datasets are raster based data representing soil classification categories, like WRB reference soil groups. Validating raster datasets with categorical data is not well researched and supported. No procedure and validation datasets exist that can take categorical diversity and similarity (taxonomic distance) into consideration. This approach would require an input validation dataset describing the categorical diversity of the spatial units to be validated. The aim of this study is to introduce a novel dataset developed for this purpose.

Keywords: ValiDat.DSM, soil validation, DSM, raster dataset, categorical data

Introduction

Digital soil mapping has become a very efficient tool in soil science, and several applications have been published (McBratney, A.B. *et al.* 2003; Lagacherie, P. *et al.* 2006). Many of these applications use environmental covariates like remotely sensed images and digital elevation models, which are raster based data sources with block support. Raster format is favoured by the many users as well. The majority of soil data users require data in raster format with values of certain properties, like pH, clay content or soil organic

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matter content. Qualitative data can be later classified and used as categorical data. The most typical categorical soil data is the soil type/classification category, like WRB (IUSS Working Group WRB, 2006) or the national classification systems.

Pixels represent a homogeneous spatial object having only one descriptive value or class allocated to it. However, the land surface area represented by a pixel has a more or less heterogeneous soil coverage. This heterogeneity is difficult to handle in a "one value environment". The quantitative variables often use the average value, while the categorical variables use the dominant class of the pixel area.

Both methods simplify the real heterogeneity of the area. Quantitative information can be further explained by descriptive statistics, like standard deviation, minimum, maximum, range etc. Explaining the diversity is more difficult for the categorical data. A potential way to characterize the pixel area is the fuzzy membership approach, when each potential class is represented by a corresponding layer representing the occurrence likelihood or spatial share of the given soil class within the pixel (A-Xing Zhua, *et al.* 2010; De Gruijter, J.J. and McBratney, A.B. 1988; McBratney, A.B. and Odeh, I.O.A. 1997; McBratney, A.B. *et al.* 1992, 2000). This is an appropriate way to keep the heterogeneity information, but user do not prefer this way of information presentation due to its data complexity. Fuzzy data sets are often simplified in the preprocessing steps by selecting the one with the highest share - namely the dominant class - and the rest of the information is lost.

The presentation and validation of the raster based, categorical soil data is not well developed. The e-SOTER project developed a novel approach to present categorical information on block support. The resulting dataset has several layers of occurrence probabilities of WRB diagnostic horizons/features/properties and an additional layer of the reference soil group (RSG) of the WRB system (IUSS Working Group WRB, 2007). However, no appropriate validation methodology and data exist so far.

This paper describes a novel approach for the development of a validation database, entitled as ValiDat.DSM and its potential use for validating digital soil mapping derived WRB reference soil groups and the occurrence probabilities of selected diagnostics. The sampling methodology combines an automated simple random sampling with slight adjustment for better accessibility and fit to the raster database and a systematic random sampling approach to populate the selected pixels with additional observations.

Methods

Overall validation procedure

An external validation dataset was developed for predicting the accuracy of categorical raster soil datasets. The *ValiDat.DSM* dataset has 114 validating sites from the four Visegrád Countries: 17 from the Czech Republic, 58 from Hungary, 23 from Poland and 16 from Slovakia *(Figure 1*). The sites/pixels for validation were randomly selected. All sites had 5 observations falling within a 450 by 450 meters pixel area. Having these 5 observations, proportions of the RSG within the pixel can be approximated with 20%, 40%, 60%, 80% and 100% coverage.

The coordinates of the sites are given in WGS_1984_UTM_Zone_34N projection system (Projection: Transverse Mercator, False Easting: 500,000, False Northing: 0, Central Meridian: 21, Scale Factor: 0.999600, Latitude of origin: 0, Linear Unit: Meter, Datum: D_WGS_1984).

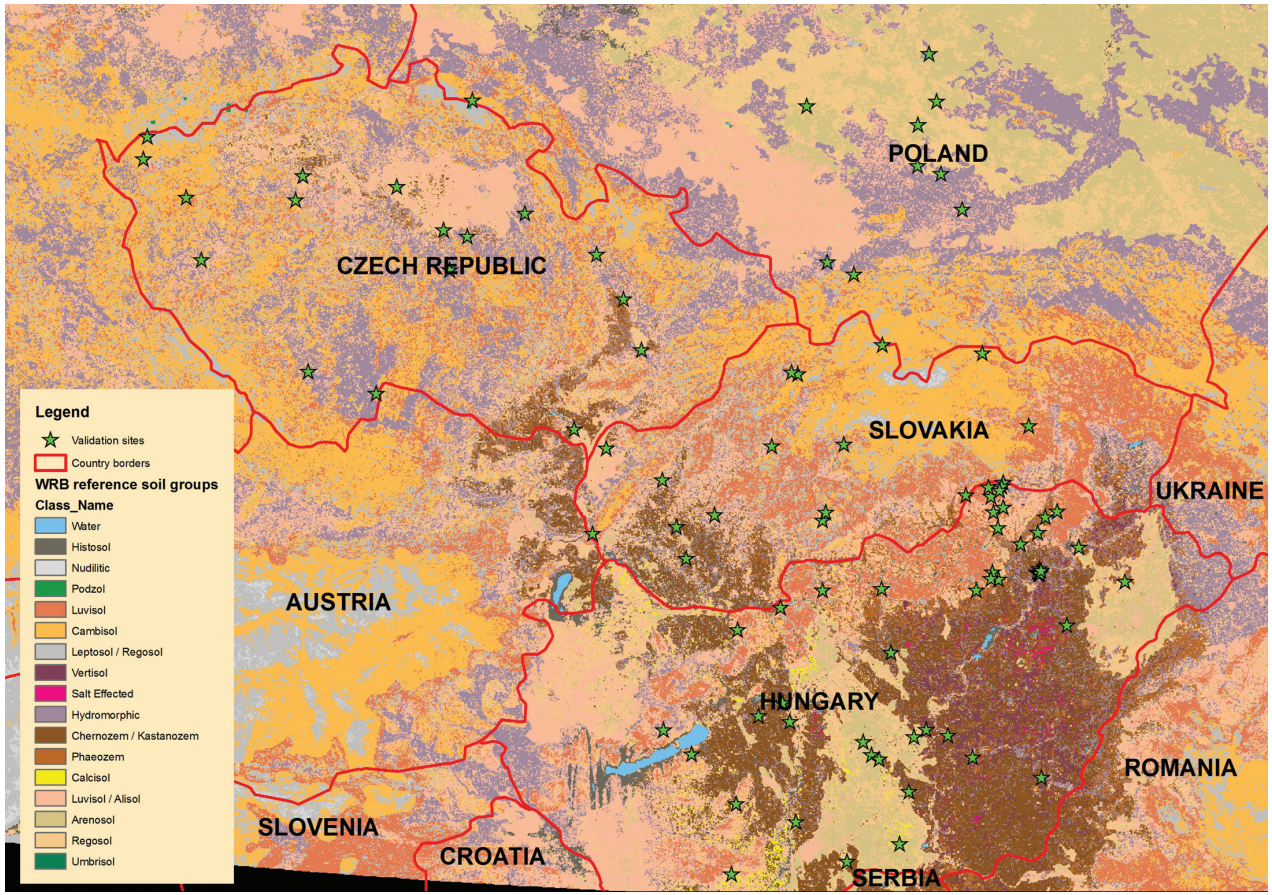

Fig. 1. The position of the validation sites

Field work and database design

Each sites had one profile opened in the centre of the selected pixel. This soil pit was described and all WRB diagnostic criteria, materials, horizons and features have been documented and the classification name was defined.

Chemical properties were identified using only field tools, like HCl 10% solution for $CaCO_3$ content, pH indicators, alpha-alpha-dipiridil test for free iron detection. The interpretation and the translation of the results into quantitative information were done using expert knowledge and the soil description guidelines of the FAO (FAO, 2006). Field work for the core set (65 profiles) was done by an international expert group representing all four countries.

Four additional augerings were deepened 100 m North, East, South and West from the pit. The material taken out from the hole has been put into a 1 m long tray keeping the original depth. By this way a disturbed profile has been created and was taken back to the pit, where all four were put next to each other in a clockwise order starting from North. Documenting photos were taken from the trays and the pit as well (*Photo 1a, b*). All four disturbed profiles have been described in the same way as the pit.

In some cases, where the disturbed material did not let us recognizing the diagnostic the features important for the classification (like the lamellas or clay coatings), the existence or lacking of them was assumed based on the pit description. At the end a table was compiled with five observations and all diagnostic properties, features, horizons and material have been listed for each of the observations (*Table 1*).

Based on the five observations per site, a table with the RSG classes and diagnostics were listed with an appropriate proportion rounded up to 20%, like 20%, 40%, 60% 80% and 100% (*Table 2*).

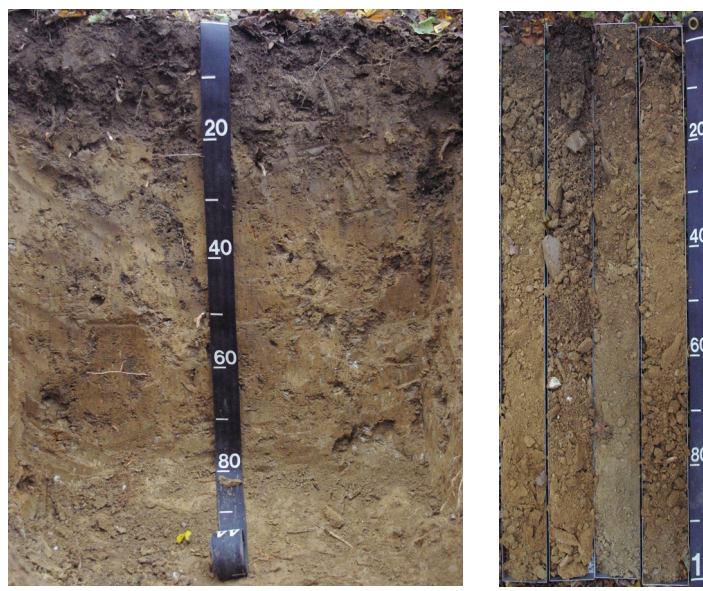

Photo 1a, b. Standard photos of the profiles and the four augerings. The soil trays from left to right are in clockwise order starting from North (N–E–S–W respectively)

*Table 1. An example of the validation dataset**

Colour	pH top	Texture	$CaCO_3$	Diagnostic horizons, properties, matterials	WRB name	North and East		South and West	
						Diagnostic horizons, properties, matterials	WRB name	Diagnostic horizons, properties, matterials	WRB name
Ap: 0–20 cm: 10YR 5/4	4–5	Sand	0	Arenic	Lamellic	Arenic	Lamellic	Arenic	Lamellic
Bt/C: 20–80 cm 10YR 5/6	–	–	–	Dystric	ARENOSOL	Dystric	ARENOSOL	Lamellic	ARENOSOL
Lamella: 10YR 4/4	–	–	–	Lamellic	(Dystric	Lamellic	(Dystric)	Dystric	(Dystric)

* Country ID: HU; Profile ID: 1; Site name: Apagy; Coordinatas. x = 567935; y = 5311601

Table 2. The interpreted validation dataset for seven profiles in Hungary

Profile ID	Co-ordinates		Class probability* %						WRB Reference Soil Group probability	
	x	y	Gleyic-Stagnic-Reducing condition	Mollic Horizon	Calcic Horizon	Calcic Horizon (Calcisol)	Dystric	Eutric	RSG	%
1	567935	5311601	–	–	–	–	100	–	Arenosol	100
2	528219	5281928	–	100	100	–	–	100	Chernozem	100
3	510872	5177845	100	100	100	–	–	100	Chernozem	100
4	446961	5206605	–	100	100	–	–	100	Chernozem	100
5	432353	5210713	–	100	100	–	–	100	Chernozem	100
6	394920	5193366	–	–	–	80	–	80	Calcisol	80–20
7	420484	5168258	40	80	80	20	–	100	Arenosol Chernozem Calcisol	80–20

* Values for Spodic, Argic, Cambic, Vertic (Vertisol), Salic and Natric Horizons were 0%.

100% was given for a certain diagnostic, when it could be found in all observations, while 40% was given when 2 out of the five showed the certain feature. The RSG column lists all RSG observed in the site having the proportion list as well, where the proportions are rounded in the same way as for the diagnostics and sums up to 100% to a site.

Site selection methodology

The sites have been selected randomly. These sites had to be moved to the closest pixel centres and checked for accessibility, potential disturbance or other restricting factors. The whole site optimization procedure was programmed in ArcGIS, no personal bias could have a significant impact on the site selection.

Required input data:

– randomly generated sampling points by ArcGIS random point generator;

– the raster dataset to be validated (in this case the e-SOTER Central European window);

– vector-based GIS databases of the settlements, road and railroad networks, water bodies, nature conservation and other protected areas of the country.

The site location optimization process

A 5 pixel circle shape neighbourhood around the selected point was selected as potential sampling pixels. Because neither the pits, nor the auger sites should be within settlements or on roads, railroads, or any similar locations or even close to them, a 50 m limit was set as minimum distance from the lines or polygons symbolizing them in the vector databases. This limit was increased to 150 m because the auger sites are 100 m far from the profile pit, so to keep the minimum 50 m distance in the case of the auger sites, the pit should be at least 150 m far from the excluded areas. Every points falling within a distance of 150 m from roads, railroads, or settlements were deleted from the possible sampling points, just like the points that were closer to the water bodies, or protected areas then this limit.

At the end an accessibility test was performed on the data. A 500 m maximum allowed distance was set up from the closest road to make sure that the field sampling group does not have to spend too much time on approaching the points and transport the gears there. These two steps of filtering result a set of potentially selectable pixels. The closest to the original randomly selected point was selected as validation pixel.

Results and discussion

Validation of categorical information, like WRB RSG, is a complex problem. Congalton, R.G. (1991) and Brus, D.J. *et al.* (2011) reviewed the most common tools and approaches. Taxonomic adjacency or genetic relationship within a certain set of soil forming factors makes a significant difference in the level of misclassification (Phillips, J.D. 2013). Misclassifying a pixel to a related RSG or to a "nonsense" RSG does not mean the same level of uncertainty. Minasny, B. and McBratney, A.B. (2007) have published an approach to quantify the differences between the soil classes by estimating the taxonomic distances for the WRB RSG classes. This approach is very promising to solve the problem of taxonomic adjacency and quantify

the taxonomic differences. However, the variables and their weights used to calculate the taxonomic distances are needed to be further refined for a more realistic picture. Besides of the lack of an advanced procedure for validation, the most limiting factor is the lack of appropriate, unbiased datasets describing the within-pixel variability, that can be used as ground truth for the validation. The aim of the ValiDat.DSM is to support new initiatives to develop a more appropriate and "standardisable" way of categorical soil data validation.

The ValiDat.DSM dataset has three major forms of information. *Table 1.* shows the field recording sheet. It describes the profile physical and chemical properties needed for the WRB classification procedure and all diagnostics that was identified in the profile and the official WRB classification category. The second half of the table records all diagnostics for the four augerings done 100 m North, East South and West from the profile and also the WRB classification names. This table can be used to understand the site when data used for scientific purposes. *Table 2.* is derived from table 1 by interpreting the soil variability expressed in a selected set of diagnostics important in Central Europe and by the WRB RSG (Dobos, E. *et al.* 2010, 2011, 2013). The tabulated information is complemented with soil profile photos and photos on the landscape and the four auger sites in one picture. This latter one is a magnificent tool for soil diversity representation.

This information can be used as field/ground truth data for validating soil categorical information with estimated proportions or occurrence probabilities. Having information on the spatial share of the soil classes within the pixels, advanced techniques can be used to assess the real reliability of the datasets. The validation can be done considering the taxonomic adjacencies/distances (Phillips, J.D. 2013; Minasny, B. and McBratney, A.B. 2007) between the WRB RSG classes and defining similarity factors to express their relationship in the quantification of the level of misclassification/uncertainty. This dataset can be used for research purposes as well for soil variability studies within different soil forming environments important for soil mapping and for the definition of the minimum set of sampling sites for mapping and validation.

Conclusions

The ValiDat.DSM dataset has been initiated for Central Europe with the contribution of four countries, Czech Republic, Hungary, Poland and Slovakia. The dataset is freely available after registration in the project site (http://www.uni-miskolc.hu/~soil/index.html). Data is presented there in several ways, excel sheet format and the documenting sets of photos and in several kind of GIS environment for visualization helping the users understanding the spatial relationships.

The dataset is a good tool for validating DSM derived soil datasets and for scientific researches on soil variability within different soil forming conditions. At the end each validation sites – pixel area – have 5 observations. Therefore the overall purity – defined as the proportion of the mapped area covered by a certain soil class – can be predicted.

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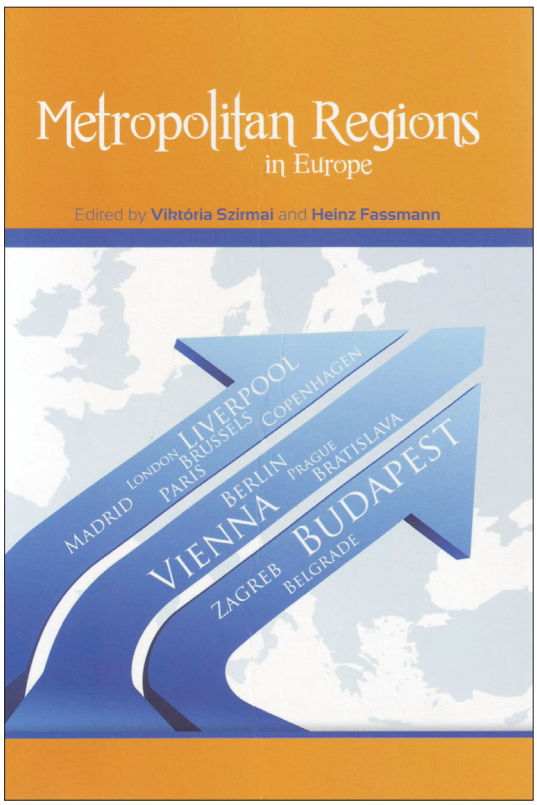
Szirmai, V. and Fassman, H. (eds): Metropolitan Regions in Europe. Austrian-Hungarian Action Fund, Budapest–Vienna, 2012. 357 p.

Due to urbanization processes, global population increases and nowadays it is a well-known fact that the number of metropolises and megacities (rapidly) grows. Over the past two decades, researchers realized that the role of cities is becoming more and more important in the global economy and they appear increasingly as the engines of national economies. It is also evident that large cities cannot be interpreted as independent entities at all, so thanks to the social and economic interrelations between large cities and their surroundings, metropolitan regions get in the focus of scientific investigations.

Today, it is well known that global economy functions the most efficiently in the metropolitan areas and the urban networks can successfully contribute to social and economic development of a country or a region. However, modern urban space also involves contradictions, for instance socio-economic conflicts, social inequality and environmental challenges. From this point of view the comparison of metropolitan regions in different European countries is of particular interest, especially in cases where the history and the development of the countries have been interweaved for centuries.



In May 2012, sponsored by the Austrian-Hungarian Action Fund, the Institute of Sociology of the Hungarian Academy of Sciences organised a professional seminar for young researchers and students. The main aim of the seminar was to provide an opportunity for the next generation to present their current scientific results and the most important findings of comparative analyses on Western and Eastern European metropolitan regions. Another unconcealed aim of the event was to strengthen the Austro-Hungarian professional relations and scientific cooperation. The main outcomes of the seminar are summarised in a new book titled "Metropolitan Regions in Europe" edited by Viktória Szirmai and Heinz Fassman. The aesthetic book contains 13 studies on 13 metropolitan regions

written by 15 authors. The choice of topics is extremely varied, the topics are classified into three major chapters: i) Transformation and regeneration of inner cities and suburbs; ii) Urban, social and economic development tools; iii) Urban tourism and its effects.

Studies included in the *first chapter* of the book describe the social and economic developments trends taking place in metropolitan areas. Johannes Riegler compares the ongoing gentrification processes of the Vienna and Budapest metropolitan regions using case studies. As he states, although Brunnenviertel in Vienna and Józsefváros (Josefsadt) in Budapest can be characterised by similar determinant organizational structures (local government, local urban renewal agencies), the purposes of the two gentrification processes are actually different. While in Budapest the main objective of the process is to enhance the city's competitiveness, experts in Vienna try to attain a kind of social balance by soft urban renewal practices. Thus, different local strategies and urban regeneration policies can generate different developmental trends in metropolitan regions.

The study of Vanessa N. Hünnemeyer draws attention to the role of development paths of metropolitan regions: as a consequence of the different development paths, Budapest and Liverpool can be characterised by different socio-economic contexts which provide distinct opportunities for implementation of large-scale urban regeneration projects. Thus, the generating and facilitating roles of the projects in urban development are also different in the two cities. Marton Berki examines the post-socialist transformation of a former industrial area in Budapest. In the theoretical part of the study he gives an overview on the urban structure models related to urban topologies, then spatial organization of the socialist and post-socialist cities are compared. Based on the investigations carried out in the former industrial area of Soroksari Road in Budapest, Berki points out that the post-socialist city is more likely to be associated with postmodern urbanism resulting in a similar (fragmented and heterogeneous) urban structure. Júlia Schuchmann analyses the suburbanization processes taking place in the Budapest Metropolitan Region. Her work is based on demographic statistics and questionnaire surveys on the intention to move. She underlines that the Budapest Metropolitan Region is the most important migration area of the country where the population of the core city has risen again in the recent years. It is an interesting fact that there is no significant correlation between the current economic crisis and the intention to move but this intention can be formed by the socio-spatial position and the extents of indebtedness of residents.

The *second chapter* starts with Marek Dinka's short essay analyzing the Bratislava metropolitan region in the context of BAUM (Bratislava Umland Management) project. Zsuzsanna Fodróczy writes about the changing role of railway stations and reveals that metropolitan railway stations besides their classic functions appear more and more as new urban centres of services and consumption. The case study areas were the Western Railway Station in Budapest and the Central Station in Vienna. Antoine Struelens pursues the train of thought on rail transport. In his study, the effects of the Petite Ceinture railway line in Paris and the Herrmann-Debroux viaduct in Brussels on urban development and transportation are compared.

Marchus Maicher guides the reader into the world of virtual forums. Based on quantitative and qualitative surveys carried out in four Viennese large housing estates, he analyses the impacts of new media, communication platforms and social networks on the virtual and real communities. He concludes that those forums play a fundamental role in the local information flow and they can help shape local communities in metropolitan housing estates. In addition, through free opinion-forming, they can increase the residential satisfaction of local society. Anna Maria Batista, Sylvia Smith and Carina Lesky draw attention to the role of artistic work in urban planning. Practical examples are presented in order to illustrate how

the application of artistic and creative solutions, contemporary arts and design in public spaces are able to change the interpretation of space and how they improve the quality of life and living environment. The authors provide positive examples for the cooperation of artists, designers, architects and residents working together on public spaces.

Similar topic is handled by Ivana Andrejić-Djukis who analysed the design, the urban perception and social utilisation of bank of the Danube in Vienna, Budapest and Belgrade. Urban open space design appeared in all three cities during the 1990s and since the millennium received more and more attention. Their results show a close correlation between the urban open space design and its public landmarks, and social actions of individuals as well. Artistic interventions combined with architectural environment are to be seen as visual consumption of signs and symbols represented through public landmarks. The greater is the potential of the urban open space design, the greater the variety of social uses is. Last study of the second chapter written by Amarilla Luke highlights the clustering process taking place in the Western Transdanubia Region of Hungary using the methods of key sector analyses and cluster mapping.

The *third chapter* leads the reader into the world of urban tourism. Bálint Kádár compares the spatial patterns of urban tourism in Vienna, Prague and Budapest. There is a very good model of urban land use of tourists provided in the study based on online image sharing. Touristic spaces in those cities before and after the change of regime are compared using that model. While Vienna can be characterised by a balanced network of tourist uses, the attractions in Prague are arranged in linear patterns due to the historical development of main urban axis. The case of Budapest shows that the development of the urban centre's tourist network is possible and it can also lead to more complex space usage. The composition and location of stores in the shopping streets are scarred by the distinct differences as well.

The final study of Paula Mett provides insight into tourism marketing strategy of Copenhagen, Madrid and Budapest. Whereas Madrid aims at preserving its position as globally influential city, Berlin's image and marketing has been changing since the city's unification and now it is promoted as hip and trendy urban tourism destination. Copenhagen's strategy is to develop its potentials and also to realise its opportunities within the emerging Oresund Region. In this light, most important differences of the strategies are highlighted in the study.

The editors put together an aesthetic and variegated volume. As it was already mentioned earlier, an important objective of the book was to provide an introduction and publication opportunity for young up-coming researchers. In certain publications the typical routine for young researchers can be still recognised, nevertheless an exciting, well-illustrated and actually interesting book was published by the editors. The topic of "Metropolitan Regions in Europe" still carries a myriad of research opportunities, so the volume will hopefully continue with new topics and results.

Tamás EGEDY

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Report on Global Soil Carbon Conference

In the last few years, a special respect has been given to carbon because of its primary importance in greenhouse effect and climate change. Soil is the second largest terrestrial carbon pool right after fossil stock. The 2 m sick uppermost layer of earth stores 2.500 Gt carbon. The processes of carbon sequestration and mineralisation in soil play very important role in climate change. That is the reason for the significant increase of global conferences on soil carbon. At the beginning of summer 2013 two scientific meetings were held on this topic within two weeks. The first one was in Reykjavik, Iceland on 26–29 May. It was followed by the IUSS Global Soil Carbon Conference.

The conference was organised by the International Union of Soil Science (IUSS) between 3 and 6 June 2013, in Madison, Wisconsin, USA. That event was hosted by the University of Wisconsin-Madison Department of Soil Science. During the opening ceremony Alfred Hartemink being a soil science professor at the university and the secretary-general of the

Alfred Hartemink, Secretary General of the IUSS introduces an Alfisol profile formed on glacial till.

Professor Hartemink presents the soils of Wisconsin State

IUSS welcomed the participants as the organiser of the conference. He was followed by Birl Lowerly, the senior associate dean of college of agricultural and life sciences. Finally, Jae Yang, the president of IUSS, emphasized the role of soil carbon in the environment.

The main topics were introduced by three keynote speaker, namely, Alex McBratney (University of Sydney) who summarised the known facts on soil carbon. The next speaker, Donald Sparks (University of Delaware), gave a very impressive speech on carbon-mineral complexation in soil and the impact of it on C sequestration and cycling. Rattan Lal (Ohio State University), the third keynote speaker, highlighted the connection between soil carbon management and climate change. The presentations were classified into 14 sections (soil C and the environment, land use change, plant nutrition, soil fertility, soil and water conservation, mineralogy, biology, physics, chemistry, pedometrics, monitoring, morphology, geography and soil genesis).

The audience in comfort

The audience consisted of more than 140 scientists from 35 countries gave 90 presentations. The principal idea of the organizers was not to apply parallel sections; in this way each participant could follow each presentation. However, that limited the size of presentations in 5 minutes. This duration allowed the speakers to present only the main findings. In some cases, it was difficult to keep the time but the chairs generally were intractable and asked the presenters to finish their speeches. Just after the presentations everyone was able to question the presenter who reflected to the unclear part. In addition at the end of each section a plenty of time was taken to discuss the methods and results. Hungary was represented by six presentations and seven scientists. Erika Micheli (Saint Stephan University) gave a speech on the role of soil carbon in soil classification systems. Zoltán Tóth (Pannonian University) reported data on long term field trials from Keszthely. Nóra Zboray (Department of Environmental and Landscape Geography, ELTE) reviewed soil organic matter measuring methods. Klaudia Kiss (Geographical Institute, RCAES HAS) demonstrated the differences in soil organic substances of Hungarian soils while Zoltán Szalai (Geographical Institute, RCAES HAS and DELG ELTE) pointed to the importance of organic carbon-iron relation in wetland. Gergely Jakab (Geographical Institute, RCAES HAS) presented data on erosion related carbon processes in the soil.

At the end of the third day the division chairs summarized the main findings of the different sections. The overall consequence was that the most important thing is to improve the discussion between the science society and the decision makers in order to control or mitigate climate change. Conference proceedings will be published in a book entitled "Soil Carbon" and edited by Alfred Hartemink and Kevin McSweeney by Springer. Hopefully, the volume will be available at the end of 2013.

On the 4th day a field excursion was organized in order to get familiar with the landscape and introduce the most interesting sites near Madison. The first stop was West Madison Agricultural Research Station where various research activities were presented. The most impressive attraction was the professional routine of composting and recycling of organic waste. Next to the station, three soil pits were demonstrated. The Alfisol and Mollisol profiles were formed on loess. Next, the O.J. Noer Turfgrass Research Facility was visited where different types of lawn production and the related problems were shown. Finally, the Arlington Agricultural Research Station was shown where more than 200 crop and animal research projects are going on. In more details, the Wisconsin Integrated Cropping Systems Trial was discussed. All the sites have miraculous infrastructure such as prime movers, lysimeters etc. During the trip the participants were continuously informed about the periglacial landscape forms and the history of South Wisconsin. After the scientific program, in the early evening, the most famous products of Wisconsin, namely, beer and cheese were tasted. Although, Californian wines are more popular after tasting the local wine, the authors can prove the quality of Wisconsin wine too.

Summing up the results of the conference, the increasing possibilities in soil carbon research are doubtless. In addition to the scientific findings, personal acquaintances were also improved.

Gergely JAKAB and Zoltán SZALAI

Conference commemorating the 50th anniversary of the Carpatho-Balkan Geomorphological Commission

Between 24 and 28 June 2013 the Institute of Geography of the Slovak and Polish Academy of Sciences organized the 50th jubilee conference of the Carpatho-Balkan Geomorphological Commission (CBGC) in Slovakia, in the mountain resort of Stará Lesná (part of Tatranska Lomnica). The first International Symposium on Geomorphology of the Carpathians was organized by the Department of Geomorphology and Hydrology of Mountains and Uplands of the Institute of Geography of the Polish Academy of Sciences and the Institute of Geography of the Slovak Academy of Sciences between 16 and 26 September 1963. The symposium started in Cracow, continued with excursions from Poland to Slovakia and finished in Bratislava.

The main aim of the Commission was not only the exchange of knowledge and experience on the geomorphological research of the Carpatho-Balkan mountain system, but also to fulfil common research tasks. The participants were Bulgaria, Czechoslovakia, Hungary, Poland, Romania, the Soviet Union and Yugoslavia. Several studies, journals (*Studia Geomorphologica Carpatho-Balcanica*) and maps dealing with the geomorphology of the Carpathian region have been produced.

The conference organized this year was the 11th during the 50-year-long history of the Commission. Similar meetings were organized in other scientific centres of the Carpathian region, for example, in Sofia (1966), Bucureşti (1970), Budapest (1975), Prešov (1982), Debrecen (1987), Băile Herculane-Orşova (1998), Bratislava (2003), Pécs (2007) and Ostravice (2011). Currentí problem areas, research trends and the results of the workshop were

The participants of the post-conference excursion at the Morskie Oko

presented during the sessions. Six internationally acknowledged geomorphologists were appointed as the presidents of the Commission: Mieczyslaw Klimaszewski (1963–1978), Emil Mazúr (1978–1987), Zoltán Pinczés (1987–1998), Dan Bălteanu (1998–2003), Miloš Stankoviansky (2003–2007) and Dénes Lóczy (2007–2013).

The International Association of Geomorphologists (IAG/AIG) endorsed the creation of the Carpatho-Balkan-Dinaric Regional Working Group (CBDRWG) in 2005. The working group was active during the period of 2005–2009 under the presidency of Miloš Stankoviansky. The IAG prolonged its operation for the period of 2009–2013. The member states of CBDRWG are Austria, Bulgaria, Croatia, Czech Republic, Hungary, Macedonia, Poland, Romania, Serbia, Slovakia, Slovenia and Ukraine. Thus the research area of the CBGC was extended to include the Dinarides too. The most important result of the cooperation of geomorphologists among the CBGC and IAG CBDRWG member countries is the monograph titled *Recent Landform Evolution – The Carpatho-Balkan-Dinaric Region* edited by Dénes Lóczy, Miloš Stankoviansky and Adam Kotarba, published by Springer in 2012. Eleven member countries out of twelve contributed to the national chapters of the book.

In June 2013 geomorphologists from the member countries of the Commission took part in the jubilee conference and showed their 38 presentations and 26 posters on their investigations. The 9 sessions (including two poster sessions) covered the following topics: paleohydrology (four lectures), fluvial geomorphology (11) being a focus of geomorphological research nowadays because of recurring extreme weather conditions, sessions of slope processes (6) as well as a miscellaneous session (with 17 papers).

Hungary was represented with the most numerous (13) delegation arrived from the University of Szeged, University of Pécs, Eötvös Loránd University and Geographical Institute RCAES HAS (Budapest) and University of Debrecen. In addition, we listened to 7 Polish, 5 Romanian, 5 Slovak, 6 Czech and 2 Slovenian lectures and studied 10 Romanian, 7 Hungarian, 4 Polish, 5 Slovak and 1 Slovenian posters in the poster session. They were associated with the research topics presented during the lectures. We met several excellent examples of international research on the Carpathian Basin and the Carpathian mountain chain during the three days of the conference.

The Joint Council Meeting was organized on Thursday evening whene Dénes Lóczy, who was the president between 2007 and 2013, resigned and the new president Petru Urdea from Romania (West University of Timişoara) introduced himself and was elected at the meeting. In addition, Leszek Starkel, the first General Secretary of the Commission, and Miloš Stankoviansky, the Chair of the Carpatho-Balkan-Dinaric Regional Working Group, recalled the important events of the last 50 years (1963–2013). They talked about former meetings, excursions, publications and the activity of the working groups in the last 50 years. At the end of the conference we took part in an excursion. Its destination was the Polish Tatra Mountains, the Morskie Oko tarn and the Chocholowska Dolina valley. We observed unique alpine landforms, the processes which formed them as well as the stages of their development in the Tatras. On the trip we experienced the competence and hospitality of the Polish colleagues, namely Zofia Rączkowska, Adam Kotarba and Piotr Kłapyta.

We would like to thank the Slovakian colleagues for all memorable experiences, especially Jan Novotny and Milos Lehotský for hosting, the organization of high quality and the continuation of the 50 years tradition.

Zsanett KOPECSKÓ and Mónika KOVÁCS