WINDOWS ON HUNGARIAN GEOGRAPHY

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BUDAPEST 1998

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Edited by

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PREFACE

It was almost 30 years ago, in 1971, when the Regional Conference of the International Geographical Union (IGU) was held at Budapest, that a volume of studies providing a brief account of geography of the organising country and the contemporary results of Hungarian research was published. More than ten years later a massive volume (Geographical Essays in Hungary, 1984) reported on the state-of-the-art of Hungarian geography, at that time as a contribution to the 25th IGU Congress in Paris-Alpes. Six years ago, a volume in the series *Studies in Geography in Hungary* was devoted to the 27th IGU Congress held in Washington D.C., USA. Now this is the fourth occasion that a set of papers is dedicated to a similar event, in our case to the *Regional Geographical Conference* to be organised *at Lisbon*, Portugal between August 28 and 3 September1998.

Over the past 27 years fundamental changes have occurred in the world in general and in the geographical domain in particular. As far as the former are concerned the dramatic socio-economic transformation in the countries of Central and Eastern Europe has been focal for Hungary involving in the last decade spatial changes, the analysis and evaluation of which has been a great challenge also to the geographical science. The emergence of the information society and the processes of globalisation are further trends to have made a profound impact on geographical thought. At the same time technological progress (e.g. the improvement of dating methods, remote sensing devices, computerisation and the resulting expansion of GIS) has provided robust tools for the geosciences.

The first chapter deals with the *geomorphic evolution* of different regions and environments. M. Pécsi's contribution is intended to set up a polygenetic model of geomorphological surface evolution of the Transdanubian Mountains, in the course of which morphostructures were affected by plate tectonic events. Gy. Gábris attributes the Late Glacial and Post Glacial development of the drainage network in the Great Hungarian Plain to tectonic effects and climatic fluctuations; downcutting, upfilling and transitional phases were established through the analysis of environmental changes. Á. Juhász and S. Marosi gave an interpretation of the Balaton basin as having formed as a result of a stadial (spatial and temporal) subsidence. The last paper of the chapter offers a specific karst surface evolution model (of vertical karstification) by M. Veress and K. Péntek.

The second chapter starts with an article (authors F. Schweitzer and T. Tiner) summarising geographical contibutions to the *site selection* for large-scale industrial and energetical projects, comprising engineering-geomorphological and geoecological mapping, environmental impact assessment, and socio-economic investigations with an emphasis on case studies. *Human impact* is also the subject of the following paper by G. Mezősi and G. Dormány dealing with a survey of forest fire hazard in a test area using remote sensing and GIS methods of investigation. Á. Kertész reports on the results of an *aridification* research programme (in order to reveal quantitatively *global climate change*, subsidence of groundwater table, changes in natural vegetation and soil dynamics) launched on the Danube-Tisza Interfluve (the driest region of the country), within the framework of the MEDALUS II project. A theoretical approach to *environmental issues* and the results of applied geographical studies within a sample area form the topics of the contribution by A. Kerényi, G. Kiss and Gy. Szabó focusing on the evaluation of landforms and soils serving environmental protection.

In his theoretical essay J. Tóth deals with the taxonomic position of geography and with the inner structure of geography science.

The fourth chapter is devoted to the *historical geographical domain*. A paper by S. Frisnyák on the economic geography of Hungary in the age of the Árpád dynasty (11th through 13th centuries) presents spatial aspects, i.e. settlement structure and economy pattern (animal breeding, crop farming, mining and craftsmanship, transport and trade) of this particular period. J. Becsei's article not only offers an historical outline of the emergence and development of the tanya system in Hungary but also provides an insight in the recent and present-day modifications of the scattered farmsteads induced by the latest socio-economic changes. A paper by K. Kocsis reflects a revival of the geography of religions in the Carpatho-Pannonian area; in addition to a concise historical analysis there is a description furnished with a map of up-to-date spatial distribution of religions in this vast region.

The final chapter is about the *spatial aspects* of a period *of socio-economic transition* having started with the 1990s. Z. Kovács and Z. Dövényi, in their paper depict the situation of the Hungarian urban system on the eve of the socio-economic transformation and the resulting post-socialist urban transition under the impact of the economic crisis and restructuring in the individual cities. Also the process of restructuring is a topic tackled in the paper by Gy. Barta suggesting alternative views on the present and future industrial development of Budapest taking into account the ongoing investment, the transformation of structure and organisational forms, and technology transfer. Successful regions in the northern part of Transdanubia are dealt with in the contribution by J. Rechnitzer with a special reference to the distribution of foreign investment by counties and economic sectors, highlighting regional disparities, and with a contemplation about prospects for the future. Female unemployment as an outcome of the recent economic transformation is discussed in a paper by J. Timár and G. Velkey from a methodological viewpoint.

The size of the present volume did not allow a thematical completeness. It should be viewed as an attempt to give the reader an impression of the trends within the Hungarian geographical research at the end of the century and millennium. Hence the title: *Windows on Hungarian Geography*.

The publication of this volume was realised by the *financial assistance of the Hungarian National Research Fund* (OTKA), and this support is gratefully acknowledged.

The Editors

L. Bassa–Á. Kertész (eds): Windows on Hungarian Geography
Studies in Geography in Hungary 28, Geographical Research Inst. HAS, Budapest 1998, pp. 9–22

A MODEL FOR THE GEOMORPHOLOGICAL EVOLUTION OF THE TRANSDANUBIAN MOUNTAINS, WESTERN HUNGARY

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INTRODUCTION

The term *geomorphological surfaces* denotes plains and gentle slopes, which are the products of erosion, of accumulation or of their combination, under the influence of tectonic processes. Their formation may be dated from their correlative sediments or by other methods.

For the timing of successive formation of landforms, ie. for a *reconstruction of the denudational chronology,* an interpretation of the different geomorphological surfaces is needed. Several models were proposed for the development of erosional surfaces (landforms) on great continental morphostructures. Some of these have become classic (Davis, W. M. 1906, 1922; Penck, W. 1924; King, L. C. 1949, 1962; Büdel, J. 1957 and his followers, Bulla, B. 1958; Bremer, H. 1986).

1. According to Davis, the *peneplain* (ultimate peneplain) is the final product of fluvial erosion on different humid regions. The *almost plane surface* is the penultimate phase of the planation at the base level.

2. Penck's *Primärrumpf* (primary peneplain) is a plain surface just emerged above the sea level. *Piedmonttreppen* (piedmont benchlands) are explained by fluvial erosion and retreat of valley sides. Erosional surfaces on slowly but uniformly elevating morphostructures may be explained this way.

3. According to King, pediplanation also takes place by the retreat of slopes on slowly but continuously elevating terrains, especially under semiarid climates, where the rate of the mechanical weathering exceeds that of the chemical one. Retreat of slopes results in a gradual surface lowering and pediplain formation. According to King, pediplanation is the most widespread process reducing relief, this way it replaces Davis' peneplain theory.

4. Büdel proposes that the *double etchplain* (doppelte Einebnungsfläche) is an erosion surface created by intensive lateritic deep weathering and strong washdown (stripping) of the thick weathered rock under a seasonal dry and wet tropical climate.

5. A *pediment* is a gentle erosional foothill slope in front of a steep mountain slope, generally formed of hard rock. *Pedimentation* is admitted to be the most general erosional, planation process. McGee, W. J. (1897) believes that a river, on leaving a mountain, deposits most of its load, while the rest of the sediment transported causes lateral planation (corrasion). The pediment is covered by a thin layer of sediment, deposited by sheetwash or by small rivers under a semiarid climate.

Several researchers adhere to the above models for the origin of *surfaces of planation*, while others criticise or modify them. In one respect these models are uniform, they suppose that the studied surfaces were formed during *long geological times*, when uplift was slow, continuous or periodical. It is generally admitted that the highest situated geomorphological surfaces are the oldest, the lower ones are ever younger. Such presumptions might only be valid for a part of the cases and for some geological times.

Presumably the planation surfaces (models 1 to 5), explained by different processes, might be attributed to effects of as many different geographical environments. If this is true, each of these models and conceptions generally represent genetically and climatologically different morphofacies rather than one single, global type of surface. It must be mentioned that these early models of planation surfaces were based on *fixist tectonism.*

In this presentation it is intended to introduce a *polygenetic model of geomorphological surface evolution*, through processes acting on different morphostructures affected by plate tectonic events, particularly in orogenic belts. The units studied were horizontally displaced over great distances, tectonically dismembered, recurrently uplifted and subsided, thus the planation surface became repeatedly buried, elevated and exhumed again (Pécsi, M. 1970a,b).

Polygenetic *morphostructures with planation surfaces*, which were shaped under the influence of alternating *erosional and depositional* processes of long duration, were removed from their original place and carried over long distances, passing under various climatic belts. This way units of most different genesis might have come in each other's proximity.

The tectonic and geomorphic history of the Transdanubian Mountains (western Hungary) was used as a model for the evolution of such polygenetic planation geomorphological surfaces. Geological and geomorphological studies of the last half century served as a basis of a new geomorphological evolutionary model, differing from the previously mentioned ones (Pécsi, M. 1968, 1975, 1993; Székely, A. 1972).

DISCUSSION

The Transdanubian Mountains (TM) is a low range of slightly folded structure, built mainly of Mesozoic and Paleogene carbonates (limestone and dolomite), affected by overthrusts and faults. Horst and graben structures are common, delimited by mainly northeast-southwest and northwest-southeast running structural lines. In the southern

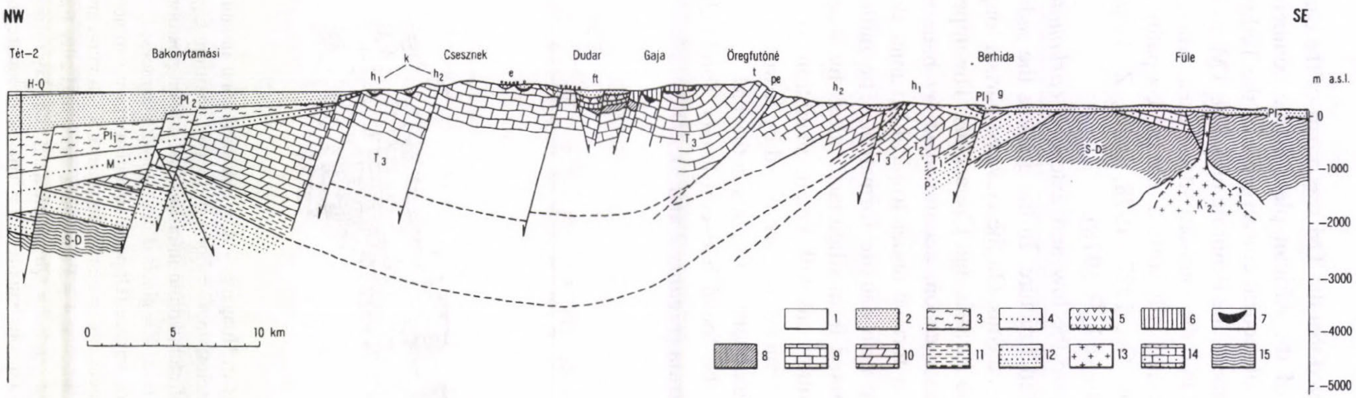

Fig. 1. Profile across the Bakony Mountains (after WEIN, GY. and PÉCSI, M.). – 1 = Holocene-Pleistocene fluvial sand and gravel, alluvial plain; 2 = Upper Pannonian sand and clay; 3 = Lower Pannonian (Miocene) claymarls; 4 = Lower Miocene-Upper Oligocene gravel and sand (in the Dudar Basin); 5 = Eocene coal seams and carbonate rocks; 6 = Lower Cretaceous (Aptian, Albian and Cenomanian) limestones and calcareous marls; 7 = Bauxite and related formations; 8 = Jurassic limestones; 9 = Upper Triassic dolomites and limestones; 10 = Middle Triassic limestone; 11 = Lower Triassic siltstone, marl and limestone; 12 = Permian sandtones and conglomerates; 13 = Upper Carboniferous granite porphyry; 14 = Lower Carboniferous conglomerate and shale; 15 = Silurian – Devonian phyllite and marble; t = uplifted remnant of tropical etchplain; ft = buried etchplain; e = exhumed etchplain, locally covered with Miocene gravel; pe = mountain margin benchland; h_2 = Pannonian marine terrace; h_1 = piedmont surface (pediment); g = Pleistocene surface formed on moderately consolidated sediment (glacis); k = remodelled tropical etchplain in threshold position; Tét-2 = prospect drilling; S-D = Silurian - Devonian; T_1, T_2, T_3 = Lower, Middle, Upper Triassic; M = Miocene; Pl_1 = Lower Pannonian (Upper Miocene); Pl_2 = Upper Pannonian (Upper Miocene)

foreland a thick Paleozoic sequence of south Alpine affinities underlies the similarly thick Mesozoic strata *(Figure 1).*

Comparative structural investigations proved that the TM was a part of the carbonate platform formed at the northern margin of the African plate in the southern Tethys, during the Triassic. During the rifting and subsequent convergence of the Tethys this unit was overthrusted on an oceanic crust fragment, the Penninic unit. The TM, as a part of a microcontinent, was subsequently carried into the southern Alpine area, wherefrom, in late Cretaceous/Paleogene times it was horizontally shifted into the Carpathian basin (Horváth, F. 1974; Géczy, B. 1974; Wein, Gy. 1977, 1978; Balla, Z. 1988, Hámor, G. 1989; Fülöp, J. 1989; Stegena, L. and Horváth, F. 1978).

During the *late Triassic* and *early Jurassic* the low and extended *carbonate platform* of the TM was cut into a horst and graben structure. In the grabens the sedimentation went on during the Jurassic and early Cretaceous. On the elevated parts a long lasting continental downwearing went on during the Jurassic and Cretaceous. The upper Triassic carbonates were affected by tropical karstification, accompanied by bauxite formation. Cockpits and tower karst may have been formed under tropical savanna climate with humid and dry seasons, simultaneously with bauxite formation. The initial sediments of the bauxite formation were resedimented from siliciclastic areas by sheet wash and by small rivers. Lateritification was simultaneous with karstic planation. Witnesses of this *marked tropical karst planation* were buried and preserved by lower Cretaceous (Albian), upper Cretaceous, and, locally, Paleogene sediments in the TM.

Buried surfaces of karstic planation may be found between horsts, forelands and on horsts, buried with Cretaceous or Tertiary strata *(Figures 2* and *3).*

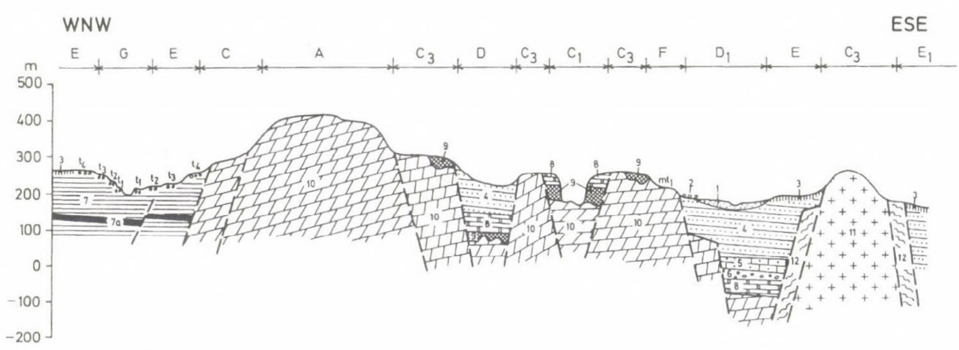

Fig. 2. Geomorphological surfaces in the Vértes Mountains in Hungary. – A = exhumed horst in summit position, a remnant of slightly remodelled Creaceous etchplain; C = horst in foothill position: C_1 = totally buried; C_3 = totally exhumed; D = buried surface of etchplain in intermontane graben position; D_1 = intermontane graben, filled with molasse and alluvial fans; E = glacis d'erosion with terraces; E_1 = rock pediment and glacis d'erosion; F = remnants of marine terrace (Upper Pannonian); G = submontane basin with river and glacis terraces; t_1–t_4 = fluvial terraces; mt_1 = marine terrace; 1 = alluvium and meadow soil; 2 = alluvial fan; 3 = loess and loess-like sediments; 4 = Pannonian sandy and silty formations; 5 = Sarmatian formations; 6 = Miocene gravel and sand; 7 = Oligocene sand and clay formations; 7a = Oligocene lignite; 8 = Eocene limestone; 9 = Cretaceous bauxite; 10 = Triassic dolomite and limestone; 11 = granite; 12 = Carboniferous metamorphic rocks

The tropical *karst planation surface* of the TM was slightly *remodelled* between the late Cretaceous and middle Eocene (Laramian tectonic phase?). On horsts summits it was well preserved, but on the margins pediments were formed due to early Eocene subarid coarse clast production. Dolomite karst towers and bauxites, if not buried, were eroded or resedimented.

During middle and late Eocene the area of the TM became an archipelago. Most of its territory subsided continuously, but not uniformly. The sea inundated the low horsts and intramontane basins. Bauxite bearing karstic surfaces of etchplanation were often buried during the Eocene.

Bauxite lenses in sinkholes, capped with Eocene layers, are often interpreted as a result of a continuation of tower-karst plain formation and bauxite genesis in the first part of the Eocene (Bárdossy, Gy. 1977; Mindszenty, A. *et al.* 1984). This would mean that such bauxites are not merely products of Eocene redeposition of earlier deposits. We think, however, that early Eocene conditions characterised by dolomite breccia formation were not favourable for bauxite genesis and tower karst evolution. Under a subaridic climate predominantly coarse clastics were formed and transported by ephemeral water-courses and pedimentation prevailed (Pécsi, M. 1963, 1970b).

From the Eocene-Oligocene boundary the TM was uplifted and the previously submerged and buried parts were eroded. Some segments or entire horsts were exhumed

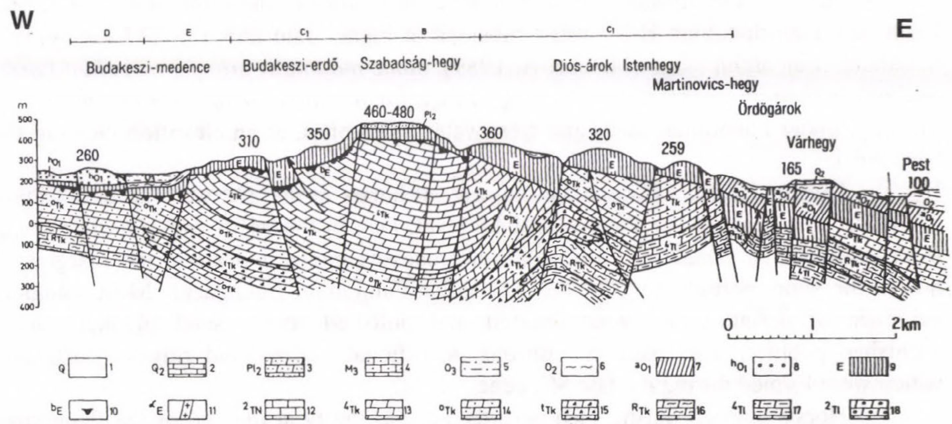

Fig. 3. Alternating erosional/accumulational planation surfaces of the Buda Highland in Hungary (after Pécsi, M. and Wein, Gy.). – A = exhumed, planated surface in uplifted pediment position; B = buried Cretaceous etchplain in uplifted position; C = surfaces of planation in uplifted pediment position: 1, totally buried, 2, partially exhumed, 3, totally exhumed; D = buried surfaces of planation in graben position; E = glacis d'erosion; 1 = Pleistocene loess and wind blown sand; 2 = Pleistocene travertine; 3 = Pliocene sand, clay travertine; 4 = Sarmatian conglomerate and limestone; 5 = Upper Oligocene sandy clay, silt; 6 = Middle Oligocene clay; 7 = Lower Oligocene marl; 8 = Lower Oligocene sandtone; 9 = Eocene formations; 10 = Preeocene etchplain, Preeocene etchplain, Eocene reworked bauxite and conglomerate; 11 = Eocene acid dyke; 12 = Upper Triassic Dachstein Limestone; 13 = Upper Triassic Hauptdolomite; 14 = Upper Triassic coarse dolomite; 15 = Upper Triassic cherty dolomite; 16 = Upper Triassic marl, limestone dolomite; 17 = Middle Triassic pink dolomite; 18 = Middle Triassic *Diplopora*-bearing dolomite

and subsequently pedimented. There are several horsts, where bauxite and tropical tower-karstic surfaces were preserved under a thick Eocene limestone cover *(Figure 3).*

During the second part of the Oligocene the horizontal shift of the TM was going on, its subsidence was highly differentiated. This is supported by the fact that sediments of differing facies (coarse clasts, gravel, sand and clay) were deposited on the surface of the TM, which moved eastward. The sediments originating from some higher, crystalline mountains in the vicinity.

During the Miocene (from 24 to 5.5 Ma) the relief of the TM and its close environs changed repeatedly and fundamentally in consequent tectogenetic phases, horizontal and vertical displacements, subduction, a powerful volcanic activity, partial transgressions and regressions. These processes resulted in a *geomorphological inversion* at the end of the Miocene. The TM were uplifted to a moderate altitude, but definitely over its surroundings, for the first time during the Tertiary. On its sinking north-eastern part andesitic volcanoes erupted during the middle Miocene (15-14 Ma BP). Deposition of terrestrial gravel and other clastics continued on the margins of planation surfaces, with some interruptions.

On some low-lying Mesozoic horsts and in intramountain small basins the remnants of etchplains were newly but incompletely buried during the late Tertiary. On tectonically uplifting horsts the old tropical karsts were exhumed and remodelled.

During the late Miocene by the *Sarmatian and Pannonian transgression* (ca 13 to 11 Ma BP) the TM subsided again, but adjacent regions to the south and north (Little Plain and Transdanubian Hills) were subsided at higher rate thus the TM remained a mainland or an archipelago (Jámbor, Á. 1989). *Some mountain groups, marginal horsts and intramountain grabens were buried, in fact, for the third or fourth time* during the Tertiary, under Pannonian sands and freshwater limestones, at an elevation close to the base level.

During the late Miocene the majority of horsts in the TM were at an elevation of 100 to 200 m above the Pannonian lake level. Due to the uplift and *climate turning from subhumid to semiarid,* pedimentation processes intensified along the margins of horsts for short periods (e.g. at the Sarmatian-Pannonian boundary). Morphological evidence of deflation are wind-abraded and polished rocks, sand blankets, iron-varnished pebbles, iron-oxide concretions, meridional valleys and ridges (yardangs), which were formed during the late Miocene.

Horsts uplifted during such periods and especially at the end of the Pannonian were stripped off a cover of Oligocene and Miocene clastic sediments. In some spots marine shelves were formed, preserved by travertine deposits *(Figure 4).* The horizontal displacement of the TM into its recent structural position lasted from the end of the Oligocene (Báldi, T. 1982; Hámor G. 1989) to the middle Miocene (12-10 Ma BP, Balla, Z. 1988, Kázmér, M. 1984), when the subsidence of the Pannonian basin started. From about this time tectogenetic processes caused repeated subsidence and uplift of the horst groups and grabens of the TM, upward movements dominated. This resulted in formation of marine terraces, deltaic deposits and erosional foothill slopes on marginal parts of the mountains.

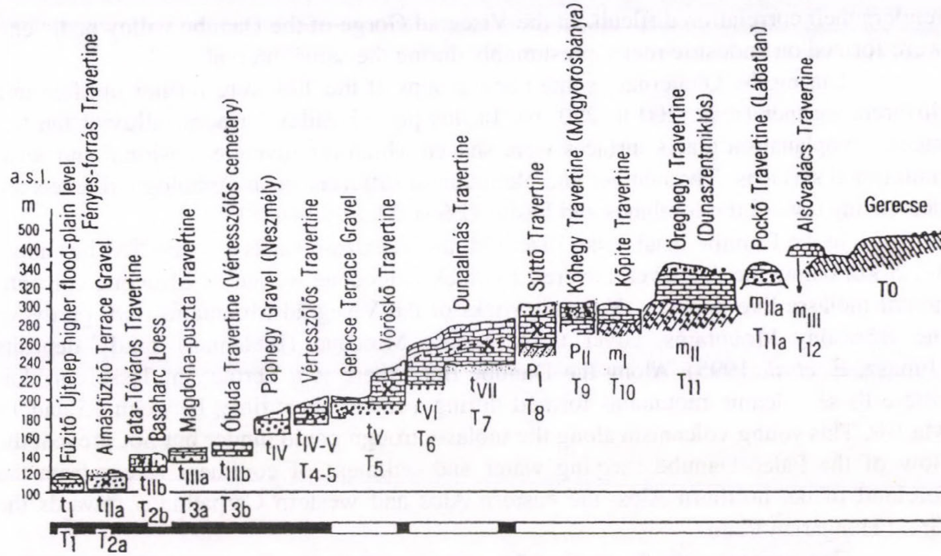

Fig. 4 Geomorphological surfaces and travertine horizons in the Gerecse foreland (Pécsi, M., Scheuer, Gy. and Schweitzer F. 1988). – t_I–t_{VII} = river terraces usually covered by travertines (T_1–T_7) and loess; P_I–P_{II} = Pliocene pediment surfaces covered by travertines (T_8–T_9); m_I–m_{VII} = Upper Pannonian (Upper Miocene) raised beaches covered by travertines (T_{10}–T_{12}); T_0– = Paleogene-Neogene planation surface sculptured by Oligocene-Miocene pedimentation with sporadic gravels.
Paleomagnetic polarity according to Pécsi, M. and Pevzner, M. A.

At the *beginning of the Pliocene* (5.4 Ma BP) uplift intensified. From the late Miocene on the climate shifted to a subhumid one. In consequence, a considerable part of the Tertiary siliciclastic, gravel, sand cover of the TM was eroded and redeposited on the forelands. On the unconsolidated molasse like sediments a broad hillfoot surface took shape, while in the forelands wide alluvial fans were deposited. The hot subarid climate was interrupted several times and followed by subhumid warm periods. This increasingly favoured the cyclic development of red and variegated clays.

Neither the considerable time span of variegated and red clay formation nor the cause of the subhumid climate has been investigated in details. The effect of these events on the morphological evolution also needs further studies.

In the Bakony Mountains. (western TM) *basaltic tuffs and lava* were deposited over late Miocene and Pliocene foothill surfaces. The basalt-capped mesas are witnesses of the removal of about 100 to 200 m thick Pannonian sequence.

Neogene and Quaternary geomorphological surfaces (Miocene marine terraces, delta gravel deposits, Pliocene foothill surfaces, Quaternary terraces and alluvial fans) were often preserved by *hard travertine deposits* capping them *(Figure 4).* A part of these geomorphological surfaces are predominantly erosional (foothill surfaces, glacis), others were formed by the joint work of accumulation and erosion. The most different elevation of Miocene foothill surfaces, marine terraces and Danube delta gravel renders their correlation difficult. In the Visegrád Gorge of the Danube valley pediments were formed on andesitic rocks, presumably during the same interval.

During the Quaternary some horst groups of the TM were further uplifted in a different manner (max. 200 to 250 m). In this period valley terraces, alluvial fan terraces, cryoplanation glacis surfaces were shaped which are juvenile erosional and accumulational surfaces. The number and elevation of different geomorphological levels are decreasing toward the forelands and basins (Pécsi, M. *et al.* 1988).

In the Danube bend, near Visegrád, the Mesozoic surface of the TM lies about 1-1.5 km below the sea level, covered by thick Oligocene to middle Miocene epicontinental molasse-like deposits. Volcanic rocks of the Visegrád Mountains and, partly, of the Börzsöny Mountains, cover thick middle Miocene (Badenian) sandy deposits (Juhász, E. *et al.* 1995). Along the Danube Bend there is a Tertiary molasse corridor, where these volcanic mountains formed during a rather short time, between 15 and 14 Ma BP. This young volcanism along the molasse trough could hinder but not prevent the flow of the Paleo-Danube carrying water and sediment of confluent rivers from the foreland of the northern Alps, the eastern Alps and western Carpathians towards the Great Hungarian Plain.

Consequently, the Paleo-Danube most probably acted as a morphological and sedimentation agent in the molasse trough between the Buda-Pilis Mountains and Naszály of the TM. Thus, the Miocene quartz-pebble containing delta remnants, high valley foothill surfaces and half plains of planation may be interpreted on the volcanic build-ups around the Visegrád Gorge.

EROSIONAL SURFACES AND DENUDATION CHRONOLOGY

In the Transdanubian Mountains the Mesozoic horsts on which bauxite-bearing ancient tropical karst forms are found overlain by thin Upper Cretaceous or Eocene sediments are regarded as *remains of the Cretaceous tropical etchplain* from a geomorphological point of view *(Figure 3)*. Depending on their orographic position, these buried horsts may occur in uplifted position (summit level), as lower-situated steps or also in threshold position. Their surfaces, however, as fundamental morphogenetic surfaces existed already in the Cretaceous and considerable reshaping did not follow during the subsequent repeated exhumation accompanying uplift. It is also common that the Oligocene sandstone covers conformably the ancient etchplain characterised by tropical tower karst, bauxite and red clay *(Figure 3)*.

In most cases, during exhumation only the Tertiary sedimentary cover was removed from the horst etchplanated in the Cretaceous and buried in the Tertiary, thus the exhumed ancient etchplain represents the geomorphological surface.

There are horsts in great number covered by Eocene and Oligocene clastic rocks, whose ancient surfaces were not merely lowered but also remodelled. In this case the surface of the horst is identified as a younger reworked e.g. Oligocene geomorphological surface.

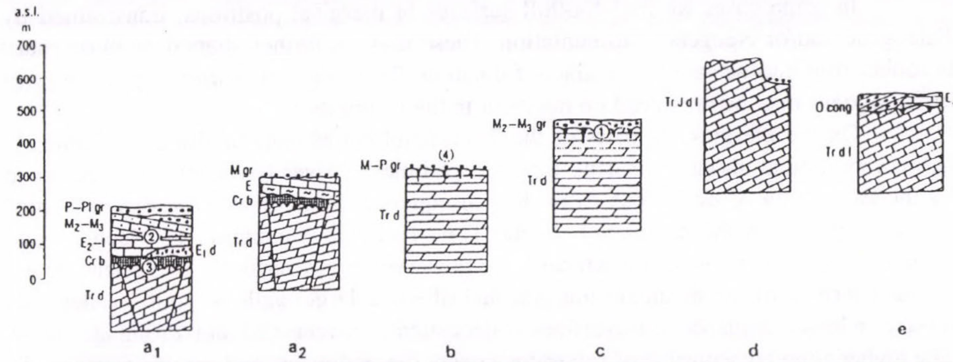

Fig. 5. Geomorphological position of the dislocated and remodelled tropical etchplain remnants of the Transdanubian Mountains (after Pécsi, M.). – a_1–a_2 = buried surface of etchplain in a sub- or intramontane graben; b = surface of planation in threshold position, exhumed and reshaped etchplain; c = buried planated surface in uplifted position, etchplain remnant partly planated in the course of deposition of Oligocene gravel sheet over it; d = exhumed etchplain in summit position, reshaped etchplain by (peri)pedimentation; e = uplifted, partially exhumed Cretaceous etchplain remodelled by pedimentation during the Tertiary (e.g. Oligocene) in the forelands of the crystalline massifs, with conglomerate covers over their subsided part; P-P_1 gr = Pliocene-Pleistocene gravel; M_2–M_3 = Middle Miocene marl, limestone and gravel; E_2l = Middle Eocene limestone; E_1d = Lower Eocene dolomite detritus; Cr b = Upper Cretaceous bauxite; Tr_3 d = Triassic dolomite; M gr = Miocene gravel; M_2–M_3 gr = Middle and Upper Miocene gravel and conglomerate; Tr., J.d.l = Triassic and Jurassic dolomite and limestone; O.cong = Oligocene sandstone and conglomerate; ① = remains of tropical weathering, with kaolinite and red clays; ② = unconformity; ③ = tower karst remnant of a tropical peneplain; ④ = gravel patches on the surface

It is occasionally difficult to determine the age of remodelling of the uncovered exhumed horst. In these cases one may start from the fact that the surface of horsts of the Transdanubian Mountains was planated already in the Cretaceous, the surface of those of low position slightly changed during the Tertiary, it is inherited. The uncovered horsts of morphologically higher position could be pediplanated in the course of the Paleogene and became pedimented at their margin during the Neogene.

Each of the horsts etchplanated in the Cretaceous then buried, semi-exhumed and being uncovered may occur at different elevations *(Figure 5).* Some types can be found e.g. at the same height besides each other within the same mountain unit. It is also common that the planated horsts covered by Oligocene sandstone overlie stepwise one another. The surfaces of different heights of these horst types do not represent geomorphological surfaces of different ages.

In the mountain margins the Neogene marine terraces represent usually younger geomorphological surfaces that the uplifted and exhumed horst surfaces. Nevertheless, it is common that the Pannonian marine formations overlie horsts uplifted to 400 to 500 m height which were buried in the Paleogene (Buda Mountains), elsewhere upper Pannonian travertine occurs on the Mesozoic geomorphologic surface (Balaton Upland, ca. 300 m above sea level).

In some cases we find foothill surfaces in marginal positions, transformed by Paleogene and/or Neogene pedimentation. These may be further shaped by Quaternary cryoplanation and accumulative glacis formation. This way *generations of surfaces of different ages* may be preserved on horsts or in their vicinities.

On the margins of horsts of the Transdanubian Mountains the Late Cainozoic geomorphological surfaces (marine terraces, pediments, river terraces) were preserved by the hard strata of travertines from the subsequent erosion. Travertines were formed by karst springs in the base level. In the Transdanubian Mountains 12 Neogene and Quaternary geomorphological surfaces were preserved by travertines. This phenomenon is characteristic of the mountain margins and of some larger valleys. In the valley-side terraces a lower sequence of travertines is deposited (between 120 and 250 m altitudes). The higher situated sequence of travertine covers the pediments and marine terraces. To determine their age, fauna remnants paleomagnetic and absolute chronological data were available (Pécsi, M., Scheuer, Gy. and Schweitzer, F. 1988).

CONCLUSIONS

Based on comparative geomorphological observations, a *model of surface evolution through alternating erosion and accumulation* is proposed, which is here used as a tool for understanding the evolution of surfaces on horsts and grabens in the Transdanubian Mountains (TM). This model aims at an improving of accuracy of terminology (Pécsi, M. 1970a,b, 1975, 1993).

The basis of this *model for alternating erosion and accumulation* is *that formerly developed* (by tropical etchplanation, pedimentation, pediplanation) *surfaces of erosion are repeatedly reshaped by erosion and accumulation during subsequent geological times. The morphostructural element is repeatedly uplifted and subsided and horizontally displaced by tectonic processes.*

This model proposes that in the TM the conditions resulting in *erosional surfaces*, due to tropical tower-karstic planation and accompanied by bauxite formation, were interrupted by the beginning of the Tertiary. This was mainly caused by changes in climate and in tectonic activities. During the Tertiary the bulk of the TM was repeatedly buried by tectonic subsidence under sedimentary sequences of different thickness. Some regions were partially or entirely elevated and exhumed twice or three times (during the Paleogene, Neogene and Quaternary). The karstic etchplain surface of Cretaceous origin was further eroded or buried under sediments during these repeated burial and exhumation events (e.g. by peripedimentation, formation of marine terraces, or alluvial fans). The TM, subdivided by grabens, contains five different groups of geomorphological surfaces:

1. Horsts of etchplanation in summit level, partly exhumed;
2. Buried horsts of etchplanation in uplifted position;
3. Horsts of etchplanation in threshold position, buried or exhumed and reshaped, mainly by pedimentation;

4. Buried etchplain in basins (cryptoplain);

5. Peripediments, rocky pediments, glacis, partly covered by alluvial fans.

On the "Geomorphological Map of Hungary" (Pécsi, M. 1976) and on the "Geomorphological Map of the Danubian Countries" (Pécsi, M. 1977, 1980) and regional landscape monographs on the TM (Pécsi, M. 1988, Pécsi, M. and Juhász, Á. 1990) the term *erosional-accumulational* surface evolution was used for the development of those geomorphological surfaces for which sufficient information was available, according to the principles and criteria of the proposed model. The model explaining and classifying the erosional surface evolution describes the surfaces of planation, buried surfaces, repeatedly exhumed and eroded planes, illustrates the polycyclic process of their superposition and reveals the main phases of the changes.

After three decades of observations in this field we think that the explanation is not just valid for the individual Intracarpathian Mountains, but may be applied in the cases of the Alpine-Dinarid mountain system, of some European ancient mountains, or of mountains and massifs of various continents.

The superposition of geomorphological levels of different ages could be demonstrated in the case of the units of the TM, using the procedures of denudation- and accumulation chronology. The particular case of it has been published several times in Hungarian and in other languages, summarised in a monograph of the Transdanubian Mountains (Pécsi, M. 1970a,b, 1993; Pécsi, M. and Juhász, Á. 1990; Pécsi, M. *et al.* 1985; Székely, A. 1972).

In the Gerecse, Buda, and Pilis Mountains (TM) the presence of almost all young geomorphological levels could be demonstrated in some sections, in addition to older ones. In the forelands of these Mountains the higher levels were represented by 3 or 4 Neogene marine terraces and deltas, by 1 to 2 foothill surfaces, and by 4 to 6 Quaternary fluvial terraces *(Figure 4).* These geomorphological levels were protected against subsequent denudation by *travertines* capping them. Thus a reconstruction of long-term morphological evolution of geomorphological surfaces became feasible (Pécsi, M. 1975, 1993; Pécsi, M. *et al.* 1985).

The chronological classification of the geomorphological surfaces gave us a key to outline the geomorphic evolution of TM during the Cainozoic era.

REFERENCES

Balla, Z. 1988. Tertiary paleomagnetic data for the Carpatho-Pannonian region in the light of the Miocene rotation kinematics. - *Földtani Közlöny*. 139. pp. 67-98.

Báldi, T. and Kókay J. 1970. Die Tuffitfauna von Kismaros und das after des Börzsönyer Andesitvulkanismus. - *Földtani Közlöny*. 100. pp. 274-284.

Báldi, T. 1982. A Kárpát-Pannon rendszer tektonikai és õsföldrajzi fejlõdése a középsõ tercierben. (49-19 millió év között) (Tectonic and paleogeographic evolution of the Carpatho-Pannonian system in the middle Tertiary, between 49-19 Ma BP.). - *Õslénytani Viták*. 28. pp. 79-155.

Bárdossy, Gy. 1973. Bauxitképzõdés és lemeztektonika (Bauxite formation and the plate tectonics). - *Geonómia és bányászat. MTA X. osztály közlemények*. 6/1-4. pp. 227-240.

Bárdossy, Gy. 1977. Karsztbauxitok (Karstic bauxites). - Akadémiai Kiadó. Budapest, 413. p.

Bremer, H. 1986. Geomorphologie in den Tropen-Beobachtungen, Prozesse, Modelle. - *Geoökodynamik*. 7. pp. 89-112.

Bulla, B. 1958. Bemerkungen zur Frage der Entstehung von Rumpfflächen. - *Földrajzi Értesítõ*. 7. 3. pp. 266-274.

Büdel, J. 1957. Die "doppelten Einebnungsflächen" in feuchten Tropen. - *Zeitschrift für Geomorphologie*. N.F. 1. pp. 201-228.

Davis, W.M. 1906. Geographical Essays. - Ginn, Boston. New edition: 1954, Dover, New York, 777 p.

Davis, W.M. 1922. Peneplains and the geographical cycle. - *Bull. of Geol. Soc. of Amerika*. Baltimore. Vol. 33. pp. 587-598.

Fülöp, J. 1989. Bevezetés Magyarország geológiájába (Introduction in Geology of Hungary). Akadémiai Kiadó, Budapest. 246 p.

Géczy, B. 1974. Lemeztektonika és a paleontológia (Plate tectonics and paleontology). - *Földtani kutatás*.17/3. pp. 17-20.

Hámor, G. 1989. Paleogeographic reconstruction of Neogene plate movements in the Paratethyan realm. - *Acta Geologica Hungarica*. 27/12. pp. 5-21.

Horváth, F. 1974. Application of plate tectonics to the Carpatho-Pannonian Region. - *Acta Geologica Hungarica*. 18. pp. 243-255.

Horváth, F., Stegena L. and Géczy, B. 1974. Szialikus és szimaikus ívközi medencék (Sialic and simaic inter-arc basins).- *Földtani Kutatás*. 17/3. pp. 11-16.

Howard, A.D. 1992. Pediment passes and the piedmont probleme. - *Journal of Geomorphology*. 5. pp. 1-31.

Jaskó S. 1988. A Magyar-középhegység neogén rögszerkezete (The Neogene block structure of the Central Hungarian Range). - *Földtani Közlöny*. 118. pp. 325-332.

Jámbor Á. 1989. Review of the geology of the *s.l.* Pannonian formations of Hungary. - *Acta Geologica Hungarica*. 32. pp. 269-324.

Juhász Á. 1988. A Bakonyvidék (The Bakony Region). - In: Pécsi, M. (ed.) A Dunántúli-középhegység B. (Magyarország tájföldrajza 6). Akadémiai Kiadó, Budapest. pp. 31-101.

Juhász, E., Korpás, L. and Balogh, A. 1995. Two hundred million years of karst history, Dachstein Limestone, Hungary. - *Sedimentology*. 42. pp. 473-489.

Kázmér, M. 1984. A Bakony horizontális elmozdulása a paleocénben (Horizontal displacement of the Bakony Mountains during the Paleocene). - *Általános Földtani Szemle*. 20. pp. 53-101.

King, L.C. 1949. The pediment landforms: some current problems. - *Geological Magazine* 86. pp. 245-250.

King, L.C. 1962. The Morphologische Analyse. - Oliver & Boyd, Edinburgh and London.699 p.

Kretzoi M.and Pécsi M. 1982. A Pannóniai-medence pliocén és pleisztocén idõszakának tagolása . - *Földrajzi Közlemények*. 30. (106) 4. pp. 300-326.

Kretzoi, M. and Pécsi, M. 1979. Pliocene and Pleistocene development and chronology of the Pannonian Basin. *Acta Geologica Acad. Sci. Hung*. 22. 1-4. pp. 3-33.

Luis, A. 1957. Rumpfflächenproblem, Erosionszyklus und Klimamorphologie. - Geomorphologische Studien, Mahatschek Festschrift. Berlin. pp. 19-26.

Mackin, J.H. 1970. Origin of Pediment in the Western United States. - In: Pécsi, M. (ed.) Problems of relief planation. (Studies in Geography in Hungary 8.) Akadémiai Kiadó, Budapest. pp. 85-105.

Maxon, J.M. and Anderson, G.H. 1935. Terminology of surface forms of the erosion cycle. - *Journal of Ecology*. 43. pp. 88-96.

Márton, P. and Szalay, E. 1981. Mezozoic paleomagnetism of the Transdanubian Central Mountains and its tectonic implications. - *Tectonophysics* 72. pp. 129-140.

Mindszenty, A., Knauer, J. and Szantner F. 1984. Az iharkúti bauxit üledékföldtani jellegei és felhalmozódási körülményei (Sedimentological features and the conditions of accumulation of the Iharkút bauxite deposit). - *Földtani Közlöny*. 114. pp. 19-48. (English summary: pp. 41-44.)

McGee, W.J. 1897. Sheetflood erosion. *Bull. of Geological Society of America*. 8. pp. 87-112.

Penck, W. 1924. Die Morphologische Analyse. - Stuttgart. 277 p.

Pécsi M. 1963. Hegylábi (pediment) felszínek magyarországi középhegységekben. - (Summary in German: Fußflächen in der Ungarischen Mittelgebirge). - *Földrajzi Közlemények.* 11. (87) 3. pp. 195-212.

Pécsi, M. 1968. Denudational levels of the Hungarian Middle Mountains with special regard to pediment formation. - The geomorphological and terminology problems of the denudation features of middle mountains and their pediments (Symposium). Inst. of Geogr. Hung. Acad. of Sci., Budapest. pp. 24-36.

Pécsi M. 1969a. A Balaton tágabb környékének geomorfológiai térképe (Geomorphological map of the broader environs of Lake Balaton). Kísérlet Magyarország áttekintõ (1:300 000-es) geomorfológiai falitérképének elkészítéséhez. - *Földrajzi Közlemények.* 17. (93) 2. pp. 101-112.

Pécsi M. 1969b. A hegységek és elõterük lepusztulásformáinak kutatásáról rendezett nemzetközi szimpózium fõbb eredményei (The geomorphological and terminology problems of the denudation features of middle mountains and their pediments). - *MTA Föld- és Bányászati Tud. Oszt. Közleményei.* 2. pp. 319-321.

Pécsi, M. 1970a. Geomorphological regions of Hungary. (Studies in Geography in Hungary 6). Akadémiai Kiadó, Budapest. 45 p.

Pécsi, M. 1970b. Surfaces of planation in the Hungarian mountains and their relevance to pedimentation. - In: Pécsi, M. (ed.) Problems of relief planation. (Studies in Geography in Hungary 8) Akadémiai Kiadó, Budapest. pp. 29-40.

Pécsi M. 1974. A Budai-hegység geomorfológiai kialakulása, tekintettel hegytípusaira (Geomorphic evolution of the Buda Mountains and its mountain types). - *Földrajzi Értesítõ.* 23. 2. pp. 181-192.

Pécsi M. 1975. Geomorphological evolution of the Buda Highland (Hungary). - *Studia Geomorphologica Carpatho-Balcanica*, Kraków. 9. pp. 37-52.

Pécsi M. 1976. Magyarország geomorfológiai térképe (The geomorphological map of Hungary. 1:500 000. Legend). - *Földrajzi Közlemények.* 24. (100) 1-2. pp. 34-41. (in Hungarian). pp. 42-44. (in English).

Pécsi, M. 1977. Geomorphological map of the Carpathian and Balkan regions (1:1 000 000) + Part of the 1:1 000 000 scale geomorphological map of the Carpathian region (Map). - *Studia Geomorphologica Carpatho-Balcanica.* 11. Kraków. pp. 3-31.

Pécsi, M. 1980. Erläuterung zur geomorphologischen Karte des "Atlasses der Donauländer". - Österreichische Osthefte. 22. 2. pp. 141-167.

Pécsi, M. 1983. A Dunántúli-középhegység sasbérc felszínei és a denudációs kronológia (Horsts in the Transdanubian Mountains and denudation chronology). - *Földrajzi Értesítõ* 32. 3-4. pp. 504-505.

Pécsi, M. 1987a. Domborzat (Relief). - In: Pécsi, M. (ed.) A Dunántúli-középhegység, A. (Magyarország tájföldrajza 5.) Akadémiai Kiadó, Budapest. pp. 140-176.

Pécsi, M. 1987b. Domborzatfejlõdés és a geomorfológiai szintek korrelációja (Relief evolution and correlation of geomorphological levels). In: A Dunántúli-középhegység A. (Magyarország tájföldrajza 5.) - Akadémiai Kiadó, Budapest, pp. 131-139.

Pécsi, M. 1988. Geomorfológiai szintek kora a Magyar-középhegységben. (Summary in English: Age of geomorphological surfaces in the Hungarian Mountains.) - *Földrajzi Közlemények.* 36. (112) 1-2. pp. 28-41.

Pécsi, M. 1993. Landform evolution model of alternating erosional-accumulational geomorphic surfaces. - *Indian Journal of Landscape Systems and Ecological Studies.* 16. 2. 1-7.

Pécsi, M. and Juhász, Á. (eds) 1990. Excursion Guide. Symposium and Field Excursion in Bakony Mountains. First Hungarian-Slovene Geographical Seminar. 27-28. Sept. 1990. Geogr. Res. Inst. Hung. Acad. Sci., Budapest. 65 p.

Pécsi, M., Scheuer, Gy., Schweitzer, F., Hahn, Gy. and Pevzner, M.A. 1985. Neogene-Quaternary geomorphological surfaces in the Hungarian Mountains. - In: Kretzoi, M. and Pécsi, M. (eds) Problems of the Neogene and Quaternary. (Studies in geography in Hungary 19.) Akadémiai Kiadó, Budapest. pp. 51-63.

Pécsi, M., Scheuer, Gy. and Schweitzer, F. 1988. Neogene and Quaternary geomorphological surfaces and lithostratigraphical units in the Transdanubian Mountains. - In: Pécsi, M. and Starkel, L. (eds) Paleogeography of Carpathian Regions. Geogr. Res. Inst. Hung. Acad. Sci., Budapest. pp. 11-41.

Pécsi, M. and Szilárd, J. 1970. Planated surfaces: Principal problems of research and terminology. - In: Pécsi, M. (ed.) Problems of relief planation (Studies in geography in Hungary 8) Akadémiai Kiadó, Budapest. pp. 13-27.

Ság, L. and Pécsi, M. 1987. Kainozoikum (Cenozoic). In: A Dunántúli-középhegység A. (Magyarország tájföldrajza 5.). Akadémiai Kiadó, Budapest, pp. 75-122.

Schweitzer, F. and Scheuer, Gy. 1988. A Gerecse és a Budai-hegység édesvízi mészkőösszletei (Travertines in the Gerecse and Buda Hills). - *Földrajzi Tanulmányok*. 20. Akadémiai Kiadó, Budapest. 129 p.

Stegena, L. and Horváth, F. 1978. Kritikus tethysi és pannon tektonika. - Budapest, *Földtani Közlöny*. 108. pp. 149-157.

Székely, A. 1972. Az elegyengetett felszínek típusainak rendszere magyarországi példákon. (Summary in German and in English: A system of planation surface type - on examples from Hungary). - *Földrajzi Közlemények* 20. 1. pp. 43-59.

Wayland, E.J. 1937. Peneplains and some erosional platforms. - *Bulletin geological Surawy Uganda*. Ann. rest. Bull. 1. pp. 77-79.

Wein, Gy. 1977. Magyarország neogén elõtti szerkezetföldtani fejlõdésének összefoglalása (A review of pre-Neogene tectonics in Hungary) - *Földrajzi Közlemények*. 25. pp. 302-328.

Wein, Gy. 1978. A Kárpát-medence kialakulásának vázlata (An outline of the evolution of the Carpathian Basin). - *Ált. Földtani Szemle*. 11. pp. 5-34.

L. Bassa–Á. Kertész (eds): Windows on Hungarian Geography
Studies in Geography in Hungary 28, Geographical Research Inst. HAS, Budapest 1998, pp. 23–36

LATE GLACIAL AND POST GLACIAL DEVELOPMENT OF DRAINAGE NETWORK AND THE PALEOHYDROLOGY IN THE GREAT HUNGARIAN PLAIN

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INTRODUCTION

The preliminaries of present day river network of the Great Hungarian Plain date back to the gradual regression of the last marine inundation (Pannonian in the Mio-Pliocene). Rivers arriving from the surrounding mountain ranges to the flatland had built up alluvial fans, depositing their coarse materials in the marginal areas and only carried the finer sediments towards the centre of the basin. The Danube only acted as a transit stream and the Tisza river was the major axis of the drainage (*Figure 1*). The geological and geomorphological investigations have confirmed the Pleistocene *(s. l.)* development of the Great Plain and in more general that of the Carpathian Basin's drainage (Sümeghy, J. 1944, Somogyi, S. 1961, Rónai, A. 1985, Borsy, Z. 1989, Mike, K. 1991), but the details of the Late Glacial–Holocene events are not clear in a number of regions.

Later a complete transformation of the spatial pattern of the river systems occurred in Northern Europe emerging after the regression of the ice cover, but the Carpathian Basin belonged to the periglacial and pseudoperiglacial region during the last glaciation. The development of the already existing drainage network was highly affected by the uneven sinking of the regions in the Great Hungarian Plain. Beside the tectonic effects the climatic fluctuations were important too. These climatic changes had caused fluctuations in water discharge and modified river mechanisms.

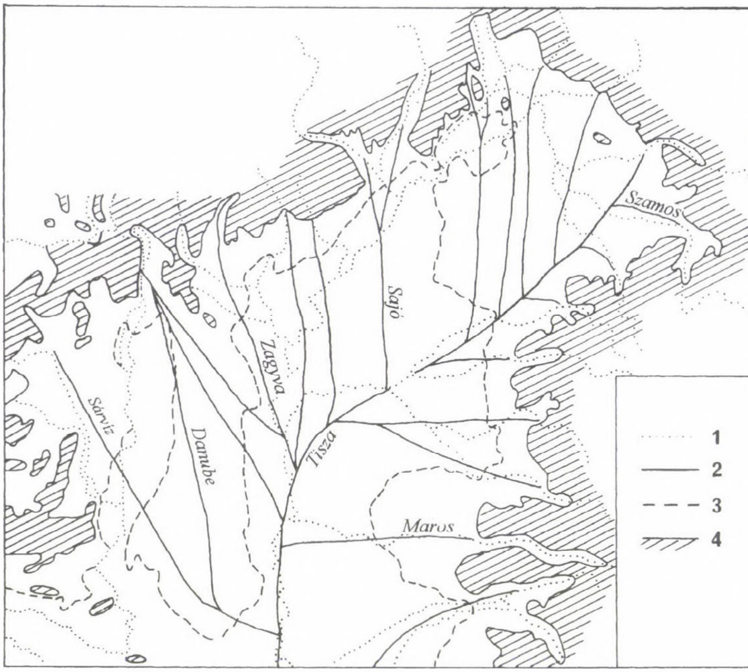


Fig. 1. The drainage system at the Upper Pleniglacial. – 1 = present day river courses; 2 = ancient rivers; 3 = contour-line of the 100 m a.s.l.; 4 = hills and mountains above 200 m

THE EFFECTS OF UNEVEN SUBSIDENCE

The tectonically well differentiated young depressions of the Great Plain – which showed marked variation in their general appearance too – were named by Sümeghy, J. (1944) "offspring-depressions". They were formed on the margin of the basin – far away from the continuously sinking central parts – and their intense subsidence has been much younger, generally starting with the end of the Pleistocene and the beginning of the Holocene.

The most important consequence of the formation of these offspring-depressions is the change in flow direction of the Great Plain's main river; by the end of the Pleistocene the Tisza had moved from the axis of the basin to its current position, closer to the foreland of the northern mountains (*Figure 2*). The time of the Tisza's shift was dated at the boundary of Pleistocene and Holocene (Somogyi, S. 1961, 1967, Borsy, Z. 1968). Recently an idea has been raised (Borsy, Z. 1989) that the Tisza occupied its actual position (near the town of Tokaj) much earlier (16-20,000 BP). Considering the evidence provided by both theories the change of flow direction of the Tisza can be

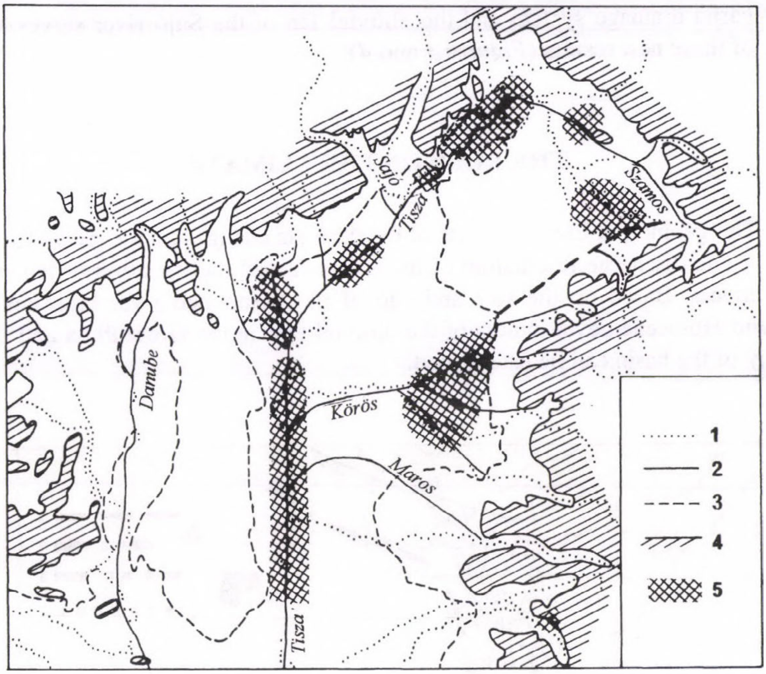


Fig. 2. The drainage system at the end of the Pleistocene, during the „warm and humid" phases (Bölling/Alleröd) of the Late Glacial. – 1 = present day river courses; 2 = ancient rivers; 3 = contour-line of the 100 m a.s.l.; 4 = hills and mountains above 200 m; 5 = offspring basins

dated to the Late Glacial instead of the Preboreal, presumably after the loess formation, notably during the Bölling/Alleröd "warm" phases, and a gradual change, or the bifurcation of the river during the Late Glacial–Preboreal shall be supposed. The author's latest investigations suggest the Late Glacial flow direction of the Tisza through the Hortobágy to the south (Fiar, S. and Gábris, Gy. 1995), but the presence of the river in its actual position along the middle reaches of the Tisza is also evident at this time.

The changing position of the Tisza was followed by the change of courses of its tributaries: the northern tributaries became shorter, while the southern ones became longer. Apart from this major change the main tributaries moved their channel only slightly within their alluvial fans. Only the history for the last 13,000 years of some of the rivers is described in detail namely that of Szamos (Borsy, Z. 1954, Benedek, Z. 1960), Maros (Gazdag, L. 1964), Sajó (Gábris, Gy. 1970), Bodrog (Borsy, Z. and Félegyházi, E 1983, Borsy, Z. *et al.* 1989).

The river courses of distinct periods might be identified by the numerous abandoned river branches of different size. The geomorphological investigations of these meanders applying sedimentological and palynological methods served to map the change of the flow directions. The Late Glacial–Post Glacial development of the

Zagyva–Tarna drainage system and the alluvial fan of the Sajó river serves as a good example of these new results (*Figures 3* and *4*).

THE ROLE OF THE CLIMATE

The geomorphological effects of the climatic changes on the rivers are varied:

– The discharge fluctuation of the rivers caused the variation of the size of the river meanders. Based on the size and age of the abandoned river branches the Late Glacial and Holocene development of the alluvial fans in the Great Plain and the paleo-hydrology of the basin can be established,

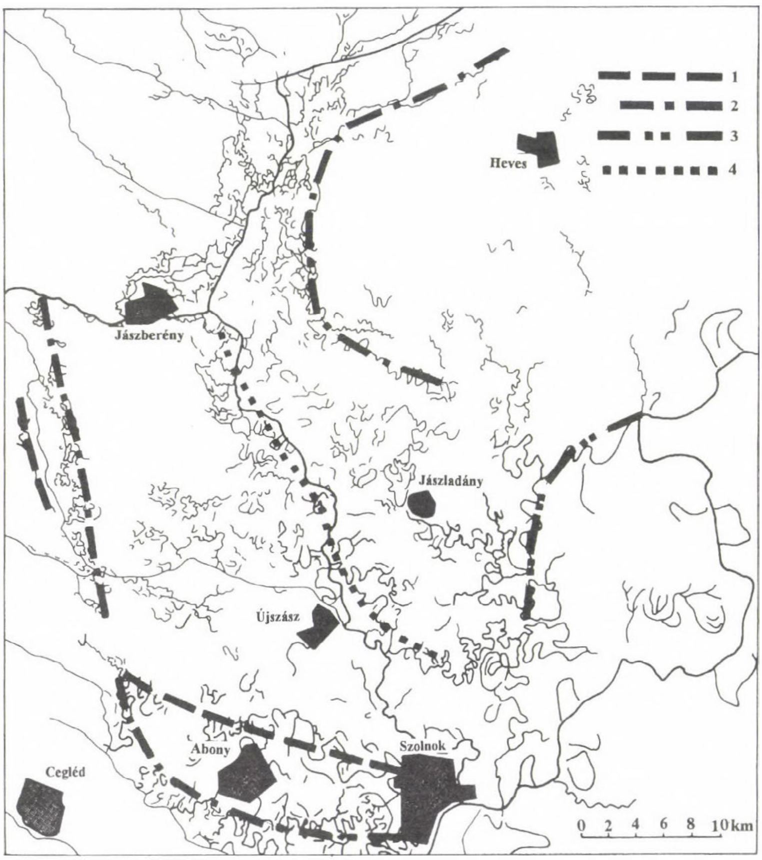


Fig. 3. Late Glacial–Holocene changes in the drainage system of Zagyva and Tarna rivers. – River courses: 1 = Alleröd (Zagyva); 2 = Preboreal (Zagyva and Tarna); 3 = Boreal (Tisza); 4 = Subboreal (Zagyva–Tarna).

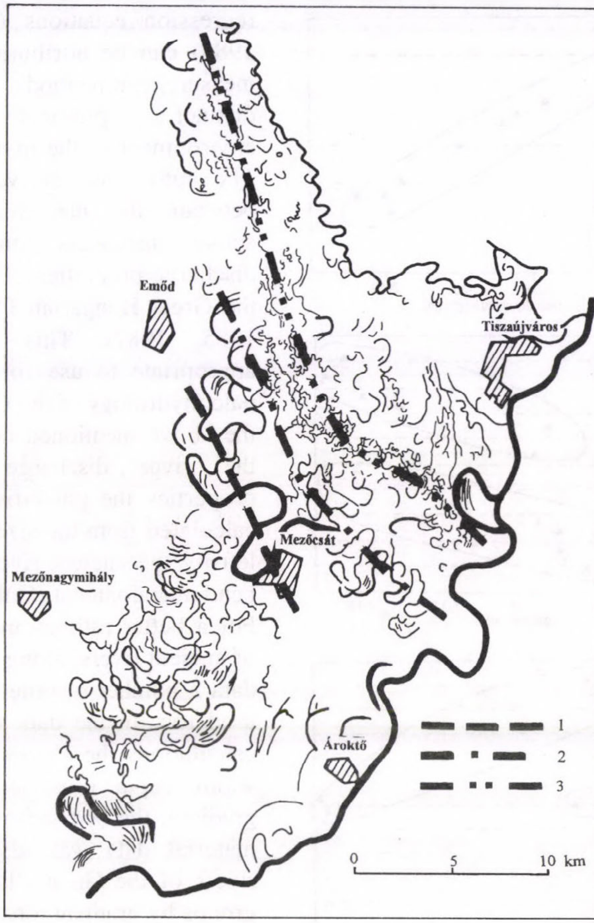


Fig. 4. Late Glacial–Holocene changes in the drainage system on the alluvial fan of the Sajó river (Gábris 1970). – River courses: 1 = Alleröd; 2 = Preboreal; 3 = Boreal

– The changing mechanism of the climate controlling rivers resulted in the formation of terraces and flood plain systems.

Correlation between meander properties and paleodischarges in the Great Hungarian Plain

During the past decades a number of researchers conducted measurements and calculations with regard to the statistical relationship between the discharge rates of the meandering rivers and the size of meanders. The discrepancies between the derived

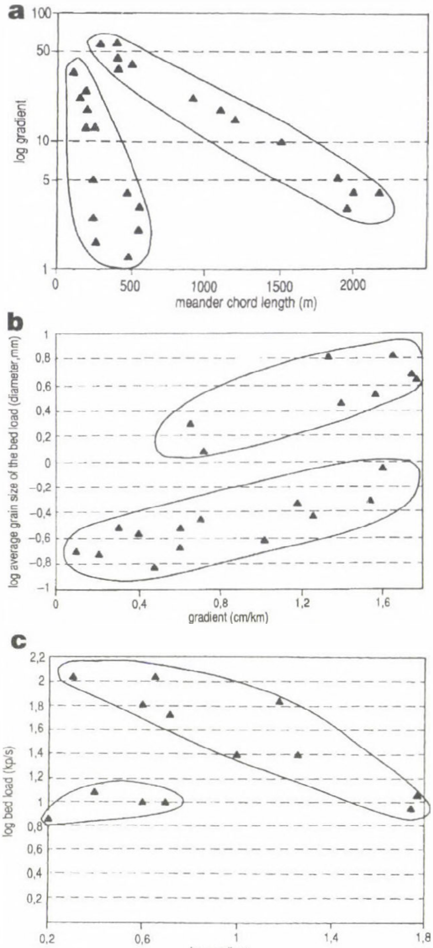


Fig. 5. Two groups of the Hungarian rivers on the base of the relations: a = between the length of meander chord and the gradient; b = between the gradient and the grain size of the bed load; c = between the gradient and the bed load

regression equations (Williams, G. P. 1984) can be attributed to the various measurement methods, and mainly to the distinct physical geographical environment of the investigated regions. The author has derived a relationship between the meander parameters of active meanders and the present discharge properties of various rivers on the Great Hungarian Plain (Gábris, Gy. 1985, 1987). This method seemed appropriate to use for establishing the paleohydrology of the Great Plain. Using the above mentioned equations between the river discharge and meander properties the paleodischarge could be calculated from the size of the meanders left by the ancient rivers at the time of bend abandonment (Gábris, Gy. 1986).

For a better estimation of the discharge of ancient rivers, along with the meander data a number of other parameters were used too. In the data base for the new calculations the channel geometry (i. e. width, depth, cross-section area), slope gradient, the bed sediment and bed load material data was also included. The rivers of the Great Plains fall into two groups by gradient, channel material and the amount of sediment yield (*Figures 5* and *6*). The calculations to determine the regression formulas were carried out for both groups of the rivers (*Figure 7*).

DISCHARGE FLUCTUATIONS

A wide variation of abandoned alluvial meanders has already been discovered on the Great Hungarian Plain by many Hungarian geographers and geologists. The meander characteristics measured for active rivers have also been determined on these abandoned meanders. The abandonment of the channels has been dated using radiomet-

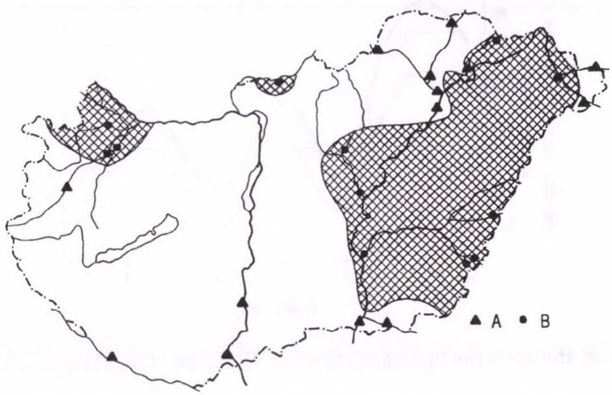


Fig. 6. Spatial distribution of the two river groups. – A = coarse bed sediment - greater bed load and gradient; B = fine bed sediment - lesser bed load and gradient

ric (^{14}C) dating methods, pollen analysis and geomorphological considerations. From the data collected it has been possible to define the age of the abandoned bend and the discharge at the time of abandonment, for several rivers. The results provide quantitative evidence of the fluctuation of the discharge of paleochannels during the last 13,000 years of the Late Glacial and the Holocene, and permit an outline of the general pattern of the Great Plain's paleohydrology. The changes of the Late Glacial–Holocene discharges thus estimated are shown in *Figure 8*. On the basis of a new relationship (*Figure 9*) between runoff and two climatic elements (annual mean temperature and annual precipitation) the author attempted to determine annual mean precipitation from Holocene discharges estimated by morphometric methods, for some periods.

These data have geomorphological consequences to be discussed in the followings.

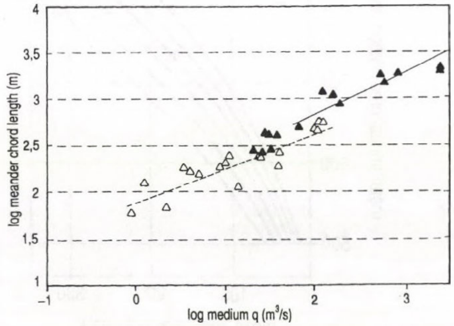


Fig. 7. Relation between the water discharge and meander length after the two Hungarian river groups separated on the basis of the meander characters. – 1 = group A; 2 = group B; 3 = regression line (A. group: $Y = 78{,}4\ X^{0{,}46}$ (R = 0,95); B. group: $Y = 80{,}3\ X^{0{,}36}$ (R = 0,89), where Y equal with the meander chord length, X with the mean discharge of the river)

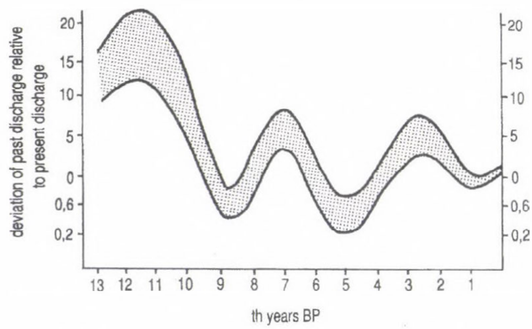


Fig. 8. Holocene fluctuation of the water discharge of the Hungarian rivers

The river activity and climatic change during the Late Glacial and Holocene in the light of the changing paleoenvironment and the discharge fluctuations of the Hungarian rivers

a) Changes in the paleoenvironment

Geographical studies during in the past 30 years in Hungary supplied concrete evidence as regards the environmental changes of the Late Glacial–Holocene period and a wide range of indirect data for a new synthesis on the chronological order of river activity (erosional, accumulational and transitional phases) in Hungary. The collected data are illustrated in *Figure 10.*

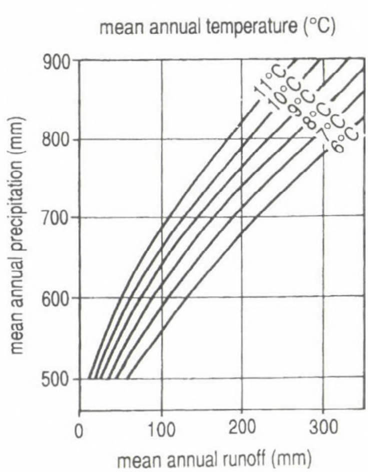


Fig. 9. Relation between the climate and the runoff on the water catchment area of the Zagyva river (Hungary) after Nováki, B. 1991

The most detailed information has been gained from palynology for the annual, July and January mean temperature changes in the Great Plain (*1, 2* and *3 rows*).

Relevant data have been obtained from cave sediments in the North Hungarian Mountains, where remnants of small mammals (voles) have been examined (*1a*). A curve of the humidity change (so-called Arvicola humidity) is drawn (*4*) on the basis of this research.

A more recent method is based on the terrestrial Mollusc fossils to determine the July mean temperatures (*1b*) during the Upper Pleistocene and Holocene.

Additional information for environmental changes could be obtained from water level oscillations of Lake Balaton (*5/a-b*).

Geomorphological research has established several stages of eolian sand movement. The new radiometric data on periods of soil formation on the dunes (ps. of humid conditions) indirectly determine the deflation periods (*7*). But the results did not fit into the old theories. Consequently, this also called for a reconsideration of the evolution of the drainage system.

The stratigraphic evaluation of archaeological excavations also enriched our knowledge of the environmental changes in the Holocene period. Especially archaeological findings supplied evidence for the periods of alkalic soil formation, or those under arid conditions (*8*).

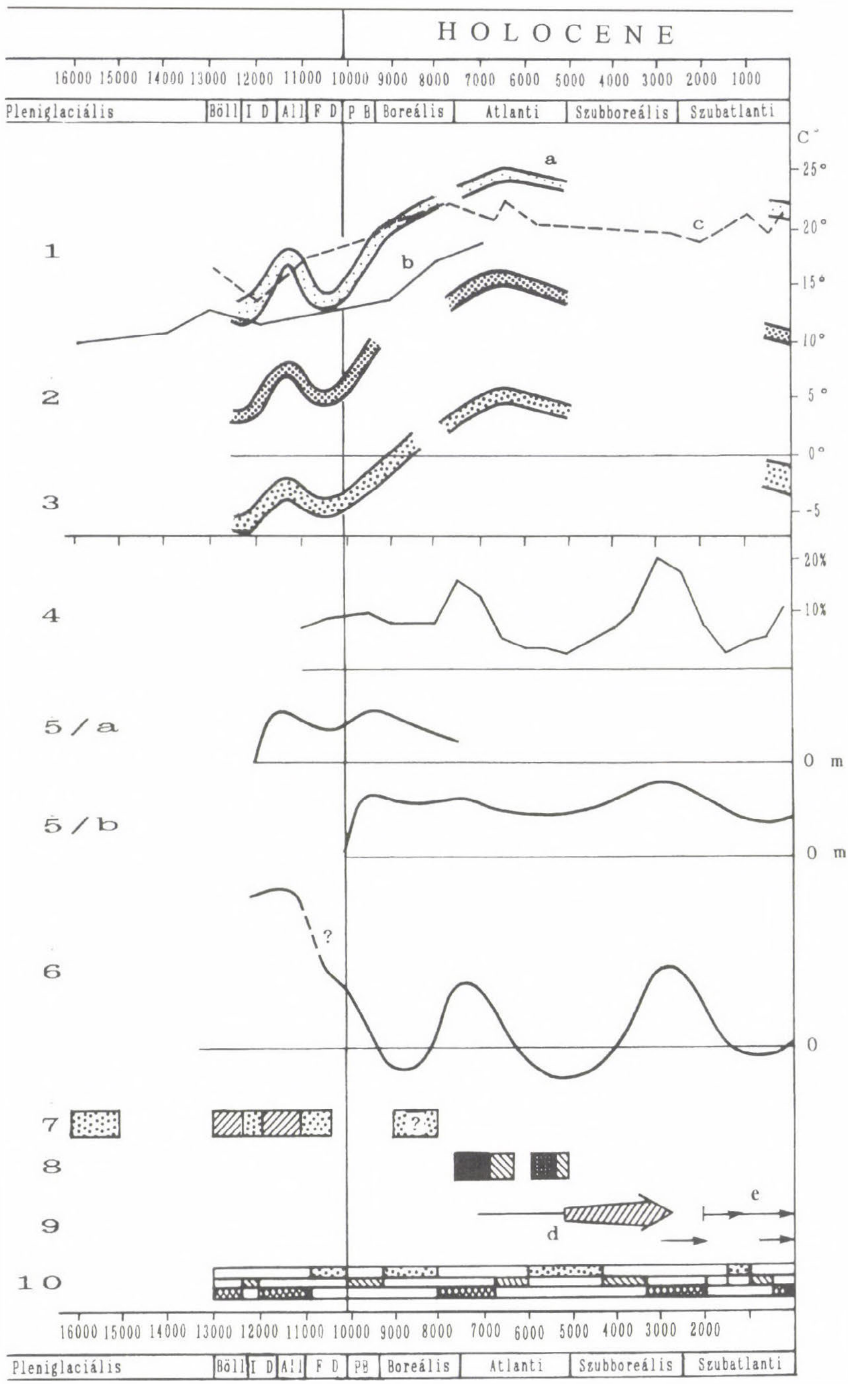
b) The mechanisms of the Hungarian rivers in the Late Glacial and Holocene

For the assessment of the rate of fluvial erosion or accumulation, one of the indicators is the water discharge. The discharge of the Great Plain rivers during the Holocene based on morphometric methods, have been re-evaluated according to the new chronological order of the paleoenvironmental changes (*Figure 10., row 6*). The second indicator consists of the changes in sediment load, but in this respect only uncertain estimations are available.

In the light of these calculations and of the more recent geomorphological and sedimentological evidence, the changes of the erosional, accumulational and transitional phases of the Hungarian rivers and their chronology were established. The dotted areas mark the accumulation (upfilling), the single-hatched ones show the transitional (valley widening) phases, and the cross-hatched ones indicate the erosional (downcutting) phases (*row 9*).

c) Geomorphological consequences

The last Pleistocene river terrace (denoted in the Hungarian literature as IIa) was previously dated Holocene because of the absence of loess cover on its surface and the presence of an eolian sand cover (Pécsi, M. 1959). This sand accumulation was dated earlier Boreal, but recent investigations (Borsy, Z. *et al.* 1985, Lóki, J. *et al.* 1995) could only find evidence for eolian deposition during the Pleistocene, especially in the Pleniglacial and Late Glacial (Early and Younger Dryas). According to the latest evi-



HOLOCENE
16000 15000 14000 13000 12000 11000 10000 9000 8000 7000 6000 5000 4000 3000 2000 1000
Pleniglaciális
Böll
I D
All
F D
P B
Boreális
Atlanti
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Szubatlanti
C°
25°
20°
15°
10°
5°
0°
-5
a
b
c
1
2
3
4
20%
10%
5/a
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16000 15000 14000 13000 12000 11000 10000 9000 8000 7000 6000 5000 4000 3000 2000
Pleniglaciális
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Szubboreális
Szubatlanti

during the Pleistocene as a result of the Alleröd erosion. During the Younger Dryas valley accumulation and occasional lateral erosion was characteristic. Sand dunes were formed not only on the flood-free terrace, but everywhere on the marginal alluvial fan surfaces too.

At the beginning of the Preboreal the increased water flow and the reduced sediment load caused a downcutting phase for a short time. Accumulation started during the second half of the Preboreal and in the first half of the Boreal (accumulation of the material of the Early Holocene or terrace I). The next humid period occurred during the transition between the Boreal and Atlantic phases. The palynological examinations show considerable differences in the climate of this period within the Carpathian Basin: the eastern part of the Great Plain was much more continental. The more frequent floods and extreme water discharges of this wet phase resulted the next phase of valley deepening (cutting into the Early Holocene terrace) in the Boreal to Atlantic transition.

The low stage of Lake Balaton and pollen analyses have proven that at least the second half of the Atlantic phase was much drier then hitherto was thought of. The paleohydrologic reconstruction by radiocarbon dating shows that some Atlantic (6200 B.P.) channels of the Tisza river (Borsy, Z. and Félegyházi, E. 1983) had lower water discharge than today (Gábris, Gy. 1985, 1986). The stratigraphical evaluation of archeological excavations indicates dry climate too (Bácskai, E. 1991). Alkalic soils having formed above the middle Neolithic cultural layer point to an excessively continental climate, with negative water balance. There are similar alkalic soils in some middle Copper age (approx. 4500 B.P.) settlements too. Due to the dry climate and low discharges the rivers were silting up during the second half of the Atlantic and the first part of the Subboreal phases.

The palynological and zoological data indicate that the latest intensive downcutting phase occurred probably during the second half of the Subboreal. Due to the abundant rainfall and the low temperatures the rivers incised and this downcutting erosion resulted in the formation of the high flood plain. The recent upfilling and forming of the low flood plain is dated Subatlantic. The Danube, the Tisza and most of the Hungarian rivers currently demonstrate a slight downcutting.

Fig. 10. Summary table of the environmental changes during the Late Glacial-Holocene period in Hungary. 1. July average temperature; a. "Vole-thermometer"; b. "Malaco-thermometer"; 2. Mean annual temperature; 3. January average temperature; 4. "Arvicola humidity"; 5. Water stage changes of Balaton (a - Western basin, b - Eastern basin); 6. Variation of the river discharges; 7. Deflation periods; c. Wind blown phases; d. Period of soil formation on the dunes; 8. Periods of alkalic soil formation; 9. Type of river mechanism (dotted areas - accumulation, single-hatched - transitional phase, cross-hatched - downcutting).

TERRACES AND FLOODPLAIN LEVELS

According to the above considerations on the surface processes four major geomorphological levels were formed in the Great Hungarian Plain. Two of them are of Pleistocene origin whereas two are of Holocene age:

On the margin of the Great Plain many flat alluvial fans reach towards the centre of the basin in continuation of the mountain river valleys.

– The surface of these alluvial fans is partially covered by young (Late Pleistocene) loess, or loess like sediments. This level lies 2-6 m higher than the Holocene flat inundation levels being an extensive flatland without any kind of microrelief. The thickness of the loess sediment is only a few metres; thicker sequences can be found only in the peripheries of the plain and in the region northeast of Debrecen.

– Large areas are also covered by Pleniglacial eolian sands (having been deposited in two phases) and these formed in the Late Glacial (Dryas). The Holocene deflation of the sand areas in the eastern and the northeastern part of the Great Plain is not yet proved, but it is very probable in the Danube–Tisza Interfluve. The last and weak eolian phase is attributed to the changing land use in the XVIII century after the Turkish occupation. This morphologically diversified sandy level rises a few ten meters above the recent flood plain. Many kind of dune forms can be found here and in the small depressions evaporites are present too.

The Pleistocene surfaces are riddled by abandoned river channels of Late Glacial and Early Holocene ages. This ancient rivers cut narrow but deep channels of different size. Most of the branches now are filled up and dry.

The Holocene levels are flooded areas. Before the river regulations of the last century more than one third of the Great Plain (about 2 million hectares) was permanently or intermittently inundated by the floods of the Tisza and its tributaries. The double fluvial cycle resulted in two Holocene levels:

– an extensive Early Holocene high flood plain surface was formed by the Middle Holocene downcutting phase of rivers and

– the areas of the currently still subsiding offspring-depressions and the current flood plains of the rivers belong to the lowest and youngest Late Holocene areas. These flood plains have variable micromorphology due to the abandoned channels and the recently sinking parts used to be marshy depressions with peat bogs in their natural condition.

CONCLUSIONS

The Late- and Post Glacial development of the drainage network in the Great Hungarian Plain was controlled predominantly by the uneven subsidence of the basin. The young "offspring-depressions" along the margin of the Great Plain forced the Tisza to move from the axis of the basin to its current position during the Late Glacial. The recent studies revealed some changes of the river courses of the Tisza tributaries during the Holocene. The climatic variations affected the river discharge and the river mechanisms. The paleohydrology of the Great Plain can be established using the equations between the river discharge and meander properties, calculated by the author. The chronological order of the river activity (downcutting, upfilling and transition phases) is established by an analysis of the environmental changes of the Late Glacial and Holocene. During this time four major geomorphological levels – those of loess or loess like sediments, sand covered alluvial fans, high and low flood plains – were formed in the Great Hungarian Plain.

REFERENCES

Bácskai, E. (1991): Some utilisation possibilities of archaeology for the geologist, Hungarian examples. – *MÁFI Évi Jelentése* 1989, 614-621

Benedek, Z. 1960: Geomorfológiai vizsgálatok az Érmelléken és Nagykároly környékén (Geomorphological studies in the region of Érmellék and around Carei-Nagykároly). – *Földrajzi Közlemények 9. (84):* 141-158

Borsy, Z. (1954): Geomorfológiai vizsgálatok a Bereg–Szatmári síkságon (Geomorphological investigations on the Bereg–Szatmár Plain). – *Földrajzi Értesítő 3*. 270-281

Borsy, Z. (1968): Geomorfológiai megfigyelések a Nagykunságban (Geomorphological observations in the Nagykunság region). – *Földrajzi Közlemények 16. (92):* 129-151.

Borsy, Z. - Félegyházi, E. 1983: Evolution of the network of water courses in the northeastern part of the Great Hungarian Plain from the end of the Pleistocene to our days. – *Quatern. Stud. in Poland 4*: 115-124.

Borsy, Z. - Csongor, E. - Lóki, J. - Szabó, I. (1985): Recent results in the radiocarbon dating of windblown sand movements in the Tisza–Bodrog interfluve. – *Acta Geogr. Debrecina 22*: 5-16

Borsy, Z. (1989): Az Alföld hordalékkúpjainak negyedidőszaki fejlődéstörténete (Quartäre Entwicklungsgeschichte der Schwemmfacher von Alföld). – *Földrajzi Értesítő 38*: 211-224.

Borsy Z. - Csongor É. - Félegyházi E. (1989): A Bodrogköz kialakulása és a vízhálózat változásai. – *Alföldi Tanulmányok 13*: 65-81.

Borsy Z. (1992) Die Entwicklungsgeschichte des Donau–Theiss Zwissenstromlandes. – In: Billwitz, K. - Jäger, K.-D. Junge, W. (Hrsg.) Jungquartäre Landschaftsräume, *Springer-Verlag* Berlin, 236-242.

Fiar S.- Gábris Gy.(1995): Paleohydrographical investigations in the Hortobágy National Park – VII.Croato-Hungarian Geographical Colloquium Mljet, 13-16 Sept 1995. *Abstract of papers*, 6-7.

Franyó F. (1980) Újabb felszínfejlődéstörténeti és vízföldtani eredmények a Duna–Tisza közi kutatófúrások alapján (Recent results in studying the geomorphic history and hydrogeology of the Danube–Tisza Interfluve based on borehole tests) – *Földrajzi Értesítő 29*: 409-443.

Gábris, Gy. (1970): Fiatal mederváltozások kutatásának módszerei a Sajó hordalékkúpjának példáján (Method for a research of recent riverbed-changes on the example of the alluvial fan of the Sajó river). – *Földrajzi Közlemények) 18. (94)*: 294-303.

Gábris, Gy. (1985): An outline of the paleohydrology of the Great Hungarian Plain during the Holocene. – In: Pécsi, M. (ed.): Environmental and Dynamic Geomorphology. *Akadémiai Kiadó*, Budapest, 61-77

Gábris, Gy. (1986): Alföldi folyóink holocén vízhozamai (Holocene discharges of rivers in the Alföld). – *Alföldi Tanulmányok 10*: 35-52.

Gábris, Gy. (1987): Correlation between meander properties and Holocene discharges in the Great Hungarian Plain. – in: Gardiner, V. (ed): Internat. Geomorph. Conf. 1985 Part I. *J. Wiley and Sons Ltd*. 723-730.

Gábris Gy. (1994): Pleistocene evolution of the Danube in the Carpahtian Basin. - *Terra Nova* **6**: 495-501.

Gábris, Gy. (1995/a): A paleohidrológiai kutatások újabb eredményei (New results of the paleohydrological investigations in Hungary). – *Földrajzi Értesítő 44*: 101-109. 1995

Gábris, Gy. (1995/b): River activity as a function of changing palaeoenvironmental conditions during the Late Glacial–Holocene period in Hungary. – in Frenzel, B. (ed.): European river activity and climatic change during the Late Glacial and early Holocene. European Palaeoclimate and Man 9. *G. Fischer Verlag*, 205-212.

Gazdag, L. 1964: A Száraz-ér vízrendszere (Water system of Száraz-brook). – *Földrajzi Értesítô 13*: 367-374

Lóki J. - Hertelendi E. - Borsy Z. (1994): Újabb koradat a nyírségi futóhomok mozgásának idejéhez. – *Acta Geogr. Debrecina*. **32**: 67-76.

Mike K. (1991) Magyarország ősvízrajza és felszíni vizeinek története (Paleohydrography of Hungary and the history of its surface waters). – *Aqua kiadó*, Budapest, 698.

Pécsi M. (1959) A Magyarországi Duna-völgy kialakulása és felszínalaktana (Entwicklung und Morphologie des Donautales in Ungarn). – *Akadémiai kiadó*, Budapest, 346.

Rónai A. (1985) Az Alföld megyedidőszaki földtana (The Quaternary of the Great Hungarian Plain). – *Geologica Hungarica ser. Geol. 21*, 446.

Somogyi S. (1961) Hazánk folyóhálózatának fejlödéstörténeti vázlata (Entwicklungsgeschichtige Skizze der Wassernetzes von Ungarn). – *Földrajzi Közlemények 9, (85):* 25-50.

Somogyi, S. (1962): Evaluation of the Holocene geographical research by hydromorphology. – *Földrajzi Ertesítő 11:* 185-202

Somogyi, S. (1967): Ősföldrajzi és morfológiai kérdések az Alföldről (Questions paléogéographiques et morphologiques dans la Grande Plaine Hongroise). – *Földrajzi Értesítő. 16*: 319- 338.

Somogyi, S. (1988): Ecological changes in the territory of Hungary during the Holocene. – in: Paleogeography of Carpathian regions, *MTA FKI* Budapest, pp. 87-94.

Sümeghy, J. (1944): A Tiszántúl. Magyar tájak földtani leírása VI. (Tiszántúl. Geologische Beschreibung Ungarischer Landschaften). – *Magy. Kir. Földtani Int. kiadása*, 208. p.

Szöőr, Gy. - Sümegi, P. - Hertelendi, E. (1991): The use of malaco-thermometer method for establishing paleotemperatures for the Upper-Pleistocene–Holocene climatic changes on the Hungarian Great Plains. – *Acta Geogr. Debrecina 28-29:* 217-229

Williams, G. P. 1984: Paleohydrologic equations for rivers. – in. Costa, J. E. - Fleicher, P. J. (ed.) Developments and applications of geomorphology, *Springer-Verlag*, Berlin. 343-367.

L. Bassa–Á. Kertész (eds): Windows on Hungarian Geography
Studies in Geography in Hungary 28, Geographical Research Inst. HAS, Budapest 1998, pp. 37–52

GEOMORPHIC EVOLUTION OF LAKE BALATON

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INTRODUCTION: GENERAL REMARKS

Balaton is the largest and best studied lake in Central Europe. The beauty of the scenery and the geologically conspicuous environment have put it in the focus of investigations and in the first half of the 20th century results were summarised in a monograph of 32 volumes.

L. Lóczy Sen. (1913) was the first to show that Lake Balaton, situated along the strike of the Transdanubian Mountains, consists of local depressions having emerged along fault planes crossing each other, and these depressions are separated by narrow ridges. He assumed the lake to have formed during the Lower Pleistocene.

Later the Balaton - based on terrace morphological investigations - was determined of Riss-Würm interglacial origin by A. Kéz (1943) and B. Bulla (1943). B. Zólyomi (1953) – concluding from palynological analyses – considered Balaton even younger, putting its formation to the end of the Würm, while geologist J. Sümeghy (1953) assumed post-glacial origin.

In the 1960s the publications by Marosi, S.-Szilárd, J. (1958), Marosi, S. (1960, 1962, 1965), Szilárd, J. (1962, 1963, 1967), Erdélyi, M. (1961, 1962) synthesised the actual knowledge leading to a conlusion that the Balaton Trench is a polygenetic basin formed as a result of a stadial (spatial and temporal) subsidence. Even later studies on the valley network of the surrounding areas, fine stratigraphic and absolute chronological analyses (Marosi, S.-Szilárd, J. 1974, 1977) confirmed this thesis, while landscape chronological investigations provided further evidence (Marosi, S.-Szilárd, J. 1975, 1983, 1986; Marosi, S.-Szilárd, J.-Juhász, Á. 1984).

Contrary to the earlier assumptions K. Mike (1976, 1980) suggested that Balaton had not been formed by a subsidence but was the result of the erosional activity of Paleo-Danube. This concept has raised heavy controversy.

The structural-morphological interpretation of the horst mountains composing the northern flank of the Balaton Basin (Bulla, B. 1958, Láng, S. 1958, Pécsi, M. 1969, Juhász, Á. 1972) appeared in the focus of further studies. Investigations into surfaces of planation, correlative sediments, of abrasional terraces along the mountain margin and of gravel formations shed light on the character of the Tertiary evolution (Pécsi, M. 1968, 1981, 1988; Juhász, Á. 1972, 1988).

A significant step forward was made by the reconstruction of basalt volcanism (Jugovics, L. 1959, 1971; Balogh Kadosa *et al.* 1982) and its dating.

More recently relevant data were provided by bottom boreholes deepened during the engineering geological mapping of the Balaton. According to the palynological analyses (Cserny, T. *et al.* 1991, 1996) the Keszthely partial basin started to be inundated by the Dryas I phase during the post-glacial.

At present the Balaton area can be subdivided morphogenetically into 1) the flood-free Balaton Basin, 2) the basin characterised by the abrasional activity of the lake and its formations and 3) the lake bed at present filled by water (Marosi, S.-Szilárd, J. 1981).

PRE-BALATON EVOLUTION

The Pannonian pre-Balaton area was characterised by a shallow inland sea with changing coastlines, intense oscillations of the water level, narrower and wider sand beaches, planes of abrasional coasts, plateau remnants and horsts of the Transdanubian Mountains or central range (Keszthely Mountains, Balaton Uplands, South Bakony) in the form of islands and their groups, sea channels, narrower and wider embayments.

The Balaton Basin had subsided into Pannonian sediments so the geomorphic evolution is outlined from this moment. Position of the basin along the mountain margin provides an explanation for the events in the history of evolution of its wider environment (formation of the Görgeteg-Babócsa Depression, southward shift of the Upper Pannonian inland lake) even if in an indirect way, played part in the formation of the pre-Balaton topography.

There might be a hiatus of the Lower Pannonian formations along the coastline, but toward south they become thicker and in the area of the Görgeteg-Babócsa geophysical maximum they exceed 2000 m (Szentes, T. 1943, Kertai, Gy. 1957, Vadász, E. 1960, Körössy, L. 1963, Bartha, I. 1959).

There are spatial and temporal differences in the regression of the Upper Pannonian inland lake, in changes of the bottom configuration. The beginning of this process can be best studied in the sequences of the high bluffs at Balatonakarattya, Balatonkenese and Balatonföldvár, where oscillations of the inland lake, coast line shifting, lake level fluctuations are referred to by the presence of marshy layers. The termination of this regression in some places is indicated by traces of erosional-denudational activity and the appearance of erosional unconformities and sand deposits (even in exposures such as Fonyód Hill /*Figure 1*/, Gomba-puszta, Zamárdi), while in other places thin clay benches appear closing the Pannonian formation (product of desiccation at e.g. Hollád, Balatonszentgyörgy, Kőröshegy, Zamárdi, Szigliget, Arács), where the long lasting inland lake state terminated in a calmer period and/or at a protected place. Resulted from the erosional-denudational activity the upper level of layers having contained Upper

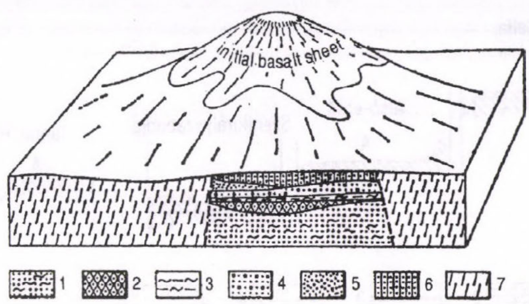

Fig. 1. Sketch bloc-diagram of the Nagy-Várdomb in Fonyód from the north. – 1 = Late Pannonian series (sand with clay and lignite beds); 2 = Late Pliocene cross-bedded sand; 3 = Late Pliocene clay bed; 4 = Pleistocene fluviatile sand with silt and debris stripes; rising and wedging from the rim to the south; 5 = wind blown sand; 6 = slope deposit of sandy loess; 7 = collapsed material

Pannonian *Congeria balatonica* have been removed in considerable thickness; older members situated deeper survived until a new stage of evolution between the Pannonian lake and Quaternary continental evolution began (Marosi, S. 1970).

The effect of slow, stadial dictiogenetic movements leading to the uplift of the bottom of the basin and its turning into land and, simultaneously, the shrinking of the Pannonian lake and its decay into partial lakes resulted in a southward shift of the inland lake, accompanied by the mentioned oscillations; finally it had been restricted to the Slavonian or Zagreb Basin. It should be emphasised, however, that this process had been very slow, gradual, even stadial.

Rivers flowing northward, transported sediment toward their base lines permanently.

This activity actually was similar to the effect of the uplift, because the fluvial sediments deposited along the margin of the inland lake which shifted southward from the water body. Slowly flowing waters and shallow channels between the residual parts of the disintegrating lake were typical. These riverines sedimented sands and clays with *Viviparus* and *Unio wetzleri*. These layers are characterised by oblique and cross bedding (fluvial bedding; Balatonaliga, Zamárdi, Balatonföldvár, Lengyeltóti, Szigliget, Szent György-hegy) or strong dip (delta-like bedding; Balatonberény). There have been an extensive discussion about the genesis of this sediment considered widespread in the western and southern parts of Transdanubia (from E. Szádeczky-Kardoss's /1938/ standpoint to that of M. Pécsi /1962/) summarised and evaluated by J. Szilárd (1967) and S. Marosi (1970) and only referred herewith.

The Upper Pannonian transgression brought about profound changes also in the morphological features of the Transdanubian Mountains. Prior to the Miocene the area probably was the pediment of the southern crystalline mountains and of the emerged horsts of the Bakony (Pécsi, M. 1969, Juhász, Á. 1995, Korpás, L. 1981), i.e. it consists of a series of pediplanated transitional types of horsts. The residual forms, in some places traces of red clays in the cracks of rocks, manganese and bauxite gravels occurring along the plateau margins and red clay mantles of 2-3 m thickness evidence to the

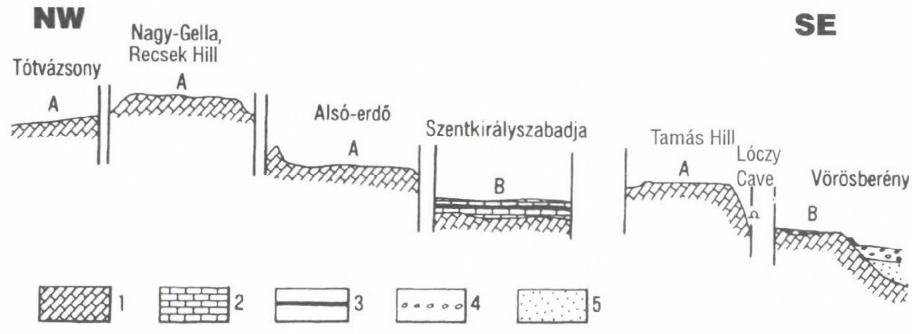

Fig 2. Principal scheme of genetic types of landforms between Nagy-Gella Hill and Tamás Hill (compiled by Juhász, Á. 1984). – 1 = Mesozoic limestone formations; 2 = travertine; 3 = red clay horizons; 4 = abrasional gravels; 5 = Pannonian sand; A = exhumed horsts in summit position; B = covered horsts in intermediate position

plateaus above the Pannonian abrasional terrace at a height of 310-350 m representing generations of landforms of different age (*Figure 2*).

During the Upper Pannonian the Balaton Uplands, Keszthely Mountains and South Bakony elevated above the inland sea as islands, while the present intramontane basins (Tapolca Basin, Nagyvázsony Basin) constituted embayments. Sediments covering the marginal plateaus and horsts in lower position were partly inundated, partly transformed by abrasion; in many places travertine was deposited on them (Szentkirályszabadja /*Figure 2*/, Nagyvázsony).

The Upper Pannonian sediment formation was accompanied with basalt volcanic activity of the basic type, and the ancient surface had became covered by material from more than 40 centres of eruption. This volcanism took place in three phases; on the Tihany Peninsula it started in the period of marine sedimentation and terminated at ca. 2 M yr B.P. during pediment formation. Lava has conserved former pediment surfaces, giving this way an opportunity for dating pedimentation. According to K/A dating this latter took place between 3.3-4.7 M yr B.P. in the Keszthely Mountains, 2.8-3.5 M yr in the Tapolca Basin and 4.5-6.0 M yr on the Balaton Uplands.

Pediment planes formed along the southeastern mountain margins simultaneously to Pannonian regression were the initial surfaces of the emergence of the Balaton Basin.

With the growing differentiation in the elevation of the mountains and their foreland, during the transition from the Pliocene subtropical to the Pleistocene climate, the former fluvio-lacustric hydrography had gradually given way to a river network producing gravelly sediments.

At the same time, subtropical semiarid climate and the growing energy of relief created favourable conditions for the emergence of torrents, consequently, for the dissection of the plateaus in the Transdanubian Mountains. During this period of evolution the highest abrasional terraces (Szentkirályszabadja, Vörösberény, Balatonfüred, Ederics, Keszthely Mountains) got started to be dissected and torrents began to build alluvial fans in the foreland areas (Juhász, Á. 1988).

Taking into account the paleoclimatic data and geomorphic evolution of the closer and broader environment, wind action (deflation) must have played a significant role (Lóczy, L. Sen. 1913; Cholnoky, J. 1918; Bulla, B. 1962; Schweitzer, F. 1997). The appearance of fine grain sediments was attributed by M. Pécsi to a savanna-like climate.

Recently F. Schweitzer provided confirming paleoclimatic data for the desert theory evolved by Lóczy and Cholnoky (Schweitzer, F. 1994, 1997).

Simultaneously to the subsidence of the Little Plain, to the uplift of the Transdanubian Mountains (central range), to the emergence of the Sümeg-Gleichenberg watershed, the Balaton area and the whole South Transdanubia lost a major part of their previous northern catchment, and the Upper Kapos–Kalocsa Depression (the middle i.e. second member of the Transdanubian generation of catchments) which had functioned as the principal base line since the Plio-Pleistocene boundary, from this time collected the sediments transported by water courses running southward from the central range (Marosi, S. 1960, 1970). Meridional valleys of north-northwest–south-southeast orientation had emerged, adjusted to the structural lines, gradually incising into the gently sloping surface and separated from each other by elongated fluvial ridges. Material of nappe sediment covering the Transdanubian Mountains, products of physical weathering and deluvium originated from the fluvial ridges were transported through these valleys to the Upper Kapos-Kalocsa Depression (Szilárd, J. 1962, 1967; Marosi, S. 1970).

During the Lower Pleistocene in the western part of the basin the formation of meridional valleys was substituted by the formation of alluvial fans within a wide strip of subsidence. This formation of fans and a uniform spatial pattern of the meridional valleys from the central range watershed up to the Upper Kapos–Kalocsa Depression continued through the Middle Pleistocene. This is evidenced by the system of terraces and valley shoulders of the meridional valleys (*Figures 3 through 5*), by an undisturbed buildup of the fan and its surface not being covered by loess-like deposits.

The actual landforms have also inherited features of the pre-Balaton topography: meridional valleys being structurally preformed, can be traced as the direct con-

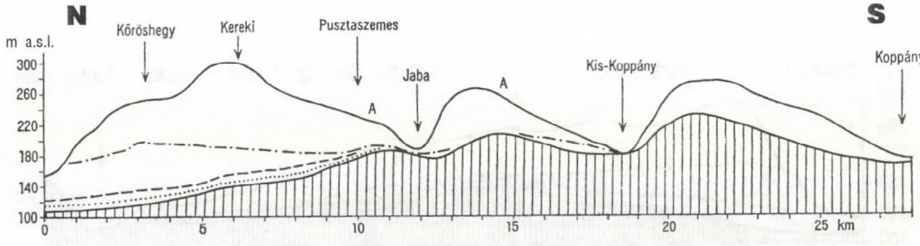

Fig 3. Longitudinal section of the Kőrös Hill meridional valley. – A = valley watershed; vt = valley floor; av_I = lower step of a low valley shoulder; av_{II} = higher step of a low valley shoulder; mv = high valley shoulder

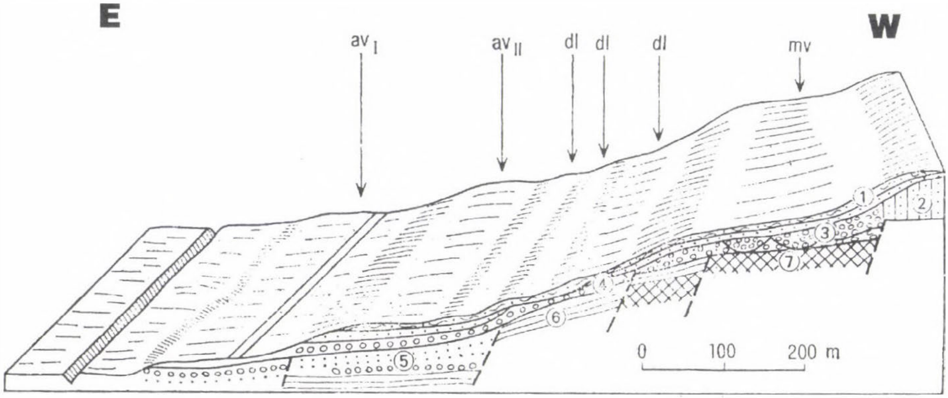

Fig 4. East-west section across the western slope of the meridional valley between Somogytúr and Orci with low (av_I, av_{II}) and high (mv) valley shoulders and with derasional steps (dl). – 1 = finely stratified slope deposits in the loess and sand fraction; 2 = sandy loess; 3 = medium-grain fluviatile sand with debris lenses; 4 = slope deposit in the loess and sand fraction with debris strings, redeposited from the previous layer by derasion; 5 = fluviatile sand with debris; 6 = overlying Late Pliocene clay; 7 = Late-Pliocene cross-bedded sand

tinuation of valleys cutting into the Balaton Uplands, while the mirror-image of the spacious Tapolca Basin on the southern side of the lake is the embayment of Nagyberek and the fluvial network, represented by valleys in the final phase of alluvial fan formation. A very similar picture is characteristic for the meridional strip of the Little Balaton.

The predominantly quartz material of the sediments transported by the pre-Balaton watercourses evidently contains some debris originated from the Transdanubian Mountains. These deposits are getting more rounded and fine grained southward; in the Inner Somogy alluvial fan they acquire normal stratigraphic sequence becoming finer vertically upward and turning into sand fraction (Marosi, S. 1962, 1970, *Figure 6*). They also occur on the high valley shoulders of the meridional valleys in the elevated Outer Somogy Hills, on the former Lower and Middle Pleistocene terraces, 70-80 m above the

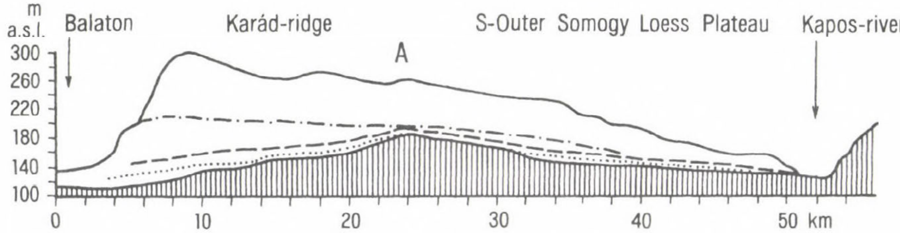

Fig. 5. Longitudinal section of the meridional valley between Somogytúr and Orci. (For legend see *Fig. 3.*)

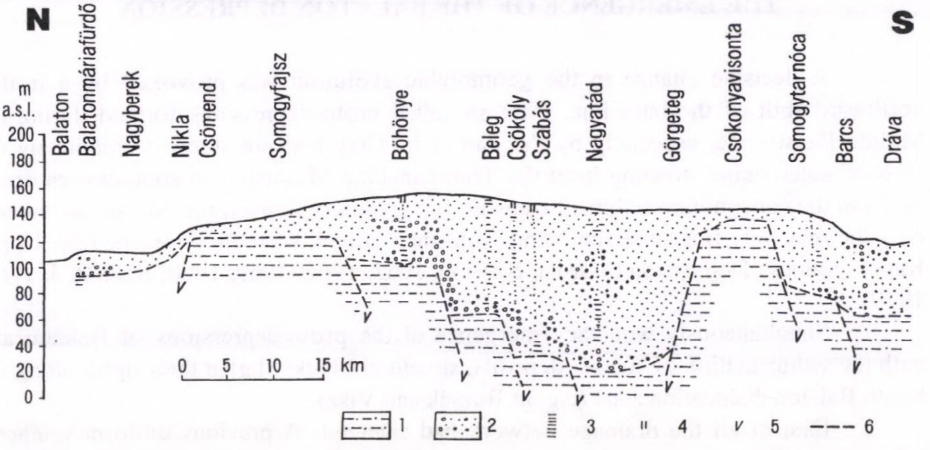

Fig. 6. North-south section of Inner Somogy from Lake Balaton to the Dráva River. – 1 = sandy-clayey Pannonian deposit, at several places with Late Pliocene cross-bedded sand of various thickness in the upper layer; 2 = Pleistocene clayey, silty, sandy, gravelly fluviatile, partly lacustrine deposits with wind-blown sand and in spots loess-like deposits on the surface; 3 = clay disclosed in boreholes; 4 = loess, sandy loess disclosed in boreholes; 5 = hypothetical fault zones; 6 = Plio-Pleistocene boundary

present medium level of the Balaton (Szilárd, J. 1962, 1967). In secondary position the major part of the contemporary filling of the valleys consists of them.

Naturally, the fluviatile sequence reaches maximum thickness in the Upper Kapos–Kalocsa Depression, where the gravelly sediments constitute several layers with a total thickness of 20-25 m in boreholes. In Outer Somogy a nearly complete Würm loess sequence can be traced underlying the sandy fluviatile series. The age of the gravelly sediments (Günz, Villafranca stage) are also supported by findings of vertebrate fauna from the lower layers (*Rhinoceros etruscus* Falc., *Elephas meridionalis* Nesti, *Elephas antiquus* Falc., *Hipparion*; Lóczy, L. Sen. 1913, Kretzoi, M. 1953).

The above described processes started on a gently sloping surface, stretching from the foreland zone of the present Transdanubian Mountains (northern shore of Lake Balaton). There was a differentiation of the relief in a double sense: on the one hand the central range experienced a steady uplift (300-400 m for the Quaternary; Láng, S. 1958, Pécsi, M. 1956, 1959) and simultaneously South Transdanubia saw an elevation of slower rate; on the other hand the local base line had shifted northward (from the Croatian-Slavonian Depression to the Upper Kapos–Kalocsa Depression; Marosi, S. 1960), besides, the surface had been dissected by meridional valleys (Szilárd, J. 1960, 1967).

THE EMERGENCE OF THE BALATON DEPRESSION

A decisive change in the geomorphic evolution was provoked by a further northward shift of the base line. First so called proto-depressions formed during the Middle Pleistocene, especially by the end of it. They had not stopped completely the flow of watercourses running from the Transdanubian Mountains in southeastern direction and the concomitant sediment transfer, but gradually trapped the coarser sediments; only the relatively finer material (sand with small gravel, sand, clay) reached the Upper Kapos–Kalocsa Depression (Marosi, S. 1960, 1962, 1965, 1969, 1970; Szilárd, J. 1967, 1970).

Simultaneously with the emergence of the proto-depressions of Balaton and with the sedimentation of coarser deposits, structural blocks started their uplift along the South Balaton dislocation zone (e.g. at Buzsák and Visz).

First of all the drainage network had changed. A previous uniform southerly orientation of the flow had lost its base line and a new one came into being with the emergence of the partial basins of the Balaton which underwent a subsidence in three stages. The first of them can be put to the Middle Pleistocene. On both banks (Balaton Uplands and meridional ridges of the Somogy Hills) a step can be can be found 3-4 km from the lakeshore flanking the escarpment at 160-190 m a.s.l. and continuing southward as high valley shoulders. The second stage was more restricted in areal extension (1,5-2 km from the lakeshore, at an average elevation of 120-150 a.s.l.). Remnant of the third stage of subsidence is a terrace from the Late Würm at an elevation of 110-112 m indicating the appearance of the contiguous water body, i.e. the emergence of the Balaton Basin proper.

In the beginning of this stadial subsidence, formation of the alluvial fan or

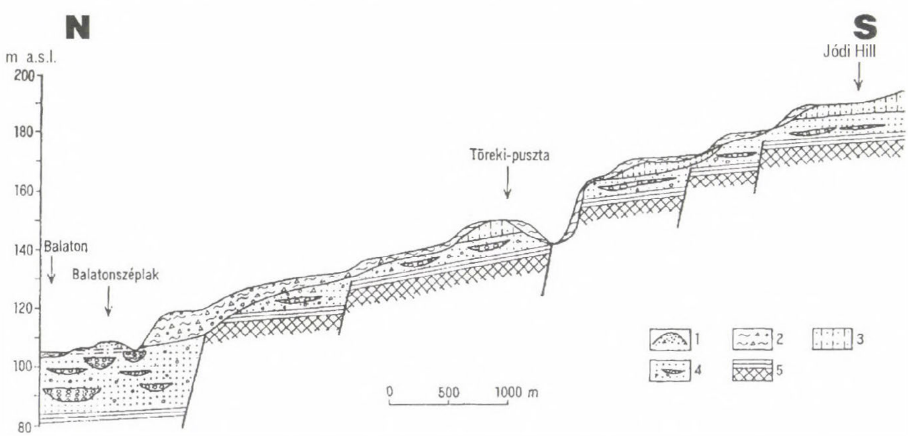

Fig. 7. North-south section across the southern rim of the Balaton Basin between Balatonszéplak and Jódiszőlőhegy. – 1 = bar sand; 2 = loess with embedded angular dolomite debris strings and calcareous slope deposit in the fine sand fraction; 3 = sandy loess; 4 = Pleistocene medium-grain fluviatile sand mixed with debris or with debris lenses; 5 = Late Pliocene cross-bedded sand overlain by clay

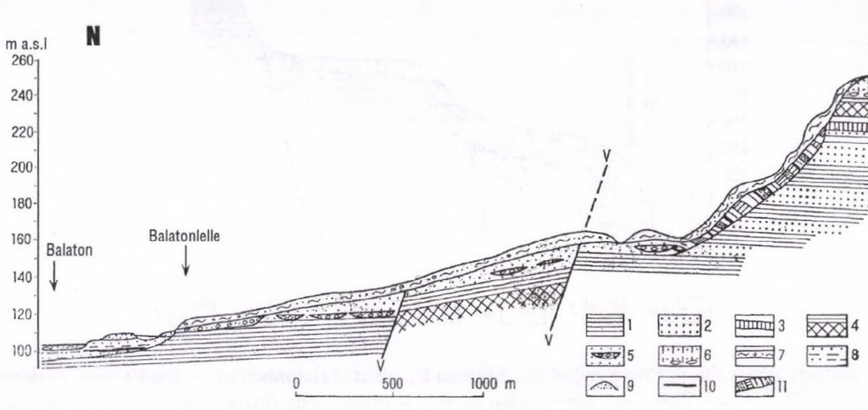

Fig. 8. North-south section across the southern rim of the lake basin at Balatonlelle. – 1 = Late Pannonian clay; 2 = Late Pannonian sand; 3 = lignite layer; 4 = Late Pliocene cross-bedded sand with overlying clay; 5 = Pleistocene medium-grain fluviatile sand with debris lenses; 6 = sandy loess with calcareous concretions at the bottom; 7 = calcareous slope deposit in the loess and fine sand fraction with debris strings; 8 = silty sand; 9 = bar sand; 10 = peat layer; 11 = layers with slides

sediment slope adjoining the Balaton Uplands only intensified, then, with the advancement of sinking, the Balaton Basin, northernmost member of the generations of Middle- and South Transdanubian depressions, came into existence. The basin became not only the catchment of waters from the central range but also of the northern reaches of those running northward from Somogy region. In the surroundings of Marcali and Öreglak, along the northern margins of the meridional ridges, deposits of fluviatile and other origin became eroded and transported northward. Both from the north (central range) and south material transport was oriented toward the sinking catchments.

At that time no uniform lake existed, it came into being only during the third stage of subsidence. Watercourses sedimented deposits on the step of the meridional ridges at an elevation of 160-180 m, up to the southern rim of the depression. These deposits consist of material of varied grain size, 2-4 cm in diameter, overwhelmingly limestone and dolomite, partly red sandstone gravel and debris (*Figures* 7 and *8*).

No traces of this material can be found even in the form of deposits of finer granulometry, which may be explained by the elimination of the uniform orientation of drainage toward South Somogy by then, and the still existing opportunity for the flow across the present area of the lake, up to the southern rim of the Balaton Basin and the northern reaches of the meridional valleys. Together with other data this should be considered an argument for the stadial subsidence of the Balaton Basin (Marosi, S. 1960, 1970; Szilárd, J. 1960, 1967).

An extremely important evidence in the calculation of the rate of subsidence and its chronological stages are the low valley shoulders of the meridional valleys. Beside a lower valley shoulder of post-glacial origin with 4-8 m relative height and another one of Würm age with 15-20 m elevation, sloping toward the lake, there are remains of the initial (Middle Pleistocene) subsidence, such as fluviatile deposits containing debris

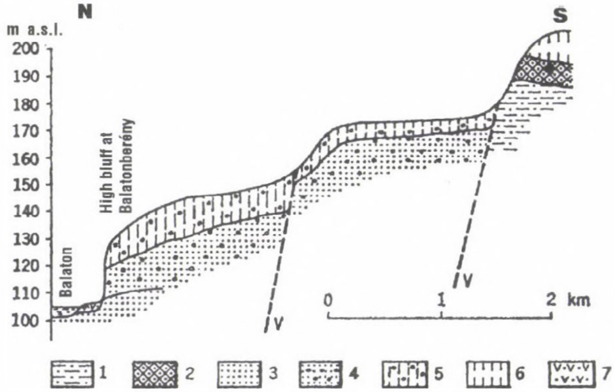

Fig. 9. Section across the northern end of the Marcali Ridge at Balatonberény. – 1 = Pannonian deposits (clay, sand); 2 = Late Pliocene cross-bedded sand; 3 = Pleistocene fluviatile sand with small grains of quartz and Permian Red Sandstone debris; 4 = Pleistocene fluviatile, partly slope deposit with dolomite debris (0.5-3 cm in diameter); 5 = Upper Pleistocene calcareous deposits in the loess and sand fraction with dolomite debris (0.3-1.0 cm in diameter); 6 = Upper Pleistocene loess, sandy loess; 7 = alluvium; V = fault zone

originating from the northern bank, that can be traced on the southern bank on the steps at a maximum altitude 180 m a.s.l., underlying loess-like sediments (*Figures 9 and 10*), but they do not continue southward.

The spatially and temporally stadial structural movements, having occurred during the Middle and Late Pleistocene resulted not only in the geomorphic levels mentioned above but also in freshwater limestone (travertine) horizons formed by springs related to the actual base line. Their most prominent occurrence can be found on Tihany Peninsula, along the northern bank of the lake in the vicinity of Balatonfüred, Bala-

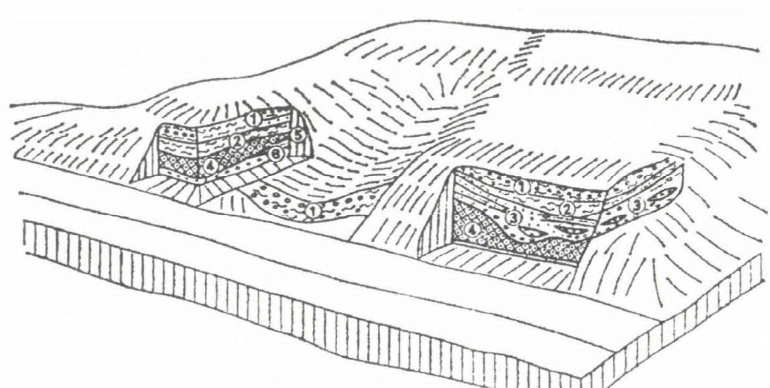

Figure 10 Sketch bloc-diagram of the abraded steep side of the lake basin at Zamárdi. 1 = slope deposits (filling the valley) in the loess and fine sand fraction with debris strings; 2 = slope loess with fossil humus-carbonate soil; 3 = medium-grain fluviatile sand with debris lenses (material of an alluvial fan from times before the existence of Lake Balaton); 4 = Late Pliocene cross-bedded sand; 5-6 = Upper Pannonian grey micaceous medium- and coarse-grain sand with overlain clay

tonalmádi, Vörösberény (*Fig. 2*), on the southern bank in the environs of Szántód, Balatonföldvár, Balatonszemes, at the earlier indicated levels. It should be mentioned that travertines also form part the „initial surface" e.g. in Tihany Peninsula at altitudes 230-300 m a.s.l. and lower, at 180-200 m; on Papvásár Hill at ca. 180 m a.s.l. mean altitude adjoining to higher levels of Balaton Uplands (Scheuer, Gy. and Schweitzer, F. 1974). They occur most frequently, however, at 180 and 150 m and traverines can be met between 120-135 m altitudes and occasionally even lower (Balatonfüred, Tihany Peninsula).

THE FORMATION OF THE LAKE BASIN

The depression of Balaton is not of a uniform origin; it rather consists of a series of partial catchments (Lóczy, L. Sen. 1913), disssected by ridges and valleys. J. Cholnoky (1918) denied this and claimed that the basin subsided between fault planes oriented in a northeast-southwest direction. M. Erdélyi (1961-62) assumed stripes having been filled between meridional valleys as proto-depressions originated from earlier stages of subsidence.

Based on borehole data S. Marosi (1969, 1970) and J. Szilárd (1962, 1967) argued that in the embayments of the meridional valleys opening to the lake the Pleistocene sequence of series is much more thicker, testifying about an uneven subsidence of the lake basin. The formation of a uniform water body was produced by the lowering ridges stretching between these depressions due to the abrasional activity of a Pleistocene terrace at an altitude of 112-114 m a.s.l., overlain and heightened at several places by slope deposits with interbedded fossil soil complexes. The formation of the Zala as a tributary of the lake at Balatonhídvég, had lifted the water level of the lake basin. In the periglacial phase Würm II this resulted in a higher water table of the lake and in formation of a contiguous water body.

This large-scale transgression extending to the whole lake basin was followed by a massive subsidence between the fault planes stretching below the lake bottom 1 km from the southern shore of Balaton described by Cholnoky and that to be found immediately along the northern bank. With the advancement of the regression accompanying this sinking, but at a relative high water level, hydromorphous and semi-hydromorphous soils formed in the Sóstó profile during a minor oscillation. Later on, with the differentiation of elevation between the base line and the margin of the shore, erosion and redeposition started in the form of linear delle and partly simultaneously, formation of forests and semi-hydromorphous soils took place in the first half of the Würm II-III interstadial.

During the rest phases of the mentioned interstadial, as a result of the decreasing rate of subsidence of the lake basin and increasing precipitation a new transgression (exceeding the previous one in height) occurred with inundation, hydromorphous soil and peat formation in the Sóstó profile (21,725±660 yr B.P.). Frequent oscillations led to sediment formation with a coterminous formation of semi-hydromorphous soils.

During the first part of Würm III, partly due to the climatic conditions (a weak evaporation) and in lack of drainage opportunity through Sió valley earlier available during high stages, an ever highest water level had been reached. This usually is 112-114 m a.s.l., indicated by sediment sequences in several places. It is not by chance the formation of the lake was correlated by B. Zólyomi with Würm III on the basis of palynological evidence.

Regression was especially strong during the second phase of Würm III, when the shore margin became land and the relief became liable to periglacial slope processes (pluviation, solifluction, cryoturbation) and various kind of sedimentation.

Starting with the post-glacial, under more humid but variable climatic conditions, a considerable erosion exerted by watercourses running to the lake, formation of the Sió Valley, oscillations of the shoreline and emergence of the related landforms, and, in a broader sense, further geomorphic evolution of the higher levels of Balaton Basin took place.

THE FORMATION OF THE LAKE BED (BOTTOM)

At the end of the Würm, over the land flanking the lake extended by the regression, the products of erosion (in the form of slope sediments, minor alluvial fans) were transported deeper inside the lake; several smaller and larger valleys had their tributaries beyond the present shoreline. This is evidenced by horizons inclined toward the Balaton within the uppermost sequences of sections along the southern bank. Having resulted from the increased precipitation and a temporary cessation of drainage through Sió, the water level had risen again.

During high stages the lake exerted significant abrasional activity. Rims on the southern bank, that becoming covered with slope sediments during the Würm had been underwashed, while on the northern bank the ridges built of consolidated rocks end steeply. In some places the lake bed had been widened by several hundred metres. As a result of this process the Riviera came into existence, while a rim of 5-10 m relative height, interrupting only at marches formed along the foothills of the Keszthely Mountains, and (on the southern shore) between Siófok to Balatonboglár, in the foreland of Marcali Ridge (between Balatonkeresztúr and Balatonberény), on the eastern slope of Castrum Ridge (stretching from the mouth of Zala River to Keszthely). Also during this time the lake underwashed high bluffs at Kenese, Akarattya and Világos, some slopes of meridional ridges running up to the shore, having turned them into steep high bluffs, similar to Boglár Hill and Fonyód Hill. The lake transgressed into Tapolca Basin, Nagyberek, on the southern shore into the estuary-like bays of meridional valleys, into valleys running from the Riviera; during this high stage Zala flowed into the lake in the northwestern embayment of the Little Balaton. On the slopes of the embayments the lake in several places formed abrasional terraces of some hundred metres width (*Figure 11*).

This rise of the water level led to an overspill after surpassing a threshold value; as a result, drainage through the Sió Valley became active again. Consequently,

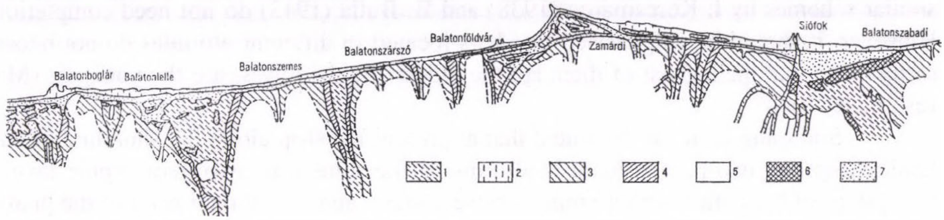

Fig. 11. Sketch of abrasional platforms and bars along the Outer Somogy shore of Lake Balaton. – 1 = alluvium, marshy pasture; 2 = younger, low-situated system of bars and intermediate abrasional platforms; 3 = older, higher situated abrasional platforms; 4 = younger abrasional platforms; 5 = fish ponds; 6 = older, higher situated bar; 7 = system of 2 to 3.5 km long bars

the level had steadily lowered and the lake retreated toward the centre of the basin. In the course of regression wave movements built systems of bars along the margins of the marhes, the shoreline had been straightened, the minor bays became closed by bars and, subsequently, became filled up by peaty and clayey sediments.

Nevertheless, this regression was presumably (even if partly) provoked by structural movements, by a repeated subsidence. Earlier in this study there was a reference to a fault stretching an average 1 km from the present southern shoreline as the border of an abrupt deepening. According to Cholnoky (1918) this scarp indicates the earlier extent of the lake which at that time was restricted to this smaller basin; the rim had been abraded, and was inundated only later, with the rise of the level of the water and its southward extension. In our opinion, however, this fault is the youngest, along which the subsidence of the middle section of the lake basin occurred latest. This steep rim with a height of 2.5-3 m was partly formed by abrasion immediately after a period of a stage 5-6 m lower (Early Holocene, a dry phase of *Corylus*, indicated by bottom peat deposits), due to a rising level of the lake.

This stadial subsidence in the Balaton region was restricted to a limited area. The structural movements creating the faulting, together with a dry and warm *Corylus* phase were responsible for the extremely low stage of Lake Balaton (the lowest one since its existence).

The peaty-marshy deposits recurring in exposures of the embayments of the lake within a 10 m relative height (relating to the lowest stages and reaching 109 m a.s.l.) are an evidence of the oscillations of the lake level.

Similarly, Holocene bar surfaces should be considered testimonies to changes in the lake level. Their maximum altitude is 109-110 a.s.l. (between Balatonberény and Balatonszentgyörgy) i.e. together with the highest occurrence of the peaty-marshy deposits they indicate a maximum stage during the Holocene.

Below this elevation the level underwent several fluctuations and the system of bars with different altitudes have been confined to the actual level. This process was described by J. Cholnoky in detail, classifying Holocene bars into three categories of elevation (1.5, 2.5-3 and 4 m respectively above the present medium level). This and similar schemes by I. Korcsmáros (1938) and B. Bulla (1943) do not need completion. However, it should be emphasised that bars located in different altitudes do not necessarily mean that the highest of them are the oldest and the lowest are the youngest (Marosi, S. 1970).

Summing up it can be stated that at present the strip along the shoreline of Balaton comprises two predominant landforms, at the same time two geomorphic levels: the system of bars often with a young terrace system, and the alluvial level of the peaty-marshy deposits of the former laguna. These marshy areas were detached from the lake by the systems of bars, straightening at the same time the shoreline. The extensive alluvial marshy levels are still spongy; their utilisation both for peat extraction and as nature reserves is typical and their important function is cleaning the arriving polluted watercourses.

REFERENCES

Balogh, Kadosa, Jámbor, Á, Partényi, Z., Ravasz-Baranyai, L. and Solti G. (1982). A dunántúli bazaltok K/Ar radiometrikus kora. Földtani Intézet Évi Jelentése 1980-ról. pp. 243–259

Bartha, F. (1959). Finomrétegtani vizsgálatok a Balaton környéki felsõpannon képzõdményeken. Földtani Intézet Évkönyve 48. Budapest

Bulla, B. (1943). Geomorfológiai megfigyelések a Balatonfelvidéken. Földrajzi Közlemények 71. pp. 18–45

Bulla, B. (1958). A Balaton és környéke földrajzi kutatásairól. Földrajzi Közlemények 6. (82.) pp. 313–324

Cholnoky, J. (1918). A Balaton hidrográfiája. A Balaton Tud. Tanulm. Eredményei I. köt. II. rész, Budapest

Cserny, T., Nagy-Bodor, E. and Hajós, M. (1991). Contributions to the sedimentology and evolution history of Lake Balaton. In: Pécsi, M. and Schweitzer, F. (Eds.): Quaternary environment in Hungary. Studies in Geography in Hungary 26. Akadémiai Kiadó, Budapest, pp. 75–84

Cserny, T. and Nagy-Bodor, E. (1996). A Keszthelyi-öböl vízzel borítottságának fejlõdéstörténete. „A Balaton és vízgyûjtõjének ökológiai állapota". Hidrológiai Közlöny, pp. 98–100

Erdélyi, M. (1961–1962). Külsõ-Somogy vízföldtana. Hidrológiai Közlöny 41. pp. 441–458, 42. pp. 56–65

Jámbor, Á. (1980). A Dunántúli-középhegység pannóniai képzõdményei. MÁFI Évkönyv 62. 259 p.

Jugovics, L. (1953). A Déli Bakony és a Balatonfelvidék bazaltterületei. Földtani Intézet Évi Jelentése, Budapest

Jugovics, L. (1971). A Balatonfelvidék és a Tapolcai-medence bazaltterületeinek felépítése. MÁFI Évi Jelentése 1968-ról, pp. 223–244

Juhász, Á. (1972). A Magas-Bakony durva üledékeinek morfometriai vizsgálata. Földrajzi Értesítõ 20. 2–3. pp. 159–185

Juhász, Á. (1975). A VEAB környezetvédelmi és tájhasznosítási kutatási területének természetföldrajzi tájfelosztása. Környezetvédelmi és Tájhasznosítási Kutatási Fõirány 1975–1979. Veszprém, pp. 7–32

Juhász, Á. (1987). A Bakonyvidék. In: Magyarország tájföldrajza. A Dunántúli-középhegység B. Akadémiai Kiadó, Budapest, pp. 11–42

Kertai, Gy. (1957). A magyarországi medencék és a kõolajtelepek szerkezete a kõolajkutatás eredményei alapján. Földtani Közlöny, 87. pp. 383–393

Kéz, A. (1943). Újabb teraszmegfigyelések a Zala mentén. Földrajzi Közlemények 71. pp. 1–18

Korcsmáros, J. (1938). A Keszthelyi halomgerinc balatoni szinlõi. Földrajzi Közlemények 66. pp. 235–252

Körössy, L. (1963). Magyarország medenceterületeinek összehasonlító földtani szerkezete. Földtani Közlöny 93. pp. 153–172

Kretzoi, M. (1953). A negyedkor taglalása gerinces fauna alapján. Alföldi Kongresszus. Akadémiai Kiadó, Budapest

Láng, S. (1958). A Bakony geomorfológiai képe. Földrajzi Közlemények 6. (82.) pp. 325–346

Lóczy, L. (sen.) (1913). A Balaton környékének geológiai képzõdményei és ezeknek vidékek szerinti telepedése. A Balaton Tud. Tanulm. Eredményei I. köt. I. rész. I. sz. Budapest

Marosi, S. (1960). Felszínfejlõdési problémák Belsõ-Somogyban. A Magyar Földrajzi Társaság XIV. Vándorgyûlése. Zalaegerszeg, pp. 31–35

Marosi, S. (1962). Belsõ-Somogy. Földrajzi Értesítõ 11. pp. 61–68

Marosi, S. (1965). Belsõ-Somogy felszínalaktana és gazdasági életének természeti földrajzi feltételei. Kandidátusi értekezés. Kézirat. Budapest

Marosi, S. (1969). Adatok Belsõ-Somogy és a Balaton hidrogeográfiájához. Földrajzi Értesítõ 18. pp. 419–456

Marosi, S. (1970). Belsõ-Somogy kialakulása és felszínalaktana. Földrajzi Tanulmányok 11. Akadémiai Kiadó, Budapest, 169 p.

Marosi, S. and Szilárd, J. (1958). A Balaton somogyi partvidékének geomorfológiai képe. Földrajzi Közlemények 6. (82.) pp. 347–361

Marosi, S. and Szilárd, J. (1974). Újabb adatok a Balaton koráról (A Balatonszabadi-Sóstónál levõ feltárás vizsgálata). Földrajzi Értesítõ 23. pp. 333–346

Marosi, S. and Szilárd, J. (1975). Balaton menti tájtípusok ökológiai jellemzése és értékelése. Földrajzi Értesítõ 24. pp. 439–477

Marosi, S. and Szilárd, J. (1977). The Late Pleistocene Origin and Evolution of Lake Balaton. Földrajzi Közlemények 1–3. pp. 17–28

Marosi, S. and Szilárd, J. (1983). A Balatoni Riviera tájtipológiai jellemzése és értékelése. Földrajzi Értesítõ 32. 3–4. pp. 441–450

Marosi, S., Juhász, Á. and Szilárd, J. (1984). Tájak és tájtípusok a Balaton vízgyûjtõjén. A Balaton kutatás újabb eredményei III. MTA Veszprémi Akadémiai Bizottság kiadványa, pp. 7–105

Marosi, S. and Szilárd, J. (1986). Szántódpuszta és környéke természetföldrajza. Szántódpuszta, Siotour, Szántódi füzetek 13. 105 p.

Mike, K. (1976). A Balaton kialakulása és fejlõdése. Vízrajzi Atlasz 21. Balaton 1. Hidrográfia, Geomorfológia. VITUKI. Budapest, pp. 30–38

Mike, K. (1980). Õsmedernyomok a Balaton környékén. Földrajzi Értesítõ 29.

Pécsi, M. (1956). Újabb völgyfejlõdéstörténeti és morfológiai adatok a Duna-völgy Pozsony (Bratislava)–Budapest közötti szakaszáról. Földrajzi Értesítõ 5. pp. 21–41

Pécsi, M. (1959). A magyarországi Duna-völgy kialakulása és felszínalaktana. Földrajzi Monográfiák III. Akadémiai Kiadó, Budapest

Pécsi, M. (1962). A magyarországi pleisztocénkori lejtõs üledékek és kialakulásuk. Földrajzi Értesítõ 11. pp. 19–39

Pécsi, M. (1969). A Balaton tágabb környékének geomorfológiai térképe. Földrajzi Közlemények 17. (93.) pp. 101–112

Pécsi, M. (szerk.) (1988). A Dunántúli-középhegység A. A domborzat. In: Magyarország tájföldrajza. Akadémiai Kiadó, Budapest, pp. 140–186

Scheuer, Gy. and Schweitzer, F. (1974). Adatok a Balaton-felvidéki forrásüledékek vizsgálatához. Földrajzi Értesítõ 23. pp. 347–357.

Schweitzer, F. (1994). A Kárpát-medence belsejének későneogén domborzatformálódása. Akad. dissz. Kézirat. MTA FKI. Budapest. 170 p.

Schweitzer, F. (1997). On Late Miocene–Early Pliocene desert climate in Carpathian Basin. Zeitschrift für Geomorfologie. Geomorphology and Changing environs in Central Europe. Ed. Hamza, B.–Lóczy, D. pp. 37–43

Szádeczky-Kardoss, E. (1938). Geologie der rumpfungarländischen Kleinen Tiefebene. Sopron

Szentes, F. (1943). Aszód távolabbi környékének földtani viszonyai. Magyar Tájak Földtani Leírása. 4. Budapest
Szilárd, J. (1960). Külsõ-Somogy néhány felszínalaktani kérdése. A Magyar Földrajzi Társaság XIV. Vándorgyûlése. Zalaegerszeg, pp. 36–42
Szilárd, J. (1962). Külsõ-Somogy. Földrajzi Értesítõ 11. pp. 68–74
Szilárd, J. (1963). A Külsõ-Somogyi-dombság felszínalaktana és gazdasági életének természeti földrajzi feltételei. Kandidátusi értekezés. Kézirat
Szilárd, J. (1967). Külsõ-Somogy kialakulása és felszínalaktana. Földrajzi Tanulmányok 7. Akadémiai Kiadó, Budapest
Szilárd, J. (1970). Formation du lac. Balaton. Revue de Geogr. Ph. et de Geol. Dynam. pp. 127–136
Vadász, E. (1960). Magyarország földtana. II. kiadás. Akadémiai Kiadó, Budapest
Zólyomi, B. (1952). Magyarország növénytakarójának fejlődéstörténete az utolsó jégkorszaktól (hozzászólásokkal). MTA Biológiai Tudományok Osztálya Közleményei. pp. 491–530

L. Bassa–Á. Kertész (eds): Windows on Hungarian Geography
Studies in Geography in Hungary 28, Geographical Research Inst. HAS, Budapest 1998, pp. 53–69

MODELLING KARST SURFACE EVOLUTION: QUANTITATIVE DESCRIPTION OF SURFACE VERTICAL KARSTIFICATION

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INTRODUCTION

Pipes and fissures are created by the infiltrating water dissolving the walls of the cracks in the rock. This type of surface karstification (vertical karstification) is only enabled if the cracks are not destroyed in the embryonic stage by the fragmentation of the blocks.

Using the differential equation for solution (Rickard, D. - Sjöberg, E. L. 1983, 1984, Dublyansky, J. V. 1987, 1988) we attempt to set up a theoretical model of vertical karstification. By this means the factors, determining the rate of evolution of the developing fissures and pipes, can be examined. The age of development of the formations can be calculated and the relation between the rate of their evolution and the shape can be examined.

Recently, the denudation of karstic reliefs is attributed to surface dissolution (Balázs, D. 1969, Jakucs, L. 1977, Zámbó, L. 1987), solution occurs on boundary surfaces (between the rock and the solvent). In the course of surface dissolution, besides the characteristic dolines, formations characterized by vertical measurements also develop (Jakucs, L. 1977, Veress, M. and Péntek, K. 1990), therefore these are summarized as "vertical karstic formations".

The most frequent formations are pipes, shafts and fissures or their combinations.

The more pronounced the vertical karstification of a karst region, the greater is the difference between the denudation of this region and karst regions characterized by dolines. While in the latter case the surface shifts downwards nearly parallel to itself during denudation, in the former one the rock is removed from the sides similarly to areas where denudation is due to linear erosion. These forms are the surface formations of the karstic relief. Besides their origin by solution the dominance of vertical dimension is a common feature. While the fissures might be many times narrower compared to their longitudinal extent, there is no such difference in the case of pipes and shafts. The latter resemble cylinders. Formations of a smaller diameter (max. 1–2 m) and of a larger diameter are referred to as pipes and shafts respectively. Neither pipes nor shafts can be discriminated definitely from avens. These objects can be termed avens (as they are actually called by some authors).

Presumably, the difference between avens and vertical karst formations is both dimensional and genetical. Avens are much bigger than the mentioned vertical karst formations. But, it is not impossible that avens partly or totally developed similarly to vertical karst formations.

However, it is possible that other factors (erosion, collapse, etc.) also played some part in the development of several avens.

GEOGRAPHICAL AREAS OF VERTICAL KARSTIFICATION

This type of karstification and the formations are characteristic or even determinant of the following karst regions:

– In alpine areas (especially above the tree line) vertical karst features together with karren represent the karstic formations (Jakucs, L. 1971, Kunaver, J. 1984). The size and frequency of these formations generally increase with height.

– Solutional fissures are frequent in the top levels of tropical residual hills (Balázs, D. 1984), representing fossilized vertical karstification. Presumably, this process also plays role in the formation of intermontane lowlands but in this case = in contradiction to temperate karstification) vertical karstification did not stop at an embryonic stage. It is also supported by J. R. Paton's (1964) opinion that intermontane lowlands developed by the fustions of the fissures widening by solution.

– In gypsum and salt karsts where the solutional shafts and pipes can partly or fully represent the surface karstic formations (Kósa, A. 1981, Szablyár, P. 1981, Takács-Bolner, K. 1982, Zentai, Z. 1990).

– In temperate zone covered karsts (e.g. Bakony-Mountains, Mecsek-Mountains, Padis Romania), where karstic formations, following vertical karstification, open up to the surface or function as sinkholes (Veress, M. 1982). the formations may occur as doline-like depressions in the covering sediment, but may form fissures as well (Veress, M. 1992). Some avens of the actually uncovered temperate karst are most likely the productions of this type of karstification (Sárváry, I. 1970).

– In allogenic karsts sinkholes developed at rock boundaries, since their development at the beginning is due to solution and only later to erosion, after an adequate hydrological and morphological stage is achieved.

Naturally, in a karst region, vertical karst formations may alternate with dolines. Moreover, formations of vertical karstification may occur even in the dolines (J. Jennings, N. 1986).

FORMATION OF PIPES AND FISSURES

Surface karstic denudation is the result of surface dissolution, i. e. pipes and fissures develop through this process. Water, moving along joints, dissolves rock surfaces widening the fissures.

Thus, surface dissolution of karstic reliefs has two types: horizontal and vertical dissolution (see below). These can develop in the following way (*Figure 1*).

The infiltrating solution widens the cracks in the rock (primary fissures). This is the first stage of evolution. The water film covering the the rock surface rapidly becomes saturated during the dissolution and the dissolved material is carried into the primary fissures by the infiltrating water. Dissolution of rock walls in a primary fissure is due to a process when the sinking saturated solution is replaced by new unsaturated solution. If primary fissures are formed closely enough, consequently the bedrock is broken up, as a result of widening the primary fissures, and horizontal karstification begins. The water film covering the rock surface is not uniform but develops separately on each fragment formed during disintegration. In this way the infiltrating water enters into contract with separate water film surfaces. This type of dissolution, that is when debris zone is formed, is called horizontal karstification (M. Veress and K. Péntek, 1990, 1995). In this case denudation of the karst topography is due to the constantly

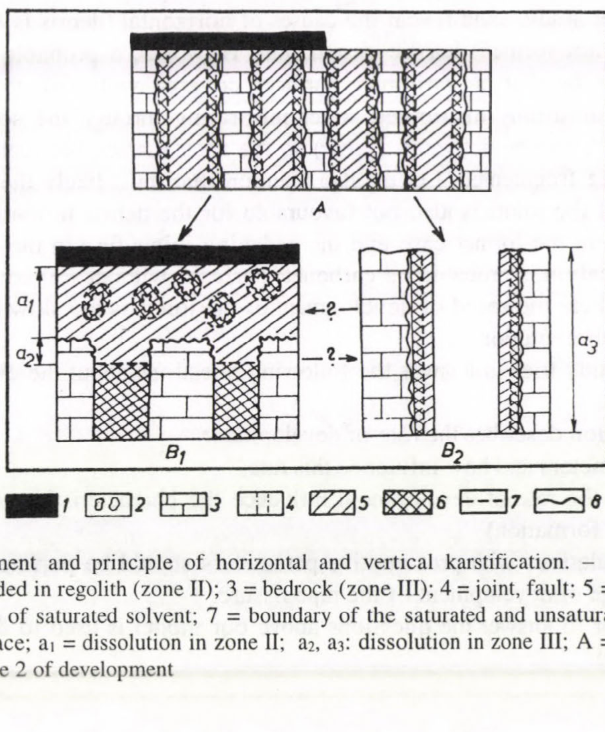

Fig. 1. Development and principle of horizontal and vertical karstification. – 1 = soil (zone I); 2 = debris embedded in regolith (zone II); 3 = bedrock (zone III); 4 = joint, fault; 5 = zone of unsatured solvent; 6 = zone of saturated solvent; 7 = boundary of the saturated and unsaturated zone; 8 = dissolving rock surface; a_1 = dissolution in zone II; a_2, a_3: dissolution in zone III; A = stage 1 of development, B = stage 2 of development

deepening debris zone. (Practically, to the degree that the debris zone diminishes by dissolution, it is supplemented from the bedrock by the process mentioned above). If without disintegration of the rock walls primary fissures attain the width when the infiltrating solvent can form a layer on the walls covered by water film, no debris zone is formed during their further growth. The vertical karst features developed in the second stage of evolution widen and thereby deepen by the parallel retreat of the bordering walls. The developing karst features are not only fissures, but also evens at the crossing of fault planes. Dissolution in the second stage (vertical karstification) is geometrically similar but it takes place quicker than it was during the first stage. In other words, the wet walls always maintain contact with fresh solvent. The duration of the dissolution is not determined by the slow sinking of the solvent filling the fissures, but by the duration of time it receives unsaturated solvent from the surface. Vertical karstification is the result of this latter type of dissolution, and thereby vertical karst features are formed. At present it cannot be proved, but it is presumed, that under certain changed circumstances the two karstification types become interchangable. While in horizontal karstification dissolution along fissures continues only if the developed debris zone lessens to the adequate degree by dissolution (the solution attaining the developed debris dissolves the surface of the fragments), during the vertical karstification avens and fissures widening by dissolution can deepen without obstacles, provided they have a sufficient width. After all, unsaturated water can get inside, because without debris zone solution flowing down on the walls becomes saturated only at a considerable depth.

Another study could reveal the causes of horizontal (debris is formed) and vertical (debris is not formed) karstic denudation. However, a probable cause of debris formation might be that on carbonate surfaces covered with soil, the parent rock is reached by an uniformly distributed water infiltrating through the soil. Thus, all the joints in the rock can be activated (grow) so the rock masses between them are small enough for being fragmented. Let us also mention that most likely the too slow or too fast widening of the joints is also not favourable for the debris formation. The process becomes steady in the former case and the widening joints fuse in the latter one. Thus, vertical karstification is probable on carbonate surfaces without soil cover (alpine karst) and on karsts where the speed of development of the joints is too slow or too fast in the first stage of their evolution.

This study tries to answer the following questions about the evolution of pipes and fissures:

– what function describes the rate of development,

– what parameters and how influence this rate,

– how does the rate of development influence the characteristics of evolution (e.g. the shape of the formation)

– what calculations with presumptive parameters should be performed for the estimation of the age of development of the pipe fissure.

In order to answer the questions above our model is used to follow the development of a pipe.

THE MATHEMATICAL MODEL OF THE SURFACE VERTICAL KARSTIFICATION

Let us examine a joint or a fault in the karstic rock (limestone) that is approximately vertical and ends at the surface. This fault gets waters flowing down upon the surface so the CO_2 originates from the atmosphere and not from the soil. Let us suppose that the solvent infiltrates at v[m/s] speed and the rock is being dissolved.

Depending on the water supply, the solution process is assumed to be quasistationary, the flow is laminar being in thermal equilibrium with the environment.

First, the saturation process of the infiltrating solution is analysed. It is assumed, that the entering water does not, contain dissolved limestone or contains it in a very small amount. The infiltrating solution contacting the surface of the rock exerts its solvent ability until it becomes saturated.

Let m[kg] denote the limestone mass that can be dissolved for achieving saturation by the V_0[m^3] volume unit of the downwards moving solution at x [m] depth from the surface.

Our experience allowed to set up two hypotheses: If $-dm$ is the decrease of m during the dx downwards moving of the solution, the CO_2 content of which is unchanged, and it does not mix with other solutions, then

1) $-dm$ is directly proportional to the value of m that is, the closer the solution approaches saturation when infiltrating downwards, the less ability it has for further solution:

2) $-dm$ is directly proportional to the value of dx, that is the longer section the solution passes downwards, the less ability it has for solution.

Therefore

/1/ $$-dm = \lambda \cdot mdx$$

where λ[m^{-1}], λ>0 is the constant characteristic of the solution process. Parameter λ practically characterises the solvent power of the infiltrating solution. From /1/ after integration

/2/ $$m = m_0 \cdot e^{-\lambda x}$$

is dissolved, when $m=m_0$ if x=0, where m_0[kg] denotes the maximum limestone mass that the unit volume of water can take up. If C_i is the limestone concentration of the infiltrating solution at x depth and C_e is the equilibratory concentration of saturated solution, then function $C_i=C_i$(x) is obtainable from formula /2/. According to it, in the case of unit volume of solution C_e and C_e-C_i are the equivalents to quantities m_0 and m, respectively. Thus

/3/ $$C_e - C_i = C_e \cdot e^{-\lambda x}$$

that is

$$/4/ \qquad C_i = C_e \cdot (1 - e^{-\lambda x})$$

is dissolved. Using the above equation, a formula is obtained which describes the shape and the temporal evolution of the formation developed during vertical karstification.

D. Rickard's, E. L. Sjöberg's (1983, 1984) and J. V. Dublyansky's (1987, 1988) differential equation is used for the mathematical description of the first stage:

$$/5/ \qquad \frac{dm}{dt} = \frac{k_K k_T}{k_K + K_T} \cdot S \cdot (C_e - C_i),$$

where

k_K[m/s] is the rate of chemical dissolution
k_T[m/s] is the rate of material transport in the boundary zone
$S[m^2]$ is the surface of the dx wide zone at x depth of the vertical karstic formation
dm[kg] is the limestone mass dissolved from zone of S surface at x depth of the vertical karstic formation during dt[s] time (*Figure 2*)

According to our experiences $k_K.k_T \ll v$. Let us determine the R[m] radius of the ideal vertical karstic formation. This radius is the function of x[m] depth measured from the karstic surface and the t[s] time. Let us search for the explicit form of $R=R(x,t)$ function which is the special solution of differential equation /5/ for the case when function $C_i=C_i(x)$ has the form of /4/.

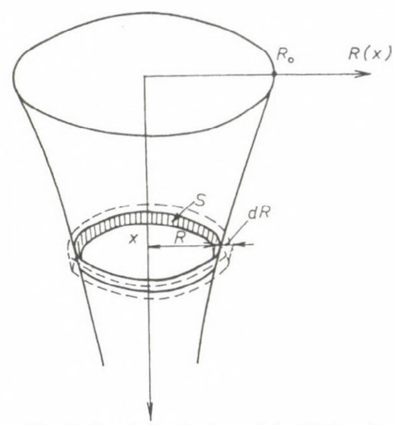

Fig. 2. Special solution of the Rickard-Sjöberg-Dublyansky differential equation

If $\rho[kg/m^3]$ is the density of the limestone, dR[m] is the increase of the radius at x depth during dt time, then

$$/6/ \qquad \frac{dm}{dt} = \rho S \frac{dR}{dt}$$

with the use of which equation /5/ has the

$$/7/ \qquad \frac{dR}{dt} = \frac{k_K k_T}{k_K + k_T} \frac{C_e - C_i}{\rho}$$

form. From this, by using /4/

/8/ $$\frac{dR}{dt}=\frac{k_K k_T}{k_K+k_T}\frac{C_e}{\rho}e^{-\lambda x}$$

and

/9/ $$\frac{dt}{dR}=\left(\frac{1}{k_K}+\frac{1}{k_T}\right)\frac{\rho}{C_e}e^{\lambda x}$$

follows.

According to J. V. Dublyansky (1987) formula

/10/ $$k_T=\frac{85}{8}\frac{1}{d}\cdot\sqrt[3]{D^2 v}$$

is valid for the rate of material transport in the boundary zone, where d[m] is the characteristic measurement of the conduit, here the diameter of the conduit at x depth, that is $d=2R$,

$D[\mathrm{m}^2/\mathrm{s}]$ diffusion constant,
$v[\mathrm{m}^2/\mathrm{s}]$ kinematic viscosity coefficient of the flowing solution.

Equation /9/, by using /10/, can be written in the

/11/ $$\frac{dt}{dR}=\left(\frac{1}{k_K}+\frac{16}{85}\cdot\frac{R}{\sqrt[3]{D^2 v}}\right)\frac{\rho}{C_e}e^{\lambda x}$$

form, from which the explicit form of function $t=t(R)$ can be derived by integration:

/12/ $$t=\frac{\rho}{C_e}e^{\lambda x}\left(\frac{R}{k_K}+\frac{8}{85}\cdot\frac{R^2}{\sqrt[3]{D^2 v}}\right)$$

It can be seen that with data denoted in years the term linear in R is negligible in relation to the term quadratic in R, thus formula /12/ has the simpler

/13/ $$R=a\cdot\sqrt{t}\cdot e^{-\frac{\lambda}{2}x}$$

form, where

/14/ $$a=\sqrt{\frac{85}{8}\cdot\sqrt[3]{D^2\cdot\nu}\,\frac{C_e}{\rho}}.$$

The explicit form of function $R=R(x, t)$ is provided by formula /13/.

In the case of fixed t or x, R is the exponential function of x depth and the quadratic function of t time, respectively. The a quantity seen in formula /14/ is related to the activity of the solution process (*Figure 3*).

From formula /13/ after substituting $x=0$ the

/15/ $$R_0=a\sqrt{t}$$

radius of the orifice of the ideal pipe is obtained as the function of time.

Analysing formula /13/ it can be seen, that the shape and evolution of the pipe is defined by the a and λ parameter pair.

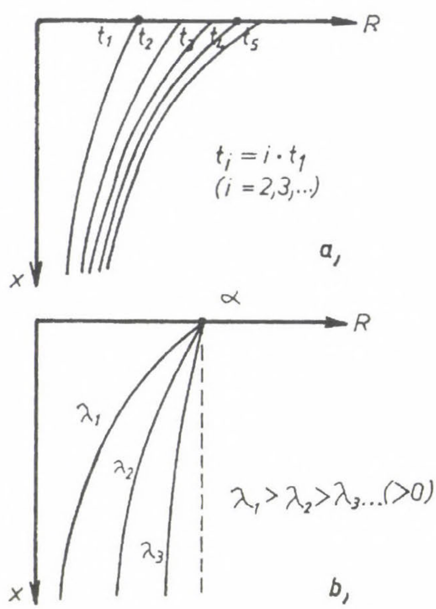

Fig. 3. Function R=R(x,t). – a = phases of growth at equal intervals; b = rise of the curve with different λ parameters

The higher the value of $a(>0)$ after a given time passing, the larger the horizontal size of the pipe. The lower the value of $\lambda(0)$ after a given time passing, the steeper the walls and the larger the vertical size of the pipe. The model describes an ideal, symmetrical pipe narrowing downwards and is theoretically endlessly deep. Our model is valid for the description of the first stage of evolution of real shafts only when the infiltrating solution is not saturated.

Formula /13/ postulates continuous water supply. Practically, it is intervallical, thus a h proportion coefficient can be determined for the given pipe. If during a fixed T_0 time - e.g. for t_0 time during a year - water infiltrates into the examined sinkhole, the η proportion coefficient is defined by formula

/16/ $$\eta=\frac{t_0}{T_0}$$

Considering the above formula /13/ shows the

/17/ $$R=a\cdot\sqrt{\eta\cdot t}\cdot e^{\frac{-\lambda}{2}x}$$

form.

The mathematical description of the second stage of the evolution is discussed in the followings. At the end of the first evolutional stage the ideal pipe obtains the horizontal dimensions when the solvent is not able to fill it up during the solutional periods, but runs down on its walls.

Simplifying the argument the shape of the pipe developed by the end of the first evolutional stage is regarded as a cone narrowing downwards, the sides of which enclose α angle with the horizontal. If the radius of the orifice of the cone is R_0 and the intensity of the incoming water is I, then according to L. D. Landau and E. M. Lifsic (1980):

/18/ $$I = 2R_0\pi h_0 \frac{gh_0^2 \sin\alpha}{3\nu}$$

where $A_0 = 2R_0\pi h_0$ is the flow section at the orifice, $v = \frac{gh_0^2 \sin\alpha}{3\nu}$ is the rate of flow at the same location, h_0 is the thickness of the solution, g is the gravitational acceleration and ν is the kinematic viscosity coefficient (*Figure 4*)

If I is known (measurable or calculable), the h_0 can be determined by /18/:

/19/ $$h_0 = \sqrt[3]{\frac{3\nu I}{2R_0\pi g \sin\alpha}}$$

If δ^*[m] denotes the thickness of the Kármán-boundary zone in the solution flowing down on the wall of the pipe, and x'[m] denotes the distance from the orifice covered by the solution, then according to F. M. White (1979):

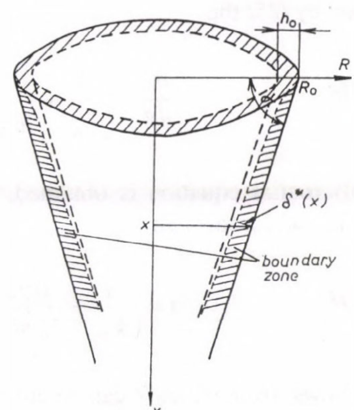

Fig. 4. Diagram of the water flow on the wall of the ideal pipe

/20/ $$\frac{\delta^*}{x'} = \frac{1.721}{\sqrt{\mathrm{Re}_{x'}}}$$

where

/21/ $$\mathrm{Re}_{x'} = \frac{vx'}{\nu}$$

is the local Reynolds number. Then, δ^* by using /20/ and /18/

/22/ $$\delta * = \frac{1.721x'}{\sqrt{\frac{gh_0^2 \sin\alpha}{3\nu^2} \cdot x'}} = \frac{2.981\nu}{h_0\sqrt{g \sin\alpha}}\sqrt{x}$$

where

/23/ $$x = x' \cdot \sin\alpha$$

is the depth from the orifice. As the rate of material transport is

/24/ $$k_T = \frac{D}{\delta^*}$$

thus, by using /22/

/25/ $$\frac{1}{k_T} = \frac{2.981\nu}{h_0\sqrt{g}D\sin\alpha} \cdot \sqrt{x}$$

follows.

As discussed above, with the help of D. Rickard - E. L. Sjöberg (1983), J. V. Dublyansky's (1987) formula /5/ equation /9/ was obtained, from which, after substitution by /25/ the

/26/ $$\frac{dt}{dR} = \left(\frac{1}{k_K} + \frac{2.981\nu}{h_0\sqrt{g}D\sin\alpha}\sqrt{x}\right) \cdot \frac{\rho}{C_e} e^{\lambda x}$$

differential equation is obtained. After integration and substitution of g=9.81 m/s^2 with fixed x formula

/27/ $$t = \left(\frac{1}{k_K} + \frac{0.952}{h_0 \sin\alpha} \frac{\nu}{D}\sqrt{x}\right) \cdot \frac{\rho}{C_e} e^{\lambda x} \cdot R$$

follows, from which R can be determined:

/28/ $$R = \left(\frac{1}{k_K} + \frac{0.952}{h_0 \sin\alpha} \frac{\nu}{D}\sqrt{x}\right)^{-1} \cdot \frac{C_e}{\rho} e^{-\lambda x} \cdot t$$

Formula /27/ and /28/ demonstrates that in our model, in the second stage of evolution the R radius is the linear function of t time at an optional but fixed x depth of the pipe.

In further descriptions the relation of the angle of the walls and the depth could be regarded, though the method above gives satisfactory results as we shall see in the followings.

Similarly to formula /13/, /28/ also postulates continuous water supply. With the help of η proportion coefficient explained in /16/ formula /28/ obtains the

/29/ $$R=\left(\frac{1}{k_K}+\frac{0.952}{h_0\sin\alpha}\frac{\nu}{D}\sqrt{x}\right)^{-1}\cdot\frac{C_e}{\rho}e^{-\lambda x}\cdot\eta\cdot t$$

form.

The second stage of the evolution of the pipe described above needs much more time, therefore the length of the first "embryonic" stage is negligible for the estimation of the age.

The possible improvement of the mathematical model of vertical karstification is discussed regarding the horizontal growth of the pipe as well. The value of η proportion coefficient introduced in /16/ was supposed to be constant and unrelated to the momentary R_0 radius of the orifice characterising the horizontal dimensions of the pipe. Actually, solution of increasing intensity is needed for the quickening of the solution as the geometrical measurements of the shaft increase, that is η decreases with the growing dimensions. Under given climatic circumstances the developing shaft achieves the inactive stage, when due to its size, even the heaviest rain fails to start a global solution process. A global solution which includes the total surface of the pipe postulates the inequality between the δ^* thickness of the boundary zone given in /22/ and the h thickness of the water flow on the wall of the pipe:

/30/ $$\delta^* < h \ .$$

Both members of the inequality depend on x depth measured from the surface. $\delta^*(x)$ is seen in formula /22/ and $h(x)$ in

/31/ $$h(x)=\frac{M}{M-x}h_0$$

where M is the depth of the pipe regarded as a cone, and h_0 is the thickness of the solution on the walls at the orifice (*Figures 5* and *6*).

Using /19/, /22/ and /31/, formula /30/ can be written in the following form:

/32/

$$\frac{2.981\nu\sqrt{x}}{\sqrt{g}\sin\alpha}<\frac{M}{M-x}\left(\frac{3\nu I}{2R_0\pi g\sin\alpha}\right)^{\frac{2}{3}}$$

which, after simple transformations, is

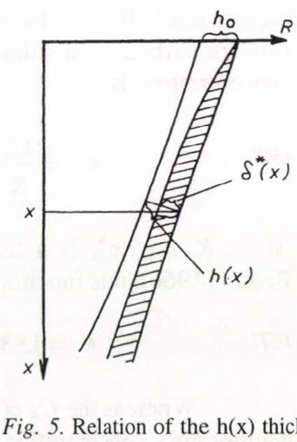

Fig. 5. Relation of the h(x) thickness of the infiltrating water on the wall of the ideal pipe and the thickness of δ(x) boundary zone

/33/ $$K < \frac{I}{R_0}$$

Here K represents the parameters characterising the given pipe K is a constant independent of x depth ($0 \leq x \leq m$). That is, the minimal water intensity I_{min} necessary for the global solution of the pipe is directly proportional to R_0 radius of the orifice, that is

/34/ $$I_{\min} = K \cdot R_0$$

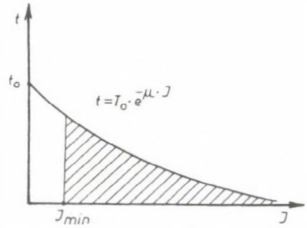

Fig. 6. Precipitation time of a given karstic area as the function of the intensity of precipitation t=t(I)

The ages of pipes can be estimated by formula /29/. First the parameters of formula /29/ are determined.

For the determination of C_e equilibratory concentration of the saturated solution we start from the concentration of the C_{CO_2} absorbed in the water from the atmosphere.

On the basis of Henry-Dalton's law

/35/ $$C_{CO_2} = 1.9634 Lp$$

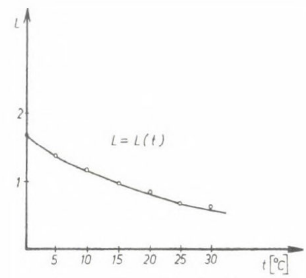

Fig. 7. Function L=L(t)

where p is the partial pressure of the CO_2 in the atmosphere, L is the solution coefficient of CO_2, which is the decreasing function of temperature. Function L=L(t) is seen in *Figure 7*, constructed on the basis of L. Jakucs's data (1971). The C_{CO_2} concentration consists of two parts; concentration of absorved in calcium carbonate C_K [kg/m^3] the equilibratory concentration C_T [kg/m^3] necessary to keep the calcium carbonate in solution. According to J. Tillmans (1932) the relation of the two concentrations is

/36/ $$C_T = \frac{C_K^3}{K_t}$$

where K_t [kg^2/m^6] is a factor conditional on an absolute temperature. Following D. Balázs (1966), this function is

/37/ $$K_t = 1.835 \cdot 10^2 \cdot e^{-0.029 \cdot T}$$

Whereas the C_K concentration of the fixed CO_2 is directly proportional to the C_e equilibratory concentration according to formula

/38/ $$C_e = 2.278 \cdot C_K$$

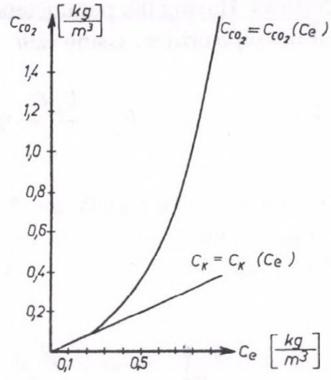

Fig. 8. Function $C_K = C_K(C_e)$ and $C_{CO_2} = C_{CO_2}(C_e)$

thus after D. Balázs (1966) by using formulas /35/ - /38/ the function of C_{CO_2} and C_e can be constructed seen in *Figure 8*. In the case of the studied atmospheric C_{CO_2} values ($0 < C_{CO_2} \leq 10^{-3}$ kg/m^3). C_T is negligible, thus formula

/39/ $$C_e = 2.278 \cdot C_{CO_2}$$

is approximately valid since $C_{CO_2} = C_K$. Parameters k_K D and ν can be determined by the Arrhenius equations.

/40/ $$k_K = A_K \cdot e^{-\frac{E_K}{R' \cdot T}},$$

where $A_K = 5{,}36 \cdot 10^5 \, m/s, \quad E_K = 5{,}41 \cdot 10^4 \, J/mol, \quad R' = 8{,}314 \, J/molK;$

/41/ $$D = A_D \cdot e^{-\frac{E_D}{R' \cdot T}},$$

where $A_D = 2.37 \cdot 10^{-3} \, m^2/s, \quad E_D = 3{,}72 \cdot 10^4 \, J/mol;$

/42/ $$\nu = A_\nu \cdot e^{\frac{E_\nu}{R' \cdot T}},$$

where $-A_\nu = 2.59 \cdot 10^{-9} \, m^2/s,, \quad E_\nu = 1.46 \cdot 10^4 \, J/mol,$

and ρ=2930 kg/m^3 is the density of the limestone. R' in formulas /40/ - /42/ is the universal gas constant while E_K E_D and E_ν are the virtual empirical activation energies characterising chemical solution, diffusion and viscosity on the basis of Sjöberg and Rickard's (1983) results.

For the estimation of parameter λ let y[m] denote the depth from the surface, where the infiltrating water is 99 % saturated. Then, according to /4/

/43/ $$0.99 C_e = C_e (1 - e^{\lambda y})$$

from which

/44/ $$\lambda = \frac{2 \ln 10}{y} = \frac{4.605}{y}$$

follows. Having the parameters above, calculations are done for the increase of R_0 radius of the pipe orifice. Using /29/

/45/
$$R_0 = \frac{k_K C_e}{\rho} \eta t$$

is obtained. The results are shown in *Figure 9* and *Tables 1* and *2*. (Calculations were based on the 0,0003 pCO_2 normal atmospheric partial CO_2 pressure and we supposed 500 hour/year activity time in 0-30 °C range.

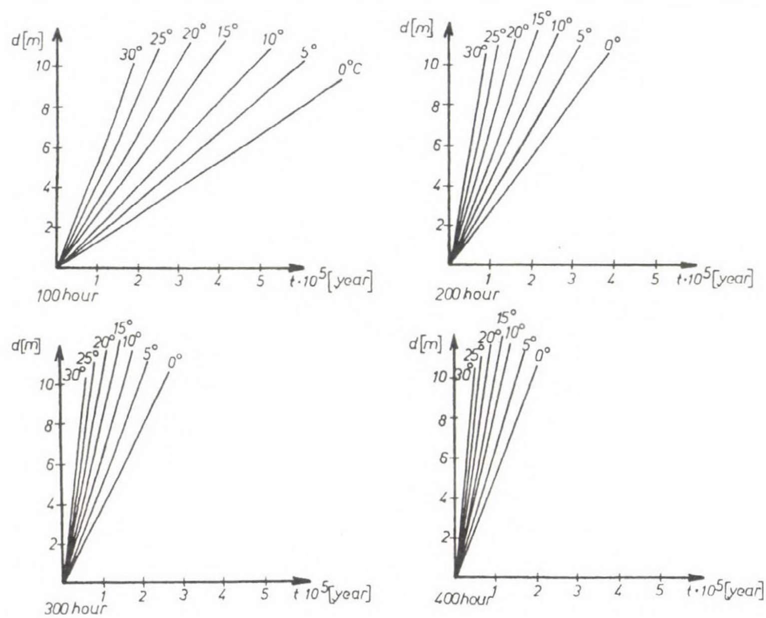

Fig. 9. Pipe diameter d as the function of t age at 0°-30°C temperature with 100-400 hour water inflow time

Table 1.Diameters of avens evolved during 10^3 - 10^5 years in 0°C - 30°C temperature interval with 500 hours rainfall time (in meter)

Temperature °C	Year				
	10^3	5.10^3	10^4	5.10^4	10^5
0	$6.7.10^{-2}$	$3.37.10^{-1}$	$6.74.10^{-1}$	3.37	6.74
5	$8.6.10^{-2}$	$4.30.10^{-1}$	$8.60.10^{-1}$	4.30	8.60
10	$1.09.10^{-1}$	$5.45.10^{-1}$	1.09	5.45	10.90
15	$1.39.10^{-1}$	$6.93.10^{-1}$	1.39	6.93	13.90
20	$1.76.10^{-1}$	$8.79.10^{-1}$	1.76	8.79	17.57
25	$2.22.10^{-1}$	1.11	2.22	11.11	22.22
30	$2.77.10^{-1}$	1.39	2.77	13.85	27.70

Table 2. The necessary time for development of avens with 1-10 m diameters in 0°C - 30°C temperature interval with 500 hours rainfall time (in 1000 years)

Tempe-rature °C	Diameter, m									
	1	2	3	4	5	6	7	8	9	10
0	14.8	29.7	44.5	59.4	74.2	89.1	103.9	118.8	133.6	148
5	11.6	23.3	34.9	46.5	58.2	69.8	81.4	93.1	104.7	116
10	9.2	18.3	27.5	36.7	45.9	55.0	64.2	73.4	82.6	92
15	7.2	14.4	21.6	28.8	36.1	43.3	50.5	57.7	64.9	72
20	5.7	11.4	17.1	22.8	28.5	34.2	39.8	45.5	51.2	57
25	4.5	9.0	13.5	18.0	22.5	27.0	31.5	36.0	40.5	45
30	3.6	7.2	10.8	14.4	18.1	21.7	25.3	28.9	32.5	36

DISCUSSION

The model described by the differential equation (according to which. fault planes widen without debris production) provides information about the growth rate and the development of the shape of the vertical karst formations. Let us emphasise that we started from a carbonate solution where the CO_2 content of the solvent is determined by the partial CO_2 pressure of the atmosphere. Therefore our model does not calculate with the biogenic CO_2. Its complicated alteration could only be followed by adequate measuring series. In vertical alpine karst formations waters drained from rock surface absorb only biogenic and atmospheric CO_2 - thus the control calculations can be done. In time scale the calculated age of development and the expectable age converge (*Tables 1* and 2)

(The expectable age of development is maximum 10,000 years, since the development of formations in glacier valleys could only start after the ice had retreated.)

The rate of development of the vertical karst formation depends on the duration of the water inflow and the water temperature. Its depth and shape depends on the rate of saturation. The developed shape is inherited during further evolution if the values of the listed factors are unchanged.

With the increase of the inflow time (the length of which depends on the time of precipitation, the intensity of melting and the run off coefficient) the de Mc Graw velopment of such karst formations is not only faster, but the differences in the rates of development depending on the temperature of the solvent are more and more diminishing (*Figure 9*). The decrease of the rate of growth is negligible. Thus the rate of growth of the vertical karst formations does not decrease considerably even if achieving larger size they get the previous quantities of precipitation according to the smaller size.

Contrary to the previous theory, the increase of the temperature of the solvent does not decrease the rate of development, but enhances it. (The quantity of the equilibratory CO_2 increases at higher temperatures, that is the quantity for the solution is decreased. This effect is largely compensated by the rate of the chemical solution growing with temperature.)

When the vertical karst formation is covered by soil (temperate karsts, tropical karsts) biogenic CO_2 also influences the development in addition to the abiogenic CO_2.

In this case the rate of development is changing (according to the daily or seasonal fluctuation of the biogenic CO_2) or is different in each formation.

The CO_2 production depends on the properties of the local soil and on the amount of solvent arriving indirectly through the soil and directly from the surface at a given moment. There exists a correlation between the CO_2 content and the rate of development in this type of karstification as well (equations 39, 45).

Therefore, each time the solvent contains more CO_2 the less time is needed for the development of a certain size (provided the other parameters are unchanged.)

REFERENCES

Balázs, D. (1966). A keveredési korrózió szerepe a karsztosodásban. - Hidrológiai közlöny 4. pp. 179-185.

Balázs, D. (1969). Kísérletek a talaj alatti karsztos korrózióról. - Karszt- és Barlang II. f. pp. 57-60.

Balázs, D. (1984). Exhumált trópusi õskarszt Lapinha vidéken (Minas Gerais, Brazília). - Karszt- és Barlang II. f. pp. 87-92.

Dublyansky, J. V. (1987). Tyeoretyícseszkoje modelirovanyije dinamiki formirovanyija gidrotermokarsztovüh polosztyej - Metodü izucsenyija geologicseszkih javlenyij Novoszibirszk - pp. 97-111.

Dublyansky, J. V. (1988). Dynamics of subaqual hydrothermal karst caves formation: Physico - mathematic simulation. - Int. symp. on phys., chem. and hydrological research of karst. - Kosice, Czechoslovakia

Jakucs, L. (1971). A karsztok morfogenetikája. - Akadémiai Kiadó, Bp.

Jakucs, L. (1977). A magyarországi karsztok fejlõdéstörténeti típusai - Karszt- és Barlang I-II. f. pp. 1-22.

Jennings, J. N. (1985). Karst Geomorphology - Basil Blackwell Ltd., Oxford

Kósa, A. (1981) Bir Al Ghanam gipszbarlangjai (Líbia) - Karszt- és Barlang I-II. f. pp. 21-26.
Kunaver, J. (1984). The high mountains karst in the Slovene Alps - Geographica Yugoslavica, Bilten zveze geografskih druster Jugoszlavije, pp. 15-22.
Landau, L. D. and Lifsic, E. M. (1980). Elméleti fizika VI. hidrodinamika, tankönyvkiadó, Budapest
Paton, J. R. (1964). The Origin of the Limestone Hills of Malaya. - J. Trop. Geogr. 18. pp. 134-139.
Rickard, D.and Sjöberg, E. L. (1983). Mixed kinetic control of calcite dissolution rates. -American Journal of Science, Vol. 283, pp. 815-830.
Rickard, D.and Sjöberg, E. L. (1984). Temperature depedence of calcite dissolution kinetics between 1 and 62 °C at ptt 2,7 to 8,4 in agueous solutions. - Geochimica et Cosmochimica Acta Vol 48. pp. 485-493.
Sárváry, I. (1970). A zsomboly genetika kérdéseirõl - Karsz- és Barlang I. f. pp. 5-14.
Szablyár, P. (1981). Az Ummal Masabih-barlang (Líbia) morfogenetikája. Karszt- és Barlang I-II. f. pp. 27-34.
Takács-Bolner K. (1982). A Harz-hegység déli elõterének gipszkarsztja. - Karszt- és Barlang I. f. pp. 41-46.
Tillmans, J. (1932). Die chemische Untersuchung von Wasser und Abwasser, Halle.
Veress, M. (1982). Adatok a Hárskúti-fennsík karsztmorfológiájához. - Karszt- és Barlang II. f. pp. 71-82.
Veress, M. (1992). Karsztmorfológiai sajátosságok a Pádis fedett karsztjainak példáján -Földr. Közl. CXVI (XL) 3-4. sz. pp. 125-141.
Veress, M. and Péntek, K. (1990). Kísérletek a karsztos felszínek denudációjának kvantitatív leírására. - Karszt- és Barlang I. pp. 19-27.
Veress, M .and Péntek, K. (1995). Kísérlet a felszíni vertikális karsztosodást kvantitatív leírására - Földr. Ért. XLIV., 3-4. f. pp. 157-177.
White, F. M. (1979). Fluid mechanics. – McGraw – Hill Book company, New York
Zámbó, L. (1986a.). Karsztvörösagyagok CO2 termelése és a karsztkorrózió összefüggése. - A NME Közl. I. sorozat, Bányászat pp. 125-128.
Zámbó, L. (1986). Paleomorfológiai rekonstrukció a karsztos oldódás intenzitásának mértéke alapján - A NME Közl. I. sorozat, Bányászat pp. 157-165.
Zámbó, L. (1987). A beszivárgó víz oldóképességének alakulása a talaj- és a karsztosodó kõzet határfelületén - Oktatási Intézmények Karszt- és Barlangkutató Tevékenységének II. Orsz. Tud. Konferenciája pp. 13-19.
Zentai, Z. (1990). A parajdi sókarszt geomorfológiai térképezésének tapasztalatai. - Szakdolgozat, Kézirat, Szombathely

L. Bassa–Á. Kertész (eds): Windows on Hungarian Geography
Studies in Geography in Hungary 28, Geographical Research Inst. HAS, Budapest 1998, pp. 71–84

THE ROLE OF GEOGRAPHY IN SITE SELECTION

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INTRODUCTION

Major investments related to large-scale industrial or energetical projects play an important role in the economic and social development of such a small country like Hungary. After completion they become a significant factor of the economy and of the environment where they located not to speak of their visual effect on the landscape. When the political leadership and economic management of the country makes a decision about the establishment of a major industrial object, e.g. a power plant. it becomes very important to choose the optimal site for its location.

To make a right and well based decision for location from geographical point of view it is necessary to investigate the geomorphological and socio-economic environmental conditions of the proposed site. The latter cannot be neglected since the settlement pattern, demographic structure, character of economic activities, provision and state of infrastructure etc. – though indirectly – exert a long-term impact on the operation of the new object, the living conditions of people working there and on the state of the environment.

Any harmful effects originating from a large plant could endanger the environment, the neighbouring settlements and the security of the local population. That is the reason why a thorough geographical analysis based on a comprehensive field research is necessary already in the preparatory phase of the decision making. One of the main tasks in this context concerns the field of geomorphology.

ENGINEERING GEOMORPHOLOGICAL SURVEYING

A standard methodological approach to investigations performed by the Geographical Research Institute Hungarian Academy of Sciences has been thematic mapping of the components of the geographical environment (relief, hydrography etc.) accompanied by explanatory notes presenting general syntheses (Pécsi, M. 1963). This way environmental geomorphological maps and maps on settlements' environmental features were compiled primarily, serving for the purposes of environmental geology, settlement development and for decision making in order to create large-scale constructions. For this reason topographical suitability with regard to forest management and agriculture was investigated and these studies also included engineering geological survey at Budapest, Pécs, Eger and Paks. Mass movement hazard was mapped in further towns and on the high bluffs along the Danube and Lake Balaton. Extended cellar systems were surveyed (Eger, Szekszárd) and areas unsuitable for construction singled out.

A complex investigation into the physical and social geographical environment has been considered indispensable for decision making as to large projects, among others in site selection for hazardous and communal waste disposal. A recent trend of research was the mapping of landforms to predict distribution and migration of radionuclids in the immediate vicinity of the Paks Nuclear Power Plant. In the wider environment of the power plant geomorphological features were mapped those presumably affecting deposition from the atmosphere and concentration in the soil of pollutants of radioactive origin. Thematic map series can be instrumental in the identification of landform units with different extent of liability to contamination (Marosi, S. 1980; Borsy, Z. 1990; Rétvári, L. and Sóvágó, Gy. 1994; Tardy, J. 1994).

INVESTIGATIONS ON LANDSLIDING

The mapping of areas affected by landsliding is also of great importance before decision making. In the course of the last decade geomorphological research in Hungary – in keeping up with the demands of engineering practice – has been aimed increasingly at solving tasks to promote economic and technical planning of large constructions (Fodor, T.-né and Kleb, B. 1986, Pécsi, M. 1993).

Until now, investigation or rather the surveying and assessment of areas and forms affected by mass movement came up mostly during the solution of actual planning or restoration tasks. Up to the present no comprehensive landslide and landscape qualification map has been drawn about Hungary indicating all mass movement processes and forms. The trends and tasks of geomorphological research work on the subject have been defined by both engineering practice and scientific demand.

During the investigations conducted under the guidance of M. Pécsi in the Geographical Research Institute Hungarian Academy of Sciences a survey of the areas affected by landslides in Hungary was prepared. The principles and methodological aspects of mapping have already been described in previous publications (Pécsi, M. 1963; Pécsi, M., Scheuer, Gy. and Schweitzer, F. 1979).

Research objectives and mapping tasks have been the followings:

1. The compilation of a scientific, comprehensive material suitable for practical purposes about Hungary's landslide areas, providing information about the geomorphological characteristics and dynamic components of these areas.

2. Identification of natural and human factors responsible for landslide processes, and revealing cause and effect relations, while relying upon the knowledge of the dynamic geomorphological condition of the areas concerned.

3. Typifying groups of forms and processes in areas affected by landslides and mass movements with the separation of the individual and general movement and process types, and categorization of them.

4. In the course of mapping of landslide areas it is aimed to collect information about the areas affected by landslides for the whole country, and to compile a comprehensive register.

Our investigations were summarized at different scales and in detailed dynamic geomorphological maps. On these maps, especially on the general geomorphological maps, mass movement phenomena are defined according to types. The detailed maps comprise the smaller individual forms created by the movements, e.g. slumps and scarps as well. Register forms were compiled about the forms and types of movement occurring in areas affected by landslides currently, about active slopes and those temporarily inactive, and finally about terrains affected by fossil landslides.

These maps are of high scientific and technical as well as practical value for registering areas of mass movements. Registers have been prepared on almost one thousand sites affected by mass movement phenomena in Hungary. Beside a sketch map, each register form provides information about the most important soil mechanical parameters as well.

On the basis of investigations it has been found that the future of mass movement areas depends – apart from natural processes – on the consequences of socio-economic development, that man-induced relief forming factors are closely related to natural processes.

This is the reason why it cannot be indifferent for us, how and to what an extent has human activity been remodelling form types and altering the various states of equilibrium, where stabilised fossil landslides and slumps, temporarily inactive slopes and active mobile slopes threatened by landslide, are found.

On the basis of the natural endowments of the areas affected by landslides, and as a result of a knowledge of present-day natural and man-induced processes and their impact, in some areas we have real possibilities for outlining the direction and rate of mass movements and surface development to be expected.

As to the future transformation of areas affected by landsliding from a practical point of view great attention has to be paid to this factor outlined above, as knowledge of future relief formation is a fundamental precondition of restoring damaged areas.

During detailed mapping work, the velocity of the widening and deepening of valleys was recorded and typical characteristics of the various valleys and the valley heads of different genesis under the present climatic conditions and under human impact were registered. In the course of mapping of landslide affected areas some special problems of deep mining regions were confronted with.

Rock movement and their crumbling-collapsing forms cause surface deformations which are due to large-scale exploitation and the growth of mining fields. These affect more and more areas in the Hungarian mining districts.

In the towns of coal mining regions affected by surface deformation and those assigned for or built up by the new housing estates often coincide, producing thereby heavy damage of the built environment. In the course of completing detailed maps it has turned out, for instance, that in the surroundings of Komló areas affected by surface collapse induced by undermining, stretch over three square kilometres.

The importance of this fact should be stressed, because the future selection of areas to be built up, must reckon with expectable changes in the morphological conditions of the area. It has to be acknowledged that human activity, landscape modification, waters leaking from public utilities etc. have been speeding up movement processes despite the most careful planning.

There is a hope that relying on the results of engineering geomorphology, and having had some threatening warnings before, in the future, knowledge of expectable changes in the morphology of areas to be built in, and a more careful consideration of these aspects, will greatly contribute to the optimal site selection for large-scale industrial or other constructions.

ENVIRONMENTAL IMPACT ASSESSMENT, GEOECOLOGICAL MAPPING

The next steps being important in site selection process are the environmental impact assessment and geological mapping of the areas investigated. In spite of the expansion of environmentally friendly technologies and diffusion of technological innovation no significant improvement in the state of the Hungarian industrial environment could have been observed up till now. Large areas are still occupied by surfaces which have undergone irreversible changes and should be rehabilitated with the adjustment to local environmental conditions. Environmental impact assessment should be based on ecological foundations, on a synthesis to be carried out by geoecological mapping.

Case studies present the achievements in the mapping methodology, moreover, they represent different type localities as far as the use of environment is concerned: industrial, mining areas and the impact zone of a nuclear power lant.

A serious deterioration of the environment in the industrial areas due to high rates of emission by industrial plants resulting in air, water and soil pollution, degradation of biota, surface scars and deformation caused by strip and deep mining, and finally, worsening of human ecological conditions have been calling for detailed investigations. Tourism and esthetical aspects make landscape planning indispensable.

Main targets of the survey are geoecological investigations; measurements and mapping of the spatial pattern of air and water pollution, soil contamination and flora degradation; creation of an environmental information system. An original concept of the survey is the geoecological context for environmental transformation and for the pollution impact. The survey included: air pollution with chemical compounds (fluor, sulphur dioxide), falling dust, changes in plant communities and their loadability, surface deformation induced by mining.

Geoecological mapping in the environs of a nuclear power plant focused on the evaluation of ecological factors (topography, climate elements, soil and plant geographical conditions, hydrogeological aspects and land use). An attempt was made at delimitation of homogeneous territorial types and mapping. Investigations in the closer and wider environs of the Paks Nuclear Power Plant are aimed at identification of zones and geoecological facies where radionuclids accumulate as a result of accidental misfunction. Geoecological facies differ in the mobility of matter so the mobility of pollution is also varied; consequently, radioactive contamination should be treated differently by geoecological facies.

IMPORTANCE OF CASE STUDIES

Investigations of a radioactive waste disposal site planned

Besides the methodological approach of the theme it is also necessary to make complex field works on the area prepared for location of a big industrial plant. The results of these field works are often summarised in case studies.

As a special case study a complex research on the geographical environment of the radioactive waste disposal site planned to Ófalu was carried out in the late 1980s (Balogh, J., Schweitzer, F. and Tiner, T. 1990, 1995). The disposal of nuclear waste presents problems anywhere where nuclear power plants are in operation. Such wastes, requiring special caution to dispose of, are also produced in the Paks Nuclear Power Plant. Waste of low and medium radioactivity has to be disposed of within the territory of Hungary, in a site with minimum risk of environmental contamination *(Figure 1).*

For the disposal site of the so-called secondary wastes of the Paks plant an area near the village Ófalu, Baranya county, was selected by designers. In their opinion this area is suitable – on the basis of its physical and geological conditions – for the long-term storage of nuclear waste. Researchers in our Institute were invited by designers to contribute to the complex (geomorphological, socio-economic, environmental) evaluation of the disposal site. The results of the investigations can be summarised in the followings:

The selected disposal site is located within the limits of the Geresd Hills, part of the Baranya Hills, in the administrative areas of the villages Ófalu, Feked and Véménd. It is a forested landscape, plateau dissected by erosion valleys, unsuitable for large-scale farming. As a consequence of geological evolution, the interfluvial ridges are mantled with thick loess, constituted of young and old loess series as well as a sequence of pink silt and red clays. At the disposal site loess is 40–50 m thick.

The major relief features are summit levels, interfluvial ridges, sloping ridges, erosional, erosional–derasional and derasional valleys, erosional gullies and gorges. In their geomorphic evolution – in addition to sheet-wash – human interventions (clearcut-

Fig. 1. Geomorphological map of the environs of the waste disposal site planned to Ófalu (ed. by Schweitzer, F. 1990). – 1 = stable slope; 2 = surface with old slumps (slopes with landslide hazard); 3 = slope with rill erosion; 4 = low plateau (250–300 m above sea level); 5 = low ridge (200–250 m above sea level); 6 = interfluvial ridge (230–280 m above sea level); 7= gentle slope segment; 8= col; 9= erosion gullies (1–5 m deep); 10 = erosion gorges (5–10 m deep); 11 = derasional valley; 12 = erosional-derasional valley; 13 = landslide heap; a= the projected disposal site

ting, cultivation and others) were most influential and they led to the acceleration of soil erosion. The hydrometeorological conditions of the environs of the projected structure – taking into account the relief and vegetation endowments of the environs – are unfavourable for the construction of the storage facility. The amount of precipitation is above the average, the number of rainy days is higher than elsewhere. A large part falls in the form of snow (repeated infiltration of snowmelt may endanger the disposal site, which requires total lack of moisture). On the other hand, intense rainfalls are also frequent and they cause heavy and recurring erosion events in the immediate surroundings of the site.

The characteristic slope categories of the area are 5–15 per cent and 15–35 per cent. This also aggravates the erosion hazard and along the middle and lower section of slopes erosion damage is visible in the environs of the site. Slope morphological investigations suggest that further mass movements and landslide hazards are possible on the slopes. On the long run the above processes may affect the summit level selected as disposal site and endanger safe storage.

The economic and social geographical situation of the area is not soothing either. For administration a heterogeneous position is observed: the five villages around the disposal site belong to four towns from the aspect of council administration. The age structure of population is unfavourable, ageing is a great problem. The qualification level of population is below the county average.

Economic activities are mostly restricted to forestry and agriculture, which would be seriously affected by a situation with radiation hazard. The servicing-supplying functions of villages are incomplete, the conditions for medical supply are poor.

Particularly depressing conditions were found in the field of infrastructure manifested in infrequent runs of public transport and few telephone lines. This is unacceptable as the infrastructural background of the disposal site. The future transport route of radioactive waste (highway No. 6) is overcrowded, its alignment touches on the border of the East Mecsek Landscape Protection Area. The disposal site itself lies very close to the nearest landscape protection areas.

The apprehension of the neighbouring population concerning the construction of the disposal site, the possible protests have to be taken into account, as their opinion had not been asked before allocation. The results of physical, economic and social geographical investigations question the suitability of the designated area for building a nuclear waste disposal site.

Geomorphological mapping of the Rózsadomb (Hill of Roses), Budapest

A special geomorphological investigation dealt with the geomorphic evolution of the Rózsadomb, Buda. Commissioned by the Surveying and Soil Analysis Enterprise, the József-hegy cave system and its broader environs were surveyed and represented on an engineering geomorphological map of 1:40,000 scale (*Figure* 2)(Schweitzer, F. 1988).

Fig. 2. Engineering geomorphological map of the Rózsadomb (ed. by Schweitzer, F. 1988). – 1 = horst; 2 = col.; 3 = pediment in lower position (220–260 m above sea level); 4 = interfluvial ridge; 5 = gentle slope segment, terrace-like platforms; 6 = pediment, mountain slope in higher position (270–330 m above sea level); 7 = debris fan; 8 = gully and gorge; 9 = abandoned channels of the Ördögárok stream; 10 = terraces of the Ördögárok stream; 11 = man-made scarp; 12 = erosional-derasional valley; 13 = erosional valley; 14 = derasional valley; 15 = travertine horizons; 16 = major explored caves and passages; 17 = stable slope; 18 = unstable slope; 19 = temporarily stable slope with landslide hazard; 20 = Terrace IIa of the Danube; 21 = higher floodplain level of the Danube; 22 = abandoned channels of the Danube; 23 = abandoned mine

Engineering geomorphological mapping is primarily aimed at representing the landforms and exogenic processes with implications to the extension and the hypothetical or suggested passage systems of the different caves.

A low plateau (200–260 m above sea level) with gentle slope segments, derasional scarps, and pediments (250–300 m above sea level), interfluvial ridges, derasional valleys, erosionally transformed derasional valleys, flood-plains, remnants of alluvial fans, erosional streams and gullies and slope conditions were mapped.

A special attention was paid to travertine horizons and their relationships to geomorphological surfaces of various origin. A series of travertines are deposited one upon another on the terraces and other platforms of the Ördög-árok and the Danube valley. These travertines are interpreted as evidence to the gradual lowering of karst water table. They are assumed to be the sites where karstic spring caves used to open to surface.

In connection with the opening sites of hypothetical karst passage systems, the reconstructed geomorphological map shows the previously wide erosional valleys of medium depth and the erosional–derasional valleys indicating their geomorphological and hydrogeological role. The major erosional valleys on the map having their base level in the Danube or the Ördög-árok seem to be recharged mainly from karst springs and only in small part from springs of free or confined groundwater. It is also possible that the former karst springs in the head-valleys of erosional valleys indicate the openings of karst passages.

Geomorphological mapping in the impact area of the Gabcikovo dam

In the process of site selection of large-scale constructions hydrogeographical features also must be taken into consideration. This task includes the quantitative and qualitative evaluation of surface and subsurface waters and the survey of all hydrogeographical factors hindering the location of a large-sized object planned. Significant changes of the hydrogeographical environment will occur after opening up e.g. a hydropower plant on the Danube river at Gabcikovo (Slovakia) and filling up the reservoir at Szigetköz region (Hungary) (Balogh, J. and Lóczy, D. 1992).

The radical decrease of flow-rate in the Danube channel will result important changes in this area, since it modifies actual groundwater flow. It has a disastrous effect on the state of the soils and agriculture of the area *(Figure 3).*

MAIN TASKS OF THE SOCIO-ECONOMIC INVESTIGATIONS

In the process of social investigations on the sites public interaction programmes should be worked out which contain the followings: providing information, understanding the issues, community relations and participating in public review (Schweitzer, F. and Tiner, T. 1996). The next step is the compiling of public information programmes. These programmes include a lot of means, e.g. information materials, public meetings, school visits, operation of public information offices, direct mail connections, advertising, toll-free information lines etc.

The necessary sociological research must consist of five parts:

1. Public opinion survey to develop an understanding of public perception by the management.
2. Leadership opinion surveys determine whether the public affairs programme is meeting their needs.
3. Media content analysis to determine whether the media relations component is effective.
4. Forms group research to test acceptability of responses to the issues.
5. Research on siting process and ethical aspects of large-scale constructions.

Fig. 3. Geomorphological facies of the Szigetköz and areas endangered by the drop of the groundwater table (ed. by Balogh, J. 1991). – 1 = levee; 2 = calculated lowering of groundwater (m); 3 = endangered forests of the flood area and backswamps and filled meanders in danger; 4 = other endangered areas; 5 = point-bars not affected considerably by groundwater lowering; 6 = filled meanders effected by the drop of the groundwater table; 7 = filled meanders not effected considerably by the drop of the groundwater table; 8 = point-bars with low water supply; 9 = map profiles

The key phenomena in the whole process are: public health and safety, risk perception and risk assessment, risk of traffic accidents in the surrounding roads *(Figure 4)*, confidence in the safety of the disposal system, monitoring and retrievability, etc. (Holló, P. 1993).

To avoid the negative socio-economic effects deriving from the lack of necessary information about the site of object it is necessary to make agreements between the local communities and the implementing agency (based on the guiding principles for siting). This agreement would determine the effects on the socio-economic environment. The programme to manage those effects would be negotiated between the community and the agency during the siting stage (Berényi, I. 1991; Gray, B. 1993).

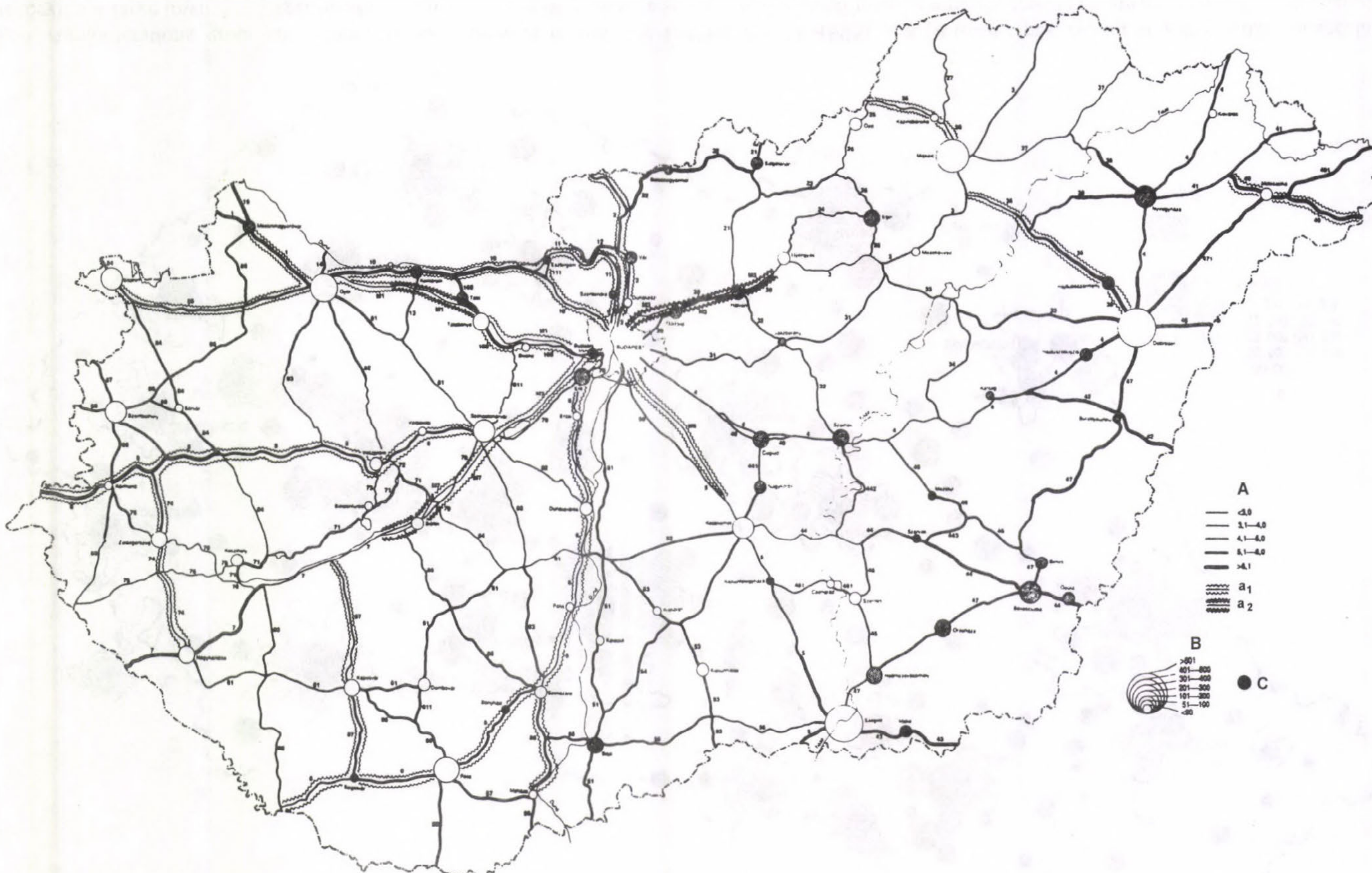

Fig. 4. Differences in the number of traffic accidents on main roads of Hungary, 1992. (ed. by Tiner, T., 1994). – A = number of accidents per 10 million vehicle unit km; a_1 = road with high; a_2 = very high accident rate; B = number of accidents in towns; C = rate of accidents more than 70 per cent in the transit section of the total urban road network

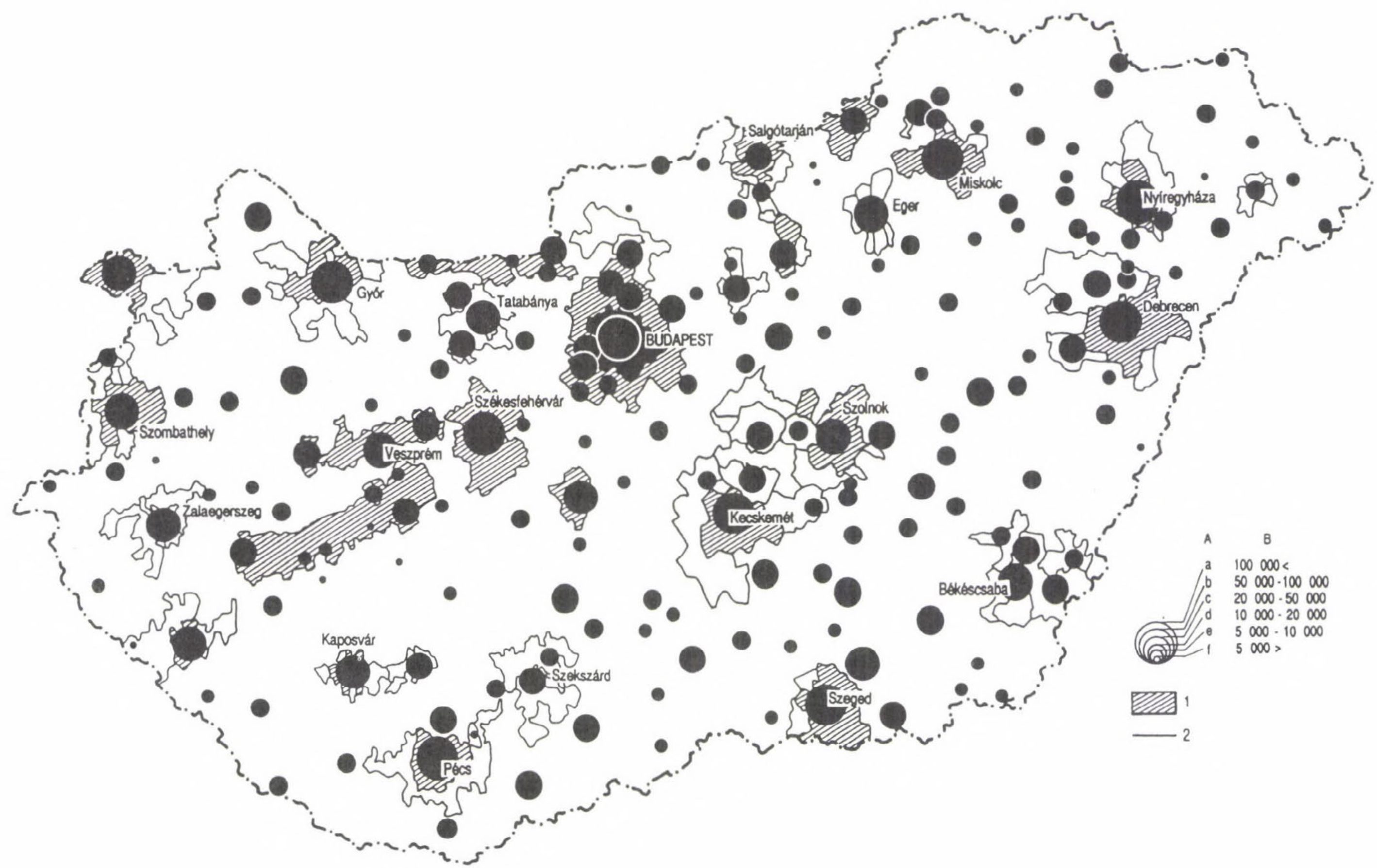

Fig. 5. Agglomerations, groups of settlements, town network in Hungary, (ed. by. Iván, L 1995). – A = town types: Budapest a metropolis (a special category); a = large town; b = larger middle size town; c = smaller middle size town; d = small town; e = pigmy towns; f = micro towns; B = Population categories; 1 = agglomerations, regions under agglomerating process; 2 = boundary of other groups of settlements

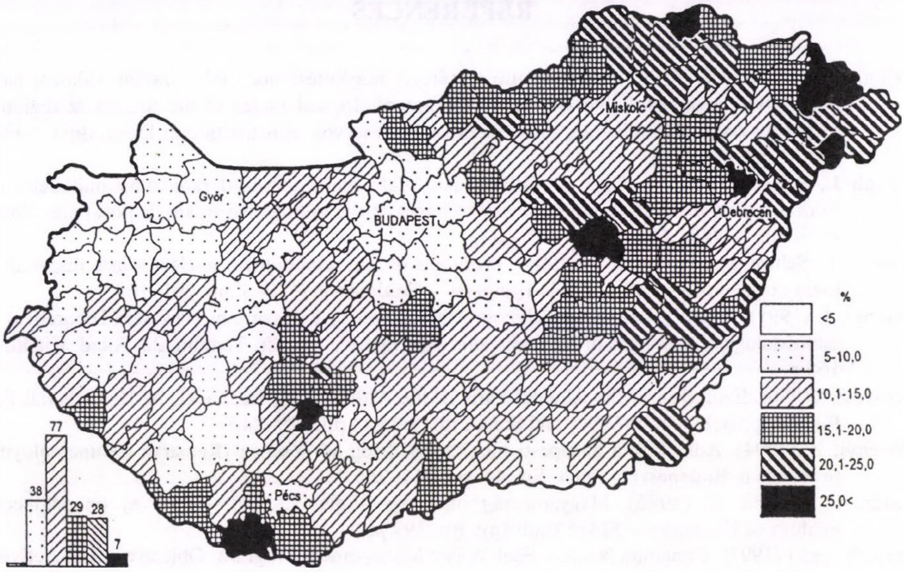

Fig. 6. Regional differences in unemployment rate in Hungary, 1994. (ed. by DÖVÉNYI, Z. 1995). – Left below: distribution of regions by categories

Planners must not forget about socio-economic analyses, because additional socio-economic effects could include population growth, level of urbanization *(Figure 5),* secondary employment, unemployment *(Figure 6),* need for additional housing, changed property values, increased local rates and changes in the social composition of local communities (Dövényi, Z. 1994; Kőszegfalvy, Gy. and Sikos, T.T. 1993; Balogh, J., Schweitzer, F. and Tiner, T. 1995).

Finally, based on the guiding principles for siting (especially voluntarism) an impact management program negotiated between the community and agency is expected to minimise negative impacts and enhance positive effects resulting from the facility.

REFERENCES

Balogh, J. and Lóczy, D. (1992). A Dunakiliti víztározó megépítése utáni talajvízszint-változás hatása a Szigetköz geomorfológiai fácieseire (Geomorphological facies of the Szigetköz region affected by water level changes subsequent to the reservoir construction at Dunakiliti). – Földr. Ért. 41. pp. 115–125.

Balogh J., Schweitzer, F.and Tiner, T. (1990). Az Ófalu mellé tervezett radioaktív hulladéktemető földrajzi környezete (Geographical environment of the radioactive waste disposal site planned to Ófalu). – Földr. Ért. 39. pp. 103–131.

Balogh, J., Schweitzer, F.–Tiner, T. (1995). Problems of site selection for nuclear waste disposal in a loess-covered hill environment in Hungary. – GeoJournal *36*. 2–3. pp. 261–169.

Berényi, I. (1991). Az alkalmazott szociálgeográfia elméleti és módszertani kérdései (Theoretical and methodological problems of applied social geography). – Földr. Tanulm. *22*. Akad. Kiadó, Bp. 165 p.

Borsy, Z. (1990). Evolution of the Alluvial Fans of the Alföld. – In: Rachocki, A. H.: Alluvial Fans: Field Approach. – John Wiley and Sons Ltd. London, pp. 229–246.

Dövényi, Z. (1994). Adalékok a budapesti munkanélküliség kérdéséhez (Remarks on unemployment problems in Budapest). – Földr. Ért. 43. pp. 257–265.

Fodor, T.-né–Kleb, B. (1986). Magyarország mérnökgeológiai áttekintése (Survey on engineering geology of Hungary). – MÁFI kiadvány, Bp. 199 p.

Gray, B. (ed.) (1993). Canadian Nuclear Fuel Waste Management Program. Objectives and Activities. – AECL Research, Canada, 160 p.

Holló, P. (szerk.) (1993). Személyi sérüléses közlekedési balesetek a közutakon (Traffic accidents on roads causing personal injures). – UKIG, Bp. 174 p.

Kőszegfalvy Gy.–Sikos T. T. (1993). Városok és falvak infrastruktúrája (Infrastructure of towns and villages). – MTA FKI, Bp. 124 p.

Marosi, S. (1980). Tájkutatási irányzatok, tájértékelés, tájtipológiai eredmények különböző nagyságú és adottságú hazai típusterületeken (Directives, evaluation and typological results in landscape research in different test areas). – Elmélet–Módszer–Gyakorlat, *35*. MTA FKI, Bp. 162 p.

Pécsi M. (1963). A magyarországi geomorfológiai térképezés az elmélet és a gyakorlat szolgálatában (Geomorphological mapping in Hungary serving theory and practice). – Elméleti és Módszertani Vitaanyagok, *4*. MTA FKCs. Bp. 18 p.

Pécsi, M. (1993). Quaternary and loess research. Summary and bibliography. – Loess Info *2*. Akadémiai Kiadó, Bp. 82. p.

Pécsi, M., Scheuer, Gy. and Schweitzer, F. (1979). Engineering geological and geomorphological investigation of landslides in the loess bluffs along the Danube in the Great Hungarian Plain. – Acta Geologica Hung. *22*. pp. 327–343. Studies on Loess, Akad. Kiadó, Bp. 1980.

Rétvári, L.–Sóvágó, Gy. (1994). Komárom környezetminősítő alaptérképe (Environmental assessment base map of Komárom). – Földr. Ért. *42*. pp. 117–128.

Schweitzer, F. (1988). A budai Rózsadomb geomorfológiai fejlődéstörténete (Geomorphic evolution of the Rózsadomb, Buda). – Földr. Ért. *37*. pp. 77–85.

Schweitzer, F. and Tiner, T. (1996). A geográfia feladatai a hazai nagyberuházások telephelyének kiválasztásában. (The role of geography in the process of site selection of large scale economic objects in Hungary). – Földr. Ért. *45*. Pp. 11–22.

Tardy, J. (szerk.) 1994. Természetvédelem (Nature conservation). – KTM Természetvédelmi Hivatal, Bp. 182 p. + 8 p. fotó + 7 térk.

L. Bassa–Á. Kertész (eds): Windows on Hungarian Geography
Studies in Geography in Hungary 28, Geographical Research Inst. HAS, Budapest 1998, pp. 85–90

REGIONAL DIFFERENCES OF FOREST FIRE HAZARD IN THE TEST AREA OF THE MÁTRA MOUNTAINS

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INTRODUCTION

Problems with forest fires have been aggravated in the recent decades. They appeared primarily as an ecological issue and not so much as an economic problem. When examining intensities of forest fires in Hungary we mostly find forest-litter fires, and only smaller territories are struck by a total destruction of forest stand. This is why the main question arising is how the damaged vegetation can be replaced in a natural way and what ecological patterns are adequate to be created during sylvicultural activity. These ecological patches (e.g. non-forest belts) should serve as barriers against fires, and they also help in re-establishing vegetation with ecological corridors. To set up efficient management, information is needed on the expected intensity of forest fires at the different parts of the woodland. The following paper presents the results of a pilot analysis made on a drainage basin at Bodony, in the Mátra Mountains where mainly man induced forest fires occurred (which is a usual case in Hungary), and natural ones were less frequent. (Another question arising could be the relationship between these fires and the global aridification.)

PRECEDENTS

The first mapping of forest fire hazard were performed over extensive territories using remote sensing methods in the 1960s and 70s. It turned out that this method is quite efficient but without detailed data from „training sites" it is not too reliable, and therefore it can only be used with reservations. The geoecological mapping of the drainage basin of Kataréti stream at Bodony in the Mátra Mountains together with GIS application allowed the combination of many variables. To make the analysis easier, TM data were available for several seasons and a forest fire has already happened in this area, so

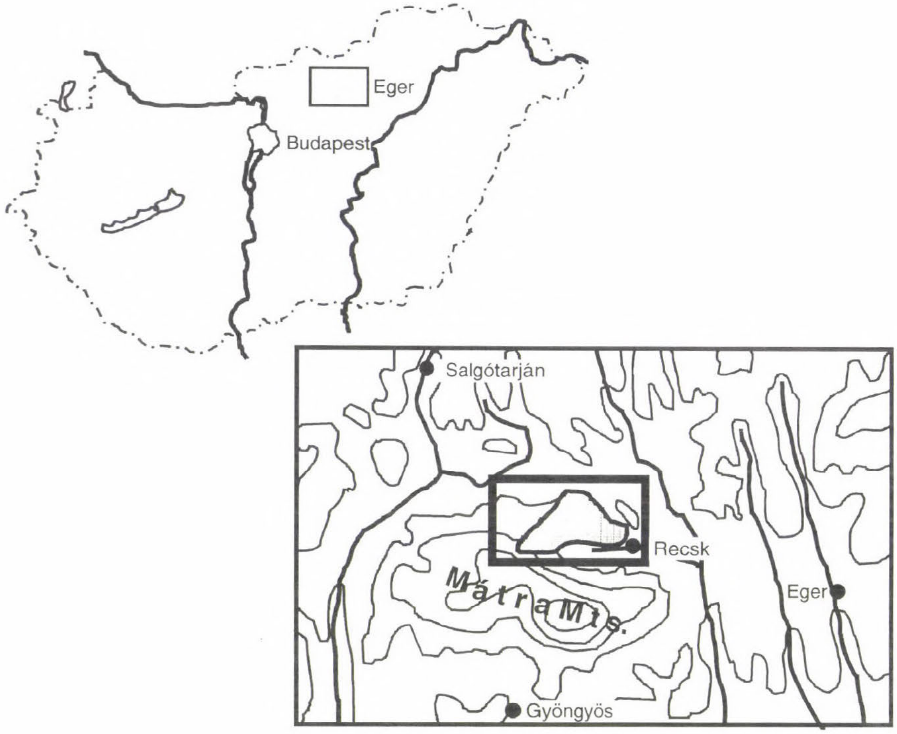

Fig. 1 - Location of the test area.

the problem could be reduced to a kind of similarity analysis, but at least it had made the checking of the results possible (*Figure 1*).

METHODS

During the analysis with the combined and integrated approach mentioned above we used three parameters according to Chuviecco, E. and Congalton, R.G. (1989):

A map was compiled, showing vegetation in general and woodland in detail at a scale of 1:25 000, and with the digital analysis of a Landsat TM image (taken July 1, 1987) the following categories were created considered important from the viewpoint of the survey (see *Figure 2):*

The Landsat TM images available were first geometrically corrected, and then according to the training sites determined during field work, and by using the maximum likelihood method the following land use categories were determined:

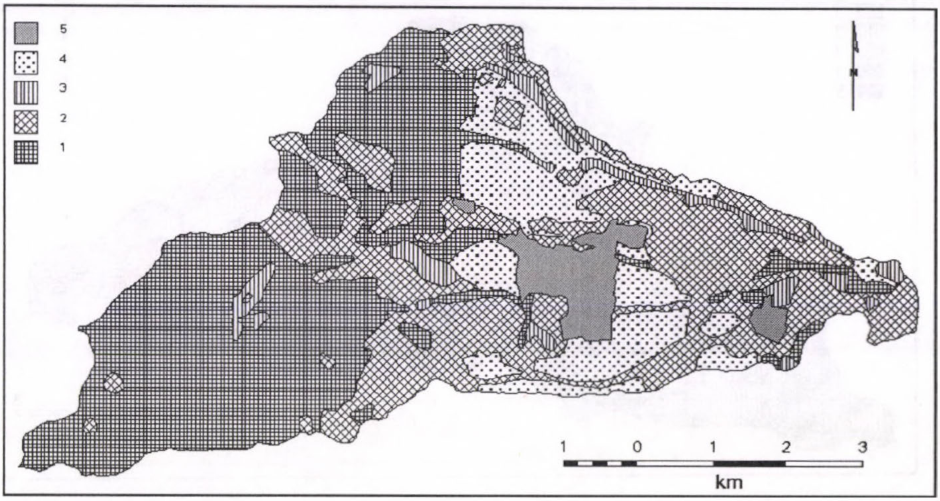

Fig. 2. The ecological state of the vegetation. – 1= degraded; 2 = initial; 3 = optimal; 4 = agricultural use; 5 = settlement (Bodony)

– dense and moderately dense coniferous forest,
– dense mixed forest,
– dense and moderately dense broad-leaved forest,
– willow and acacia grove, and
– other patches of forest.

To determine forest density the above described remote sensing image was used, i.e. the vegetation density index (NDVI value) was calculated with the combination of bands 3 and 4 (4-3/4+3). The analysis was carried out using ERDAS software (version 8.2) on SUN workstation. After processing the remote sensing data it was also shown, that certain ecological differences could be identified on the basis of digital information alone with a rather high accuracy (80-85%), which opens perspectives for the further investigation of the problem of forest fires.

The other parameter analysed from the viewpoint of forest fire hazard was topography. No serious differences in precipitation were detected in the test area between the forest sections, which might be attributed to the eastern aspect and the moderate angle of slopes. The map of hillslopes were composed of digitised contours made by ArcInfo 7.03 based on the logic, that the steeper the slopes are, the more serious the hazard is (e.g. through the effect of burning parts rolling down the slope)(*Figure 3*)

As the third factor, the forest paths and paved roads were involved in the research. Their role is very complex. On the one hand they reduce the potential hazard as barriers, on the other hand they could be the corridors of fire spreading through their intensive use. The main reason why the buffer zones were constructed along these routes

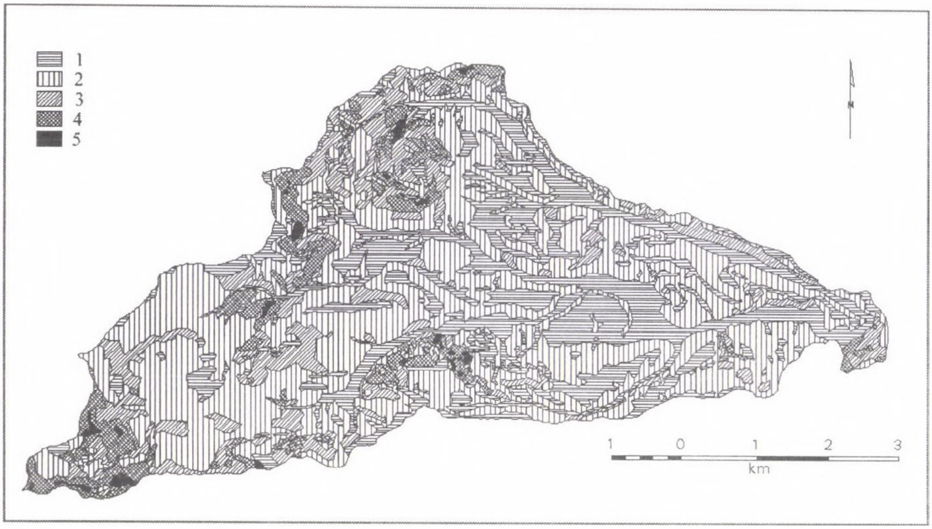

Fig. 3. Map of slope categories of the test area.– 1 = 0-5%; 2 = 5-12%; 3 = 12-17%; 4 = 17-25%; 5 = 25% and more

using GIS was to specify the increased hazard in the 150 meter zone along forest paths, and in the 50 meter zone along paved roads.

We calculated fire hazard from the above mentioned factors, according to the following method. We categorised vegetation, the angles of slopes and the buffer zones along the roads according to the hazard posed by them in a way that vegetation was given a tenfold multiplier, slope had received a triple one and buffer zones had a multiplier of 0.5. We divided the vegetation and slope angles into the following categories:

Type of vegetation	Fire hazard	Coefficient
dense and moderately dense coniferous forest	serious	2
dense mixed forest	serious	2
dense and moderately dense broad-leaved forest	medium	1
willow and acacia grove	low	0
other patches of forest	low	0

Angles of slope	Fire hazard	Coefficient
0 - 12%	low	0
12 - 25%	medium	1
above 25%	serious	2

Areas belonging to the buffer zones along roads and paths received a value 1 while the other surfaces 0.

RESULTS

After all, we calculated the topologic sum of the weighted values and coefficients. The higher the values were acquired, the more serious the hazard is expected. As *Figure 4* shows, we put the results into three hazard categories. These results were compared analogically to the remote sensing data, and it figures out the visible correlation between the wetness of vegetation (band 4, TM) and the ecologically explained fire hazard, which is less related to land use. Nevertheless, these results were compared – with the intention of verification – to the forest-litter fires, that were observed in the summer seasons during 1992-95. The agreement was evident in the middle part of the drainage basin (around village Bodony), and it was the same west of the settlement. On the western edge of the test area with the highest orographic position where the most serious hazard was predicted no forest litter fires and forest fires were observed.

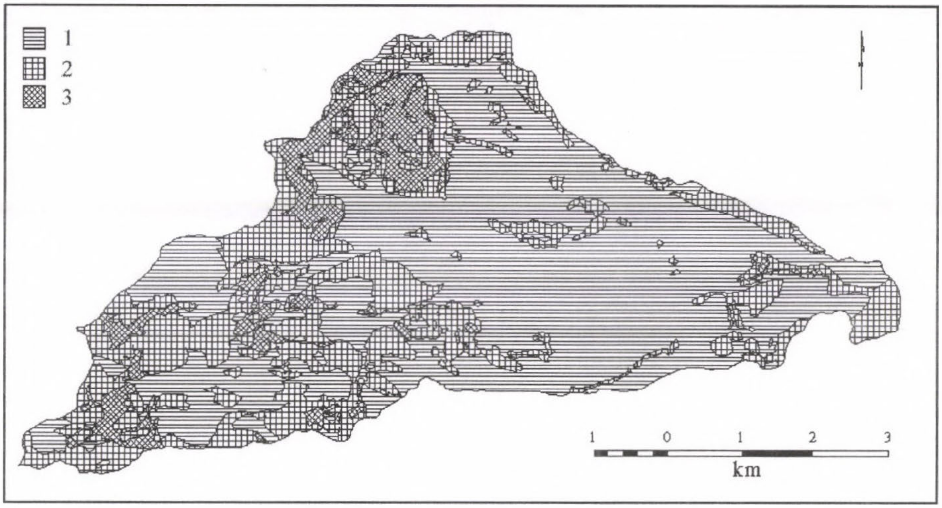

Fig. 4. Map of forest fire hazard. – 1 = no hazard; 2 = moderate hazard; 3 = serious hazard

REFERENCES

Chuvieco, E. and Congalton, R. (1989). Application of remote sensing and GIS to forest fire hazard mapping. Remote Sensing Environ. 29. pp. 147–159

Csorba, P. (1989). A tájstabilitás és ökogeográfiai stabilitás. Földrajzi Értesítő 38. pp. 395–410.

Leser, H. and Klink, H. J. (1988). Handbuch und Kartieranleitung Geoökologische Karte 1:25 000 (KA GÖK 25). Trier, 349 p.

Mezősi, G., Bárány-Kevei, I., Mucsi, L. and Balogh, I. (1993). First results of GIS based geoecological mapping. Földrajzi Közlemények, pp. 132–155.

Naveh, Z. and Liebman, A. S. (1984). Landscape Ecology. Theory and Applications. Springer Verlag, New York-Berlin-Tokyo

Zólyomi, B. *et al.* (1967). Einreichung von 1400 Arten der ungarischen Flora in ökologischen Gruppen nach TWR-Zahlen. Fragmenta Botanica. 4. pp. 101–142.

L. Bassa–Á. Kertész (eds): Windows on Hungarian Geography
Studies in Geography in Hungary 28, Geographical Research Inst. HAS, Budapest 1998, pp. 91–98

ARIDIFICATION - CLIMATE CHANGE AND ITS CONSEQUENCES IN HUNGARY

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INTRODUCTION

As a consequence of global climate change, southeastern Central Europe belonging mainly to the moderately humid continental zone (Köppen's Cf/Da boundary; Lauer and Frankenberg's C2sa) has experienced climate conditions characterized by long periods of drought. Lying in the very heart of the Carpathian Basin and mostly on a low-lying flat terrain, Hungary has to face probably the most severe problems.

Taking the concept of desertification into consideration we can describe climatic change in our region by the term *aridification.* In our definition aridification means increasing semiaridity and after a shorter or longer period a situation approaching aridity manifested in the increase of mean annual temperature and, thus, of potential evaporation and a parallel decrease in annual precipitation. Aridification is a process which will cause considerable changes not only in the climate but also in all factors of the physical environment.

Physical processes of aridification can be traced in the change of environmental factors. The Danube-Tisza Interfluve is one of the most severely affected regions of Hungary.

The *aridification research programme* presented below was launched within the framework of the MEDALUS II (MEditerranean Desertification And Land USe) project, funded by the EC under its Environment Programme, contract number EV5V 0128/0166, and the support is gratefully aknowledged here. Its objectives include climatological investigations to explore the impact of global change on the climate of Hungary on the one hand and the induced physical and biological changes (e.g. subsidence of groundwater level, variations in the soil dynamics, adaptation of vegetation to the changed environmental conditions) on the other. These studies were carried out in the *Kiskunság test area* located on the Danube-Tisza Interfluve (*Figure 1.*).

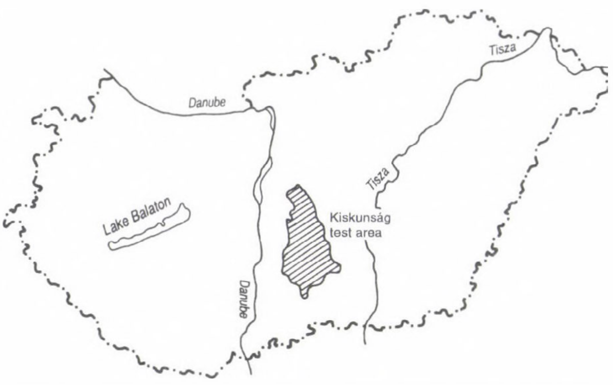

Fig. 1. Kiskunság test area on the Danube-Tisza Interfluve

CLIMATE CHANGE IN HUNGARY

Climate change scenarios usually involve two climatic elements, *temperature* and *precipitation*, for which long data series are available in Hungary. For a meteorological station in Budapest, for instance, trends can be identified from observations going on since 1881 *(Figure 2).*

For the verification of an aridifaction trend time series of *monthly mean temperatures* and *precipitations between 1900 and 1990* were analysed. The data base consists records for 16 and 17 meteorological stations, respectively. In order to trace the impacts of presumed global change, but to preserve the advantages of a long obser-

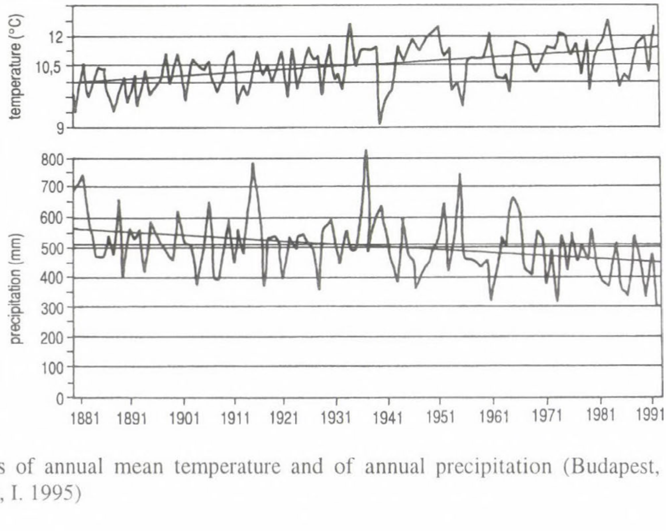

Fig. 2. Trends of annual mean temperature and of annual precipitation (Budapest, 1881–1992, by Matyasovszky, I. 1995)

vation period, the time series of 1900–1990 was divided *into two intervals*: the 50 years between 1900 and 1949 and the 40 years between 1950 and 1989 (Molnár 1994, Molnár - Mika 1997).

In areas of colder climate *annual mean temperatures* were 0.2–0.3 °C higher during the interval 1950–1989. For stations with the warmest climate the increase is even more remarkable (+0.3–0.5 °C). From the analysis of monthly averages it becomes clear that most of the warming is due to rising temperatures in the *winter half-year*.

Temperatures between 1950-1989 are several tenths of degrees higher than those measured between 1900–1949. The annual mean temperatures of the 16 stations are on the average 0.3 °C. Milder winters and the reduced annual range may be interpreted as regional indicators of global warming.

To the results of linear regression analysis T-proof was applied to check which of the stations show significant trends. (T critical belonging to the 95 per cent level: 1.983.) The re-evaluated data base shows a fundamentally different picture. For all 16 stations there is a *moderate warming tendency* (0.010 °C per year) *(Table 1)*.

Table 1. Temperature trends (re-evaluated data base)

town	temperature trend (°C/year)	T value	95% significance level
Nyíregyháza	0.011	5.532	yes
Zalaegerszeg	0.011	5.307	yes
Debrecen	0.011	5.707	yes
Baja	0.011	5.718	yes
Kalocsa	0.011	5.727	yes
Pápa	0.011	5.330	yes
Pécs	0.011	5.545	yes
Budapest	0.011	5.806	yes
Kecskemét	0.011	5.332	yes
Keszthely	0.010	5.490	yes
Mosonmagyaróvár	0.010	5.307	yes
Szombathely	0.010	5.372	yes
Sopron	0.010	5.174	yes
Szarvas	0.010	4.635	yes
Túrkeve	0.010	4.795	yes
Szeged	0.010	4.519	yes
average	**0.0105**		

At stations with the *lowest annual precipitation*, there is a precipitation decrease observable compared to the first half of the century. Monthly mean precipitations confirm the falling tendency. For each station studied a *negative precipitation trend* is found. It is accepted for 12 stations out of the total 17 on 95 per cent significance level. (For further seven stations T values are somewhat lower than the T value at 95 per cent level.) Out of the precipitation trends a precipitation decrease of -0.917 mm per year on the average seems to be predictable *(Table 2)*, in agreement with international and national research findings (Koflanovits-Adamy, E. and Szentimrey, T. 1986, Szentimrey, T. 1994).

Table 2. Precipitation trends for 17 stations in Hungary

town	precipitation trend (mm/year)	T value	95% significance level
Pécs	-2.30	5.765	yes
Szombathely	-1.41	4.432	yes
Sopron	-1.22	3.518	yes
Budapest	-1.09	3.309	yes
Nyíregyháza	-1.02	3.086	yes
Túrkeve	-0.98	2.980	yes
Szeged	-0.91	3.002	yes
Kecskemét	-0.86	2.892	yes
Szarvas	-0.79	2.754	yes
Baja	-0.71	2.070	yes
Mosonmagyaróvár	-0.61	1.953	no
Zalaegerszeg	-0.56	1.526	no
Debrecen	-0.47	1.358	no
Kalocsa	-0.43	1.436	no
Keszthely	-0.39	0.994	no
Pápa	-0.27	0.745	no
Eger	-0.47	1.618	no
average	**-0.918**		

Ambrózy, P. *et al.* (1990) studied change over a 84-year period (1901–1984) and claimed that in the Great Hungarian Plain the first decades of the 20th century were characterised by increased humidity, followed by a long stagnation and then drought ensued. The range almost amounts to 10 per cent of annual precipitation. The drop of precipitation and rising temperatures in Hungary have led to *increased aridity* and support the *climatic scenarios* for the area (Mika, J. 1988, 1991, 1993).

CONSEQUENCES OF ARIDIFICATION

Subsidence of the groundwater level

The most remarkable impact of climate change is the subsidence of the groundwater level. According to hydrologists (Pálfai, I. 1996) a combined effect of several factors is responsible for dropping groundwater levels: lower precipitation and increased evaporation explain about 50 per cent of the drop, but the extraction of confined groundwater for drinking water supply (25 per cent), afforestation and other land use changes (10 per cent), drainage regulation (7 per cent), direct extraction of free

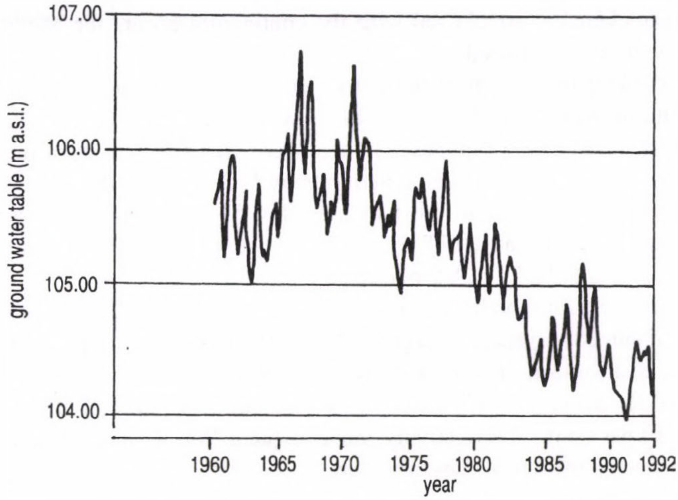

Fig. 3 Monthly groundwater tables in observation well No. 816 (Ágasegyháza).

groundwater as well as reduced recharge from the neighbouring hills and from the Danube (6 per cent) are also significant factors. The curve provided by a data set of an observation well presented here *(Figure 3)* clearly shows the gradual drop of the annual average groundwater table.

With dropping groundwater, *soil moisture* contents also reduced considerably during the 1990s (Pálfai, I. 1996, Szalóki, S. 1994). For instance, in spring 1990 in some sections of the Danube–Tisza Interfluve the uppermost 1 m of soil had only 60 to 70 per cent soil-moisture reserves as opposed to the long-term average of 100 per cent of field capacity. In 1992 in the same area the 0 to 0.5 m topsoil contained less than 15 per cent moisture, which is below the wilting-point of most agricultural crops. The drought also involves water level drops in ponds.

Changes in natural vegetation

Natural vegetation in the sand region of the Danube-Tisza Interfluve is the best indicator of ecological conditions and trends. In the most adverse habitats, open sand grasslands of low percentage cover develop into closed grasslands and occasionally even to arborous associations (open or closed *Convallario-Quercetum* – Szujkó-Lacza, J. and Kováts, D. 1993).

In the study area *continental species* predominate, but somewhat more than one third belongs to the Mediterranean group. The ratio of Pannonian (endemic) species is relatively high, while adventives and cosmopolitans are negligible. As Pontian-

Mediterranean elements are classed with the continental group, the Mediterranean character is even more pronounced.

According to ecological indicators developed in Hungary (Borhidi, A. 1995), heat and water demands of plants have been evaluated. In the cenological surveys altogether ten test squares of 5 m times 5 m size were identified for each microhabitat. The interpretation of the index of *relative heat demand* (TB) shows the following types:

- mesophilous broad-leaved forest species (TB: 5) – 5.3 per cent of flora;
- submontane broad-leaved (TB: 6) – 17.8 per cent;
- thermophilous (TB: 7) – 38.9 per cent;
- *submediterranean* woodland and grassland species (TB value: 8) – 34.5 per cent;
- plants of eumediterranean evergreen belt (TB value: 9) – 3.5 per cent.

The distribution of types according to the index of *relative groundwater* or *soil moisture* (WB) shows a dry character: the cumulative ratio of categories WB 1–3 amounts to 80 per cent. The relatively most frequent WB 2 category indicates an intensive Mediterranean influence. The types are

- plants of extremely dry habitats of bare rock (WB: 1) – 22.9 per cent of flora;
- *xero-indicators* on habitats with a long dry period (WB: 2) – 45.9 per cent;
- *xero-tolerants*, but also occurring on moist soils (WB: 3) – 16.5 per cent;
- plants of semiarid habitats (WB: 4) – 9.3 per cent;
- plants of intermediate semihumid habitats (WB: 5) – 1.8 per cent;
- plants of moist soils (WB: 6) – 1.8 per cent;
- plants of wet soils not desiccating and well aerated (WB: 7) – 0.9 per cent;
- plants of wet soils tolerating short waterlogging (WB: 8) – 0.9 per cent.

The index of *continentality* (CB) shows the degree of tolerance to extreme climate and point to a continental character in the region. At the same time, transitional nature is indicated by the high ratio of species in the CB 5 category. The types are distributed as:

- (sub)oceanic species, area: whole of Central Europe (CB: 3) – 2.8 per cent of flora;
- suboceanic, mainly in Central Europe but expanding to East (CB: 4) – 10.8 per cent;
- intermediate with slight suboceanic-subcontinental character (CB: 5) – 31.5 per cent;
- subcontinental species, area: eastern Central Europe (CB: 6) – 9.9 per cent;
- (sub)continental species, main area in Eastern Europe (CB: 7) - 12.6 per cent;
- continental species only reaching eastern Central Europe (CB: 8) - 12.6 per cent;
- eucontinental, main area: Siberia and Eastern Europe (CB: 9) - 19.8 per cent.

From the investigation it is claimed that in the test area (and in the broader environment) the typical continentality is accompanied by a remarkable (sub)mediterranean character. A possible explanation to this phenomenon could be aridification in the wake of global warming.

Soil dynamics

In the Danube–Tisza Interfluve the shift of wind-blown sand was stopped by the expansion of vegetation. The decomposition of organic matter produced humus in sufficient amounts to make the individual quartz grains more coherent, sometimes in only some centimetres thickness, and further stabilise sand movement. This is the origin of *humic sand*, a characteristic soil type of dune summit levels in the Kiskunság National Park. Some summits are still covered by blown sand or blown sand veneer. An overwhelming part of the humus content clearly concentrates in the uppermost layer. The humus was produced by a scattered *sand grassland* of incomplete (20 to 25 per cent) cover. That is a pioneer association over surfaces of extremely adverse conditions (strongly exposed to radiation, sand substrate of excellent infiltration and poor water retention capacity and containing only traces of mineral colloids [clays]).

In interdune hollows and flats a *hydromorphic* (or often alkali) *influence* was also present, since groundwater table was closer to the surface. The most common genetic soil type here (Várallyay, Gy. *et al.* 1981) is *double-layered humic sand under hydromorphic influence both from above and below* (although it has to be noted that the influence of capillary water rise is certainly greater.

With the gradual lowering of the water table in alkali ponds of various size and with the complete desiccation of some of them (eg. Szappan-szék pond near Fülöpháza) the direct contact between groundwater and salt-affected soils is interrupted, *the solonchak soil dynamics ceases* and even leaching may ensue. The sodium salts previously accumulated in the soil profile are transported by rainwater (available in sparse but sufficient amount) into the subsoil or into the groundwater now occurring at some metres depth.

Disregarding salt-affected horizons, hollows, on the whole, have soils with higher water retention capacity and, thus, more favourable ecological conditions and give rise to the development of a more closed vegetation richer in species and, therefore, their tolerance to aridification is much higher.

CONCLUSIONS

The above findings prove that there is a very well defined trend towards aridity and aridification processes have been leading to detectable changes of the environmental factors.

Future research aims at the definition and delineation of environmentally sensitive areas in Hungary and at the application of the MEDRUSH model for a larger catchment to allow the prediction of the impacts of aridification and land degradation processes.

REFERENCES

Ambrózy, P., Koflanovits, E. and Kövér, B. (1990): A csapadékeloszlás időbeli átrendeződése Magyarországon (Changes of the temporal distribution of precipitation in Hungary). – Időjárás, *94*. 2–3. 156–167. 1980. 75+43 p.

Borhidi, A. (1995). Social behaviour types, the naturalness and relative ecological indicator values of the higher plants in the Hungarian flora. – Acta Botanica Hung. 1-2. Pp. 97–181

Koflanovits-Adamy, E. and Szentimrey, T. (1986). The variations of the precipitation amounts in the Carpathian Basin during the present century. – Időjárás, *90*. 2–3. 206–216.

Mika, J. (1988). A globális felmelegedés regionális sajátosságai a Kárpát-medencében (Regional features of global warming in the Carpathian Basin). – Időjárás, *92*. 2–3. 178–189.

Mika, J. (1991). Nagyobb globális felmelegedés várható magyarországi sajátosságai (Predictable impacts of a major global warming in Hungary). – Időjárás, *95*. 6. 265–278.

Mika, J. (1993). Az Alföld éghajlatának megváltozása a globális klímaváltozás összefüggésében (Changes in the climate of the Great Hungarian Plain in relation to global climate change). – Alföldi Tanulmányok, Békéscsaba, *15*. 11–29.

Molnár, K. (1994). Magyarország tájainak éghajlati bemutatása feltételezett klímaváltozás esetére (Climatic description of the landscapes of Hungary under conditions of a presumed climate change). – Dissertation, Manuscript. Budapest, 82 p.

Molnár, K. and Mika, J. (1997). Climate as a changing component of landscape: Recent evidence and projections for Hungary. In: Bremer, H. and Lóczy D. (eds.): Geomorphology and changing environments in Central Europe. – Zeitschrift für Geomorphologie, Supplementband 110. 185-195.

Pálfai, I. (1995). A Duna–Tisza közi hátság vízgazdálkodási problémái és megoldásuk lehetséges útjai (Water management problems on the Danube–Tisza Interfluve and possible solutions). – Vízügyi Közl. **76:**1-2. 144–164.

Szalóki, S. (1994). A talajvízszintsüllyedés következményei a növénytermesztésben (Consequences of dropping groundwater levels in crop cultivation). – In: Pálfai, I. (ed.): A Duna–Tisza közi hátság vízgazdálkodási problémái (Water management problems on the Danube–Tisza Interfluve), Nagyalföld Foundation, Békéscsaba. 53–58.

Szentimrey, T. (1994). Magyarországi hőmérsékleti adatsorok inhomogenitásának becslése (Estimation of inhomogeneity for the temperature series of Hungary). – Climatological and Agrometeorological Papers), 2. 42 p.

Szujkó-Lacza, J. and Kováts, D. (eds.) (1993). The flora of the Kiskunság National Park in the Danube--Tisza Mid-region of Hungary. Vol. 1. The flowering plants. – Hungarian Museum of Natural History, Budapest. 469 p.

Válallyay, Gy. *et al.* (1981). Magyarország agroökológiai potenciálját meghatározó talajtani tényezők 1:100 000 ma. térképe. (Map of soil properties controlling the agroecological potential of Hungary on 1 to 100 000 scale.) Földrajzi Értesítő 30. pp. 235–250.

L. Bassa–Á. Kertész (eds): Windows on Hungarian Geography
Studies in Geography in Hungary 28, Geographical Research Inst. HAS, Budapest 1998, pp. 99–109

GEOGRAPHY AND ENVIRONMENTAL PROTECTION

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INTRODUCTION

The Department of Applied Landscape Geography at the Kossuth Lajos University of Debrecen (KLTE) is engaged in the theoretical, applied and methodological study of landscape geography, landscape preservation and environmental protection. The paper is intended to present some of the results.

First, the contribution of geography to environmental protection is investigated from a theoretical aspect and then some achievements in the field of research concerning pollution are treated. Finally, a method for the identification of abiotic natural values is described.

THE BASIC ENVIRONMENTAL PROBLEM

The concept of environmental protection has been interpreted in different ways and, consequently, the role of various disciplines is not uniformly formulated in this intricate system of activities.

The interpretation of the authors is founded on the relationship between the society and the environment. This relationship has been changing both in quantitative and qualitative terms over human history. The period of hunting and gathering was replaced by that of agriculture, including crop farming, and it meant a new quality since seeds can only be sown if the soil has been disturbed and natural vegetation removed from the site in question. The care taken of the crop selected by man involves that all other plants are designated weed and obliterated from the cultivated fields. Consequently, the living system changes, matter and energy cycles undergo alterations.

With the expansion of human population, the need for food and, consequently, for agricultural land has increased. This quantitative change was made possible by the invention of the plough and later of the tractor and, not in the least, by irrigation, which – under certain circumstances – may lead to qualitative changes (secondary salinisation).

The 'green' revolution of the 20th century brought another qualitative change, namely the large-scale application of chemicals, which might have resulted in a massive environmental pollution.

Industrial development has involved even more dramatic consequences. In the early phase of metal working all the essential elements of industrial production were already present. The extraction of raw materials was locally accompanied by the destruction of biota and soils. Metallurgy as any other industrial activity requires energy, which is also produced through processes damaging the environment (in the beginning, forest clearance, then coal mining and mineral oil extraction). Industrial production is nothing else but a matter and energy transformation process which produces articles useful for humanity as well as useless matters and energy (solid and fluid wastes, polluting gases, waste energy) through mechanical destruction (mining) of the environment. The 'superfluous' matters and energy are the causes of many of the environmental problems, endanger biota, including humans.

Thus, it is claimed that the conflict between man and environment is rooted in production and in the expansion of human population and its needs. It can also be proved that consumption leads to similar environmental consequences as production does. *Figure 1* shows a general approach to the basic problem of the environment.

The concentric circles are only symbolic. They are meant to indicate that humans as biological creatures in their existence are dependent on the built environment, on the characteristics of the biota (where they belong) and the abiotic environment, and, at the same time, through their productive and consumptive activities, they weaken these very 'protective envelopes' and, on the long term, risk their own survival.

Although production and consumption without damage to the environment is a mere illusion, the *degree* of these influences is of great importance. In fact, it is regarded the key issue of environmental protection. Living systems, including the global Earth system, possess self-regulating and regenerating capacities. The fundamental task of environmental protection is to prevent that processes damaging and polluting the environment destroy its ability for regeneration. In addition, the natural feedback mechanisms of the Earth system have to be maintained since they ensure self-regulation on the planet and the stability of an environment securing life.

SCIENCES IN THE SYSTEM OF ENVIRONMENTAL ACTIONS

The above suggest that environmental protection comprises an interrelated system of intricate activities. Here a simplified classification of environmental actions is presented in order to identify the place and role of the various scientific disciplines (Figure 2). Since most of the polluting and destructive impacts on the abiotic environment and on the biota derive from economic activities, the most important scene of environmental action is the *economy* and solutions have to be sought here.

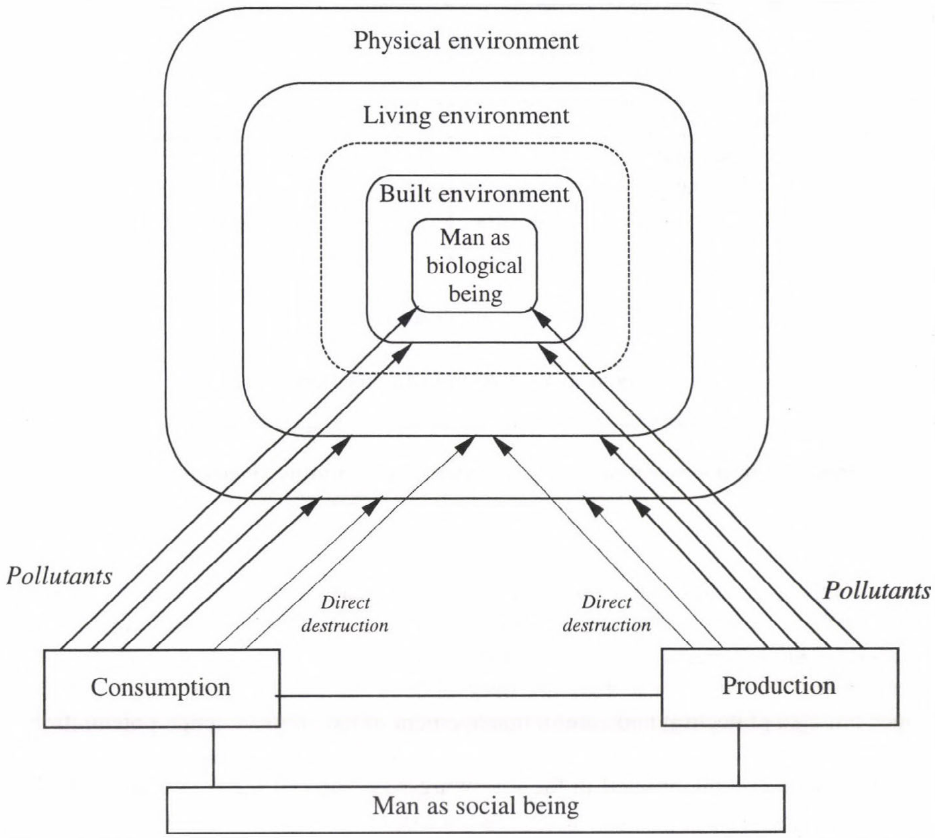

Fig. 1. Effects of the most important human activities on the physical, living and built environment and the man as biological being

Sciences should also contribute to the solution of environmental problems: without deep-reaching scientific research no efficient protection of the environment is conceivable. An equally important part is played by *environmental education*, the creation of environmental thinking in the broadest possible circles of society. Environmental actions motivated by internal factors is much more efficient than those performed under external force.

In spite of all this, instruments of forcing, *legal regulation, acts*, whose violation by individuals or communities is punished by law, are also needed in environmental protection. The organisation of environmental movements and groups and their actions are organic parts of the civil society, and the significance is similar to that of official bodies, institutions governing environmental policy. The efficiency of environmental protection is greatly dependent upon the co-ordination of these activities, to what extent they strengthen or weaken each other.

Environmental protection	
Intellectual sphere	Practical sphere
Sciences Education Other methods of shaping consciousness	Economic activities Consumer activities Population
Administration Non-governmental organisations	

Fig. 2. Groups of environmental protection activities according to the dominance of intellectual and practical activities

In our concept, environmental protection is a system of activities of broadest sphere, which serves the moderation of conflicts between man and environment and the solution of environmental problems. In this sense, nature conservation is also part of environmental protection. It does not only include the passive preservation of natural values but also protection and careful management of the environmental potentials.

In accordance with our topic, the place of sciences in the system of environmental actions is contemplated in the following way. First of all, it is claimed that several disciplines are engaged in topics which serve the scientific basis for the solution of environmental problems. (By the authors it is considered the main role of sciences in environmental protection.) No doubt that physics and the technical sciences have great contributions to the development of the security systems of nuclear plants, to the elaboration of the legal regulation of environmental issues, chemistry in experiments with environmentally friendly chemicals etc. There are disciplines, however, which are concerned with complex environmental research from the very beginning of their history. Such are ecology, which investigates into the interrelationships between the natural biota and its environment, and geography, aiming at a comprehensive research of the geographical environment. Geography occupies a special position in the system of sciences: it is a link between natural and social sciences (physical and human geography). It is a favourable endowment for complex environmental and landscape protection analyses within the limits of the discipline.

In recent decades, specialisation has characterised all academic disciplines and it points towards the disintegration of unified geography: in many countries physical and human geography are institutionally separated. At the same time, environmental problems call for a complex scientific approach. This demand may bring geographical disciplines closer to each other in the future. The requirement of profound research at the contemporary level involves that successful research can primarily be conducted in teams. In the department of Applied Landscape Geography at the KLTE attempts have been made to work in a team system. We know, however, that the physical geographical side of our research is stronger and this fact also implies a possible future direction of extending our investigations.

In the following sections some results of research from the system approach in an agricultural environment are treated. The roles of man and geographical environment are analysed in the development of pollution of various degree and, finally, methodological research scientifically founding the protection of natural values is reported on.

A SYSTEM-APPROACH PRESENTATION OF PROCESSES IN THE SAMPLE AREA

One of the sample areas of the Department for landscape protection research lies on the foothills of the Bükk Mountains, North Hungary. In the landscape section of a 10 km^2 area farming predominates. In order to interpret the observations a system model was constructed (*Figure 3*).Using this model processes and impacts harmful to humans are to be presented.

In the model the *social subsystem* including man, machines and the built environment is distinct from the *natural subsystem* comprising rocks, soils, relief, surface waters and farming crops. The atmosphere and the climatic effects as not decisive parts of the visible structure of the landscape are shown outside the limits of the system. Their influence is indicated by including some major impacts.

The sample area is a typical *agricultural area in rural environment*, where large-scale arable farming prevails and, in addition, vineyards occupy considerable areas and vegetable gardens occur over a small percentage of the land. In order to achieve higher yields *irrigation* (1) is practised regularly. Nutrient recharge is ensured through the application of *manure* (2), *fertilisers* (3) and *sewage sludge* (4). Against plant diseases various *pesticides* (5) are used. It can be seen that the amounts of various material inputs of the system are *controlled by man*. It is an essential point as manure, fertilisers, sewage sludge and pesticides contain *compounds harmful to human health*. Nitrogen fertilizers, for instance, may increase the nitrate contents of soils and of groundwater. In phosphate fertilizers cadmium concentration is often high and sewage sludge may also contain heavy metals in considerable amounts. Therefore, the appropriate control of input is of primary importance for in its absence the pollution of the environment may reach critical levels.

The amounts of pollutants arriving in the area through *atmospheric deposition* (9) cannot be influenced by man on the site of immission, the rate of which primarily depends on the distance from emission source, the amount of pollutants in air and atmospheric conditions. The sample area lies quite a distance away from major industrial areas, and thus, no sizeable deposition has to be taken into account.

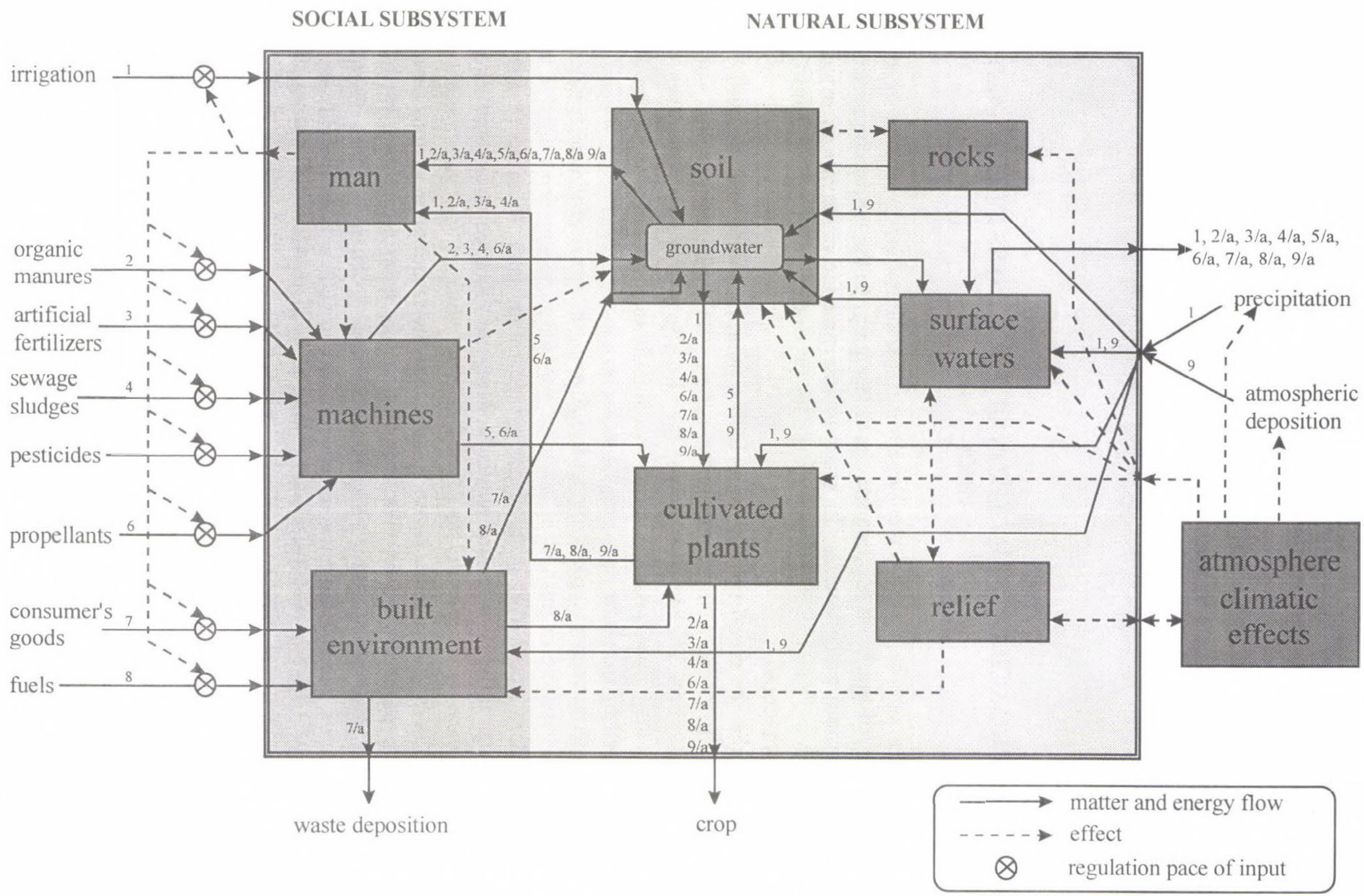

Fig. 3. The system model of the sample area on the foothills of the Bükk Mountains

The population in the villages of the sample area uses the *water of groundwater wells*. The model shows how diverse sources supply pollutants into the groundwater, and thus, also into drinking water. Nitrate is a major danger. Therefore, the nitrate content of groundwater have been monitored for several years. From hundreds of measurements it has been established that in a considerable percentage of wells *nitrate content exceeds the health limit of 40 mg/l*. Values between 100-200 mg/l were frequently found and a nitrate content above 700 mg/l has also been measured. The investigations revealed that a main source of nitrate content in groundwater was *nitrogen fertilizers* spread from the neighbouring agricultural area. Topographic conditions allow the redeposition of part of the fertilizer amount in the lower lying terrain through sheet wash during major rainfall events. Lysimeter observations and auger holes revealed that it takes only some years for the nitrates of fertilizers to be washed into the groundwater, which also flows towards villages situated in valleys. In addition, *pollution sources within the built-up areas of settlements* (manure heaps, privy pits, sewage septic tanks) also contributed to high nitrate contents.

In addition to the considerable nitrate levels, using the GC/MC method, various *chemical residuals* (DDT, DDE, atrazine), decomposition products of the mentioned manures and pesticides (2/a, 3/a, 4/a, 5/a), *fuels* like oil derivates used for agricultural machines and road vehicles (6/a) as well as for heating homes (8/a) have also been found in groundwater. (/a marks chemically transformed compounds of the material or group of materials indicated by *Figure 3*) A further source of pollution can be *domestic waste* (7/a) from settlements as its safe disposal is not yet solved.

The model clearly shows that polluted groundwater is not only a direct risk for human health, but since plant roots are able to take up dissolved pollutants from the soil, indirectly, *through plants*, may also cause problems.

Various toxic heavy metals may present an additional danger. For this reason, the horizontal and vertical distribution of these metals in the soils of the sample area has been studied in detail with atomic absorption spectrometer. It was found that *the role of morphology* is decisive in the distribution of certain metals. In the case of metals accumulating in topsoil, for instance, maximum values of concentration are often measured on the valley floor. This might be attributed to erosion induced by sheet wash, which mainly affects the uppermost soil layer. From the interpretation of several thousands of measurements, it was found *that the heavy metal content of soils in the sample area is* – disregarding some exceptions – *below the health limit.*

The factors influencing the behaviour of heavy metals, controlling the migration of these elements with in the soil-plant system, have been analysed in detail. It is claimed that in the soils of the sample area among the heavy metals investigated, lead, cobalt, chromium, nickel, manganese and vanadium are present in forms not easily available for the plants, while – compared to the metal content of soils – much higher amounts of zinc and copper are taken up by plants.

Another important issue is the *distribution of heavy metals within plants*. It is not at all indifferent in which organ of the plant they accumulate. In the three most widely grown crops of the area, corn (maize), wheat and sunflower, heavy metal distributions have been investigated and the highest metal contents are found in *roots*. From the viewpoint of toxicity it is favourable, since the roots of these plants are not suitable for human consumption or animal feeding. On some occasions, however, primarily in the case of sunflower, *leaves* contained the highest amounts of metals. It can be conceived that *atmospheric deposition* (9) is most efficient at this plant of the largest leaf area of the three most frequent crops and the epidermis is rich in plant hair, which further increases specific leaf area. It is remarkable that *large amounts of copper and* particularly *zinc accumulate in the fruits* of the crops studied. Consequently, if crops are grown on soils contaminated with the two metals mentioned, the danger is high.

The model shows that various chemical residuals, pollutants are carried by sheet washand the resulting soil erosion into *surface waters*. In the sample area Hór stream collects waters and transports them (together with pollutants) out of the area.

The sample area lies in the contact zone of sedimentary and volcanic rocks, which control soil formation mechanisms and determine the mineral components of soils. The investigations suggest that the territorial variation of heavy metal content in soils is partly due to differences in parent rocks.

The system model is naturally unsuitable to include all minor details but the *routes of matter and energy flows* most important for the operation of the system and the major *impacts* are demonstrated. It is clearly visible that *the dangers which emerge during functioning are almost exclusively the consequences of human activities and* it is also unambiguously stated that *the key of regulation is in the hand of man.*

RESEARCH FOR FOUNDING THE PROTECTION OF PHYSICAL GEOGRAPHICAL VALUES

A new research topic of the Department is the study of geographical aspects of nature conservation, the evaluation of abiotic natural objects and soils for the conservation of the biotic components. Today this field does not receive due attention in nature conservation, which focuses on the preservation of the living nature. Although it is basically a correct concept, but, along with botanical and zoological values, abiotic natural objects and soils, transitional between living and non-living nature, should also be preserved. These systems are constituents of the same rank of nature systems and, primarily because of their significance in science and education, are worth of preservation.

To decide what a geological, geomorphological, hydrological or pedological value is, needs scientific investigations. However, special studies expressly aimed at the evaluation of abiotic natural objects and soils for nature conservation are still missing.

This neglect also applies to the methodology of identification of these values. Therefore, our first objective was to elaborate methods for this evaluation. In the following sections the method applied for the evaluation of landforms and soils aimed at nature conservation is presented.

A method of evaluation of landforms and soils for nature conservation

The objective of *evaluation for nature conservation* is to express the qualitative features of nature in quantitative parameters in order to determine the value of certain natural objects and areas numerically (de Groot 1992). The nature conservation values resulting from the evaluation allow the comparison and ranking of the objects and areas investigated and the setting of protection priorities.

The first step is *the selection of criteria*. First of all geomorphological and pedological values have to be defined and the applied criteria have to be derived from the definitions. In our concept geomorphological and pedological values include

– special geomorphological and pedological objects and

– typified occurrences of all landform and soil types in Hungary, out of which those of representative and rare types are particularly valuable.

Such criteria determine the scientific significance of the object, which is an objective value, most independent of human considerations. In addition, however, the investigation of two practical aspects is regarded important. The degree of endangerment defines the need for legal conservation, while educational significance expresses the applicability of the given object in the development of nature conservation thinking.

The second step of evaluation is to *establish the role of the criteria*. The method applied is multi-phase interpretation (Margules in Usher 1986). The greatest advantage of this approach lies in avoiding weighting, a generally applied, but undoubtedly most criticised technique, in evaluation. On the other hand, no single score is applied to express the value for nature conservation and, thus, a more differentiated picture is provided about the preservation of objects. The method employed for the evaluation of landforms and soils is presented in *Figure 4*.

The next step of evaluation is *the identification of the numerical value of the individual criteria*. In the following sections the method for establishing the typifiedness of soils is described.

Determining the typifiedness of soils

For the exact identification of the most typified profiles within each soil type a scoring system has been elaborated. The steps in computing the value of typifiedness are the following:

1. *Selection of soil properties controlling typifiedness*. When selecting the properties, the following factors are taken into account:

– comparability (only those properties are employed for which data are available from each occurrence);

– exactness (only properties which can be exactly determined are assessed);

– permanence (only properties described with relatively permanent values are used).

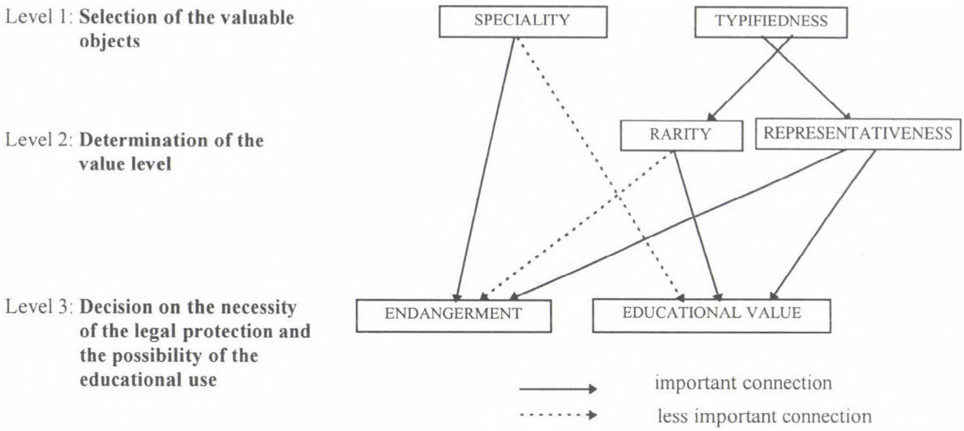

Fig. 4. Levels of investigations in the evaluation of landforms and soils and the role of various criteria in the evaluation process

2. *Weighting properties.* Properties are referred into three groups according to their significance in typifiedness (primary, secondary and tertiary properties). The classification is based on the nature of soil formation processes (characteristic and prevailing process) responsible for the soil properties in question.

3. *Setting limit values.* To identify the limit values of the properties, in addition to our own investigations, a statistical processing of profile descriptions available in literature is also necessary. An important consideration is that only those profiles are processed which are described from natural or quasi-natural sites.

4. *Computing weighted scores.* The calculation of partial scores for the individual properties is made with the help of an evaluation table, which has to be elaborated for each soil type and subtype investigated. It has been elaborated for podsolised brown forest soil (Kiss, G. 1997). Maximum score is attributed to a profile for a property if its values are within the limit values of typifiedness. If values are beyond this interval, score reduction is applied in proportion to deviation. The maximum score for typifiedness and the degree of score reduction – in proportion to the weighting of properties – is the highest for primary properties, while the lowest for tertiary properties.

5. *Computing typifiedness value through summarising partial scores.* It is a simple mathematical operation: the partial scores are summarised and the percentage of the maximum score reached by the given occurrence is computed. This percentage value is called typifiedness value. It helps select the most typified profile out of those of the same type and, on the other hand, the typifiedness of soils of different types can be compared.

REFERENCES

de Groot, R. S. (1992). Functions of Nature. Evaluation of Nature in Environmental Planning, Management and Decision Making - Wolters-Noordhoff, 315 p.

Kiss, G. (1997). Talajok típusossági értékének meghatározása a podzolos barna erdőtalaj példáján (Determination of Typifiedness Values of Soils, with the Example of Podzolized Brown Forest Soil), Agrokémia és Talajtan, under publication

Margules, C. R. (1984). Conservation Evaluation in Practice II. Enclosed Grasslands in the Yorkshire Dales, Great Britain, Journal of Environmental Management, No. 18., pp. 169-183.

Margules, C. R. - Usher, M. B. (1984). Conservation Evaluation in Practice I. Sites of Different Habitats in North-East Yorkshire, Great Britain, Journal of Environmental Management, No. 18, pp. 153-168.

Usher, M. B. (ed.) (1986). Wildlife Conservation Evaluation - Chapman and Hall, London, 394 p.

L. Bassa–Á. Kertész (eds): Windows on Hungarian Geography
Studies in Geography in Hungary 28, Geographical Research Inst. HAS, Budapest 1998, pp. 111–116

GEOGRAPHY SCIENCE: AN OLD-NEW DISCIPLINE

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INTRODUCTION

The aim of all those efforts that have been made in order to elaborate the topics and clarify the principles of cultural, sport and medical geography – in the success of which our younger colleagues have played a great role – is to try to widen the scope of geography, to analyse new geographic fields and to prove the usefulness and efficiency of this attempt.

Summarising the results of this attempt, and trying to determine the place and connection system of these new subdisciplines in the inner structure of geography science, it is unavoidable to speak about the taxonomic position of geography and the inner structure of geography science.

It is necessary because, regarding this issue, one can find conflicting views in the international literature. Without analysing the bases of certain details and presenting the whole set of arguments, a brief summary is presented below.

STEREOTYPES

There are several misinterpretations or simplifying stereotypes concerning geography. For the non-professional, who meets geography only as a primary or secondary school subject, and at most through the news of the media that contain geographic information, the ties and differences between the *subject*, the *university major* and the *science* are not clear. Concerning the above mentioned domains there are great differences in geography, thus identification – owing to a slow appearance of the modern achievements of the discipline in the training – is not easy. Therefore, the public opinion devaluates geography science to the level of a school subject which describes facts and phenomena, determines their place and collects the data.

With respect to the geographic science the scientific public opinion is embarrassed by the concept of geography being a natural and a social science at the same time.

According to a superficial approach, part of it belongs to the natural, another part to the social sciences. This latter approach has representatives even among professionals, however the view, according to which geography is a uniform, but Janus-faced science, is spreading.

Naturally, these problems are the concomitants of the development of each scientific discipline. Only the self-improvement of the disciplines and that of the whole science can bring solution, at the same time producing new conflicts.

THE TOPIC OF GEOGRAPHY SCIENCE

Human being – through his needs as of a biological being – can live only in the natural environment using its endowments. The relationship between nature and human beings organised into society, becomes stronger and stronger with the development of the forces of production. Dividing this complicated process into three phases *(Figure 1)* one can state the following:

1. In the first, pre-industrial phase, the relation between the undisturbed nature and society (with the latter including a low number of population) is weak and – except some limited regions – well-balanced.

2. In the second, industrial phase, as a result of the accelerated development of the forces of production, the two circles, symbolising the two spheres begin to overlap with each other and a new space type appears, which belongs to both of the spheres simultaneously. The relation becomes unbalanced.

- In this space type the laws of both spheres are valid, because it is part of both of them.
- In this space type – since the laws of both spheres are valid – the assertion of the laws is influenced by the other sphere.

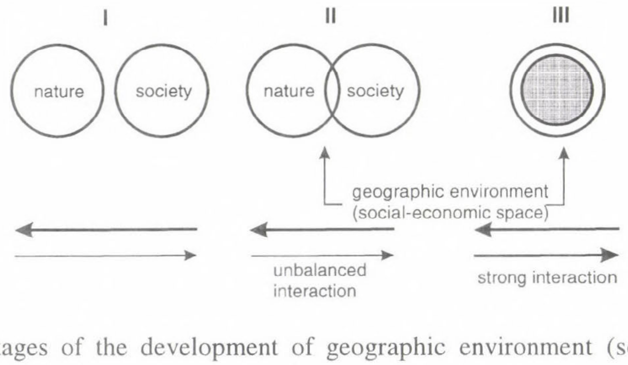

Fig. 1. The stages of the development of geographic environment (social-economic space)

- This new space type means a new quality. One can call this geographic environment or, with a synonym, social-economic-natural-infrastructural space.
- This new space type is the domain of geography science, the exploration of its structure and evolution is the task of geography science.

3. In the third, post-industrial phase the nature-human interrelationship becomes strengthened and balanced, and a new space, the total geographic environment is coming into existence. The topic of modern geography science is to become global, instead of the physical space, geographic environment of the mental type, structured through the distance weighted by the closeness of socio-economic relations, as an increasingly significant domain necessarily raises the prestige of the science itself.

The three phases shown in *Figure 1* are the three stages of the temporal development of a given area, but in an other approach this means that at a given time all of them can exist side by side in some segments of the social-economic space. It is natural that in this latter situation the trend of development and the type of relations are determined by the most developed area.

In our opinion, geography is a natural and a social science, since its topic is a special new space type of a new quality, which is the system of the interrelationship of social-economic-infrastructural-natural spheres, thus its inner structure is complex.

ISSUES OF APPROACH

1. The development of forces of production and the deepening of labour division is mentioned so often, that the concepts themselves have become cliches. In fact we do not think over the essence of the process, thus a schematic picture evolves in our mind. This suggests that if the development level of the forces of production rises from stage "A" to stage "B" during time "t", the certain stages can be characterised by lines *(Figure 2).*

Meanwhile, the well-known fact that the advancement of the forces of production is unbalanced, the different sectors of economy appearing during labour division have different dynamics of development and their initial levels of development are different, is pushed into the background. If replacing the former schematic, straight lines equivalent to development levels "A" and "B" with zigzagged ones, in a way that one part of this line gets under, other part gets over the straight meaning the average, then one can get the development level of forces of production in stages "A" and "B". With the line-section getting above the straight representing the average, calling alpha-, and the other sections calling beta-branches, one can predict that after period "t", alpha-branches have better chances in stage "B" to keep on functioning as alpha-branches (to maintain their position), while beta-branches remain under the average level.

In the case of structural transformation, changes might occur, however they are the result of some technical-technological rearrangement, or that of central interventions.

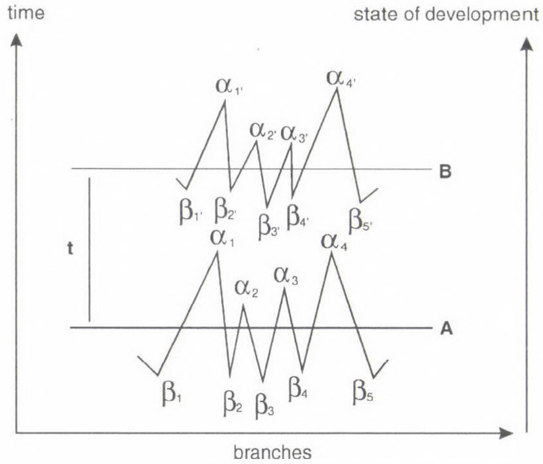

Fig. 2. The sectoral aspect of the development of production forces

From a sectoral view it can be stated that the unequal sectoral development of the forces of production means further inequality, moreover it proceeds with the appearance of inequalities. It is natural that alpha and beta branches have special interests and these interests are related to the position of the given branches.

2. If the unified process of the development of production forces are viewed not from sectoral aspect, but approached from the spatial side, then it can be said that in certain regions alpha branches prevail, while in other ones beta branches are concentrated as a result of the effect of the social-economic-historical factors *(Figure 3).* This kind of concentration does not mean exclusivity, rather the predominance of the alpha- or beta type of branches that counts. As a result of the different spatial allocation of the

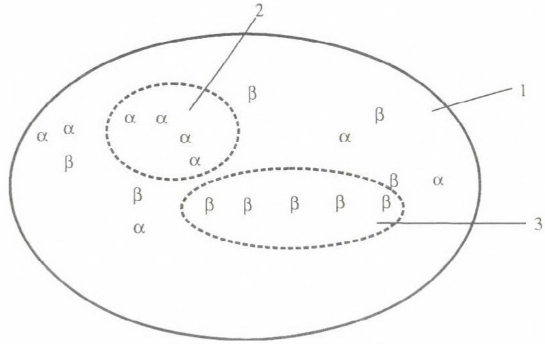

Fig. 3. Spatial aspect of the development of production forces. – 1 = social-geographic space; 2 = developed, innovative regions with the concentration of alpha-branches; 3 = underdeveloped, depressed regions with the concentration of beta-branches

two branch-types, inequalities and regional disparities appear in the course of the development of social-economic space.

According to the above mentioned positions, it is evident that with the development of regions, characterised by the concentration of alpha- or beta branches, specific interests are associated stemming from the situation of the related areas.

These two approaches – the regional vs sectoral aspect of the development of productive forces – are of the equal rank. Both the development of sectoral and regional disparities can be considered an objective process, as well as those interests which follow the progress and can be interpreted from sectoral and regional aspects.

3. Geographical approach – according to the summary of our explanation – means that the expert

– interprets the phenomena in a broad system of complex interrelationships;

– his/her ideas comprise the social-economic-infrastructural-natural space, i. e. the geographic environment;

– interprets the phenomena both from sectoral and regional aspects;

– when observing things spatially, the temporal aspect is not left out of his/her consideration.

4. It should be stated that the indispensability of the geographic approach cannot be restricted to geography. Starting from the point that everything is allocated somewhere in the social-economic space, the approach related to space and spatial processes have significance for the society.

THE INNER STRUCTURE OF GEOGRAPHIC SCIENCE

In connection with the inner structure of geographic science there are several approaches. The author disregards describing the details relating to this, but it should be mentioned that the reason for the different divisions or the confused logical base of division stems from the topic of geographic science itself, or from the issues of approach.

The subdivision illustrated with the attached scheme *(Figure 4)* is only one of the possible alternatives, but it is based on the experience of research and educational activity of many decades, and seems to be consistent. According to the scheme it is reasonable to emphasise the following characteristics:

1. Geography shown in the *Figure 4* is uniform, but according to the focus of the approach it is threefold:

– human geography, dealing with the topic of geography from the aspect of society,
– physical geography, dealing with the topic of geography from the aspect of nature,
– regional geography, dealing with the topic of geography from the aspect of the separated elements (regions, countries, areas) of the social-economic-infrastructural-natural space (geographic environment).

2. For all of the three aspects and in between the connecting aspect-pairs a number of auxiliary sciences provide the material to be synthesised and built in. The

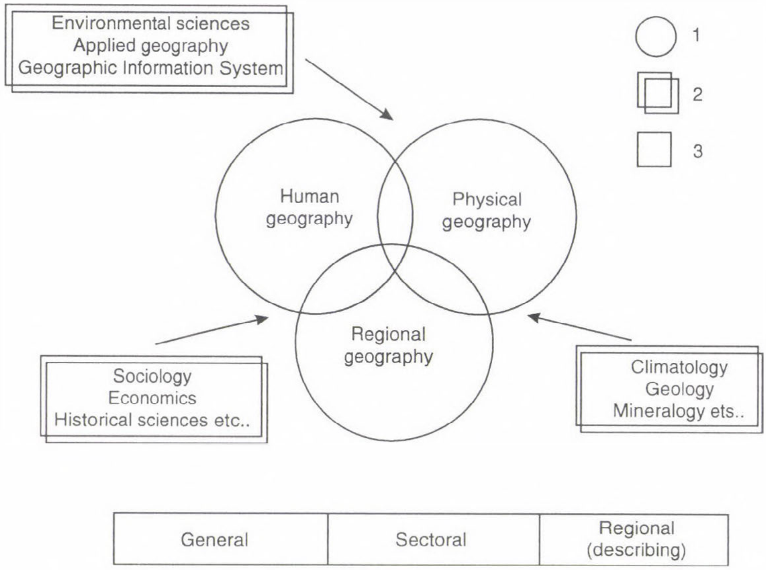

Fig. 4. The inner structure of geographic science. – 1 = branches of geography; 2 = auxiliary sciences; 3 = ways of approach

demand for the knowledge of the auxiliary sciences – in the case of the large number of disciplines – makes the cultivation of geography particularly difficult.

3. The complexity and versatility ensures that the graduated experts are able to occupy jobs beyond their narrower qualification successfully.

4. In *Figure 4* it is shown that in contrast to the former (horizontal) approach, the aspects of geography can be interpreted according to general, sectoral or regional viewpoints coming to the fore.

5. The general, sectoral, and regional approaches can be conceived within human, physical and regional geography, moreover they are valid for the broader subdisciplines of certain branches of geosciences.

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THE ECONOMIC GEOGRAPHY OF HUNGARY IN THE AGE OF THE ÁRPÁDS

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INTRODUCTION

The age of the House of Árpád (895-1301) was a decisive period in the social and economic development of Hungary.

With the Hungarian Conquest (895-900), the era of migration of the Magyar tribes came to an end. Subsequently Hungary found its place in feudal Europe through a radical change in lifestyle. Changing the way of life was a long and complicated process, which was imposed upon the nation by the circumstances, but at the same time valuable elements of an ancient civilisation survived and had been modified. The civilisation brought from the East was not inferior to, but *different from* that of the contemporary Central Europe. This civilisation had to be adjusted to the new social and economic circumstances.

Adoption of Christianity as a faith and culture was the foundation of the survival of the nation, of the emergence of the new feudal Hungarian state that was integrated into the community of European nations. The new feudal state caught up with the rest of Europe by the end of the 15^{th} century.

After the establishment of the feudal state and following the Mongolian invasion in the 13^{th} century, the work to build up the nation and to develop the economy went parallel with the adoption of the achievements of the contemporary revolution of agriculture and craftsmanship in Europe and with the economic expansion in the whole Carpathian Basin. Geographical division of labour started, large economic geographical units came into being and a settlement pattern emerged. The adoption of innovations, inter-ethnic relations and an autochtonous development modernised the economic geographical structure of Hungary during the Árpádian Age.

In the present paper an attempt will be made to provide a summary of the phenomena and processes which took place in the course of economic development during this essentially successful period of 400 years, paying a special attention to the wide variety of human activities.

SETTLEMENT PATTERN AND THE STRUCTURE OF ECONOMY

The area of settlement of the conquering Hungarian tribes were extended over the inner part of the Carpathian Basin, including the plains and hills, comprising ca. 220,000 km^2, that is, two thirds of the total area of the country. *The populated area was roughly identical with that covered by loess and Tertiary deposits and by oak forests (bordered by the 600 mm isoline of mean annual precipitation).* (Bulla, B. and Mendöl, T. 1947, László, Gy. 1986; Somogyi, S. 1988, 1994). The 1,500 km long and 150-200 km wide of the mountain range of the Carpathians – covered with forests – was not suitable for the semi-nomadic stock-breeding and farming of the Hungarian tribes coming from the steppe so this was the area where they created the medieval defence system surrounding the country including uninhabited and hardly penetrable marches and waste land, *the border guard counties*. 51% of the area of the Carpathian Basin consists of plains lower than 200 m a.s.l., 24% is of gentle hills between 201 and 500 m a.s.l., whereas 20% is medium-height mountains of 501–1,000 m and only 5% is higher than 1,000 m. The basins and the high mountains along the margin are related to each other through the *centripetal* drainage network, which provides a uniform geographical framework for the whole land. Vast areas of the inner basins were regularly inundated at about the time of the Conquest and during the following centuries. Before the integrated, large-scale water regulation and environment restructuring works (1846–1920) these areas extended over 48,700 km^2 (Lászlóffy, W. 1938). Of the inundated areas 38,500 km^2 of them were plains, and 10,200 km^2 of them were hilly regions and closed valleys (Ihrig, D. 1973, Lászlóffy, W. 1938, Somogyi, S. 1988, 1994). Lászlóffy's map of inundation approximately matches the situation during the time of the Conquest, despite the fact that there was a extremely warm and dry period in the Carpathian Basin between 750 and 900 (Győrffy, Gy. and Zólyomi, B. 1994). The swamps, moorlands and flooded areas were probably somewhat smaller than those reconstructed in Lászlóffy's map. More abundant precipitation occurred around 900, producing the necessary amount of fresh vegetation on the grazing land for large-scale animal husbandry and farming. It had contributed fairly to the survival of the Magyars (Győrffy, Gy. and Zólyomi, B. 1994).

From 895 to 900 or 902 (as some historians maintain) the occupation of the western parts of Pannonia was completed, and the whole Carpathian Basin became under the rule of the Hungarians. The military conquest was complete, but economic activities were only extended to the peripheries during the 13th century (Gyimesi, S. 1994). New settlers proceeded to the mountain regions of the Carpathians from the central plains along the valleys of rivers and minor streams. Hungarian population was in itself too low to inhabit the mountain regions, so other ethnic groups were invited to settle. On the meadows in the high mountains and in the areas of forest clearance people found entirely different ecological conditions and they had become involved in animal husbandry and forest management. Cultivating the land was also common in the valleys, and crafts developed in the mountains between the 10th and 13th centuries.

In the first centuries of the Árpád age subsistence farming was typical, although the different geographical environments had created distinct economic structures. As the economic regions slowly began to be specialised, exchange of surplus goods, domestic trade and financial management commenced. Social and natural factors both affected the geographical distribution of economic activities. Exchange of goods became more intensive not only between large geographical units but also within homogeneous regions. By the end of the 13th century areas around towns became the terrain of significant economic activity. The gravity zone of a town included a circle with a radius of ca. 25-30 km, as this was the distance people were able to cover on foot in a day (Gyimesi S. 1994). A "cluster" of agricultural villages was integrated by a town which had a market place and incorporated various craftsmen. The market places, the transport routes including waterways indicated the emergence of large centres of economic regions for the future (*Figure 1*)

Economic specialisation of the geographical regions started approximately one hundred years after it had taken place in the West. It started in the 13th century, and proceeded in a concentricpattern from the central plain towards the Carpathians (Cameron, R. 1994, Frisnyák, S. 1990). The two basic morphological levels of the Great Plain and the Little Plain, the regulary flooded areas along the rivers and the flood-free areas a few meters higher, for example the flat regions, covered by sandy soils and the loess plateaus were suitable primarily for breeding large animals and for farming (grain production). Mixed farming was characteristic of the hill regions, where crop farming, animal husbandry and forest management existed side by side. In some areas wine produc-

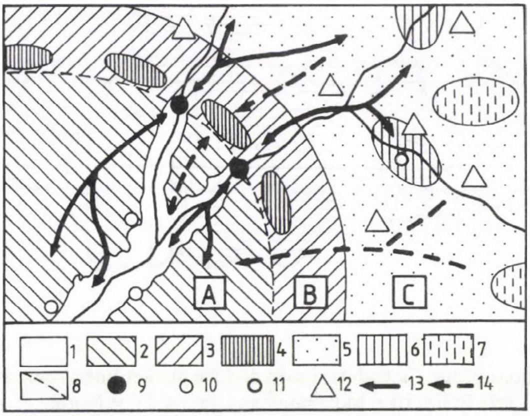

Fig. 1. Scheme of geographical division of labour in the Carpathian Basin in the feudal times. – A = basin flatland, B = hill region, C = mountain range, 1= flood plain with animal husbandry, 2 = flood-free areas (lifecells) with farming, 3 = hill region with mixed farming, 4 = grape and fruit growing, 5 = forest management, 6 = agricultural production in small basins, 7 = high mountain (rough) grazing, 8 = market line, 9 = market town, 10 = settlement along the margin of the flood plain 11 = centre of the intramontane basin, 12 = mountain crafts, 13 = exchange of goods, 14 = direction of labour force migration

tion was dominant. In the Carpathians mountain craftsmanship, mining, animal husbandry and forest management were the most important sectors of economy, but in the broad valleys and intramontane basins farming was also widespread. The orographic borderline of farming was 1,000-1,100 m a.s.l., that of wheat growing was 600 m in the north and 800-900 m in the south. (75% of the area of the Carpathian Basin is suitable for growing cereals.) The different regions were involved in economic activities that complemented each other. The exchange of goods took place at the market towns, the early regional centres. The rim of the flood areas seemed to be the proper location for market places, but river forks, ferries and fords were also attractive places. The busiest market places were in towns located near the mouth of valleys, where the goods of large geographical units (e. g. those produced in plains and mountains) were exchanged (*Figure 2*).

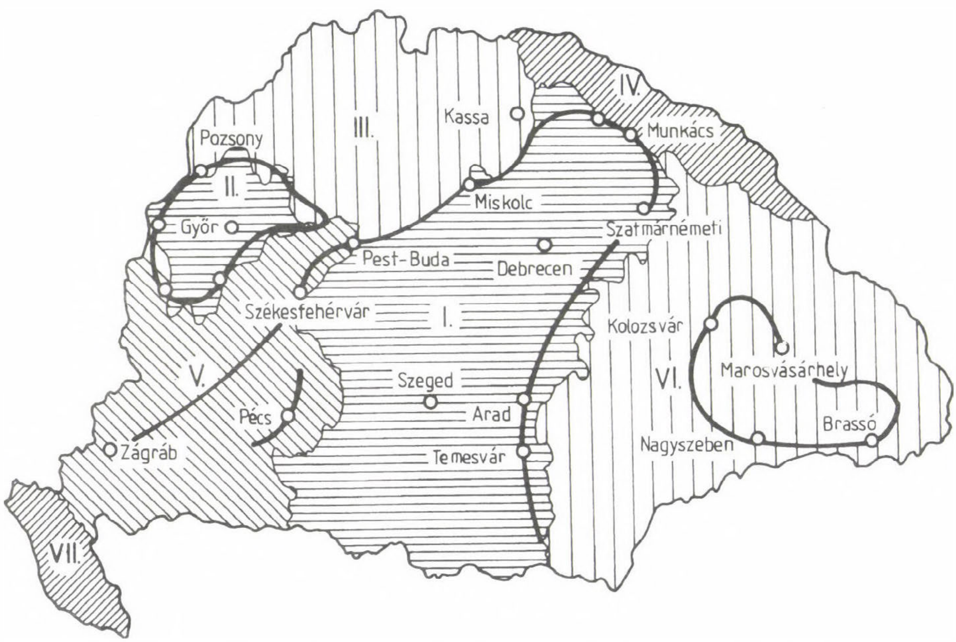

Fig. 2.: The regions of the Carpathian Basin and the market line system in the feudal times. – I = Great Plain, II = Little Plain, III = Mountains and basins, IV = Northeast Hungary, V = Transdanubia and the Drava–Sava Interfluve, VI = Transylvania, VII = The Karst and the Adriatic Coast

THE BASIC SECTORS OF ECONOMY – BREEDING LARGE ANIMALS AND CROP FARMING

Before the Conquest the livestock of the Hungarians amounted to an approximate 10 million. An area of 500,000 to 800,000 km^2 was used by the migrating tribes for grazing the animals on the vast steppes. In the Carpathian Basin a total area of 200,000 to 220,000 km^2 grassy plains and oak forests was at their disposal. The reduction of the grazing area was not a significant problem, as a part of the livestock perished through the Conquest and the grass in the Carpathian Basin was of much higher quality than what they had out in the steppes of the East. The capacity of the Carpathian Basin in terms of animal husbandry was higher than that of any other territory the ancestors of the Magyars had before. It was due to the abundant precipitation and the high density of water courses.

Animal husbandry on the plains was based upon the quality of fodder grown on the flood areas of rivers. The grazing lands of the intermittently inundated areas and those of the so called "Glaser Chambers," free of flood, were used alternately, following the floods of the rivers. This method of grazing is called *meadow transhumation* (Glaser, L. 1939, Szabadfalvi, J. 1984). Traditional nomadic migration was rendered unnecessary by the rich meadows of the plains and impossible by the high density of villages. The distance between the two extreme points of the migration of shepherds shrunk significantly, and it could not be more than two or three days' journey. Archeological findings provide information on the composition of the livestock in the villages. In the age of the Árpáds, the proportion of domestic animals in the villages of Kardoskút and Tiszalök-Rázompuszta was the following: horses 24–27%, sheeps 8.5-16% and pigs 15-21.5% (Fodor, I. 1996, Paládi-Kovács, A. 1993).

Animal husbandry was the dominant subsector of the diversified farming on the flood areas. The special agricultural activities on the flood areas appeared in the Árpádian age, flourished during the 14th and 15th centuries, and, despite the Turkish invasion, continued to function until the mid-19th century (Andrásfalvi, B. 1973). The utilisation of the flood (fishing for various river and lake fish, hunting, fruit and vine growing) was based on the rational use of the natural resources.

Animal husbandry primarily satisfied domestic needs. In the 10th and 11th centuries the export of fully grown cattle was prohibited (Paládi-Kovács, A. 1993). In the Árpádian age semi-processed animal products (hide and skin, leather, wool etc.) were exported. It is believed that cattle was first exported in the early 14th century. Later, in the 16th through 19th centuries, it amounted to 60–90% of the total export of the country. The major centres of livestock trade came into being in the 12th and 13 centuries (e. g. Debrecen, Pest, Pozsony, Sopron, Szeged, Székesfehérvár). Animal husbandry was common all over the Carpathian Basin, but only became a dominant branch of economy in the plains and hill regions. Due to the agroecological differences of the various subregions within the 100,000 km^2 of the Great Plain, livestock composition varied by microregion. In and along the flood plains of the rivers and the adjacent drier parts horse and cattle breeding was typical, whereas the alkali flats and sandy plains were more suitable for sheep grazing. The swamps, moorlands on the margins of the plains and the oak forests were the specialised areas of pig keeping, as the animals were fed on mast.

Animal husbandry on the plains made use of the flood areas and the adjacent flood-free parts alternately. The complex farms of the extensive "Glaser Chambers" (e. g. in Bácska, on the loess plateau of Békés–Csanád, and in the Nyírség area) were also involved in animal husbandry. These farms were, however, specialising in crop growing, and animal husbandry was of secondary importance. They bred animals for the burden and for consumption, not for sale. This complexity was also typical of the farms in the hill regions, where forestry was added to the range of activities. Stock breeding in the high mountains was also a type of animal husbandry in the early feudal times. This activity began around the turn of the 13th and 14th centuries. The first people to deal with high mountain animal husbandry were the border guards in the Upper Hernád and Poprád valleys in the 11th and 12th centuries. The *royal forestry districts*, organized in the 12th century (Bereg, Sáros, Torna, Ugocsa and Zólyom) were also involved in animal breeding, in addition to their special activities (hunting, protection of waters and forests). They kept the animals in the clearings. Classic forms of mountain shepherding had started to take shape in Transylvania in the 13th century, before the Rumanian (Vlach) ethnic group settled down there. Rumanians appeared in increasing number in the Southern Carpathians after the 13th century, and they used the *transhuming form of high mountain shepherding*. At the end of the Árpádian age, when the Carpathians had a higher population density, high mountain shepherding was part of the complex agriculture of the valleys, which was spatially separate during the summer months (A. Paládi–Kovács 1994). The transhuming form of high mountain shepherding, especially the way the Vlachs (Rumanians) were doing it, only became widespread later, in the 14th and 15th centuries. In addition to dealing with breeding of large animals, many farms kept poultry and bees as well. Memories of beekeeping in the age of Árpád's are the stone beehives, found in the rhyolite tuff belt of the Bükk Mountains. These stone beehives were used until the 15th century.

The other subsector of agriculture in the age of the Árpáds, crop cultivation, was typical in the valleys, basins and in the contact zone of the mountains and plains (these areas were later to become the most active economic belts). Crop growing extended to the hilly regions, the closed basins and the broad terraces of the mountains during the period between the 10th and 13th centuries. In the centuries following the Conquest, the pattern of the cultivated areas had often changed, and only became stabilised towards the end of the 12th century, when ploughing the land became common in the whole country. Despite the expansion of farming, the cultivated areas remained isolated spots until the end of the Árpádian age. Creating the cultural landscape is a major achievement of the Hungarians and of the other nations inhabiting the Carpathian Basin, although we do not still know all the details of the process.

Special attention should be devoted to two factors attributed in the spreading of farming: one is the *expertise* brought by the Hungarians from the East. The expertise includes the tools, such as the plough, spade, hoe, and short scythe. The other factor is the system of *inter-ethnic relations,* the intensive exchange of know-how and experience. In the process of following the European model of agriculture the sample farms of the cloisters, the German and Walloon settlers and perhaps the observations of the marauding warriors of the Hungarian tribes in the West before 955 played significant role. As a result of the medieval agricultural revolution (at the end of the 12^{th} century) the simple pasture-ploughland or ploughland-forest alternating system was replaced by a two-course and three-course rotation system. Another important innovation in the 12^{th} and 13^{th} centuries was the appearance of the turn-plough. This large plough, pulled by 6-10 steers, was suitable for breaking up virgin lands for regular cultivation. Further development of ploughing was made possible by the increasing use of animal power and the improved harnesses. The types of plough used in the Árpádian age served the extensive development of agriculture, whereas the tools of smaller household farms were the spade and hoe, made of wood and equipped with an iron plate to increase their durability. Grass was cut with sickles or short scythes. Longer scythes, similar to the ones used today, were only introduced at the end of the Árpádian age, first used in the cultivation of pastures and meadows only. They became the most important tool of harvest as late as the 15th and 16th centuries.

Millet, wheat, rye, barley and other crops were grown in the ploughed fields. During the 12^{th} and 13^{th} centuries the yield was increased from double to four times the amount of the sown seeds. In the small gardens around the dwelling houses and farm buildings labour-intensive plants were grown, such as beans, peas, onion, cabbage and beetroots. An indispensable part of the family farm was the hemp and flax plantation, serving as a source of raw material for clothing. Several sources on the history of the Árpádian age mention hop-yards as well. Wine production was also common in many places south of the 9,5 °C isotherm line, in the foreland of mountains, on hills and also in the plains. The vineyards on Somló Mountain are regarded as the oldest ones in Hungary, dating back to the 11^{th} century. The centre of the vine-growing region of the Somló Mountain was Apácavásárhely (today Somlóvásárhely). In the 11^{th} and 13^{th} centuries the Balaton Highlands, the Mór Valley, the Szekszárd Hills, the surrounding of Pécs, the slopes of Fruška Gora, the environs of Sopron and Pozsony, the southern foreland of Bükk and Mátra mountains, the eastern slopes of Cserehát Mountain, facing Hernád River, Tokay and its vicinity and the promontories at Arad became well-known wine producing areas. In Transylvania the valleys of Kis (Little) and Nagy (Big) Küküllő Rivers were famous for their wine. In the central part of the country, Buda, with the southern slopes of Gellért Hill and Sas Hill was a significant wine producing micro-region. In the age of the Árpáds Tokay was not an outstanding wine producing region, but the Walloon settlers arriving in the 11^{th} and 12^{th} centuries introduced French cultivating and processing methods and thus significantly developed the area (Bodrogolaszi, Olaszliszka and Tállya). Constructing the first irrigation canal in Hungary is also attributed to the Walloons. It was used for irrigating the gardens of Olaszliszka in the 13th century. (Ihrig, D. 1973).

As a result of recent archeological and ethnographic research, "the medieval vine growing culture of the Great Plain grew out of the vineyards of the flood areas of the rivers" (Égető, M. 1993). Vine trained on live wood, a typical way of growing vine in the flood areas in the Árpádian age, is regarded "as a transitory phase between a food gathering way of life and real agricultural production" (Égető, M. 1993).

Similar features characterised fruit growing in the flood areas of rivers. The primeval orchards of the Upper Tisza Valley, Szamos, Danube, Dráva and those of the Olt and Maros in Transsylvania supplied the villages of the neighbourhood with fruit, for which people did not have to work much.

The structure and geographical distribution of agricultural activities that emerged during the Árpádian age – animal husbandry in the flood plains, crop growing in the flood-free areas – had stabilized over the centuries that followed. Until the major landscape transforming works of the 19th century (regulation of the rivers and draining of swamps) *"the real centre of agricultural works was the meadow of the plains and not the ploughland"* (Orosz, I. 1994). Towards the end of the age of the Árpáds the system of royal counties and dominions had broken up, and the feudal monopoly of land came into being. The landlords had the exclusive right to the land. The peasant was transformed into the serf, who inherited his land from his father, but who owned services to his landlord.

The serf's farm became the spatial framework of the peasant's work. It was divided into the internal and the external parts. On the internal part (Lat. *fundus*) stood the dwelling house with one or two sheds and a garden. The external farm consisted of the ploughland and meadow. The serf was also entitled to use, in a regulated way, the meadows, forests, rivers, lakes and reed banks of the community. In the 13^{th} century the farm of a serf was approximately 12 hectares. The serf was allowed to rent vineyards, freshly cut clearings in a forest or barren ground to plough and add to his farm. In addition to the small farms of the serfs, large farms of the landlords (Lat. *predia*) were also found in the country. On the predia servants and freed servants (Lat. *libertinus*) worked. After the 13th century these farms were gradually replaced by a new type of farms, which were cultivated by serfs as part of their compulsory service to their landlord and partly by paid farmhands.

MINING AND CRAFTSMANSHIP

In the period from the 10^{th} to the 13^{th} centuries, mining and smelting were based upon the raw material mines in the valleys of streams and rivers in the mountains. Mining and smelting soon became a characteristic sector of economy in mountain regions. *Iron ore mining, with the processing industry based on it, primarily served domestic needs, whereas the extraction of salt and precious metals worked also for export from the 12^{th} century.* Mining, as far as the value produced is concerned, was one of the most important branches of economy of medieval Hungary, although its significance did not exceed that of agriculture. In the 11^{th} and 13^{th} centuries, and also in the later times of the Middle Ages, Hungary was one of the leading countries in mining of the world. Hungary had been the world's first precious metal and copper mining country, before the American continent was discovered (Zsámboki, I. 1982).

Salt mining started in Hungary during the time of the Conquest, when the tribes occupying Transylvania organised mining at places that had been used as salt mines since prehistoric times. The salt reserves of the Carpathian Basin are concentrated in the Transylvanian and Máramaros Basins, although smaller amounts are found in Upper (North) Hungary (Sóvár) as well. Along the margin of the Transylvanian Basin, in the so called diapir belt, a total of 4,100 km^3 salt accumulated within an area of 16,000 km^2. The thickness of the salt layer varies from 100 to 3,000 m. Cliffs of salt protrude from the surface of the land (e. g. at Parajd), and salt was excavated from them as well as from ordinary deep mines during the Árpádian age (Aknaszlatina, Dés, Kolozsakna, Szék, Tordaakna and Vízakna). Salt mining was a royal monopoly, to which storage, transportation and other auxiliary and supplementary services were added.

Precious metal mining in Hungary started in the early Árpádian age, and developed dynamically after the 12^{th} century. In the second half of the 13^{th} century, when the total amount of gold mined in Hungary was 1,000 kg per year, it constituted 1/3 of the total amount of gold mined in the world and 80% of that in Europe (Zsámboki, I. 1982). This was the first golden age of precious metal mining in Hungary. As a comparison, the amount of gold mined in Bohemia was 100-120 kg per year, that in Silesia was 80-100 kg. The amount of silver mined in Hungary per year was 10,000 kg towards the end of the age of Árpáds, which was one fourth of the total amount of silver mined in the whole European continent. Gold and silver mining concentrated in four districts: in the valley of Garam and its side valleys, in the Gömör-Szepes Ore Mountains and its vicinity (e. g. Telkibánya), in the Gutin Mountains and in the Transylvanian Ore Mountains (Ompoly valley). The mining settlements were usually scattered over an extensive area, far away from each other, especially in the Garam Valley and in the Gömör-Szepes Ore Mountains.

In addition to mining gold in ordinary mines, gold washing along rivers was also an important activity, although its beginnings are not quite clear yet. (In Transylvania gold panning was widespread on rivers Aranyos, Beszterce, Kis-Küküllő, on the upper stretches of Nagy-Szamos, in the valley of the Fekete (Black) and Fehér (White) Körös. In Upper Hungary it was common along rivers Nyitra, Vág and on the northern bank of the Danube).

German settlers played an important role in developing precious metal mining and, together with it, promoted urbanization in the North Hungary and in Transylvania (e. g. Selmecbánya, Radna). The Royal Treasury of Esztergom was the organizer and supervisor of precious metal mining, and this is where the first *mint* of the country worked. Copper, lead and tin mining also started in the Árpádian age, but they only became significant later, in the 15^{th} and 16^{th} centuries.

Clay and stone mining had many small centres all over Hungary. They supplied raw material to potters and builders. Clay pottery has been one of the oldest and most common crafts. Potters set up their workshops on or close to raw material sources, but the market places also influenced them in their choice of a place to work. Another influencing factor was the availability of fuel, as the furnaces required a large amount of firewood, to reach the desired temperatures of 800–900 °C. Potters often settled down near forests or rivers, where they could collect driftwood. Clay vessels often broke, so there was a constant demand for them.

Stone quarrying and processing primarily served the households in the early age of the Árpáds, producing the indispensable grinding stones. Later on, as watermills became more common, and construction of churches and castles commenced, the quarries worked for the building and construction trade (12th and 13th centuries). An important source of nicely carved and formed stones was the volcanic belt of the Inner Carpathians, from where millstones and building blocks were transported to the plains on river boats and carts. Handmills belonged to the basic equipment of all households in the Árpádian age in the centuries after. It is supposed that the earliest millstone carving centres were at Tokay and on the Beregszász Hill (Nagymuzsaly). *Iron industry* was an extremely important branch of economy in the age of the Árpáds (Fodor, I. 1996, Gömöri, J. 1994, Heckenast, G. *et al.* 1968, Zsámboki, I. 1982). This was the branch of industry that supplied the royal army with weapons and the population with tools and other equipment necessary for daily work and life (plough, spade, sickle, spur and knife). Two major iron industrial centres emerged in the period between the 10th and 13th century: one in the northern part of Borsod County, and the other in the western part of Hungary. In addition to these two, there was a number of smaller places where local iron industry was important (Pécsvárad in the Mecsek Mountains, Csabrendek in the Bakony Mountains, Somogyfajsz in the Somogy Hills, and Tiszalök, Tiszaeszlár and Orosháza in the Great Plain). Iron smelting was based on the local ore and local energy sources. The raw material was mostly limonite, close to the topsoil and easy to excavate with simple tools like wedge and pickaxe. Siderite and other kinds of iron ore were also found and used, mostly in the plain. The charcoal, necessary for smelting was supplied from the nearby forests. It resulted in clearing large forest areas, and agriculture was ready to occupy the new arable land wherever it was possible. It was particularly important along the valleys of rivers and streams where agricultural cultivation expanded rapidly towards the inner parts of hilly and mountain regions.

The iron ore was reduced at a temperature of 1,200 °C. 50–65 tons of charcoal were required to produce one ton of pig iron. The foundries were set up in the direct neighbourhood of the mine pits. Their diameter was usually 30–40 cm, and they were 70–80 cm, sometimes 100 cm high. The melting furnaces were constructed into the side walls of the workshop pits, a few meters in diameter, and there were several pieces of them at one place. Small "foundry agglomerations" came into being around the iron ore mines. In the North Borsod iron range the foundries (Dédes, Dövény, Edelény, Felsőkelecsény, Imola, Kurityán, Martonyi, Rudabánya, Szuhafő, Tornabarakony, Tornaszentandrás, Trizs etc.) were arranged around the mines (Uppony, Rudabánya Mountains, Szalonna Karst). In addition to meta-somatic (hydrothermal) iron ore, people made use of the iron ore accumulations of the Esztramos caves.

Within the western Hungarian iron range it is possible to identify three subregions: the neighbourhood of Vas Hills (Gyepűfüzes, Kendszék, Németújvár, Szarvaskend, Vasvár), Kőszeg Mountains (Borostyánkő, Felsőpulya, Kőszegfalva, Nemeskér, Olmód, Szakony, Tömörőd, Velem, Zsadány) and the Sopron-Kismarton area. At Kópháza near Sopron more than 200 small mine pits serve as a memory of limnite mining in the Árpádian age (Gömöri, J. 1994). Pig iron was further processed in the blacksmith workshops set up next to the foundries, but later on iron smelting and smithery were separated from each other. Smiths manufactured tools, but manufacturing weapons was the responsibility of a group of craftsmen who were at the same time peasants as well. They were called *csatár*, and they lived near castles and fortresses. During the 10th through 13th centuries iron industry was under royal control. There was a settlement called *Vasvár* (= Iron Castle) in each of the iron industrial district, where royal officials were in charge of collecting, storing and redistributing iron tools.

By the end of the 13th century iron ore reserves close to the topsoil were exhausted in both of the iron ranges. Mining and pig iron production shifted to the area of the Gömör-Szepes Ore Mountains. In the valleys of Gölnic, Bódva, Sajó, Csetnek, Murány and Túróc, watercourses were also a significant factor in allocation of iron foundries, as this was the time when kinetic energy of waterflows was first used. (Iron ore and forests as energy sources continued to be important factors. Iron foundries and processing plants of regional importance were founded in the valley of Garam and its tributaries and in Transylvania, in addition to Gömör-Szepes Ore Mountains. In the 13th century, with the growing demands, the amount of iron imported from Karinthia and Steiermark also increased.

Iron foundries, as we have seen, sprung up near the sources of raw material. Other craftsmen, however, (potters, wrights, carpenters, turners, websters, furriers and others) settled down and worked in smaller towns and settlements with a market place. As milling technology improved, small watermills spread in Hungary as early as in the 13th century. Cereal grinding mills were constructed on the waterlocks of canals in the plain, and on rivers or large streams in the hills and mountains. A mill with the capacity of grinding 1 ton of crop a day required a waterflow with a discharge of 30-40 l/sec.

TRANSPORT AND TRADE

The web of communications in Hungary in the age of the Árpáds consisted of a radial system of routes than run from the mountains on the borders of the country towards its centre. These routes, used by the horsemen and carts, connected the concentric economic belts of the Carpathian Basin with each other. Proceeding outward from the centre, we find regional junctions at the points where large valleys offered an entry into the mountains from the plains (Miskolc, the Szamos Valley, the Maros Valley, and the Temes Valley). The headquarters of bailiffs and the major centres of defence (earthworks at the beginning, and stone fortresses from the 13th century) were connected to the main communications network. The ancient routes avoided the natural barriers and found the most suitable crossing points, passes across mountains and fords on rivers and moorlands. Via the passes in the mountains, the inner communications network of the country was connected to the international strategic and commercial routes that approached the chain of the Carpathians from the outside. The major intercontinental roads were not close to Hungary, except the way of the pilgrims leading to the countries of the Levant.

The centre of the web of routes was in the heart of the country, at the ford on the Danube where Pest is found now. The area situated between Esztergom, Székesfehérvár and Pest was regarded as the centre of the country. The web of routes that had come into being in the Árpádian age, served as a basis for the communications system of the country in the following centuries. In addition to road transport, river navigation was also significant in the 10^{th} through 13^{th} centuries. The centripetal hydrographic system provided a total length of several thousand kilometres. Crop transporting vessels and warships were towed upriver by horses, steers and by human force.

Commercial life started to flourish in Hungary in the 12^{th} and 13 centuries. In the centres of urban life, which were often towns under castles *(suburbium),* local trade was flourishing. As geographical division of labour became widespread, the exchange of goods among the geographical regions intensified. Domestic trade was concentrated in market towns, whereas the focus of foreign trade was in the major towns near the borders.

Fish, wine and salt were the most common goods in the domestic market places in the 12^{th} century. Clothing articles, tools and basic production equipment complemented the choice of goods offered by traders. In the 12^{th} century, when Hungary started to be involved in international trade, export started with mined goods (salt and precious metals). At the turn of the 12^{th} and 13^{th} centuries wheat, wine, wooden products, hides and skins, honey, wax, and livestock were added to the export list of Hungary. Import in the beginning was confined to military equipment and luxury articles for the royal court and the aristocracy. The quantity of goods increased steadily, and the composition of goods also changed (clothing, oriental spices). The development of trade was also indicated by he fact that the total annual amount of ford taxes, road and market tolls amounted to the value of 7,500 kg silver (Viga, Gy. 1990).

REFERENCES

Andrásfalvi, B. (1973). A Sárköz és a környező Duna-menti területek ősi ártéri gazdálkodása és vízhasználatai a szabályozás előtt. Budapest: Vízdok

Bulla, B. and Mendöl, T. (1947). A Kárpát-medence földrajza. Budapest: OKT

Cameron, R. (1994). A világgazdaság rövid története a kőkorszaktól napjainkig. Budapest:Maecenas

Égető, M. (1993). Az alföldi paraszti szőlőmûvelés és borkészítés. Budapest: Akadémiai Kiadó

Fodor, I. (ed.) (1996). A honfoglaló magyarság. Budapest: Magyar Nemzeti Múzeum

Frisnyák, S. (1990). Magyarország történeti földrajza. Budapest: Tankönyvkiadó

Glaser, L. (1939). Az Alföld régi vízrajza és a települések. Földrajzi közlemények 67 4

Glatz, F. (ed.) (1988). Magyarok a Kárpát-medencében. Budapest: Pallas

Gömöri, J. (1994). A 9-10. századi vaskohászat. In: Kovács,I. (ed.) Honfoglalás és régészet. Budapest: Balassi

Gyimesi, S. (1994). Utunk Európába. Budapest: Nemzeti Tankönyvkiadó

Győrffy, Gy. (1963–1987). Az Árpád-kori Magyarország történeti földrajza Vols. I-III. Budapest: Akadémiai Kiadó

Győrffy, Gy. and Zólyomi, B. (1994). A Kárpát-medence és Etelköz képe egy évezred előtt. In: Kovács, I. (ed.) Honfoglalás és régészet. Budapest: Balassi

Heckenast, G. *et al.* (1968). A magyarországi vaskohászat története a korai középkorban (A honfoglalástól a XIII. század közepéig). Budapest: Akadémiai Kiadó

Ihrig, D. (ed.) (1973). A magyar vízszabályozás története. Budapest: OVH

László, Gy. (1986). Árpád népe. Budapest: Helikon

Lászlóffy, W. (1938). Magyarország vízborította és árvízjárta területei az ármentesítő és lecsapolási munkálatok megkezdése előtt. Budapest: M. kir. FM

Németh, P. (1996). Újabb eredmények a honfoglaló magyarság települési rendjének kutatásában. Szabolcs-Szatmári-Szemle (4)

Orosz, I. (1994). Az alföldi agrárfejlődés történeti útja. Az „alföldi út" kérdőjelei. Békéscsaba,

Paládi-Kovács, A. (1993). A magyar állattartó kultúra korszakai. Budapest: MTA Ethnographic Research Institute

Somogyi, S. (1988). A magyar honfoglalás földrajzi környezete. Magyar Tudomány. 8

Somogyi, S. (1994). Az Alföld földrajzi képe a honfoglalás és a magyar középkor időszakában. Miskolc-Nyíregyháza,

Szabadfalvi, J. (1990). Tanulmányok a magyar pásztorkodás köréből. Debrecen: KLTE UP

Viga, Gy. (1990). Árucsere és migráció Magyarországon. Debrecen-Miskolc: KLTE UP, Hermann Otto Múzeum

Zsámboki, L. (1982). Magyarország ércbányászata a honfoglalás korától az I. Világháború végéig. Közlemények a magyarországi ásványi nyersanyagok történetéből. Miskolc UP

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THE HUNGARIAN SYSTEM OF TANYAS

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INTRODUCTION

Tanya is a kind of dispersed (scattered) settlement. The most general condition of its formation is related to the ownership, use and the regime of cultivation of land property. It can be stated that big estates (either in private or in collective /of rural community or co-operative/ property) exclude the development of tanyas, whereas small- and medium-sized holdings make it feasible. However this is only a necessary precondition, creating a mere possibility, the emergence of dispersed settlements actually depends on several other factors. These factors varied throughout the history of the Hungarian tanya.

As one of the flexible components of the settlement network, the tanya in the Great Hungarian Plain has undergone permanent change, a sequence of recurring elimination and revitalisation. Only for the past fifty years three stages of its development could be recorded. During the first one (1945-1950) due to the change in property relationships and in farm operation a large number of tanyas appeared, then a serious decline followed, while nowadays a change of ownership forms and urbanisation processes have given rise to the revitalisation of the tanya as a form of settlement. The question is if the opportunities offered recently are going to lead to the emergence of new tanyas, contribute to the stabilisation of the existing ones, or, as an alternative, to the transformation of their character.

There is a rather extensive special literature on tanyas. As regards the time of publication, both peaks and low tides can be registered. At the same time this wealth of writings suggests the emergence of a "tanya ideology", since among the authors there have been advocats or opponents of this phenomenon of human settlement, form of economic activity and social phenomenon, or realists, analysing the tanya as one of the elements of the settlement network from the aspects of their particular discipline.

Further it should be stated that tanyas in the Great Hungarian Plain is not simply a component of the settlement network, that is why they have attracted the attention of the representatives of various disciplines like ethnographers, historians, sociologists, geographers, agricultural scientists, architects, managers, statisticians; moreover, also a great number of politicians have been involved in the discussions. This multifold mass of opinions can be grouped around the following main problems:

a. Origin, processes of development and transformation of tanyas

b. Lifestyle on the tanyas

c. The tanya as a form of settlement

d. The tanya as an economic unit

e. Policies towards the tanyas

In the present article an attempt is made to summarise characteristic opinions concerning the origins and evolution of tanyas, and to highlight the changes during the 20^{th} century and their spatial differences.

General preconditions of the emergence of tanyas were enlisted by Ferenc Erdei (1976) when discussing factors of the formation of farming settlements:

a. The landscape

b. Laws of agricultural production

c. Legal foundations of the society

d. Legal regime of land property ownership

e. Ethnicity

István Rácz (1980) identified the following general and direct (specific) prerequisites of the emergence of tanyas:

a. General conditions:

- Settlement and population
- Administrative territory of large extension
- Legal conditions promoting the development of tanyas
- An adequate land property ownership and land use

b. Direct (specific) condition:

- Land should be in individual ownership permanently or at least for a longer duration.

General conditions had created the possibility, a framework for the emergence of tanyas, as it was the case - in the Great Hungarian Plain - during Turkish rule and in some places even prior to that, while the actual appearance of them depended on the specific condition. The latter appeared at different time in different places, thus the system of tanyas in some regions had undergone all stages of their evolution, while in other areas only some of these stages were covered. As a result considerable spatial, temporal and typological variations could be observed (Erdei, F. 1976).

The present system of tanyas pursuing farming activities is a consequence of a change in economic life and in life style having taken place in the middle of the 18^{th} century, but its antecedents during the preceding centuries could be recognised in settlements belonging to a central one and located on the fringe of its administrative area, and its roots date back to the turn of the 15^{th} and 16^{th} centuries. Consequently, in my interpretation the development process of the Hungarian system of tanyas includes two main time periods. The first one started with the appearance of the so called gardens-in-the-outskirts, terminated in the mid-18^{th} century and could be subdivided into three phases, while the second, still lasting one comprised four phases.

THE PERIOD OF THE EMERGENCE OF THE SYSTEM OF TANYAS

Historical studies of settlements denote the time between 1200 and 1350 as the "classical" era of rural decline (abandonment of villages) in Hungary. From the middle of the 14^{th} century this was followed by the decay of the serfs' farms lasting for another ca. 150 years. These two processes were a consequence of the outflow of population from the earliest rural settlements. Towns, market towns (*oppidum*), large-size villages with fertile land provided opportunities for the settlement of serfs as did landlords offering acceptable conditions. The number of market towns (50 *oppidums* at the end of the 14^{th} century) had risen up to 800 by the end of the 15^{th} century. The increased demand in commodity production called into existence market towns fulfilling commercial functions, each for a cluster of 15-25 villages. All this contributed to the areal extension of the major centres and since there was an abundance of land, apart from plots cultivated in rotation system, vacant areas were available, where individual ownership became possible. On these lands gardens-in-the-outskirts were erected.

In the process leading to the formation of the present system of tanyas, dispersion, which had followed a concentration of population, played a decisive role by spreading tanyas within the extensive administrative area of settlements. The earlier scattered farmsteads with temporary dwellings should be considered the antecedents of the permanently inhabited tanyas, which formed part of the system of land use and labour organisation on the fringe of the administrative area of large market towns. The scattered settlements themselves (*dispersion* in the French terminology) were classified by Albert Demangeon as follows:

1. Primary or ancient (Pre-Medieval and Early Medieval) dispersion
2. Dispersion filling in vacant spaces between the earlier formed closed settlements
3. Secondary dispersion by moving out of population from closed settlements (with the survival of the parent village or by its dissolution)
4. Primary, but modern dispersion (Mendöl, T. 1963, Hofer, T. 1974)

Demangeon classified Hungarian tanyas into the third type and chose the Hungarian system of tanyas as a typical example of the secondary dispersion of closed settlements. Nevertheless the Hungarian tanyas show certain common features with dispersion filling in vacant spaces.

According to our present knowledge in the formation of gardens-in-the-outskirts a transition from rough grazing to a more intense livestock breeding played a decisive role. The stimulating factor was a boom in western Europe. Animals were held in pastures taken from common land into private use, where hayfields and later cultivated lands together provided feedstuff for the livestock which could be marketed all year long. On these individual plots (sometimes granted by the market town), the temporary dwelling of herdsmen was replaced by a shed with a fire-place, then a hut for human stay appeared, finally a house was built already called tanya e.g. at Kecskemét in the last decade of the 16^{th} century (Rácz, I. 1980). There is evidence of this ancient form of tanyas dating back to the turn of the 15^{th} and 16^{th} centuries. Area of their distribution is rather uncertain, but gardens-in-the-outskirts presumably existed within the administarive borders of Cegléd, Nagykőrös, Kecskemét, Abony, Kiskunhalas, Kiskunfélegyháza, Szeged, Debrecen, Hortobágy, Jászapát, Pótharaszt (Rácz, I. 1980; Solymosi, L. 1980) and at the turn of the 16th and 17th centuries similar tanyas might have been found within the administrative borders of Békés, too (Becsei, J. 1973). The emergence of gardens-in-the-outskirts should be considered the first phase of tanya formation comprising the era prior to Turkish occupation.

The settlement system of the end of the 15th century was heavily reduced during the Turkish rule and the population number had dropped in a spatially differentiated pattern (Frisnyák, S. 1990). Most of the large settlements were found in the areas under Turkish rule (with Debrecen as the largest town with 15,000 inhabitants and the population number of Kecskemét, Nagykőrös, Cegléd, Makó, Hódmezővásárhely, Békés, Kiskunhalas, Mezőtúr had increased considerably), while those towns, where Turks had moved (Szeged, Csongrád, Gyula, Kalocsa, Szolnok) followed a path of development different from the general trend in the Great Plain. In László Makkai's more recent opinion "...there was a heavy loss of population during Turkish rule, but the number of inhabitants of the country probably had not dropped below four million (an estimated population during Matthias's reign in the second half of the 15th century), rather the natural increase was skimmed... No doubt the period of Turkish rule brought about changes in demography and geographic distribution pattern having been in close relationship with each other but it was not due to a complete depopulation, rather was a result of changes in the spatial order and even more of population transfer and, as a consequence, of the transformation of economy." (Makkai, L. 1985). These processes are relevant for our topic, since population had concentrated in larger market towns and owing to the low number of settlements and high density of population, market towns of vast extension came into being (Kecskemét: 500,000 *holds*[1], Hódmezővásárhely: 250,000 *holds*, Nagykőrös: 200,000 *holds*). At that time within the borders of the present-day Hungary population reached its maximum concentration in the Great Plain.

Partly as a consequence of the above processes, and partly due to their inherited privileges, towns of the Great Plain had a specific legal status. In this respect the pattern was varied, as Jászkun and Hajdúság regions possessed collective rights of freedom resembling those of noblemen. Hajdú towns in the surroundings of Debrecen were located in the Trans-Tisza Region as was Nagykunság, while the settlement area of the *jász* people and Kiskunság extended over the Danube-Tisza Interfluve from Jászárokszállás through Kiskunhalas, down to the environs of Szeged. The military border zone of Bács-Bodrog County enjoyed specific privileges, and some of the towns in the Great Plain (Debrecen, Szeged, Kecskemét, Szabadka, Nagykőrös) had certain preferences, too, dating back to the era prior to Turkish occupation. Towns repopulated at the beginning and in the middle of the 18th century had been trying to ensure that charge-tenement relationship enjoyed by towns having survived the occupation (Rácz, I. 1980). This legal status for certain towns secured the freedom of disposition over their land,

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[1] Hungarian cadastral hold=0.57 hectares=1.42 English acres

while for those in landlords' possession saved an exclusive right of the regulation of land use by the community.

The system of rotational land use (shift of crops) with the lack of compulsory services meant that there was a free land use in the belt of ploughland or at least in those areas where tanyas had formed. Historicians refer to four variants of land use in the Great Plain (Orosz, I. 1980). One of them was a two-course or three-course rotation system (*Figure 1*) where tanyas have come into being since the second half of the 19th century. Regulation of the system of free occupation of land excluded the rotation system, so tanyas emerged on the arable land. In the third type ploughland was subdivided into two parts: in the internal part plots were cultivated in course system (ploughland

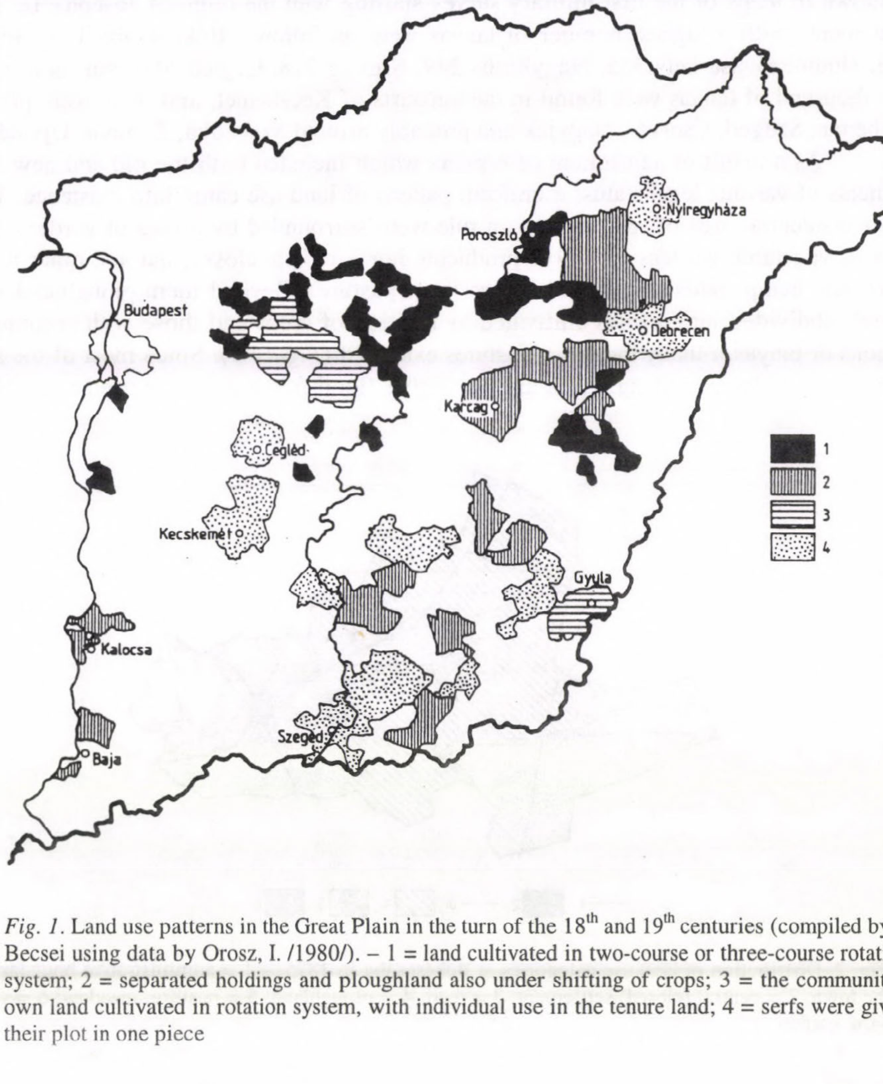

Fig. 1. Land use patterns in the Great Plain in the turn of the 18th and 19th centuries (compiled by J. Becsei using data by Orosz, I. /1980/). – 1 = land cultivated in two-course or three-course rotation system; 2 = separated holdings and ploughland also under shifting of crops; 3 = the community's own land cultivated in rotation system, with individual use in the tenure land; 4 = serfs were given their plot in one piece

with shift of crops), while the external fields were in private ownership and the first tanyas were built here. Finally, in the fourth type the community's own land was used in rotation system, while tanyas sprang up in the tenure area.

The above circumstances had led to the second and third phase of the evolution of tanyas, from the first third of the 16^{th} century until the middle of the 18^{th} century in each region where natural conditions and the regime of land use had allowed it (i.e. actually everywhere with the exception of inundated areas, sandy regions, woodland). In the second phase tanyas had formed in settlements that had survived devastations under Turkish rule, while in the third phase they were spreading over the outskirts of the settlements repopulated after Turkish occupation (in several places by colonisation) and that was the moment when the tanya system became a coherent one. Their spatial pattern is shown in maps of the first military survey starting with the reign of Joseph's II. The settlements with a highest number of tanyas were as follows: Békéscsaba 173, Békés 263, Hódmezővásárhely 335, Nagykőrös 249, Karcag 218, Cegléd 500, but more than one thousand of tanyas were found in the outskirts of Kecskemét, and there were plenty of them at Szeged, Csorvás, Nagylak and probably around Szabadka, Zombor, Újvidék.

As a result of adjustment of borders which included both the old and new settlements of various legal status, a uniform pattern of land use came into existence. The inner residential area of settlement as a rule were surrounded by a ring of gardens (vinyards, vegetable gardens and plots producing horse radish, clover, oat and other feedstuff) and hemp fields surrounded by the inner pastures. Beyond them ploughland was found subdivided into arables cultivated by rotation of crops and those with accommodations or tanyas. Finally the outer pastures extended (*Figure 2*). Since most of the settlements were located along rivers and the higher flood-free areas were used as arables,

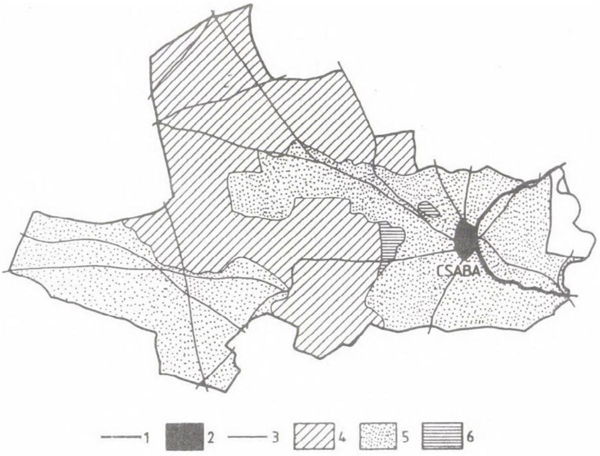

Fig. 2. Distribution of land use categories at Békéscsaba in 1875. – 1 = administrative boundary of the town; 2 = central (closed) settlement; 3 = road; 4 = ploughland; 5 = pasture, meadow; 6 = vineyard, garden

while the inundated areas could be utilised only in summer, tanyas were unfrequent in the latter. They appeared in these areas starting with the second half of the 19^{th} century only, following the water regulation and draining activities.

The system of tanyas in this period was characterised not only by the growing number and change in configuration as dwelling within the administrative borders of settlements. In the phase of the emergence of tanyas on the arables the production unit was spatially separated from the dwelling, from the households. As a result, the tanya had become a farming unit (Rácz, I. 1980) while the household remained in the inner residential area of the settlement. For the first phase of this period a temporary dwelling was typical. In the first half of the 18^{th} century the only permanent dwellers were the farmers (as a rule one peasant by one tanya) but in the second half of the century colonies of farm servants were established as permanent settlements (Szabó, I. 1929). This way the tanya and the inner residential area of the settlement were of unequal importance; the tanya was to be considered auxiliary settlement. (It should be noted that Tibor Mendöl considered each permanently accommodated tanya dwelled by anybody as permanent /partial/ settlement /Mendöl, T. 1963/).

As far as the spatial pattern of tanyas is concerned, scattered (singular) settlement (*Singulär tanya* in German) was typical; as a rule they prevailed in the tanya belts. At the same time specific kinds of tanya were called into existence by special regimes of ownership and land use (*groups of tanyas* in the environs of Nyíregyháza, *dwellings* around Kalocsa). Beyond that, topography, drainage conditions and ethnicity played a considerable role in the evolution of tanyas (*Tanyagasse* at Szarvas, Békéscsaba, Tótkomlós, *Reihegehöft* at Szarvas and Tótkomlós) and *tanyas stretching along the road* (Entlang der Straße liegendes Tanya) in the vicinity of Békés which remained rather restricted spatially and only added to the general distribution pattern.

FOUR PHASES OF THE SECOND PERIOD OF DEVELOPMENT OF THE SYSTEM OF TANYAS

The system of tanyas reached the above level of development by the mid-18^{th} century and so existed and functioned until the mid-19^{th} centrury; this era was called by F. Erdei (1976) the first phase of the evolution of tanyas on the arables. Maps of the second military survey display this "classical" configuration (*Figure 3*). From the mid-19^{th} century, however, important socio-economic transformation commenced which had modified the system of tanyas as a whole. The most important change was that tanyas were spreading over the whole administrative area of settlements, and number of people living in the individual tanyas was on the increase, too. This period of ca. fifty years of duration was called by F. Erdei the second phase of the evolution of tanyas.

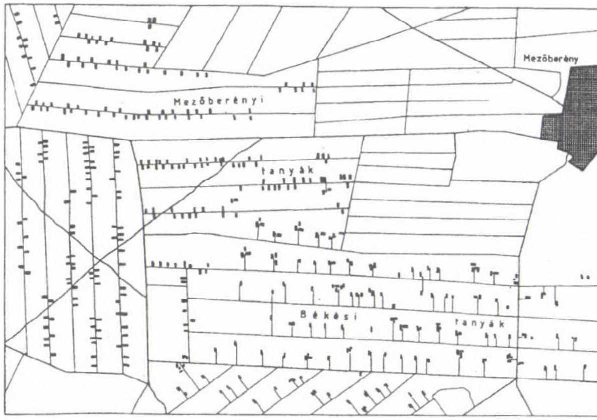

Fig. 3. Tanyas in the environs of Mezőberény in 1864 (after the map of the second military survey)

Motivations and processes leading to this transformation could be summarised as follows. There had been a scarcity of arable land in the circumstances of a rapid growth of population, of an ensuing boom of cereals, and the emergence of new branches of production, of a starting capitalisation and technological development. Extension of the arable land, and its more intensive cultivation had become indispensable. Parcelling of the land of pastures and converting them into ploughland, fixing of quicksand, water regulation, flood protection and draining works all contributed to the extension of land to be taken into cultivation and farming activities with the tanyas as centres could be started. With the consolidation of holdings and giving them in individual property an opportunity opened to build tanyas in places where they hitherto had not appeared (*Figure 4*).

As a consequence the previously inundated areas were dotted by tanyas, too. In the sandy regions vineyards and orchards extended and potato was cultivated. Certain areas (Szeged, Makó, Nagykőrös) specialised in vegetable production, notably in labour intensive hoe crops also demanding a permanent stay. In regions (e.g. in the *hajdú* towns) where there had been a rotation system of plots earlier and tanyas could not be built on them, holdings became consolidated and tanyas began to appear. "Within the given settlement pattern intensive farming could be pursued only around the tanyas, and in the second half of the 19th century with the intensification of the Hungarian agriculture tanyas became more numerous and extensive". Starting with the second half of the century "the farmers built a house with a room for permanent stay and spent most of his time there, maintaining a house in the town, too. New buildings had appeared on the tanyas and the construction standard was raising. A free ownership of land property had provided opportunities for that; so the accumulation of holdings started, involving an expansion of farmyards. This way tanyas with servant population as wage earners had come into being typically on holdings of medium size (100-1000 cadastral holds) and solid small size (50-100 cadastral holds)". "Servant tanya only is one of the types of tanyas developed after the disintegration of the system of manors. Small holders' tanyas

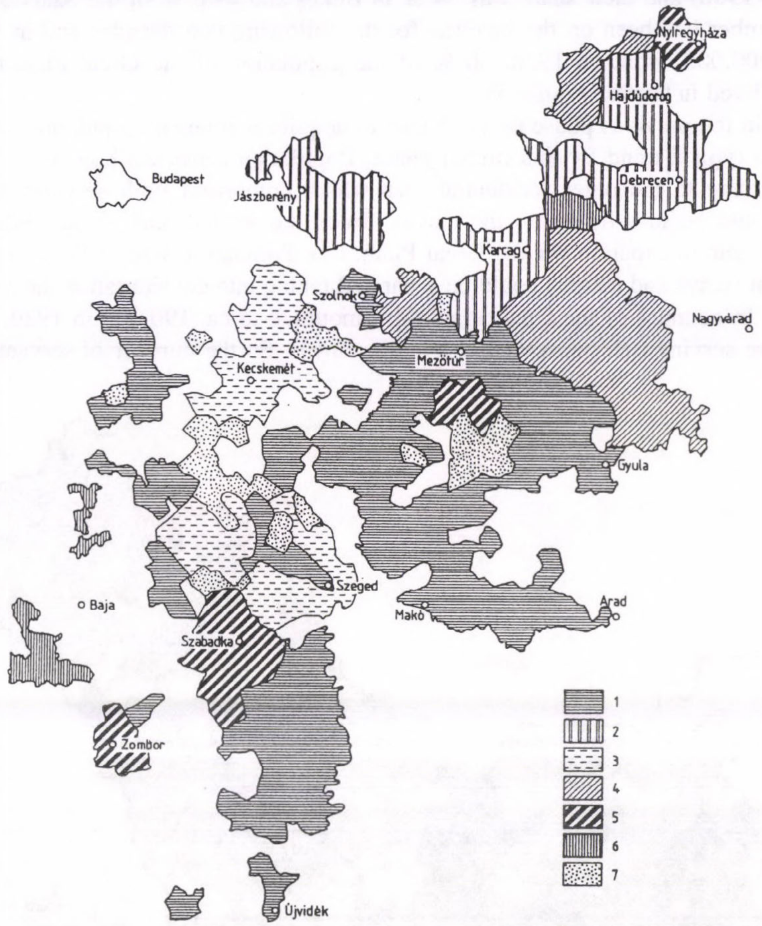

Fig. 4. Regions with tanyas in the Great Plain at the beginning of the 20[th] century (compiled by J. Becsei using data by Erdei, F. /1976/. Settlement inscriptions are only those mentioned by F. Erdei. Administrative areas of towns belonging to the same type are merged in the map). – 1 = standard tanyas; 2 = underdeveloped tanyas; 3 = overdeveloped tanyas; 4 = redeveloped tanyas; 5 = tanyas of special kind; 6 = transformed tanyas; 7 = tanyas as scattered farmsteads

played a similarly important role in the surroundings of Debrecen, owner or tenant of which had moved out of the town and lived there permanently". (Szabó, I. 1929).

The era between the turn of the 19[th] and 20[th] centuries and the repartition of land in 1945 can be considered the third phase in the development of the system of tanyas. In 1910 (outer residential areas with more than 100 inhabitants have been registered in population censuses since then) of 225 settlements with 2,203,403 people, with tanyas in their outskirts, 725,139 persons, i.e. 32 % already lived in the outer residential area

(Rácz, I. 1980) and their share was 34 % in Békés and 49.6 % in the Szarvas district. Their number had been on the increase for the following two decades and in 1920 exceeded 900,000, while in 1930, 30 % of the population of the Great Plain (977,384 persons) lived in tanyas (*Figure 5*).

In the previous phase tanyas began to acquire permanent population which had become a typical trend by this (third) phase. Population censuses, however, contained data referring to the outer residential area which comprised both servants as manor dwellers and persons living on the tanyas. Since the second half of the 19th century manors began to expand over the Great Plain, too. Population size of the two forms of settlement (tanya and manor) could be separated taking into consideration the number of servants. In counties of the Great Plain this amounted to ca. 190,000 in 1930; some of them were serving rich peasants and lived in tanyas. So the number of servants can be

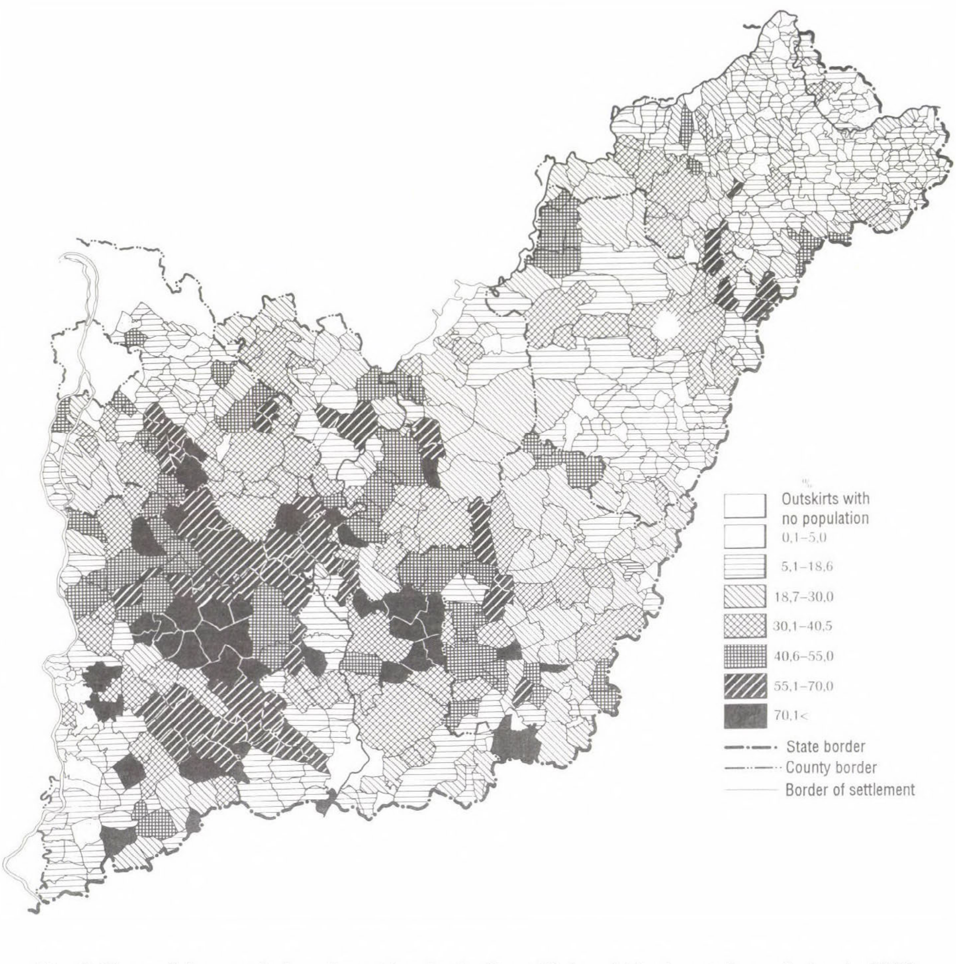

Fig. 5. Share of the population of outskirts in the Great Plain within the total population in 1930

estimated about 150,000 and of those living in the tanyas might have been 750 to 800 thousand (Becsei, J. 1990).

This growth in the permanent population of the tanyas is an indicative of their changing character; they used to be parts of settlements but then became scattered agricultural settlements on their own, with a permanent population. Tanyas of the rich peasants and those of small holders kept on prevailing. New forms of tanyas also emerged such as farmsteads or tanyas inhabited by crop-sharing tenants. There were marked differences between the earlier typical tanyas of rich peasants and small holders. Though they had preserved their previous character, but linkage with the inner residential area of settlements showed wide variation (Erdei, F. 1976). This stemmed from the contemporary prospectives of agriculture having related not to the areal expansion but rather to intensification, which was also due to the lack of available land to be taken into cultivation. At the same time there had been a growth of population and holdings were partitioned through inheritance, and the contemporary agricultural policy also accelerated this trend. All of these stimulated the expansion of labour intensive cultures and with a change in land use pattern economic units had also undergone transformation. A process of urbanisation started in the Great Plain comprising the inner residential areas of the towns (with the spreading of commerce, industry, management etc.), the farming character of which had been modified, though at a different rate.

Although the population living in outer residential areas of the Great Plain earned their living in agriculture (85.5 % of the active earners were occupied in farming in 1930) still there was a marked regional differentiation. The highest proportion was registered in Bács-Kiskun County (90.9 %) while the lowest one in Hajdú-Bihar County (67.9 %). This showed a differentiation of the employment structure in the society of outskirts: in the inner belt of tanyas a social layer of non-agricultural employees appeared, at the same time the stratification of those working in farming had changed its predominantly peasant structure. Of the population of the outskirts the share of owners and tenants in farming and horticulture made up a mere 25 % (the proportion of those with holdings under 10 cadastral hold /ch/: 13.8 %; of 10-50 ch: 7.9 %; with holdings over 50 ch: 3.3 %).

After 1945, as a consequence of the re-allotment of land a new phase of the evolution started called generally the phase of decline and differentiation of the system of tanyas. It might sound contradictory that maximum number of population living in the outskirts of the Great Plain was reached in 1942 (1,107,798 persons or 33 % of the population). Following the land reform of 1945, 75,000 tanyas were constructed (Erdei, F. 1959), and number of those living in the outer residential area – the overwhelming majority of whose were tanya dwellers – had increased by 130,414 compared with 1930. However, the new landowners – mainly former servants – in the overwhelming part (ca. 75-80 %) of the new tanyas were formed as a new, scattered settlement unit, i.e. a permanent settlement (habitation and production unit). In the meantime the manor economy and rich peasants' tanyas were eliminated. Most of the cultivated land belonged to farming units based on the individual ownership of land property, on the other hand a dramatic shrinkage of the size of holdings occurred. Individual farming on the small holdings became typical, and the pattern of scattered settlement followed the above changes. The whole Great Plain turned into a uniform area dotted with tanyas, even e.g. the most of the land belonging to the Mezőhegyes State Horse-breeding Farm. For this half-decade period, the system of tanyas having become a totality of independent scattered settlements, held the symptoms of decline.

In the following phase a reversed trend became determinant. Notably: with the development of the state and co-operative ownership forms a concentration of holdings had taken place, which led to the withering of tanyas, a typical farming and settlement form based on the individual ownership of land. This phase lasted until the wake of the 1990's, the shaping of new ownership forms. This period of four decades was the era of factual, physical decay of the system of tanyas, and of a multifold (functional, structural and spatial) differentiation of tanyas themselves (*Figure 6*).

At the beginning of the last phase, population of the different settlement types

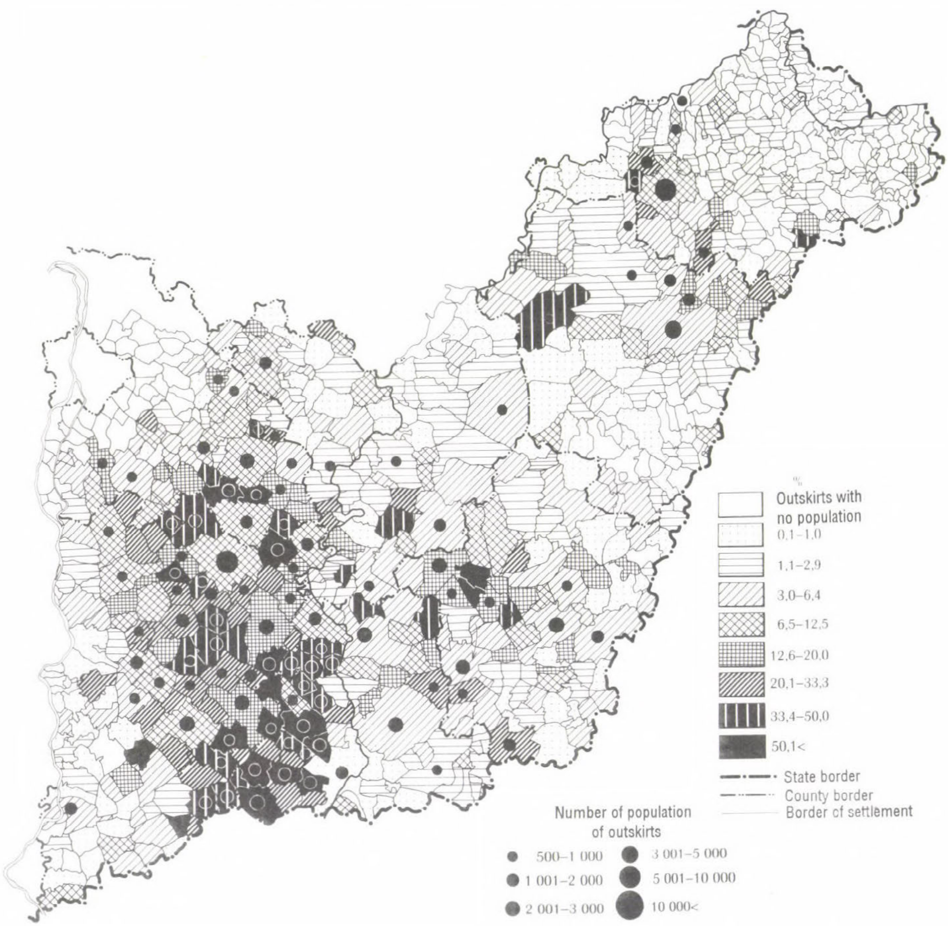

Fig. 6. Share of the population of outskirts in the Great Plain within the total population in 1990

living in the inner and outer residential areas underwent different, often opposite changes. In general, population of the outskirts grew at a higher rate than that of the inner areas, so a process of deconcentration might be registered. While the number of inhabitants in the inner urban areas decreased considerably (a loss of 114,240 persons), there was a population increase in the inner parts of villages (90,298) and a loss in the outskirts (*Table 1*). This way a concentration of the population took place in the villages, while there was and outflow to the outer residential areas in the urban settlements. This was typical in all of the larger towns incorporating tanyas with the sole exception of Debrecen, where the population number in the outer areas dropped from 50,411 down to 24,446. During the following period an influx of population into the inner areas became dominant.

In 1949 the population of outskirts was characterised by a very young age structure (*Table 2*) with a high ratio of people under the age of 15 (27.1 %) and a low proportion of those aged 60 and over. The following decades saw a considerable ageing. These unfavourable changes started with the 1950's. During this decade - between 1949 and 1960 - which can be called the phase of decay, the population of the Great Plain living in the outskirts dropped by 30.2 %. This decrease was differentiated spatially, and also by the different types of settlement. It was less intense in the villages (–5.5 %) than

Table 1. Population change in the Great Plain (1930–1960)

Unit	Total population			Population change			
	1930	1949	1960	1930–1949, number	%	1949–1960, number	%
Towns	1,009,809	1,032,517	1,007,038	22,708	2.2	–25,479	–2.5
Villages	2,245,601	2,329,365	2,525,890	83,764	3.7	196,525	8.4
Great Plain, total	3,255,410	3,361,882	3,532,928	106,472	3.3	171,046	5.1

Unit	Population in the inner residential area			Population change			
	1930	1949	1960	1930–1949, number	%	1949–1960, number	%
Towns	666,700	552,460	827,112	–114,240	–17.1	274,652	49.7
Villages	1,611,326	1,701,624	1,932,395	90,298	5.6	230,771	13.6
Great Plain, total	2,278,026	2,254,084	2,759,507	–23,992	–1.1	505,723	22.4

Unit	Population in the outer residential area			Population change			
	1930	1949	1960	1930–1949, number	%	1949–1960, number	%
Towns	343,139	480,057	179,926	136,948	39.9	–300,131	–62.6
Villages	634,275	627,741	593,495	–6,534	–1.0	–34,246	–5.5
Great Plain, total	977,384	1,107,798	773,421	130,414	13.3	–334,377	–30.2

Table 2. Age structure of the population of outskirts in the Great Plain in 1960 and 1980

County	Age structure (%)							
	under 15 years		15–39 years		40–59 years		over 60 years	
	1960	1980	1960	1980	1960	1980	1960	1980
Bács-Kiskun	29.2	19.4	36.6	32.2	23.0	27.7	11.2	20.6
Békés	28.2	18.7	36.8	32.8	24.4	27.6	10.6	20.9
Csongrád	24.3	17.7	33.2	31.0	23.0	28.9	11.9	22.9
Hajdú-Bihar	36.3	23.7	37.8	35.6	18.3	25.5	7.5	15.2
Jász-Nagykun-Szolnok	29.4	21.0	36.4	33.1	23.1	26.5	11.1	19.4
Pest	28.7	22.4	37.3	32.9	23.8	25.3	10.2	19.4
Szabolcs-Szatmár.Bereg	35.4	23.3	37.3	34.5	17.5	26.1	8.8	16.1
Great Plain, total	30.1	20.4	36.7	32.9	22.5	27.3	10.7	19.4

in the towns; 89.8 % of the loss had fallen to the urban settlements (300,131 persons). Also the population of towns as a whole tended to decrease (by 2.5 %), but that of the inner areas rose by 49.7 %. This concentration was fed partly by natural change and partly by an inflow from the outskirts.

The period between the organisation of large-size farms and 1990 can be characterised by a substantial drop in the number of the population in the outer residential areas (*Table 3*). As a result, a marked spatial differentiation took place:

Table 3. Population of outskirts in the Great Plain

Year	Population of outskirts		Time period	Size (persons)	Rate (%)
	number	ratio (%)	of loss		
1949	1,107,798	33.0			
1960	773,421	21.5	1949/1960	334,377	30.4
1970	572,387	16.3	1960/1970	201,034	26.0
1980	325,208	8.6	1970/1980	247,179	43.2
1990	206,988	6.4	1980/1990	118,220	36.4
Total			1949/1990	900,810	81.3

1. Whole regions have lost their outskirt population, or the number of the latter has reduced and now it can be considered negligible. These areas extend over the major part of Szabolcs-Szatmár-Bereg County, those territories of Hajdú-Bihar and Békés counties (parts of the former Bihar Conty) where tanyas appeared later, the Jászság Region within Szolnok County, areas along the Danube and Tisza rivers, and parts of Pest County belonging to the Budapest agglomeration.

2. Those regions, which formerly had a sizeable rural population, that in the outskirts have survived, primarily on the Danube-Tisza Interfluve (sand ridges). Beside historical antecedents, this can be attributed to the cultivation here of labour intensive crops here. Their production called for a specific kind of co-operation and ownership form of land property differing from the other regions of the Great Plain of "monocultural" farming. In the latter the kolkhoz-type co-operatives contributed to the decay of the tanya system, and their number had been reduced. In some regions, however, belts

and nodes formed with a sizeable population in the outskirts: in Hajdú and Szabolcs, in central Békés, in the towns of Nagykunság, at Jászberény and in its immediate surroundings.

3. In the majority of settlements with outer residential population, the number of the latter varies between 100 and 1000, in 32 of them it is over 1000, while in a smaller group it is between 50 and 100 persons.

Changes concerning the employment structure of the population in the outskirts have led to another kind of spatial differentiation. In this respect larger regions in the Great Plain should be distinguished and belts within the system of tanyas of individual settlements can be identified.

Within the Great Plain as a macroregion there are areas

1. with the dominance of the farming function, with a negligible number of population in the outskirts: Tiszahát, Szamoshát, Szatmár Plain, southeastern Nyírség, Kis- and Nagy Sárrét, Hortobágy; Csanád Loess Plateau and the eastern portion of the Békés Loess Plateau; Danube Valley; part of the former Cegléd and Dabas districts;

2. with the dominance of the farming function, with a sizeable population in the outskirts: Kiskunság, Csongrád County, towns of the Nagykunság, Gyomaendrőd and its environs;

3. with the dominance of secondary and tertiary sectors in the employment structure, with a low ratio of population in the outskirts: Jászság, Middle-Tisza Region, western portions of Nyírség with the exception of Nyíregyháza and its vicinity; Rétköz, the Budapest agglomeration; the former Csanád County with the exception of Makó;

4. with the dominance of non-agricultural employment, with a sizeable population living in the outskirts: the three towns in Hajdúság; Szeged and Hódmezővásárhely; Kiskunhalas and Jánoshalma; the towns of central Békés; Szarvas and its environs; western part of Jászság.

Within the system of tanyas spatial differentiation at the level of individual settlements can be described primarily for those of large extension. Outskirts are subdivided into distinct belts:

a. the belt of farming has survived on the fringe of the administrative area of settlements or in the parts of poor accessibility from the central settlement.

b. a zone of transition in the middle belt, where part of the local population are employed in the non-agricultural sectors.

c. the inner belt, where the majority of inhabitants are engaged in non-farming activities. The occupational structure is extremely complex. Most of them are manual workers formerly engaged in farming and now employed in the town; after having changed their profession they keep on using the tanya as residence and for auxiliary farming. The second typical group of people could not settle in the town but have bought a tanya serving as residence; they commute to work in the town. The third group has been creating suburbia in this belt; they are the well-off people having moved out of the central settlement. Finally, there are a lot of tanyas, with owners or tenants living in the inner residential area and pursuing some kind of economic activity outside (hothouse farming, floriculture, animal husbandry, etc.).

As a result of the urbanisation and a restratification of the population by employment, and also owing to the general housing shortage and the high prices of plots in the central settlement, a kind of suburbanisation started in the outer residential area. This process, however, only slightly resemble the one having taken place in the developed countries, since it affects the innermost belt of a very mixed social structure.

Settlements in the outer residential area also have become differentiated as far as their infrastructural provision is concerned, which shows a pattern according to the above described belts. It can be stated that provision of infrastructure generally is poorer in the belts of the outer residential area than in the central settlement, but there are considerable variations between the innermost belt and the farming fringes. In the immediate surroundings of the inner residential area the conditions are better, especially in towns with suburban belts (*Figure 7*).

Five essential components of provision with infrastructure are as follows:

- percentage of single-roomed dwellings;
- percentage of dwellings with electricity;
- percentage of dwellings with piped water;
- percentage of dwellings with piped or bottled gas;
- percentage of dwellings with bathroom or shower.

Each were mapped by census districts and scored in a six-ball scale; their summarised value resulted in a map (*Figure 7*).

Also there are morphological differences by tanya regions. Areas of scattered or singular (*Singulär* in German) tanyas are typical all over the Great Plain, they are the most numerous. Their provision of infrastructure involves high costs because the tanyas, representing the most dispersed form of habitation, should be linked to the central settlement individually. The second type is the row of tanyas along the road (*Tanyagasse*) with a rather restricted spatial distribution, mainly in the outskirts of settlements of Slovak colonisation (Szarvas, Békéscsaba). The third type is the group of tanyas to be found exclusively in the environs of Nyíregyháza. These last two form a closer settlement making provision of infrastructure simpler, since the tanya dweller lives in a community which as a whole maintains linkage with the central settlement.

Recently there has been a question frequently raised: will the new conditions of ownership of land property lead to the revitalisation of the former system of tanyas? Though for the time being only forecasts can be made, the following facts might be decisive for the future development.

1. The present-day fragmentation of cropland (holdings on some hectares as a result of privatisation) is not viable, particularly in the predominantly cereal producing regions. The elimination of small holdings is expected mainly through selling, with their concentration in large and efficient economic units. The other option is the tenure of the small parcels and the formation of land tenement of tens or hundreds of hectares, which also is to reduce the number of economic organisations. Since the number of farmers is much less than the number of owners, people interested in the foundation of tanyas are going to become less or at least not to increase essentially. This is a hindrance to the revitalisation of the system of tanyas.

2. Along with the process of elimination of the system of tanyas the settlement network had also undergone profound changes; on the fringe of towns of large areal extension new villages have come into being, the density of settlements has increased, the distance between the farming workplace and the central settlement reduced. Land can be cultivated commuting from the residential area. Not only the physical distance shortened but the accessibility of the farm is easier using modern machinery and vehicles. This is also against the overall expansion of tanyas.

3. The spatial pattern of closed settlements has been modified for the past decades, primarily through the fragmentation of the large plots. The present-day structure is unable to accommodate larger agricultural economic units, moreover, the prices of plots are high and there is no sense to extend the inner residential area for farming purposes. There is a motivation to relocate farming centres to the outkirts, and this is a stimulation for the establishment of tanyas.

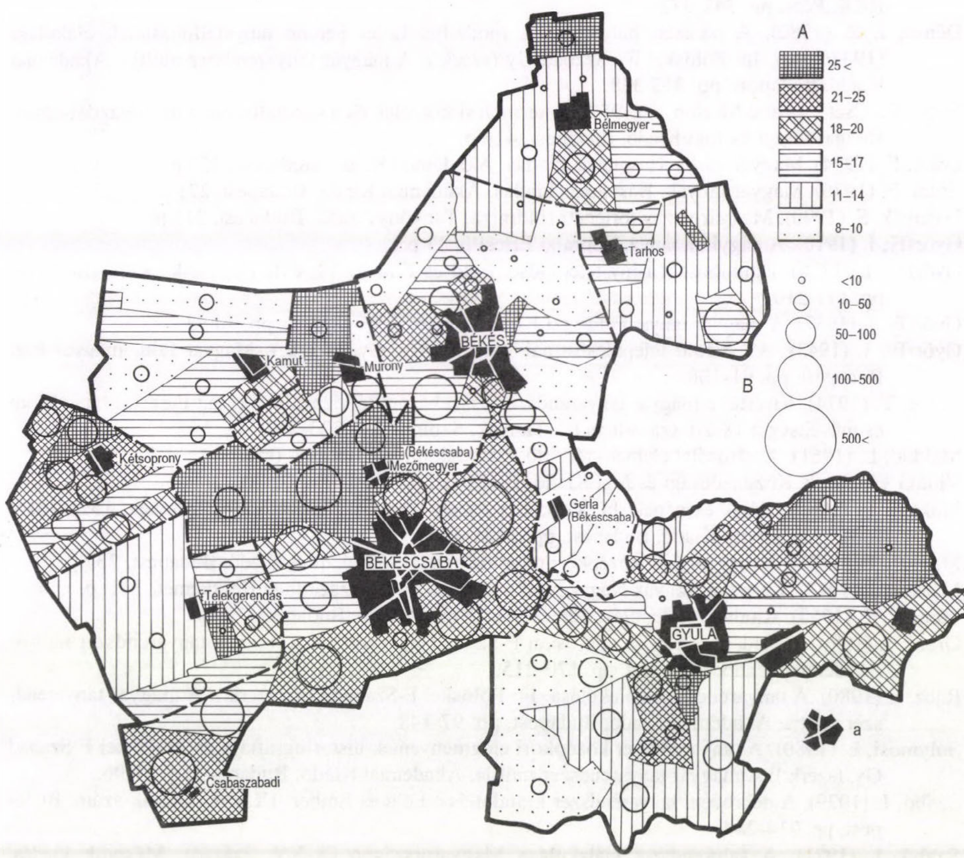

Fig. 7. Population number of outskirts in the central Békés region and their provision of infrastructure. - A = infrastructure provision classes (1980); B = population categories (persons,1990)

4. Suburbanisation is likely to expand, but it is the innermost belt of tanyas, where further construction is expected, and these buildings will not be tanyas actually.

To sum up: there are conflicting factors in the rural spaces. How many farming centres are to emerge in the outskirts, only will be known at the moment of the emergence of viable economic units and for the time being it is impossible to decide, if these centres are going to be tanyas in the classical sense or modern farms.

REFERENCES

Bárth, J. (1987). A szálláskert. Forrás, 19. évf., 1.sz., Kecskemét, pp. 37.50

Becsei, J. (1973). Békés az átalakuló agrárváros. Békés, 101. p.

Becsei, J. (1990). Az alföldi tanyarendszer változása. In: Tóth J. (szerk): Tér-Idő-Társadalom. MTA RKK, Pécs, pp. 342-372.

Dénes, I. Z. (1980). A paraszti polgárosodás modellje. Erdei Ferenc tanyafelfogásának alakulása (1933/1942/. In: Pölöskei F - Szabad Gy (szerk.): A magyar tanyarendszer múltja. Akadémiai Kiadó, Budapest, pp. 313-338.

Erdei, F., Csete, L. and Márton, J. (1959). A termelési körzetek és a specializáció a mezőgazdaságban. Közgazdasági és Jogi Kiadó, Budapest, 416 p.

Erdei, F. (1974). Magyar város. Hasonmás kiadás. Akadémiai Kiadó, Budapest, 255 p.

Erdei, F. (1976). Magyar tanyák. Hasonmás kiadás. Akadémiai Kiadó, Budapest, 271 p.

Frisnyák, S. (1990). Magyarország történeti földrajza. Tankönyvkiadó, Budapest, 213 p.

Győrffy, I. (1910). A nagykun tanya. Néprajzi Értesítő, 11 p.

Győrffy, I. (1926). Hajdúböszörmény települése. Föld és Ember, VI. évf. Negyedik szám, Budapest, pp. 177-210.

Győrffy, I. (1937). A magyar tanya. Földrajzi Közlemények, LXV, 4-5. f., pp. 70-93

Győrffy, I. (1943). Az Alföld településformái. In. Győrffy, Gy. (szerk.): Magyar falu, magyar ház. Budapest, pp. 91-108.

Hofer, T. (1974). Kísérlet a magyar tanyarendszer összehasonlító vizsgálatára. In.: Paraszti társadalom és műveltség a 18-20. században III. Tanyák, Szolnok, pp. 223-237.

Makkai, L. (1961). A városélet elemei - tér, idő, társadalom. In.: Boros J. (szerk.):

Vidéki városaink. Közgazdasági és Jogi Kiadó, Budapest, pp. 25-117.

Makkai, L. (1985). Tájak és népek. In: Várkonyi Ágnes (szerk.): Magyarország története 1526-1686. II. K., Akadémiai Kiadó, Budapest, pp. 1425-1461.

Maksay, F. (1971). A magyar falu középkori településrendje: Akadémiai Kiadó, Budapest, 237 p.

Márkus, I. (1943). Kertek és tanyák Nagykőrösön a XVII-XVIII. században.Kecskemét, 141. p.

Mendöl, T. (1963). Általános településföldrajz. Akadémiai Kiadó, Budapest, 567 p.

Orosz, I. (1980). A "rideg" tanya. In.: Pölöskei F-Szabad Gy. (szerk.): A magyar tanyarendszer múltja. Akadémiai Kiadó, Budapest, pp. 170-215.

Rácz, I. (1980). A tanyarendszer kialakulása. In: Pölöskei F-Szabad Gy. (szerk.): A magyar tanyarendszer múltja. Akadémiai Kiadó, Budapest, pp. 97-148.

Solymosi, L. (1980). A tanyarendszer középkori előzményeinek historiográfiája. In: Pölöskei F-Szabad Gy. (szerk.): A magyar tanyarendszer múltja. Akadémiai Kiadó, Budapest, pp. 71-96.

Szabó, I. (1929). A debreceni tanyarendszer kialakulása. Föld és Ember, IX. évf., Ötödik szám, Budapest, pp. 214-244.

Szabó, I. (1971): A falurendszer kialakulása Magyarországon (X-XV. század). Második kiadás, Akadémiai Kiadó, Budapest, 215 p.

Tánczos, S.-né (1992). Tanyabibliográfia. Budapest, MTA FKI, 20 p.

L. Bassa–Á. Kertész (eds): Windows on Hungarian Geography
Studies in Geography in Hungary 28, Geographical Research Inst. HAS, Budapest 1998, pp. 149–155

CONTRIBUTION TO THE GEOGRAPHY OF RELIGIONS IN THE CARPATHO-PANNONIAN AREA

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INTRODUCTION

The Carpatho–Pannonian Area[1] is both religiously and ethnically the most diverse region of the present-day Europe. This is the area where the Roman Catolicism, the Protestantism and the Orthodoxy meet, mix with each other and where also the presence of the Jewish and Islamic culture looks back on more than one thousand years. The religious spatial structure closely connected with the natural and social environment, mainly with the ethnic structure, with the traditional lifestyle of the population, with the 'soul of the people', was radically changed several times during the last half of a millennium. The study of this and of the spatial characteristics of the religiousness seems to be very important due to a recent slowdown of the secularisation, to the increased role of the religion and to the spreading of the free churches, religious communities at the expense of the historical ('great', 'national') churches. This paper attempts to outline the main changes having occurred during the last five hundred years and the present state of the religious structure on the base of the estimated and census data (before 1790 and after).

CHANGES IN THE RELIGIOUS STRUCTURE OF THE CARPATHO-PANNONIAN AREA (1495 – 1989)

At the time of the royal assessment of taxes the division of the ca 3.1 million total population of the Kingdom of Hungary according to the religious affiliation could be the following: 89.5 % (Hungarians, Croats, Germans, Slovaks) Catholic, 10.1 %

[1]Carpatho-Pannonian Area: Slovakia, Transcarpathia in Ukraine, Hungary, Transylvania in Rumania, Vojvodina in Yugoslavia, Croatia without Dalmatia, Adriatic Islands and Istria, Prekmurje in Slovenia, Burgenland in Austria.

(Rumanians, Serbs, Ruthenians) Orthodox and 0.4 % Jewish (Kubinyi 1996, Szabó 1941)[2]. This religious structure was fundamentally transformed owing to the rapid spreading of the Reformation during the early, politically and ideologically chaotic decades of the Ottoman occupation and due to the increasing immigration of the Orthodox (Serbs, Rumanians, Ruthenians) and Muslim (Bosnians, Turks) population. At the turn of the 16th and 17th centuries 80 % of the total population of the Kingdom of Hungary torn into three parts, counted as Protestant (Gesztelyi 1991). The Germans and Slovaks followed Luther's teachings almost completely, while 90 % of the Hungarians became adherents of the Helvetic Confession (eg. Zwingli, Bullunger, Calvin) at that time. The Unitarian (Antitrinitarian) Church played also an extraordinary important role among the Transylvanian Hungarians during the second half of the 16th century. Only the Croats and few Hungarians (around Pozsony-Bratislava, Nagyszombat-Trnava, Győr, in northeast Szeklerland, in Moldavia) remained true to the Catholic faith. At the same time Slavonia, Southeast Transdanubia, Bačka, Banat, Apuşeni Mountains, the South and Northeast Carpathians, became dominantly Orthodox due to the gradual immigration of Serbs, Rumanians and Ruthenians.

The Habsburg Empire as the most important secular pillar of the Catholic Church responded to the retreat of the European Catholicism with more and more violent Counter-Reformation, i.e. Catholic renewal during the 17th and 18th centuries. At the beginning the majority of the Protestant social elite, the aristocrats, later their subjects, serfs were forced to re-catholise according to the principle of *'cuius regio, eius religio'* (whose the land, that determine the religion). The Union of Ruthenians (Ungvár-Užhorod, 1646) with the Catholic Church was also an important issue of Counter-Reformation. The focus of the Re-Catholisation led by the Jesuits and supported by the state expanded to the liberated territories at the turn of the 17th and 18th centuries, when the Turks were driven out of Hungary. A considerable part of the Orthodox Rumanians[3] desiring national-social emancipation and political advantage converted to the Catholic faith of Byzantine rite in 1698/99. In addition to conversions the position of Catholicism was reinforced also by the stately organised colonization of Roman Catholic (mostly German) population in the liberated, mostly southern territories (East Slavonia, Bačka, Banat) primarily during the first half of the 18th century. The ratio of the Protestants had dropped as a consequenceof the Counter-Reformation from 80 % (late 16th century) to 23 % in 1790; at the same time the share of Catholics reached 55.1 % (Wellman). The majority of the Hungarians, Slovaks and Germans became Roman Catholic due to the Re-Catholization and the 'Swabian' immigration from Germany. By the end of the 18th

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[2] The presumable ethnic structure of the mentioned denominations was the following in 1495. Catholics: 2,073,000 Hungarians, 340,000 Croats, 200,000 Germans, 170,000 Slovaks; Orthodoxes: 180,000 Rumanians, 100,000 Serbs, 35,000 Ruthenians; Jews: 11,000.

[3] The Catholic church of Byzantine rite (Greek Catholics or Uniates) became increasingly popular among the Rumanians first of all in Maramureş, Satu Mare, Sălaj counties, in North and Central Transylvania, in the environments of Făgăraş and Haţeg following 1699.

century a religious spatial structure had formed which remained basically unchanged until 1945.

The increasing conversion of the Orthodoxes to Greek Catholics resulted certain modification[4] in the religious structure during the first half of 19^{th} century. The Greek Catholics had increased their share among the Rumanians of Grand Duchy of Transylvania from 16.6 % to 50.4 % between 1761 and 1850 (Bielz 1857, Ciobanu 1926)[5]. Beside conversions some shift in the religious structure occured due to differences in the natural change of population, demographical behaviour of the people of different religious affiliations to the advantage of Catholics and at expense of Protestants[6]. The number of Jews of the studied area increased from 88,000 to 932,000 (between 1790 and 1910) due to the large waves of Jewish immigration provoked by the plight, antisemitic pogroms, persecutions of Jews in Russia and encouraged by the liberal Hungarian laws[7]. Beside Budapest the Jewish population engaged mostly in commerce and in economic trade settled down in the northeastern territories[8] and in other important towns[9]. According to the last Austro-Hungarian census (1910) 52.1 % out of the 20.9 million total population of the studied area declared themself as Roman Catholic, while the ratio of the other denominations was the following: Greek Catholics 9.7 %, Orthodoxes 14.3 %, Reformed (Calvinists) 12.6 %, Lutherans 6.4 % and persons of Jewish religious affiliation 4.5 %.

The partitioning of the territory of Hungary (1920) did not result in basic changes with regard to the religious structure of the successor states in the interwar period. However the percentage of Orthodoxes slightly increased and of the Roman Catholics and of Reformed decreased in a similar way in Vojvodina and Transylvania as a result of the growing immigration of Serbs and Rumanians and of the escape, emigration, repatriation of hundred thousands of Hungarians and Germans. The Czechoslovak government intensively supported the development of Russian identity of the Ruthenians treated as a 'hungarophilous' ethnic group and, accordingly their conversion from Greek Catholic to Orthodox faith was forced. As a result of the Czech propaganda, the share of the Orthodoxes increased from 0.04 % to 15.3 % in

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[4] The percentage of Greek Catholics increased from 6.3 to 10.3, while the ratio of the Orthodoxes decreased from 20.9 % to 17.7 % between 1790 and 1840.

[5] This case we identified the Rumanians of Transylvania as the collectivity of the Orthodoxes and Greek Catholics.

[6] The ratio of the Roman Catholics increased from 48.8 % to 51.5 %, parallel with the fall of the share of Protestants from 23 % to 19.8 % between 1790 and 1900.

[7] E.g. Act Nr. XVII. (about the civil and political equality of the Jews before the law, 27.12.1867) and Act Nr. XLIII. (among others about the emancipation of the Jewish denomination into the accepted churches in Hungary, 22.11.1895).

[8] E.g. Kassa-Košice, Ungvár-Užhorod, Munkács-Mukačeve, Beregszász-Berehove, Huszt-Hust, Máramarossziget-Sighetu, Szatmárnémeti-Satu Mare.

[9] E.g. Miskolc, Debrecen, Nagyvárad-Oradea, Arad, Temesvár-Timişoara, Újvidék-Novi Sad, Kolozsvár-Cluj, Marosvásárhely-Târgu Mureş.

Transcarpathia between 1910 and 1930, parallel to the decrease of the Greek Catholics from 64.1 % to 49.1 % during the same period.

During the World War II – as a result of the success of the Hungarian policy of territorial revisionism– 82 % (725,000 persons) of the Jews of the region became Hungarian citizen. Between 1941 and 1944 681,000 persons mostly of Hungarian mother tongue and identity were deported (partly killed) out of the 825,000 persons qualified of Jewish ethnic origin in the enlarged territory of Hungary. The total number of those having survived the Holocaust locally (e.g. 119,000 persons in Budapest) and of Jews returned from deportation numbered 260,500 in the former territory of Hungary at the end of 1945 (Stark 1989). From Slovakia of J. Tiso 71,000 persons were deported out of the 87,000 Jews between 1942 and 1944. During the same period the Rumanian authorities did not deport, but liquidated 45,000 Jews of South Transylvania, Banat, Transnistria, Bessarabia and in Moldova.

Significant changes occured in the religious structure of the region due to the migration (evacuation, escape, expulsion, deportation, voluntary immigration, repatriation etc.) of many million persons and to the anticlerical measures during the period of 1944–1950. The exodus to Israel and to other countries and the radical decrease of percentage of the survived Jews continued[10]. The number of Lutherans also diminished strikingly as a result of the escape, deportation of Germans and of the voluntary emigration of ten thousands of Slovaks by 104,000 in Transylvania, by 52,000 in Hungary, by 44,000 in Vojvodina between 1930 and 1948/1953. Similar demographical losses were observed among the Roman Catholic believers of Transylvania (-100,000) and of Vojvodina (-200,000) because of the German and Hungarian casualties and emigration. The Ruthenian and Rumanian Greek Catholic (Uniate) churches were liquidated by the measures claiming the realisation of national (Ukrainian, Rumanian) and religious (Orthodox) unity between 1949 and 1950 (Gesztelyi 1991)[11]. As a result of these acts 1,6 million Transylvanian, 450,000 Transcarpathian and 225,000 Slovakian Greek Catholic believers were forcibly declared Orthodox. Transcarpathia and Vojvodina became provinces inhabited dominantly by Orthodox population due to the conversions and to the mass immigration of Russians, Ukrainians and Serbs by 1950.

Parallel to these events the emergence of the party-state, dividing the church from the state, depriving of the churches of their financial basis and of independence in the Communist countries of the region was already in progress. Following this the secularisation accelerated, the indifference concerning the religious life intensified and the number of the non-religious, atheists increased among the growing up generations and in the urbanized areas under the influence of atheist, anticlerical ideological education. The ratio of the non-religious, atheist population was estimated at 15.9 % in

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[10] The ratio of Jews fell from 3.5 % to 1.7 % in Transylvania, from 5.1 % to 1.5 % in Hungary, from 14.1 % to 3.1 % in Transcarpathia, from 4.1 % to 0.2 % in Slovakia between 1930 and 1948/51.

[11] Date of the liquidation of the Greek Catholic Church: in Transylvania 21.10.1948, in Transcarpathia 29.08.1949, in Slovakia 28.04.1950.

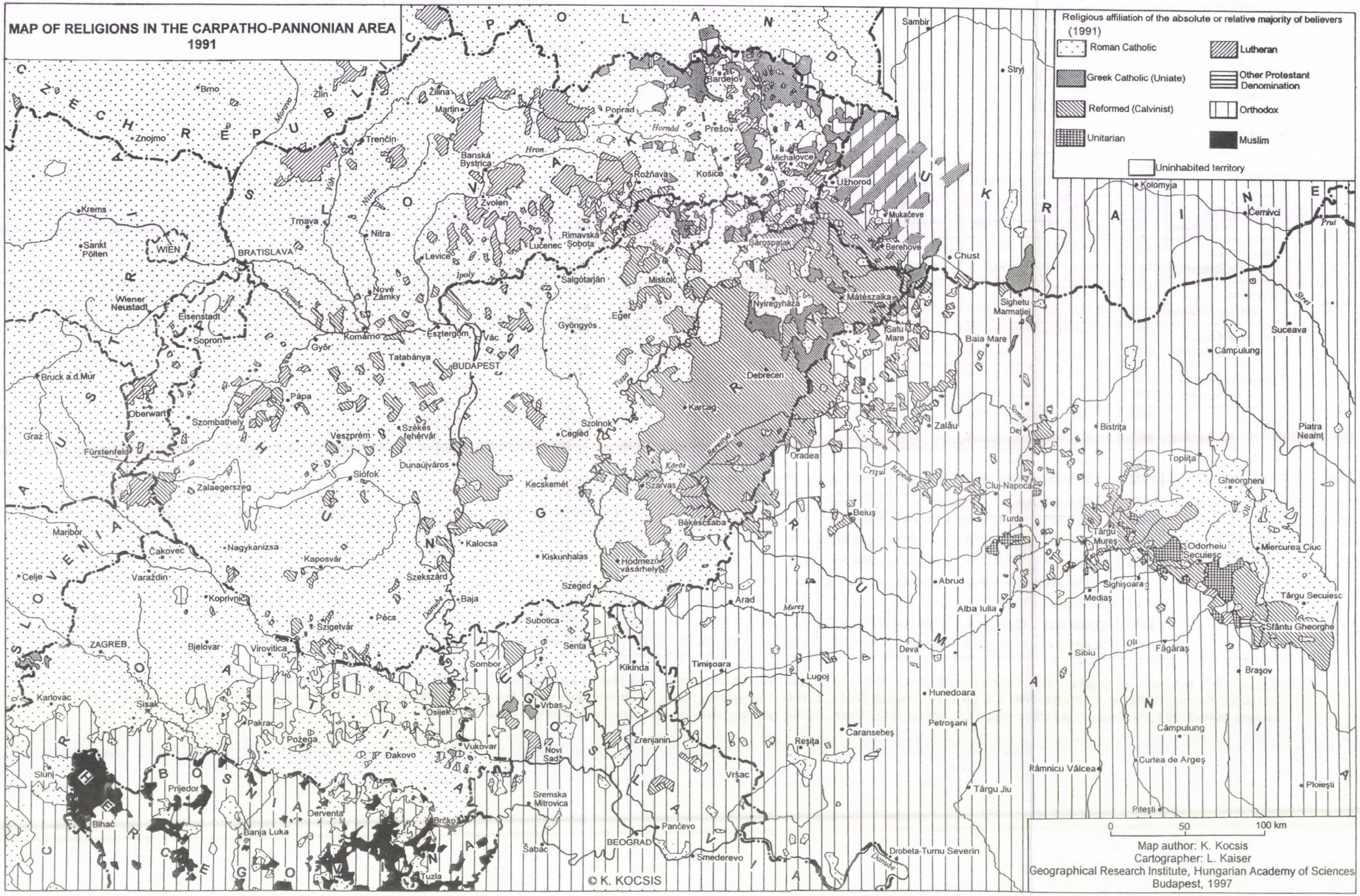
MAP OF RELIGIONS IN THE CARPATHO-PANNONIAN AREA
1991
Religious affiliation of the absolute or relative majority of believers (1991)
Roman Catholic
Lutheran
Greek Catholic (Uniate)
Other Protestant Denomination
Reformed (Calvinist)
Orthodox
Unitarian
Muslim
Uninhabited territory
0
50
100 km
Map author: K. Kocsis
Cartographer: L. Kaiser
Geographical Research Institute, Hungarian Academy of Sciences
Budapest, 1997
© K. KOCSIS

Table 1. Religious structure of the population of the Carpatho-Pannonian area

country, region	year	Total Population	Roman Catholic	Greek Catholic	Lutheran	Reformed	Unita-rian	Orthodox	Israelite	Other Religious	Unknown	Non Religious	RC%	GC%	Lut%	Ref%	Un%	Ort%	Isr%	Oth%	Unk %	Non %
Slovakia	1930	3,323,347	2,384,915	212,653	400,594	141,363		8,979	135,975	21,978	0	16,890	71.76	6.4	12.1	4.25	0	0.27	4.09	0.66	0	0.5
	1991	5,274,335	3,187,383	178,733	326,397	82,545		34,376	912	30,603	917,835	515,551	60.43	3.39	6.19	1.57	0	0.65	0.02	0.58	17	9.8
Hungary	1930	8,685,109	5,631,146	201,092	533,846	1,813,144	6,266	39,839	444,552	15,224			64.84	2.32	6.15	20.9	0.07	0.46	5.12	0.18	0	0
	1989	10,374,823	6,000,000	230,000	430,000	2,000,000	12,000	38,000	80,000	38,100		1,546,723	57.83	2.22	4.14	19.3	0.12	0.37	0.77	0.37	0	15
Transcarpathia	1930	734,249	71,559	360,269	2,750	75,240		112,228	103,319	8,884			9.746	49.1	0.37	10.2	0	15.3	14.1	1.21	0	0
(in Ukraine)	1989	1,245,618	70,000	350,000	3,000	95,000		700,000	3,000	0	24,618		5.62	28.1	0.24	7.63	0	56.2	0.24	0	2	0
Transylvania	1930	5,548,991	947,788	1,385,452	274,415	696,320	68,330	1,932,412	192,833	45,681	2,968	2,792	17.08	25	34.8	12.5	1.23	34.8	3.48	0.82	0.1	0.1
(in Rumania)	1992	7,723,313	854,935	206,833	36,264	796,682	75,978	5,360,102	2,768	366,142	4,595	19,014	11.07	2.68	0.47	10.3	0.98	69.4	0.04	4.74	0.1	0.2
Vojvodina	1931	1,624,158	727,213	18,026	119,140	39,130		689,296	18,179	12,805	369	0	44.77	1.11	7.34	2.41	0	42.4	1.12	0.79	0	0
(in Yugoslavia)	1991	2,013,889	434,683	24,000	58,925	20,000		1,170,694	284	14,830	211,345	79,128	21.58	1.19	2.93	0.99	0	58.1	0.01	0.74	10	3.9
Pannonian Croatia	1931	3,785,000	3,059,220	12,883	15,765	14,231		647,136	22,760	12,500	505	0	80.82	0.34	0.42	0.38	0	17.1	0.6	0.33	0	0
(in Croatia)	1991	4,784,265	3,666,784	12,003	3,469	7,374		532,141	633	375,700		186,161	76.64	0.25	0.07	0.15	0	11.1	0.01	7.85	0	3.9
Transmura Region	1931	90,717	67,114	9	22,163	761		175	476	19			73.98	0.01	24.4	0.84	0	0.19	0.52	0.02	0	0
(in Slovenia)	1991	89,887	66,180		14,611			258	14	311	7,431	1,082	73.63	0	16.3	0	0	0.29	0.02	0.35	8.3	1.2
Burgenland	1934	299,447	254,750		40,382					4,036		279	85.07	0	13.5	0	0	0	0	1.35	0	0.1
(in Austria)	1991	270,880	222,284		35,379	1,595			33	7,242	940	3,407	82.06	0	13.1	0.59	0	0	0.01	2.67	0.3	1.3
CARPATHO-PANNONIAN AREA	1495	3,109,000	2,783,000	0	0	0	0	315,000	11,000				89.51	0	0	0	0	10.1	0.35	0	0	0
	1790	9,940,000	4,853,000	628,000	855,000	1,400,000	34,000	2,078,000	88,000	4,000			48.82	6.32	8.6	14.1	0.34	20.9	0.89	0.04	0	0
	1840	12,880,406	6,130,188	1,322,344	1,006,210	1,846,844	47,280	2,283,505	244,035	0			47.59	10.3	7.81	14.3	0.37	17.7	1.89	0	0	0
	1869	15,417,327	7,502,000	1,592,689	1,109,154	2,024,332	54,438	2,579,653	552,133	2,928			48.66	10.3	7.19	13.1	0.35	16.7	3.58	0.02	0	0
	1880	14,447,687	6,849,050	1,494,090	1,118,415	2,024,615	55,791	2,267,390	627,214	11,122			47.41	10.3	7.74	14	0.39	15.7	4.34	0.08	0	0
	1890	17,349,398	8,820,770	1,667,980	1,204,500	2,225,126	61,645	2,631,843	725,222	12,312			50.84	9.61	6.94	12.8	0.36	15.2	4.18	0.07	0	0
	1900	19,254,559	9,919,913	1,854,143	1,288,942	2,441,142	68,568	2,815,713	851,378	14,760			51.52	9.63	6.69	12.7	0.36	14.6	4.42	0.08	0	0
	1910	20,886,487	10,888,138	2,025,508	1,340,143	2,621,329	74,296	2,987,163	932,458	17,452			52.13	9.7	6.42	12.6	0.36	14.3	4.46	0.08	0	0
	1930	23,461,521	12,608,984	2,190,114	1,408,817	2,780,163	74,596	3,337,452	917,597	143,798			53.74	9.33	6	11.8	0.32	14.2	3.91	0.61	0	0
	1990	30,605,540	13,613,235	1,000,884	907,713	3,002,669	87,978	7,720,081	87,561	685,205	1,212,401	2,287,813	44.48	3.27	2.97	9.81	0.29	25.2	0.29	2.24	4	7.5

Sources: 1869 and after: census data, 1495 - 1840: estimations. For 1495 (our calculation based on Kubinyi, A. A Magyar Királyság népessége a 15. század végén (Population of the Kingdom of Hungary at the end of 15th century), Történelmi Szemle (Budapest) XXXVIII. 1996. 2-3. pp.157-159 and on Szabó, I. 1941 A magyarság életrajza (The biography of the Hungarians), Magyar Történelmi Társulat, Budapest, 51 p.), for 1790: Wellman I. Magyarország története 1686-1790 I., Akadémiai Kiadó, Budapest, 69 p., and for 1840: Fényes, E. Magyarország statistikája (Statistics of Hungary) I. 1842, Pest, 52 p.

Hungary and Rumania, at 16.7 % in Yugoslavia and at 20.1 % in Czechoslovakia in 1988 (Britannica 1989).

RELIGIOUS STRUCTURE OF THE CARPATHO-PANNONIAN AREA SINCE 1989

Following the collapse of Communism and of the Marxist ideology it seems as if the population of the region got tired of the global ideologies, organizations and their demand on traditional moral standards, on civic organizations, on local-regional identities increased. This resulted not only in a 'religious renaissance' in the majority of the former Communist countries, but the strengthening of smaller churches, religious communities and an increasing religious 'pluralization', too (Andorka 1991). According to the census data and estimations around 1990 only 13.6 million persons (44.5 %) declared themselves Roman Catholics and there were one million (3.3 %) Greek Catholics out of the total population of 30.6 million. The number of the Orthodox believers exceeded 7.7 million due to the keeping of 50-90 % of the former Greek Catholics forcibly converted in Transcarpathia and Transylvania between 1948 and 1950. The number and share of the Lutherans affected recently by considerable Transylvanian Saxon migration loss sank below one million, i. e. 3 %. The rate of increase of the atheists, non-religious and of persons with unknown religious affiliation was especially high in Slovakia, Hungary and in Vojvodina due to the mentioned ideological reasons. At the same time, following the collapse of the Ceauşescu dictatorship their proportion did not exceed 0.4 % in Transylvania. The free churches, small religious communities, sects have strengthened mainly at the expense of the accepted, historical churches and the number of their believers increased from 144,000 to 627,000 (2 %) between 1930 and 1990. Out of these communities the Pentecostals (170,000), Baptists (130,000) and Adventists (45,000) could enlarge the camp of their adherents, first of all in Transylvania[12].

Nearly one half of the believers (about 14 million) of the studied area counted as **Roman Catholic**, who represented absolute majority in Burgenland (82 %), in Croatia (76,6 %), in Prekmurje (73,6 %), in Slovakia (60,4 %) and in Hungary (57,8 %). They are the dominant denomination in Hungary west of the Tisza River, in whole Slovakia excluding the peripheric areas of East- and Central Slovakia, in the middle of Rumania, in the northeast Szeklerland and in the northeast Bačka region in Yugoslavia. Their most populous communities were found outside of the Roman Catholic countries in the following urban settlements (in thousand persons) in Subotica (62), Timişoara (43), Miercurea Ciuc (35), Oradea (30), Arad (28) and Satu Mare (27).

The population of **Orthodox** faith of 7.7 million formed an absolute majority in Transylvania (69.4 %), in Vojvodina (58.1 %) and in Transcarpathia (56.2 %), mainly in

[12] Transylvania was the homeland of 93 % of the Pentecostals, of 73 % of the Baptists and of 64 % of the Adventists in the Carpatho-Pannonian Area in 1992.

the Rumanian, Serbian, Russian, Ukrainian and East-Ruthenian ethnic area. The Orthodoxy was mostly driven out of Croatia (Krajina, West Slavonia) due to the escape and expelling of the majority of the Serbs between 1991 and 1995. The most important Orthodox communities of the Carpatho-Pannonian Area, beyond the borders of Orthodox countries lived (in thousand persons) in Zagreb (39), Rijeka (18), Osijek (14), Vukovar (13), Sisak (9), Budapest and Petrinja (7-7) at the beginning of 1991.

The strongest Protestant church of the Carpatho-Pannonian Area is the **Reformed** (Calvinist) with 3 million believers (9.8 % of the total population), who represented the dominant denomination of the Hungarians living between the Tisza River and the Harghita Mountains. In Transylvania the half, in Hungary the fifth, in Slovakia the tenth of the Hungarians belonged to the Reformed church. The homes of the largest Reformed communities are today Budapest, Debrecen, Târgu Mureş, Cluj-Napoca, Oradea, Miskolc, Hódmezővásárhely and Satu Mare.

The **Greek Catholic** faith (one million adherents) has recently formed an absolute majority only among the population of the peripheric, former ethnic Ruthenian regions of East Slovakia, of the boundary regions of Hajdú and Szabolcs in Hungary and of West Transcarpathia. This denomination could recover only seventh of the former Uniate adherents from the Orthodox church in the Rumanian ethnic area. Their most important urban communities live in Užhorod, Mukačeve, Budapest, Cluj-Napoca, Satu Mare, Košice, Debrecen and Nyíregyháza.

The native country of the half of the **Lutherans** of the studied area (900,000 believers) was basically Hungary, while one third of them lived in Slovakia. They were concentrated mostly in Budapest, Békéscsaba, Szarvas, Bratislava, Orosháza, Nyíregyháza and Banská Bystrica.

The adherents of the **Pentecostal** denomination (170,000 persons) lived – excluding seven Transylvanian villages – everywhere in minority and their most important communities of 5-8,000 persons were found in Oradea, Cluj-Napoca, Timişoara and Arad.

The **Baptists** (130,000) live also in diaspora first of all in Transylvania (e.g. Arad, Oradea, Timişoara, Cluj-Napoca) and in Hungary (e.g. Budapest, Debrecen).

The main basis of the **Unitarian** Church taking care of 88,000 souls are some Székely-Hungarian villages in the neighbourhood of Odorheiu Secuiesc, south-west from Turda and in some important centres of attraction (Odorheiu Secuiesc, Budapest, Târgu Mureş, Cluj-Napoca).

The number of the **Jews** of the region fell – due to the Holocaust and to the emigration – to the level of 1790 (88,000 persons). 85 %, i.e. 75,000 of them are residents of Budapest, where the majority had survived the deportations of 1944 (Gesztelyi 1991, Stark 1989). The Jews of the Hungarian countryside are mostly inhabitants of Debrecen, Miskolc and Szeged.

REFERENCES

Andorka, R. (1991). Vallásosság és egyházak a 20. században - fõ tendenciák és nyitott problémák (Religiousness and churches in the 20th century – main tendencies and open problems), Info—Társadalomtudomány (MTA Budapest) Nr.17. (July 1991), 46.p.

Bielz, E.A. (1857). Handbuch der Landeskunde Siebenbürgens, Hermannstadt, 162.p.

Britannica 1989. Book of the Year-Encyclopaedia Britannica, Inc. Chicago, pp. 762-763.

Ciobanu, V. (1926) Statistica românilor din Ardeal..., Cluj

Gesztelyi, T. (ed.) (1991). Egyházak és vallások a mai Magyarországon (Churches and religions in the contemporary Hungary), Akadémiai Kiadó, Budapest

Kubinyi, A. (1996). A Magyar Királyság népessége a 15. század végén (Population of the Kingdom of Hungary at the end of the 15th century), Történelmi Szemle XXXVIII. 2-3. pp.135-161.

Stark, T. (1989). Magyarország második világháborús embervesztesége (Casualties of Hungary during the World War II, MTA Történettudományi Intézet, Budapest, 26.p.

Szabó, I. (1941). A magyarság életrajza (The Biography of the Hungarians), Budapest

Wellman, I. Magyarország népességének fejlõdése a 18. században (Population Development of Hungary during the 18th century) – in: Ember Gy.-Heckenast G. (Ed.) Magyarország története (History of Hungary) 1686-1790 I., Akadémiai Kiadó, Budapest, 69.p.

L. Bassa–Á. Kertész (eds): Windows on Hungarian Geography
Studies in Geography in Hungary 28, Geographical Research Inst. HAS, Budapest 1998, pp. 157–173

URBANISATION AND URBAN DEVELOPMENT IN HUNGARY

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INTRODUCTION

Urbanisation and urban development in the former state-socialist countries have attracted great attention among geographers both within East Central Europe and outside the region (French, R. A. and Hamilton, F. 1979, Enyedi, Gy. 1990, Szelényi, I. 1983). The available literature in this topic is extreemly rich and the number of new publications has been growing setadily in recent years, which reflects that the transformation of the "socialist city" has inspired many researchers towards new explanations (Andrusz, G, Harloe, M, and Szelenyi, I. 1996, Kovács, Z. and Wießner, R. 1997, Lichtenberger, E. and Fassmann, H. 1995).

Hungary is typical in this sense in the eastern half of Europe, a great part of the international interest is focusing on the transformation process of the urban system (Zoványi 1985). This paper seeks to explore the most important features of urbanisation and urban development in Hungary, focusing mainly upon the processes of the last half a century, but historical elements of urban development have also been taken into account. Thus, our paper consists of basically two major parts. First the nature and conditions of socialist urbanisation and urban development are examined displaying some of the major preconditions of socialist urbanisation, secondly, the most important features of the post-socialist urban transition are investigated. Our aim is to analyse what socialist urbanisation brought about in Hungary and in which direction the cities of the country have been developing since the political changes of 1989-90.

THE LEGACY OF THE PAST

Some of the specific features of the national settlement system persisted even for the 45 years of socialist urban planning and urban development policy. In order to understand the urbanisation and urban growth in Hungary under and after state socialism it is necessary to highlight some of the characteristics of the urban development of the pre-socialist period.

Just like the whole region, urbanisation and urban development in Hungary was considerably delayed by comparison with Western Europe (Enyedi 1996). Medieval urbanisation started significantly later than in the West, and Western-type historic cities with strong urban middle-class only penetrated into the north-western part of the country. On the other hand large monofunctional agrarian towns and giant villages constituted the loose "urban network" on the eastern plain area of the country. During the Turkish occupation (16th and17th centuries) the medieval development of towns was broken and a large part of the urban network was destroyed. As a consequence of the late and disturbed urbanisation process the urban network of Hungary remained relatively poorly developed by the time of capitalist industrialisation (i.e. second half of 19th century), with sparse and functionally weak urban network.

The modern industrial-urban development was also delayed and incomplete in Hungary, just like in the whole East Central European region. Compared to the West, modern capitalist development began only in the 1870s and was restricted to Budapest and a small number of towns, mostly due to foreign (Austrian, Czech) capital investment. Most of the Hungarian cities retained a strong agricultural profile with feudalistic traditions until the big wave of communist industrialisation started. The relatively underdeveloped nature of the overall settlement pattern is well reflected by the fact, that in 1910 a total of only 156 towns were registered in Hungary, with a wide range of size and function. At that time only 16,7 per cent of the population were town-dwellers (Zoványi 1985).

Another important characteristic of the historical development of urban network in Hungary was the increasing weight of Budapest as a primate city. On the eve of the official establishment (1873), with a population of 280,000 the Hungarian capital ranked only seventeenth among the large cities of Europe, while by the 1910 census the population increased to one million and the city advanced to the seventh place in Europe. The dominance of Budapest was further increased by World War I and the consequent dissolution of the Austro-Hungarian Monarchy. Until the Trianon Peace Treaty of 1920 Budapest had been the capital of a much larger state. By virtue of the agreements fixed in the peace treaty a new regional order was established in the Carpathian Basin and the socio-economic character and urban pattern of Hungary were altered fundamentally.

As a consequence of the peace treaty Hungary lost 71 per cent of its territory and 64 per cent of its population. Only 47 towns remained within the new borders of the state, and most of the bigger and more developed centres which constituted the counterpoles of Budapest previously (e.g. Bratislava, Košice, Oradea, Cluj, Braşov, Timişoara, Novi Sad etc.) were transferred to the successor states. Out of the ten most populous country towns only three (Debrecen, Szeged, Pécs) remained in Hungary (Beluszky 1990). The new borderline only conformed in a few sections to the earlierpattern of urban regions, and in many cases it divided urban centres from large parts of their tributary areas (*Figure 1*). This, of course, had serious economic and social consequences as the development of these towns has been retarded significantly and the rate of growth of the population in these towns has fallen behind the national average

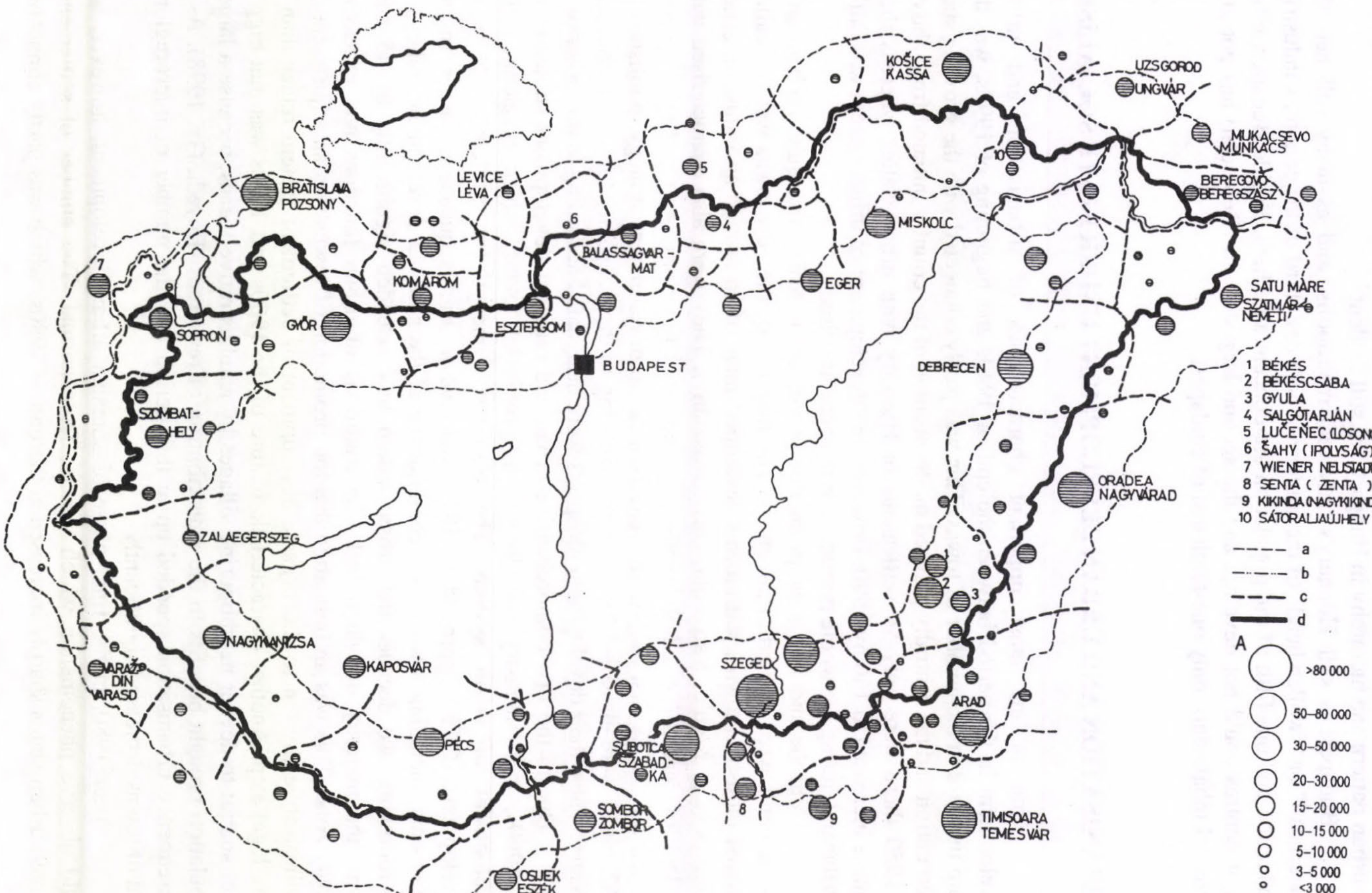

Fig. 1. The pre-1914 urban system in Hungary along the national border. – A = population (thousand persons); a = 30 km border zone; b = historical state border; c = boundary of hypothetical zones of influence; d = national border after 1920

(Kovács, Z. 1989). Even after seven decades the negative effects of border changes on the urban pattern and hierarchy in Hungary are still evident.

Budapest is still Hungary's only real metropolis, and as many call her, the "waterhead" or "swollen head" of the country. About one third of the country's industrial production and one fifth of the population are concentrated here. Beside Budapest other major centres could not develop, and the second largest town (Debrecen) has got 200 thousand inhabitants, only one-tenth that of Budapest.

URBANISATION AND URBAN DEVELOPMENT UNDER STATE SOCIALISM

One of the most important characteristics of urbanisation and urban development in the period between the end of 1940s and beginning of 1990s, was the sharp increase in the number of towns. This was partly connected with the growing state intervention and the centrally planned modernisation of the country initiated from above. In 1950 there were only 54 settlements in Hungary with urban status, whereas their number increased to 166 by 1990. However, the development of urban system was fairly unbalanced during the whole period, both in space and time.

Until the mid-1960s the promotion of villages to towns was quite limited, only 9 settlements were granted urban status. The majority of the new towns were so-called socialist industrial towns, settlements developed most often around an industrial estate or mines (e.g. Komló, Várpalota, Ózd, Oroszlány). They were also characterised with the lack of central (i.e. administrative, cultural etc.) functions. As Gy. Enyedi (1996) pointed out, in the first long-term Hungarian urban development strategy, published in 1962, cities were classified by planners according to their capacity for accommodating industry. Thus, their development prospects were designated according to this criterion.

Due to the first comprehensive urban and regional development strategies of the 1960s, more industry was located in provincial towns, which accelerated the development of urban system. The National Concept for Settlement Network Development (OTK) approved in 1971 specified a strict sequence of order among settlements, including towns. As a consequence of the national development policy, in the following two decades the urban system was extended significantly by 45 new towns, the majority of which had long traditions of urban functions and excessive gravity zone. This was an indication that the promotion of towns was an adjustment of administrative divison to the organic development of settlement system rather than a mere legal step. Another characteristic feature of the 1960s and 1970s was that bigger cities sought to devour neighbouring villages by administrative means, because a larger population brought benefits in the redistribution of resources (Enyedi, Gy. 1998). As a consequence urbanisation speeded up in this period and the number of microregions void of towns decreased significantly.

After 1980, in the final phase of socialist urban development, however, we could observe phenomenon which was far from normal. The number of settlements granted urban status sharply increased at the end of 1980s, which was partly connected with the weakening role of central planning and the gradual abolishment of the former urban development policy. This is well reflected by the fact, that during spring 1989 altogether 41 settlements were authorised with urban status. In most cases the title came before the real preconditions could be created, and some of the new towns were rather weak in central functions, and underdeveloped both in terms of technical infrastructure and urban landscape.

Despite the excessive development of urban network during the post-1945 period, the evolution of small towns (i.e. towns under 10,000 population) remained very slow and the bottom part of the urban hierarchy is still weak. There are approximately 80 settlements with urban status, whose central functions are underdeveloped and they can be classified as intermediate formations between towns and villages in many respects. The number of such "semi-towns" is especially high on the Great Hungarian Plain, where quite often several smaller towns lying next to each other form a functional unit (dispersed city) and play the role of a bigger centre (*Figure 2*).

Owing to the legal extention of the urban system and the high-level of rural to urban migration the ratio of urban population also increased substantially during the state socialist period. In 1949 the national level of urbanisation was still 37 percent, thus, Hungary was predominantly a rural country compared to the West. However, by the time of the 1980 census already 53 percent of the population lived in urban places, which increased further to 62 percent until 1990. By the middle of the 1990s, roughly two-thirds of the Hungarian population lived in towns, therefore, we can say that Hungary approached the level of the more urbanised part of the world, although with some distance from the level of highly developed countries of Western Europe (e.g. Germany, Benelux) and North-America.

The growth of urban population and the intensity of rural-urban migration was fairly uneven during the state socialist period. The peak of rural-urban migration fell to the 1950s and 1960s when over a million of people left villages and moved to cities, as a consequence of the forced collectivisation of agricultural land and the extensive development of heavy industry. However, rural-urban migration slowed down gradually during the 1970s, and subsequently even population decrease occurred in some of the towns of the Great Hungarian Plain due to natural decrease. This process became general in the whole Hungarian urban system by the end of the 1980s, which resulted in stagnation (and later decline) of urban population.

The political changes of 1989/90 (or as it is called in Hungarian the "system change") did not represent a sharp break with the liberal practice of late socialist urban development policy and the promotion of villages to towns became rather symbolic. As a consequence, the number of towns in Hungary increased to 218 by summer 1996, although functionally and infrastructurally only ca. 150 of them could be qualified as real towns, the rest remained villages in many respects (Berényi, I. and Dövényi, Z. 1996). The large number of towns is also accompanied with siginificant regional variations, some parts of Southern Transdanubia and Northern Hungary still lack towns, whereas the eastern plain area has got a lack of subordinated settlements and a surplus of towns, basically due to historical reasons (*Figure 3*).

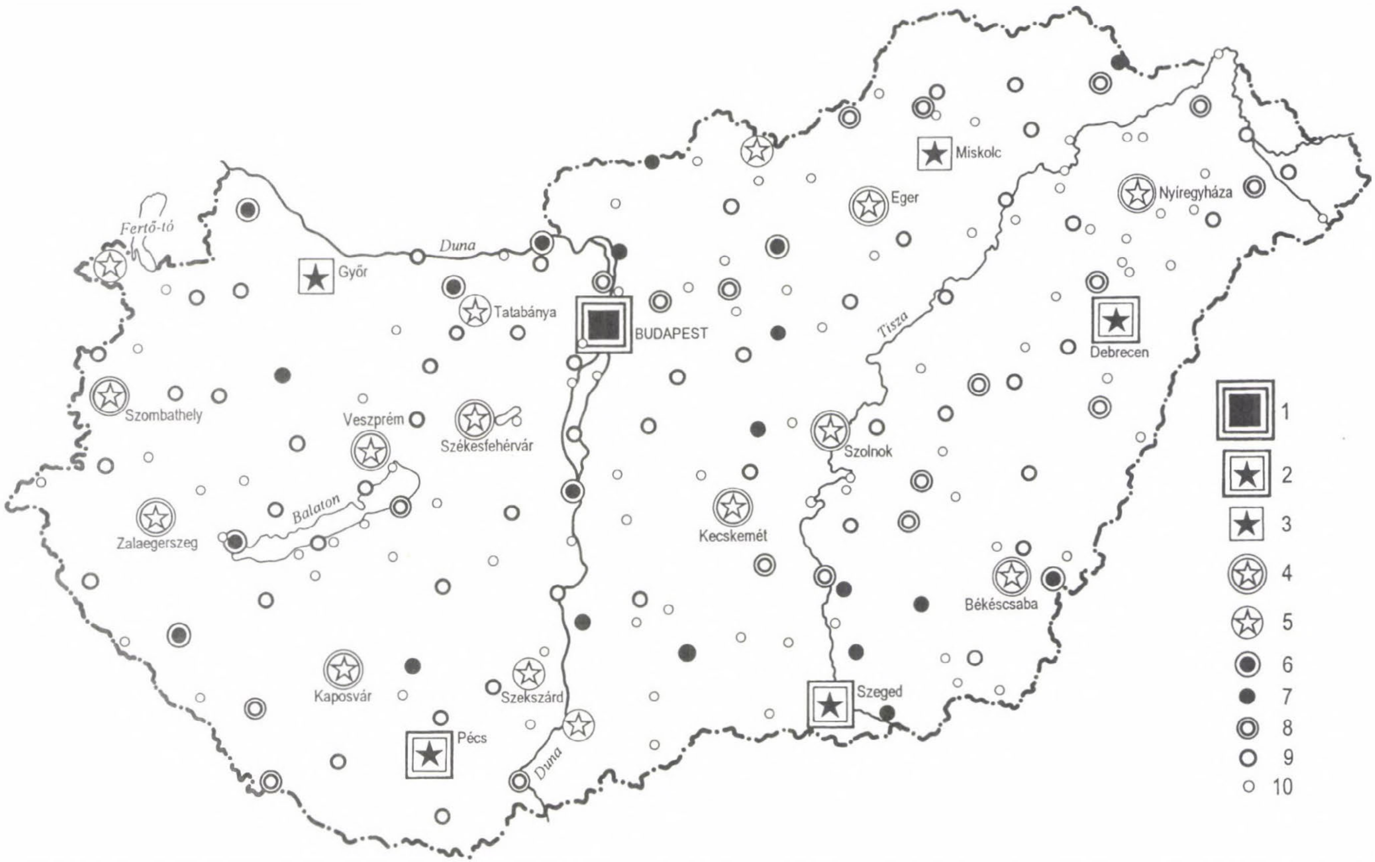

Fig. 2. Urban hierarchy in Hungary at the beginning of the 1990s. – 1 = capital; 2 = first order macro-regional centres; 3 = second order macro-regional centres; 4 = first order regional centres; 5 = second order regional centres; 6 = middle towns with higher functions; 7 = middle towns; 8 = small towns with higher functions; 9 = small towns; 10 = elementary centres

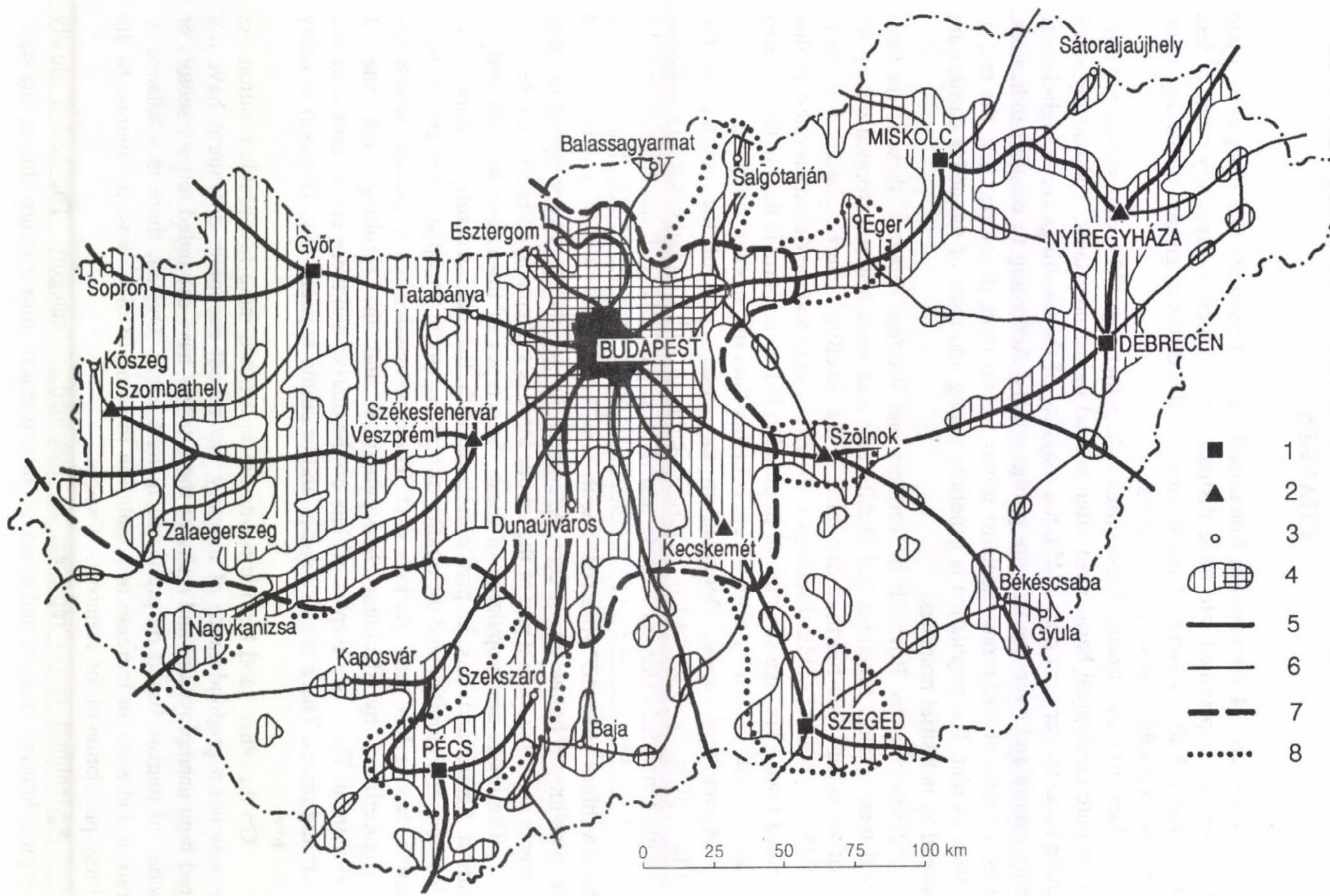

Fig. 3. Spatial pattern of urbanisation in Hungary. (adopted from Tóth, J. 1992). – 1 = macro-regional centres; 2 = booming towns; 3 = county seats and other middle towns; 4 = highly urbanised areas + Budapest urban region; 5 = main directions of regional connections; 6 = directions of interregional connections; 7 = boundary of highly urbanised areas; 8 = axis of urbanisation

THE HUNGARIAN URBAN SYSTEM ON THE EVE OF THE POLITICAL CHANGES

At the end of communism functionally and structurally the Hungarian urban network could be spearated into three distinct types, which are spatially more or less discrete. *Table 1* shows some of the features of the different groups displaying some housing, demographic and social indicators.

Socialist (new) towns. These cities - altogether some 25 - were developed after 1945 on pure ideological basis, most often around industrial estates. The housing stock is young (over 90 per cent post-1945), the majority of the dwellings are in high-density housing estates and over one-half are public rentals. According to comfort indicators, such as the ratio of bathrooms, socialist towns are far more developed than the rest of the urban system. The population is generally young and most of the active earners are employed by industrial branches.

Historic towns. Primarily in Northern and Western Hungary, these towns have retained their historic functions and architecture and were less transformed during 45 years of socialism. One-fourth to one-third of the dwellings can be classified as "old" (pre-1945), the ratio of public dwellings is 20-25 per cent and the density is one-half that of socialist towns. The age structure of population is less favourable than in the socialist towns and the rate of tertiary employment is higher than in the other categories.

Agricultural towns. Dominant in the eastern part of the country on the agricultural plain, these towns have a rural orientation with excessive territory scattered with single farmsteads (*tanyas*). These towns were particularly disadvantaged and the least transformed by socialist urban development policy (Timár, J. 1989). Forty per cent of the dwellings are "old" (pre-1945) with very low comfort levels, and the ratio of public dwellings is below 10 per cent. Ageing of the population is very typical in these settlements and a substantial part of the labour force is still employed in agriculture.

The image and popularity of these three types of towns can be indicated by migration figures and this in part correlates with the age structure of population, employment opportunities and the quality of housing stock. Socialist towns are the least attractive, having lost their glorious past. There is massive out-migration, which has been exacerbated by declining heavy-industry and the resulting high rate of unemployment. There is a surplus of flats on the market and these empty flats have led to declining prices. There are also social and/or ethnic tensions (e.g. Gypsies) in many of these towns.

On the other hand historic towns are in a much more favourable position. As there was not a preponderance of industry, the recent economic downturns have not created high unemployment and many of these towns have expanded tertiary sectors or branches of tourism based on preserved historic areas. Overall, there is a balance of migration and even an increase in population in some of the towns, in contrast to the declining population of the country as a whole.

Agricultural towns represent an intermediate category. The had a slowly developing housing market and a lack of investment in infrastructure during the state

Table 1. Housing and social conditions in different types of Hungarian towns, 1990

	Dwellings built after 1945 (%)	Public dwellings (%)	Dwellings with bath (%)	Agricultural employment (%)	Ageing index	Balance of migration 1970-90 (%)
Socialist towns:						
Dunaújváros	97.74	47.38	98.0	2.8	53	-7.38
Tatabánya	89.84	53.16	95.0	3.3	69	-3.49
Kazincbarcika	96.64	50.84	96.0	1.9	36	-11.15
Komló	91.91	47.09	96.0	1.6	60	-5.08
Historic towns:						
Vác	71.23	20.76	90.0	5.3	71	-2.59
Nagykanizsa	78.25	27.35	91.0	5.7	72	+1.55
Tapolca	77.77	22.65	91.0	9.5	47	+0.24
Pápa	65.81	23.97	88.0	9.3	76	-000
Agricultural towns:						
Mezőtúr	60.86	5.11	72.0	19.3	92	-4.34
Jászberény	64.43	6.11	74.0	11.5	101	-3.57
Karcag	64.84	6.4	75.0	22.2	74	-6.31
Kiskunfélegyháza	58.88	8.31	74.0	20.1	91	-2.62

socialist period, the local society was least transformed among the three groups. They have negative migration figures, although not as sharp as in the case of socialist towns. These towns were also hard hit by the post-socialist transformation of agriculture, although this has not created such problems as in socialist towns.

As far as *economic* development was concerned, the towns of Hungary were hermetically cut off from the effects of global economic restructuring and urban competition during the state socialist economic system. Therefore, similar to other socialist countries, Hungarian cities preserved a strong industrial character of Fordist type until the political changes of 1989-90.

In term of the *society* capitalist types extremes of social inequality were attacked and to a large extent eliminated through different channels (e.g. nationalisation, social housing provision, new wage system etc.) after 1945. As a result, the very rich and very poor strata disappeared, social differences and the level of segregation within cities started to diminish very quickly (Ladányi, J. 1989). The capitalist system of housing production and distribution, blamed for the previous inequalities and segregation, was abolished and replaced by a communist type housing system. Mass state-housing construction started at the beginning of the 1960s also contributed to a lowering segregation.

However, from the end of 1960s social inequalities and residential segregation in Hungarian cities started to increase again. The main reason was that, after 1968 Hungary moved away from the Stalinist model of redistributive economy and egalitarianism, and started to liberalize its economy. The role of private initiatives in the form of the so-called *second economy* increased, which resulted in the reappearance of the artificially repressed social inequalities. Income differences started to grow again, better housing, western made consumer goods, cars, second homes etc. became available for the better-off strata. Economic difficulties in the 1980s further intensified this segregational trend, which led to a relatively high level of segregation in Hungarian towns by the eve of political changes, especially when compared with other East European cities (Kovács, Z. 1990).

State socialist urban development also influenced the built environment and the *physical structure of towns* in specific ways. The central business area remained generally small, because the centrally planned economy did not need financial services and other tertiary institutions. Given the lack of land-rent and real property market inner-city areas preseved much of their residential functions. In order to provide housing for the new wave of immigrants much of the public expenditures was spent at the fringe of the cities in the form of huge high-rise housing estates, containing vast number of almost identical dwelling units. Simultaneously inner city quarters were neglected and slums grew up because of physical decay and failure to maintain state-owned residential buildings (Enyedi, Gy. 1998).

Prior to 1990 towns of Hungary were organised in a hierarchy according to the level of their central functions. The share of urban settlements in the central budget depended on their position in the hierarchy. As Gy. Enyedi (1998) pointed out the availability of resources for development was determined neither by a city's actual endowments, nor by successful management, but merely by the city's effective bargaining power in the process of redistribution at its own level of the hierarchy. The political transition led to the dissolution of this practice of central planning and the role of state was replaced by the regulatory forces of market. Moreover, the shift of control from central (state) to local (community) level also meant that cities could adopt their own development policies, adjusted to their potentials and priorities.

All these resulted in the strengthening process of *regional differentiation* within the urban system. The possibility of turning local characteristics and advantages to account has released considerable energies and led to a spectacular development of some of the towns, especially Budapest and those located in the northwestern part of the country (e.g. Győr, Székesfehérvár, Szombathely). On the other hand cities located in regions with traditional heavy industries and agricultural sectors (e.g. Miskolc, Ózd, Debrecen) have been hard hit by economic restructuring under the new competitive circumstances. The geographical pattern of new types of businesses reveals some important features of strengthening regional differentiation within the country (*Figure 4*).

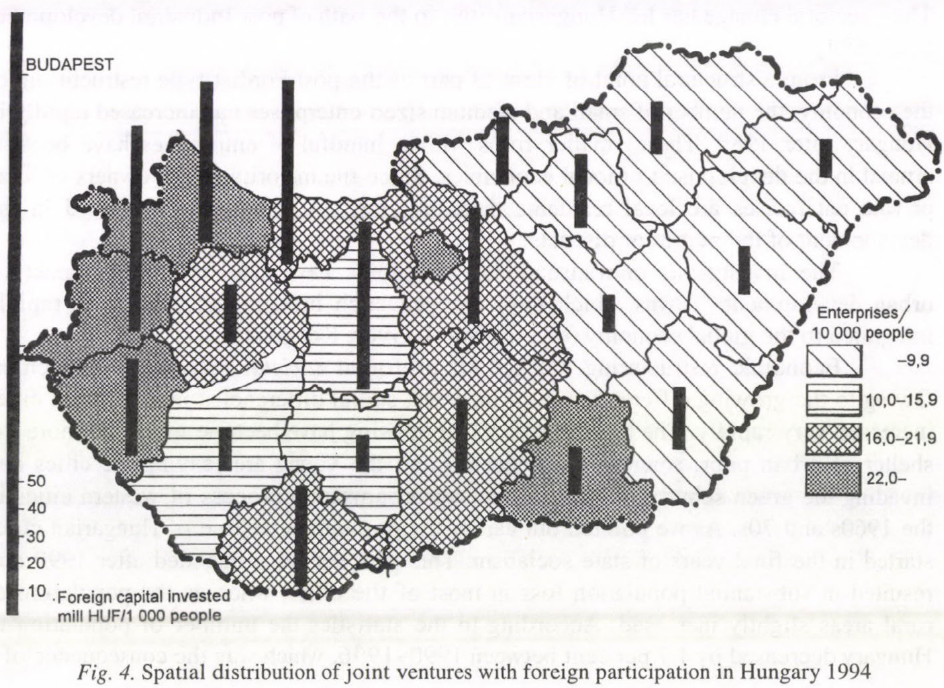

Fig. 4. Spatial distribution of joint ventures with foreign participation in Hungary 1994

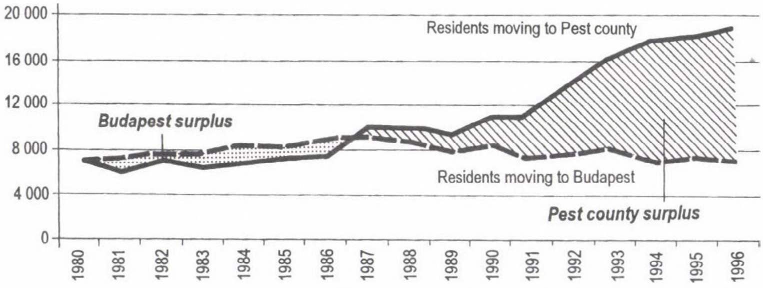

Fig. 5: Balance of migration between Budapest and Pest county

In the post-socialist urban development *economic transition* played a decisive role. In this respect we can distinguish two important sets of changes which affected the development of towns dramatically. With respect to sectoral changes, due to the collapse of COMECON market, Hungarian industry (especially the heavy industrial branches) sank into deep recession after 1989. Most of the former state complexes and mammoth firms went bankrupt and were either closed or disintegrated into smaller, more flexible units. In the meantime there was a real boom in the tertiary sector, especially in the fields of trade, tourism, financial and business services, which generally stand out with their high demand for qualified labour. A good example of rapid sectoral change is Budapest, where the number of industrial workers dropped nearly half between 1990 and 1995, and the total share of industry decreased to 18 percent of the labour market. Thus, sectoral change has led Hungarian cities to the path of post-industrial development irreversibly.

From a structural point of view, as part of the post-Fordist type restructuring of the economy, the number of small and medium sized enterprises has increased rapidly in Hungary after 1989. These smaller firms with a handful of employees have become crucial in the development of local economies. Since the majority of the owners of local private enterprises are local residents therefore they are personally interested in the development of their cities or districts.

The investments of transnational companies have also had great impact on urban development. Towns which have enjoyed such investments have been rapidly integrated to the global economy (e.g. Budapest, Győr, Kecskemét).

Economic restructuring has set off profound *societal changes* within cities. Owing to the growing differentiation of incomes, social differencies in Hungarian cities increased very rapidly. The remnants of social housing have become more and more the shelter of urban poor, whereas the better-off and the young are leaving the cities and invading the green suburbs, modelling the subsurbanisation process of western cities in the 1960s and 70s. As we pointed out earlier the population decline of Hungarian cities started in the final years of state socialism. This process has proceeded after 1990 and resulted in substantial population loss in most of the cities, whereas the population of rural areas slightly increased. According to the statistics the number of population in Hungary decreased by 1.7 per cent between 1990–1996, which was the consequence of

Table 2. Population change in Hungary 1990-1996

	Population (1.000) in 1996	Population change 1990-1996 (%)	Natural growth 1996	Balance of migration 1996
Budapest	1,886	-6.5	-12,467	-7,980
Budapest agglomeration	607	6.7	-564	9,340
County seats	1,798	-3.4	-3,383	-5,065
Other towns	2,700	-1.8	-7,149	-37
Villages	3,788	1.7	-14,723	13,082
Country total	10,174	-1.7	-37,858	

a 3.7 per cent population decline in urban areas and a 1.7 per cent population growth in rural areas (*Table 2*).

The phenomenon of suburbanisation has perhaps been most typical around Budapest. The Hungarian capital lost a total of 130 thousand inhabitants (ca. 7 per cent

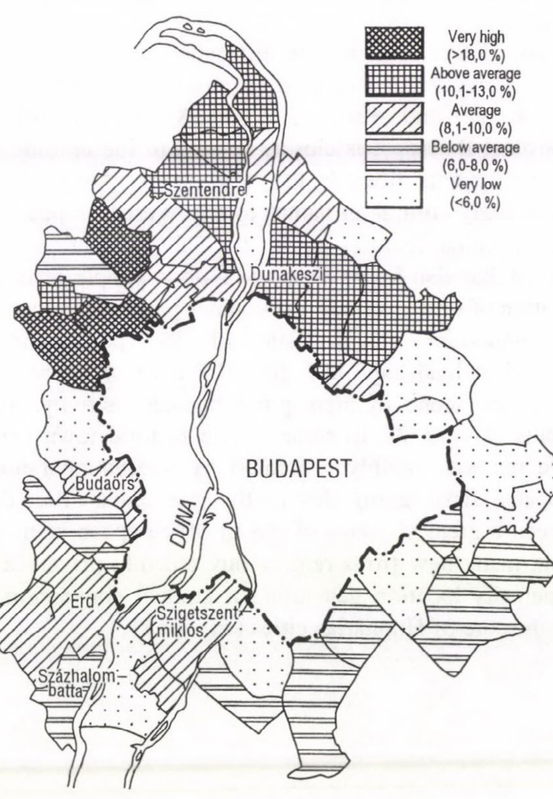

Fig. 6: Intensity of housing construction in the Budapest agglomeration 1990–1996

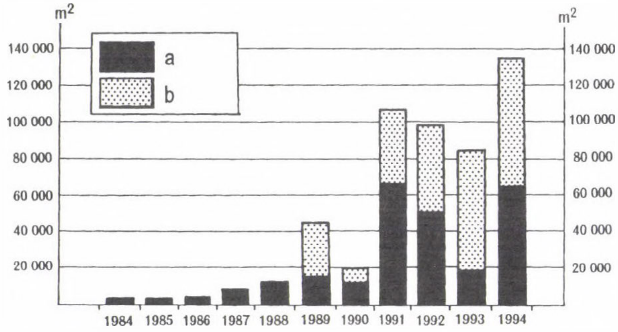

Fig. 7: Office space development in Budapest. – a = foreign capital; b = domestic capital

of the population) between 1990 and 1996. Approximately 41 percent of this loss could be attributed to outmigration, the rest to natural decrease. *Figure 5* shows that the outmigration from Budapest into the surrounding Pest county outnumbered the immigration as early as 1987, which reflects that the process has already started before the political changes.

We can also detect considerable differences in the intensity and directions of suburbanisation in the region of Budapest (*Figure 6*). According to our investigations (Dövényi, Z., Kok, H. and Kovács, Z. 1998) the intensity and direction of suburbanisation around Budapest is closely related to the attitude of local people and policy of local governments towards the newcomers. Although the suburbanisation around Budapest is fairly similar in nature to the West-European modell, yet, we can also observe some peculiar features e.g. in the suburbanisation not only middle-class families are involved, but also lower-class and elderly people, who utilised their fortune made via privatisation of state dwelling in the inner part of the city.

Another important characteristic of the post-socialist period is the transformation of urban landscape and the *relocation of urban functions*. The inner cities have become the scene of high-spired business activity, attracting large scale office developments (*Figure 7*). In some of the historic town centres we could also observe excessive renewal, mainly generated by international tourism (e.g. Sopron, Pécs, Eger, Sárospatak, Esztergom). Despite the spectacular office development in inner cities there has been a great shortage of cheap office space in most of the Hungarian towns. As a result, many new firms rent or buy recently privatised flats directly from individuals at inner city location generating a gradual conversion from residential to office function in the core of Hungarian cities (*Figure 8*).

Fig. 8: Intensity of urban renewal, October 1993 (developments and renewals under way and completed for the preceding 5 years)

CONCLUSIONS

The profound changes in the political and economic system seem to have resulted in a radical transformation both in the Hungarian urban system and within the individual cities.

Towns of Northern Transdanubia and Budapest have benefited most from their favourable geographical position and traditionally developed infrastructural background. Following the collapse of communism Budapest has attracted approximately half of the 18 billion USD foreign investment (FDI) that has arrived in Hungary. This has also meant that the Hungarian capital has been re-integrated rapidly into the network of great European cities at the focus of the country's most dynamic region. Some towns such as Győr and Székesfehervár have also fared exeptionally well in attracting western direct investment since 1990. Other cities, especially heavy industrial 'socialist cities' and towns of the eastern plain area have found themselves in deep economic crisis.

As our modell (*Figure 9*) shows the social structure and the pattern of segregation have also changed in Hungarian cities. The inner cities have been going

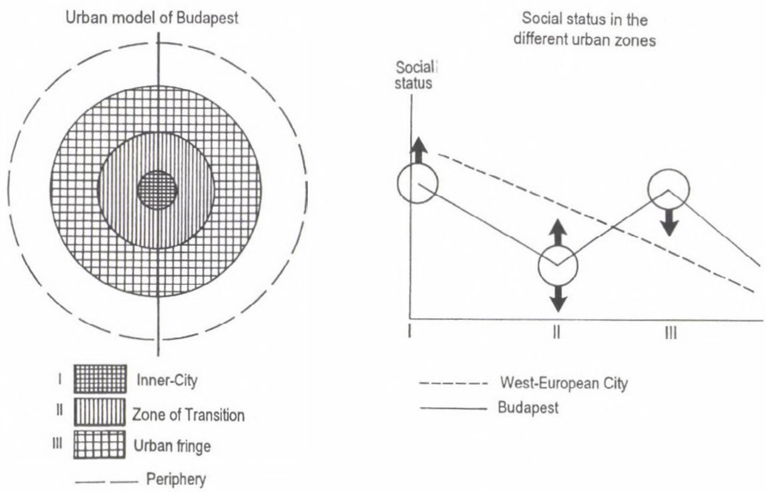

Fig. 9. Spatial structure of Budapest

through a remarkable upgrading process, whereas the prestige and social status of the outer housing estate zone have been generally declining (*Figure 9*). In the intermediate transitional zone we can identify quite opposite processes: some quarters have been upgrading, others declining often in each other's immediate neighbourhood.

REFERENCES

Andrusz, G., Harloe, M. and Szelenyi, I. (eds) (1996). Cities after Socialism. Urban and Regional Change and Conflict in Post-Socialist Societies. Blackwell. 340 p.

Beluszky, P. (1990). Magyarország városhálózata 1900-ban (The urban network of Hungary in 1900). In: Tóth, J. (ed.) Tér-Idő-Társadalom (Space-Time-Society). Pécs. pp. 92-133.

Berényi, I. and Dövényi, Z. (1996). Historische und aktuelle Entwicklungen des ungarischen Siedlungsnetzes. In: Mayr, A. - Grimm, F.D. (eds.) Städte und Städtesysteme in Mittel- und Südosteuropa. Beiträge zur Regionalen Geographie. 39. pp. 104-171.

Dövényi, Z., Kok, H. and Kovács, Z. (1998) A szuburbanizáció, a lokális társadalom és a helyi önkormányzati politika összefüggései a budapesti agglomerációban (The relationship between suburbanisation, local society and local government's policy in the Budapest agglomeration). Budapest. Manuscript 8 p.

Enyedi, Gy. (1990). Specific urbanization in East-Central Europe. Geoforum. 21. 2. pp. 163-172.

Enyedi, Gy. (1996). Urbanization under Socialism. In: Andrusz, G., Harloe, M. and Szelenyi, I. (eds) Cities after Socialism. Urban and Regional Change and Conflict in Post-Socialist Societies. Blackwell. pp. 100-118.

Enyedi, Gy. (1998). Transformation in Central European Postsocialist Cities. Discussion Papers 21. Centre for Regional Studies of Hungarian Academy of Sciences. 46p.

French, R. A. and Hamilton, F. (eds.) (1979). The Socialist City. John Wiley. 541 p.

Kovács, Z. (1989) Border changes and their effect on the structure of Hungarian society. Political Geography Quaterly. 8. 1. pp. 79-86.

Kovács, Z. and Wießner, R. (eds) (1997). Prozesse und Perspektiven der Stadtentwicklung in Ostmitteleuropa. Münchener Geographische Hefte 76. 293 p.

Ladányi, J. (1989). Changing patterns of residential segregation in Budapest. International Journal of Urban and Regional Research. 13. 4. pp. 555-572.

Lichtenberger, E. - Fassmann, H. (1995). Märkte in Bewegung. Metropolen und Regionen in Ostmitteleuropa. Wien: Böhlau.

Szelényi, I. (1983). Urban Inequalities under State Socialism. Oxford University Press. 158 p.

Timár, J. (1989). New Features of the Linkages between Tanyas (Farmstead Settlements) and Towns in the Great Hungarian Plain. In: Compton, P. A. - Pécsi, M. (eds) Theory and Practice in British and Hungarian Geography. Studies in Geography in Hungary 24. Akadémiai Kiadó. pp. 273-294.

Tóth, J. (1992). Villages, Cities, Counties, Regions and Peculiarities of Urbanization in Hungary. In: Zsilincsar, W. (Hrsg.) Zur ökonomischen und ökologischen Problematik der Städte Ostmitteleuropas nach der politischen Wende. Graz. pp. 10-46.

Zoványi, G. (1985). Structural change in a system of urban places: The 20th-century evolution of Hungary's urban settlement network. Regional Studies. 20. 1. pp. 47-71.

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FUTURE PATHS IN INDUSTRY: DE-INDUSTRIALISATION OR RE-INDUSTRIALISATION IN BUDAPEST?

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INTRODUCTION: HIGH INDUSTRIAL CONCENTRATION IN BUDAPEST

In Hungary both the dynamic capitalistic development at the beginning of the century, the unfavourable territorial changes as a consequence of World War I, when Hungary's size was reduced by two thirds and its population slashed by half, and the forced industrial development within the economic policy of state-socialism after World War II contributed to the fact that the highest industrial concentration had developed in the Budapest agglomeration. In the "golden time" at the beginning of the 1960's, 650 thousand workplaces were registered in Budapest's industry, and an approximately 50-60% of national production came from the capital.

By the time of the height of state socialism in the 60's, the potential for further industrial development in the capital had decreased, the main constraint on expansion being the shortage of labour. As a consequence, companies with headquarters in Budapest started to expand into the countryside. The entire economy became dominated very quickly by multi-branch plants, multi-regional companies, and a significant part of production was moved to the countryside. Subsidiary plant industry, also termed 'the colonisation of the countryside', contributed significantly to relieving the labour shortage experienced by companies in Budapest. At the same time, the capital was able to draw much of the profit from this dynamic development. This way Budapest's industry survived, and, its strategic significance even increased.

During the last decades of the centrally planned economy, important changes had taken place in Budapest's industry, and this tendency accelerated after the change of the political system (1990). Although the number of industrial jobs began to decrease as early as the mid-60s, a trend that resulted in dramatic unemployment figures after 1990, the number of industrial jobs in Budapest was halved again between 1990 and 1994. Although it has slowed down somewhat, the same trend seems to be still at work today. (*Table 1*)

Table 1. Budapest's decreasing industrial workforce

Year	Number of employees	Decrease	Annual rate of decrease (%)
1990	277,851	10,194	3.5
1991	239,104	38,747	13.9
1992	195,273	43,831	18.3
1993	164,797	30,476	15.6
1994	140,614	24,183	14.7
1995	126,902	13,712	9.8
1996	116,940	9,962	7.9

Source: Budapest Statisztikai Évkönyvei (Budapest Statistical Yearbooks) 1994, 1997, KSH, Budapest

Until the change of the political system, it was the industrial workforce that had to bear the brunt of restructuring the economy. After 1990 the impact was felt on the company level itself. This was most spectacularly shown by the disintegration of the giant companies typical of the centrally planned economy. Many companies had first closed their subsidiary plants in the countryside, then laid off part of their workforce at their company headquarters and were finally forced to shut down completely. About 2500 big companies went bankrupt between 1992 and 1995, 30% of which had their headquarters in Budapest.

(There are scores of examples which illustrate this process. The case of the Csepel Iron and Metal Works in Budapest, a company with a long and great tradition, is only one of many. Approximately 30 thousand people worked there in the 1970s. This industrial trust was first split into 15 independent companies in 1983, and subsequently into 22 independent units in 1990. Today the former assets of this big trust are shared by as many as 170 proprietors.) (Kasza, B. 1996)

The country's industrial production has fallen to one half of its previous level between 1988 and 1992. Although some industrial growth has been registered since 1993, industrial output is still 30% below the level reached in 1985. And Budapest's industry has been no exception to this national trend. The last year of growth in Budapest's industry under the old system was 1987; by 1993 production had fallen to 55% of its 1987 level.

Since 1993 Budapest's industry has been on a growth path again, its number of industrial companies has multiplied (from 6000 in 1993 to 17000 in 1996). 28% of the national industrial production, 25% of the industrial exports and 23% of the industrial GDP were generated by Budapest's industry in 1996, but only 16% of all Hungarian industrial jobs can be found in Budapest. At the same time this shows that the productivity of Budapest's industry by far exceeds the national average: In 1996 it was more than double that of the industry located in the countryside. Moreover, during the last few years, other regional differences in industrial productivity have increased as well.

To sum it up: Although it shrank considerably during the period under review, Hungary's largest industrial concentration is still to be found in Budapest. The radical decrease in industrial jobs poses some questions: Which way is the changing industry of Budapest heading? Or: What are we to make of the trends described: Is it a radical *restructuring and modernisation of Budapest's industry, or a slow disappearance of industry from Budapest's economy altogether?*

ALTERNATIVE VIEWS ON THE PRESENT AND FUTURE DEVELOPMENT OF BUDAPEST'S INDUSTRY

Many argue that Budapest's industry is in *crisis,* or worse, altogether in ruins as a consequence of the political-economic transition. It is not hard to produce evidence to support this view by taking a look at the array of disintegrated large industrial companies, closed-down factories, vacant industrial areas, plants. If, for instance, one considers the present situation of Budapest's industry from the perspective of the already mentioned Csepel Works, one will certainly find nothing but disintegration and decay.

Those who maintain that Budapest's industry has been undergoing a process of *de-industrialization* share to some extent the above view. At the same time, instead of describing disintegration as a dramatic development they see it as an inevitable necessity. Budapest's economy, they claim, has been subject to a radical transformation process, not unlike other developed metropolises of the world. Industry and the building sector are playing an increasingly minor part, being more and more overshadowed by the services sector. On the one hand, industry leaving Budapest can be observed to be moving to the agglomerational zone of the capital. A growing number of investments, however, are being realized in towns of the northwestern region of Hungary situated between the Austrian border and Budapest (Győr, Székesfehérvár, Szentgotthárd), on the other.

Nor is it particularly difficult to demonstrate the trend of de-industrialisation in Budapest's industry. There is little disagreement concerning the radical decrease of the share of industrial jobs in Budapest's economy and the various indices of prosperity in the northwestern region of the country. In other words, recent developments in industry clearly attest to an extensive spatial restructuring involving a considerable fall in the share of Budapest's industry.

By contrast, others hold the *unbalanced, disintegrated* and *dual structure* of industry to be the most characteristic feature of the current situation (Budapest Bank, 1997). While small enterprises make up as much as 90% of Budapest's industrial companies, industrial growth is to be attributed to a few foreign, usually multinational firms (their number hardly exceeds ten). Most of the small enterprises have been forced to embark on some kind of economic activity for the lack of other possibilities alone. They suffer from a grave capital shortage and survive on a day-to-day basis. Even among the more successful small enterprises only very few have managed to work their way up and become medium-sized companies. In fact, medium-sized companies have been practically missing from the Hungarian company structure.

Large foreign companies playing a decisive role locally have been experiencing serious difficulties in integrating into the capital's economy as well as into the Hungarian economy in general. Only a tiny fraction of Hungarian small and medium-sized enterprises have been able to establish contacts to financially powerful, upward-moving foreign companies operating in Hungary. This situation may well contain the rudiments of an emerging dual economy.

Finally, there are experts (including the author) who assess the state of Budapest's industry in a more optimistic fashion. They argue that the capital's industry has been undergoing a dynamic transition which involves a much-needed downsizing, restructuring and modernisation (Kornai, J. 1993). It can be generally concluded, however, that *industry has been far more important in the Hungarian metropolis* than observed in the course of industrial transformation processes in large Western European cities. At the same time, it is difficult to determine whether this is to be attributed to specific characteristics of privatisation and the domestic operation of foreign direct investment, or rather to the peripheral position of Eastern European countries (including more developed countries as well). Processing industry, for example, has in fact strengthened the capital's intermediary position in Central and Eastern Europe. The question is whether Budapest's industry will also continue to play an unusually important role in the future or this will ultimately prove to be a temporary phenomenon.

It is difficult to keep track of these developments for a number of reasons. First of all, changes have taken place at an extremely rapid pace. In accordance with Schumpeter's theory of 'creative destruction', the first two or three years following the political-economic transition saw a period of disintegration and general recession, while growth and restructuring has prevailed since then. Even more important is the fact, however, that all of the above mentioned phenomena – collapse, deindustrialisation, dual structures as well as reindustrialisation – have appeared together, side by side or in combination, in the course of the transition.

THE FUTURE OF BUDAPEST'S INDUSTRY

Expected industrial growth

Economic forecasts predict an upward trend in the world's economy (IKIM 1995). For the Hungarian economy, this implies the possibility of maintaining an export-oriented attitude. (International demand will positively affect the chemicals and pharmaceuticals industry, office equipment and computer manufacture as well as the production of precision machinery, optic instruments, electric devices and applications. Average demand can be expected in other sectors of the machine and paper industry. Finally, moderately increasing demand is predicted, among others, for metallurgical products and the textile industry). These predictions are particularly favourable for Budapest's industry where chemicals and engineering industries are responsible for two-thirds of production.

Investments in the processing industry make up a growing share of total investments in Budapest (from 115.2% in 1994/95 to 122.8% in 1995/96). It is likely, therefore, that the processing industry will contribute to the production of Budapest's economy at an increasing rate. Interestingly, however, foreign investments are falling both in industry in general and in the processing industry in particular. (The latest foreign investments have shown more interest in the telecommunications, financial, insurance and real estate sectors. The composition of foreign direct investments FDI in the 'second division' of developed countries shows a similar trend.) It follows that *domestic* investments on the other hand have been on the rise in recent times. (85% of investments in the processing industry came from abroad in 1994, 83% in 1995, but only 66% in 1996).

Forecasts predict a steadily growing industrial contribution to the GDP until 2003 in Hungary, including the building sector. A gradual decline in the share of industry and building in total production is only expected in approximately 6-7 years (Petschnig, M.Z. /ed./ 1997). At the same time, a further decrease in industrial employment in Budapest seems likely as well. Calculations reckon with 20-25 thousand jobs less in industry by 2005, amounting to a 19-20% share of industry and the building sector at the time. Nevertheless, in the future, cuts in the size of the labour force – one of the available means to increase productivity – will be less frequently accompanied by the complete closing down of companies in the category of medium-sized and large enterprises.

It can be concluded, therefore, that industry will most probably remain an important sector of Budapest's economy in the next 10 to 15 years, even if it is bound to lose some of its former importance. In Eastern European countries, a shrinking industrial workforce seems to be a direct consequence of the economic transition itself (the transformation of the centrally planned economic structure to a market economy), i.e. resulting from an initial economic recession and subsequent period of gradual growth. In short, falling employment figures in industry do not entail the same process of radical de-industrialization which large cities of the most developed countries have had to undergo.

A transforming industrial structure

The last few years have brought about the emergence of market-economic structures, including wide-ranging changes in ownership (foreign ownership amounted to 45% in 1995, while Hungarian private ownership was around 28%, similar percentages were recorded in Budapest's industry as well). Nevertheless, capital concentration will long remain the characteristic trend. Although there is no doubt that a thorough transformation of company-size structure took place in the early 1990's, the *organizational structure of companies* is still changing continuously. In particular, considerable fluctuation can be observed in the category of small enterprises. There have been considerable shifts, especially since 1993, *within the various sectors* of the processing industry as well, textile and clothing industry has declined significantly, while machine, food and chemicals industries are responsible for 82% of the industrial output in Budapest.

The dynamics and structure of investments enables the making of certain predictions concerning the production structure of the next few years.

Table 2. Structure of industrial investments (%)

Sectors	1994	1995	1996
Processing industry	69.8	63.8	75.7
food industry	26.7	17.8	14.3
textile, clothing and leather industry	1.0	1.3	1.3
wood, paper and printing industry	8.8	6.2	8.6
chemicals industry	21.0	19.6	27.5
metallurgy	1.9	1.9	3.1
machine industry	9.5	16.5	20.0
Public utilities	29.3	35.3	23.7
Industry total	**100.0**	**100.0**	**100.0**

Source: Statistical Yearbook Budapest, 1996. p. 266

Three sectors of the processing industry have concentrated investments in the last three years: *food industry* (although at a decreasing rate), *chemicals and machine industries* (at an increasing rate). These percentages highlight the fact that current investments actually consolidate the structural transformation of Budapest's industry. (This investment structure more or less corresponds to national figures as well.)

Danger of the dual economy

The *structure of economy* has been still far from a balanced, stabilized stage, and even more there are unstable elements in the economic structure, which can hamper or slow down the positive macroeconomic tendencies as well. *The contradiction of the Hungarian economy is associated with the fact, that the economic dynamism is exclusively due to the FDI (particularly to that of multinationals), while the majority of small companies have not been prospering, and the category of the medium size companies is relatively "thin".*

After the change of the political-economic regime the small companies have been mushrooming, partly because of the desintegration of the huge socialist enterprises, partly as new foundations. A big part of them has been the result of the difficult economic situation (as the only possibility for people trying to avoid unemployment). Majority of the small companies are fighting with a severe lack of capital, the shrinking domestic consumption, with the unacceptable high interest for credits, the irreally high taxes, and the lack of the protectionism of the state economic policy. This way the small companies (in Hungarian ownership basically) suffer from limited competitiveness. Because of the very slow domestic capital accummulation a tiny part of small and medium enterprises was able to enlarge or develop.

The "curative injection"for the ill Hungarian economy was a totally imported one. It is well known, that approximately a half of the western foreign capital invested in Eastern Europe was concentrated in Hungary. The FDI is already producing, but at the same time its integration into the domestic economy is slow, or going on with difficulties. The main reason of this fact is the widened technological gap between the foreign and domestic enterprises, but their interests and possibilities are basically different, too (Barta, Gy. 1994, Csáki, Gy. *et al.* 1996).

All these tendencies can pose the danger of a dual economy. The question is, whether the present and future, international and domestic circumstances will help the inner integration of the Hungarian economy, or they will rather stabilize the dual character of the economic system?

Technological development / R&D

One of the legacies of the former central planning is a serious technological gap between developed countries and Eastern Europe. It is true, however, that after the change of the political system the motivation for innovation has not reappeared, and R&D activity has not yet been revived in the Hungarian economy/industry. Yet the ability of the new enterprises for a more rapid adjustment to new circumstances is recognisable.

Absolute expenditures on R&D decreased by 54% between 1988 and 1993, falling at a much higher rate than the GDP. The share of expenditures on R&D in Hungary has been rather low in international comparison: 2% of the GDP in 1989, 1,7% in 1990, 1,2% in 1991, and 1% in 1993. The number of scientific researchers had decreased from 17 550 to 11 820 by 1993. The pressure for further cutbacks is still intense (van Geenhuizen, M. 1997).

The increasing scarcity of R&D funds has affected the various types of organisations in a differentiated way. Some of the industrial research institutes have been closed down, while others just barely survive in a day-to-day struggle with the lack of contracts and scientific projects. Between 1988 and 1993, the nominal value of the revenues received by research institutes decreased by 82%. R&D activities as well as the underlying institutional system have been subject to a fundamental restructuring process. While independent R&D activities and separate R&D departments within companies have been on the decline, the number of occasional and specialised R&D tasks has increased significantly.

Industrial enterprises have generally shown a lessening and less interest in innovation. Spending on R&D has decreased. Enterprises have to rely on their own resources to finance the bulk of their R&D costs. The government has only limited funds available to foster domestic R&D potential, and foreign investors are rarely interested in sponsoring R&D in Hungary. Consequently, R&D activities of enterprises in foreign ownership are not pursued with great intensity (Tamás, P. 1995). It must be noted, however, that the dwindling of R&D is not only a result of changing spending policies. It seems to be overwhelmingly the case that company managements prefer the application of foreign technologies to the potential results of in-house research. This explains the growing import of licences and know-how, especially in joint ventures with foreign participation.

The cutbacks in R&D activities are also to be attributed to the shrinking average size of companies. As already mentioned, one of the principal reasons for the fragmentation of the structure of enterprise organisations has been the disintegration of large industrial companies dominating the centrally planned economy. These had functioned as the main centres of technological development. Small companies are less innovative and their financial possibilities are much more limited.

It is clear, that the role of the state can not be shifted to the market-oriented institutions. But at the same time any governmental R&D policy can only be based on a market economy. As a consequence, a successful R&D activity, an effective relationship between R&D and production in Eastern European countries can be expected only after the transitional period of economic development has ended.

New orientation of enterprises, networks, central functions

The fundamental problem of the present Hungarian/Budapest industry is the fact that only a minority of the small and medium-sized companies is able to act as suppliers or subcontractors to the big companies, mainly in foreign ownership, producing the major part of industrial output and exports. The main obstacle to the co-operation is a technological gap.

An interesting finding of our research is that multi-plant enterprise structure of the former centrally planned economy has partly survived, even after privatisation. A certain continuity exists, although a part of the former units of the giant enterprises having emerged during the period of state socialism has become independent (the other part was, or will be, closed down). But the former, mostly personal relations and contacts are still there and active or are being rebuilt between these newly independent companies.

New networks of enterprises have begun shaping, too, creating, for example, new plants abroad, mostly in countries of the former Soviet-bloc. Very often, a decisive and strong purpose of western investments is to develop a "bridgehead" or distributing centres for western companies founded in Hungary in general or at Budapest in particular. From there, they hope to continue their expansion into other countries of Central and Eastern Europe and the CIS. Such efforts are in fact strengthening the position of Budapest as a regional centre, on the one hand, and the long-range presence of industrial activities in the Budapest economy, on the other.

The changing location of industry in the Budapest agglomeration

„Industrial ruins" in Budapest will probably disappear in the not too distant future. The utilisation of empty industrial factory buildings has already changed, and most of them will be remodelled or razed sooner or later. The disintegrated, restructured or closed giant industrial enterprise-empires of the past will be industrial history, hopefully recorded and analysed in the future.

But there is some discussion among urban planners and industrialists as far as the future of Budapest's industry is concerned. Urbanists believe in total de-industrialisation, i.e. the complete disappearance of industrial activities from Budapest, while, according to economists and industrialists, Budapest will remain an industrial centre for a long time to come, and the Hungarian capital, as an industrial location, will continue to offer several advantages for further industrial development. At any rate the spatial division of labour will be changed.

The belt of the Budapest agglomeration and the region between Budapest and the Austrian border, is becoming the preferred location of new industrial siting, particularly for greenfield investments (Matolcsy, Gy. 1997). Yet the slowly growing subcontracting system and the increasing co-operation between enterprises of all sizes will multiply economic transactions mostly in the Budapest agglomeration. As a consequence, this development will create industrial districts in Budapest that are more integrated into the Hungarian, European and global economies than ever before.

CONCLUSIONS

As far as the international and domestic circumstances are concerned, both the international and home prognoses predict a global – at least European – economic prosperity. This may open perspectives for SMEs those to be joining the big foreign and domestic companies, multinationals as subcontractors. The internal integration will be supported by the European integration processes. There is a hope Hungary will join European Union by 2002-2003. The EU membership will help the companies to increase their export, and to create a larger network of subcontracting, but at the same time the competition will be sharper. The Hungarian policy will probably increase - particularly during the period of the preparation for joining EU – its support in order to improve the positions of the domestic economy.

Summarising the ideas about the future: there is no need for too vivid imagination to forecast the prosperity of the industry in Budapest. It will bear marks of the peripheral economies (an increase of mass production, a limited interest in innovation, and a relative "low tech-big success" orientation) on the one hand, and the strengthening control function of the metropolis on the other. Budapest will be an industrial centre in the semi-peripheral Hungary.

REFERENCES

Barta, Gy. (1994). Foreign investment in the Hungarian economy: the role of transnational companies. In: P.Dicken and M. Quévit (eds): Transnational corporations and European regional restructuring. Netherlands Geographical Studies 181. Utrecht. pp. 131-151.

Csáki, Gy., Sass, M. and Szalavetz, A. (1996). Reinforcing the modernization role of FDI in Hungary. Working Papers No. 62. Institute for World Economics, Hungarian Academy of Sciences, Budapest, 37 p.

M. van Geenhuizen (1997). Opportunities for innovation in Central and Eastern Europe: The role of FDI. Paper for the RSA Nederland Dag 1997 "Innovatie in bedrijf en regio: strategie en praktijk". April 11th 1997, Utrecht.

Kasza, B. (1996). Vörös Csepel (Red Csepel). *Holmi,* no.2.(February 1996): 219-228.

Kornai, J. (1993): Transzformációs visszaesés (Transformational recession). *Közgazdasági Szemle,*no.7-8(1993): 569-599.

Matolcsy, Gy. (1997). A budapesti régió lehetséges szerepe a regionális együttműködésben (A potential role of the Budapest Region in the regional cooperation). Tulajdon Alapítvány Privatizációs Kutatóintézet, Budapest, 111. p.

Petschnig, M. Z. (ed)(1997). Előrejelzés a 2005-ig várható gazdasági folyamatokról. (Forcast for the future economic tendencies till the years of 2005). Pénzügykutató Rt. 78. p.

Tamás, P. (1995). Innovációs folyamatok a magyar gazdaságban (Innovative processes in Hungarian economy). Budapest, Országos Műszaki Fejlesztési Bizottság.

Középtávú iparpolitika az ipar versenyképességének növeléséért. (A report about the medium-range industrial policy for increasing competitiveness). Ipari és Kereskedelmi Minisztérium (IKIM) (911/795/1995). Budapest, 1995. december.

Makrogazdasági elemzések, prognózis 1997-re. (Macroeconomic analysis and prognosis for 1997). Budapest Bank Rt., March 1997

L. Bassa–Á. Kertész (eds): Windows on Hungarian Geography
Studies in Geography in Hungary 28, Geographical Research Inst. HAS, Budapest 1998, pp. 185–197

ALLOCATION OF FOREIGN INVESTMENTS IN THE TRANSDANUBIAN REGION

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INTRODUCTION

As a consequence of the new trends in world economy, foreign investors have appeared in Eastern Europe. The process was stimulated by the establishment of institutions of the market economy, slow and firm consolidation of the economic development, and the privatisation in these countries that enhanced the opportunities of potential investors. Furthermore, costs of production (particularly, labour costs) are low compared to the western part of the continent and the Eastern European countries provide specific preferences to attract foreign investors. Although, proportion of the latter was increasing significantly in the 1990s, it is still a modest performance compared to other regions of the world. For instance, the amount of invested foreign capital in Mexico exceeded the aggregated index of the Czech Republic, Hungary and Slovakia. The gross amount of foreign capital flowed into the East European region between 1989 and 1993 was 13 billion USD, whilst developing countries received 80 billion USD investments. German investors that are the most important ones in the region regarding the amount of the capital flow, directed only 2% of their investments into East Europe in 1993.

The attractiveness of a region for the investors is determined by the performance of the national economies. About 30-40% of the gross foreign investments implemented in the Eastern European region was realised in Hungary in 1994. As a consequence of the different national statistical systems, this proportion is higher (by about 50%) in the case of Hungary according to the analysis of international organisations (OECD). So, the reason for the low level of foreign investment in East Europe is that the only attractive place to invest is Hungary in the region (Antalóczy K, Ludányi A, Salgó I. and Sass M. 1996).

Hungary is favoured by foreign investors for several reasons, such as the size of the inner market, political stability, and the existing elation (established in the era of the centrally planned system) for consumer-oriented investors. Low labour costs, fairly high level of qualification of the Hungarian labour, and entering the inner market inspired

Table 1. Foreign investment in Eastern European Countries (million USD)

Country/year	1989	1990	1991	1992	1993	1994	1989-1994
Albania	-	-	-	20	48	n.a.	*68
Bulgaria	-	4	56	42	55	n.a.	*157
Czech Rep.	171	120	511	983	517	832	3,134
Hungary	215	354	1,462	1,479	2,350	1,147	7,025
Poland	11	89	291	678	1,715	1,400	4,184
Rumania	n.a.	112	40	77	94	295	618
Slovak Rep.	86	53	82	72	120	200	613
Slovenia	-	-	41	111	112	58	332
Russia	n.a.	n.a.	**-100	200	400	n.a.	*500

*Cumulated data, including the years 1991-1993.
**In 1991, capital export of Russia exceeded the import by 100 million USD. The main target of Russian investors was Germany.
n.a. no data available
*Source:*Antalóczy, Ludányi, Salgó and Sass 1996.

investors oriented towards resource costs to make a business in Hungary. (Éltető A, Sass M. 1997) (*Table 1*).

The central government was conscious of the needs of foreign investors and the national economic policy had been preparing the conditions of such transactions. In the first stage of the transformation (1988–1990), the main elements of the legislative framework were set up that guaranteed the security of foreign investments. In line with the legislative procedure, institutions for stimulating such investments were also set up, like tax preferences, central governmental funds for supporting the preparation of premises and re-training of labour, and state commissions. Furthermore, the fairly rapid privatisation that followed the principles of market economy (competition among applicants) also stimulated foreign investments despite the discordance of the process. 63,4% of the privatisation incomes were realised in foreign currency between 1990 and 1996, that shows the high participation of foreign investors in the process. (Voszka É. 1997).

SPATIAL DISTRIBUTION OF FOREIGN INVESTMENT

Surveying the spatial distribution of foreign investment in Hungary some methodological issues should be raised. In the official statistics, the foreign share in the companies is presented only at county level. This index does not reflect the real value of foreign investments, because the purchase of shareholdings may occur below or above face value. Furthermore, enterprises are registered at the settlement of headquarters' seat but the activity may be settled somewhere else. For instance, the majority of headquarters are in Budapest, and the companies have plants in distinct parts of the country that have substantial weight in local and regional economies in terms of employment, tax revenues for the local government and through multiplication effect of activities. Our study is based on official statistics and surveys by independent experts to give a sketch of spatial distribution of foreign capital focusing mainly in the North Transdanubian region.

At present, there is no official regional subdivision in Hungary. It is expected to be presented in 1998. Official statistics are available only at county level. Counties are included in the units of statistics and planning proposals, the regions have competence neither in spatial administration nor in economic development. In our concept the North Transdanubian Region includes three counties of West Transdanubia (Győr–Moson–Sopron, Vas and Zala) and three counties of Central Transdanubia (Veszprém, Fejér and Komárom–Esztergom).(*Table* 2).

Table 2. Indices of the Economic Potential of the North Transdanubian Region

County	Population (thousand)	Area (sq. km)	Number of economic organisations	Invested capital (million HUF)	Number of active earners	Unemployment rate (%)	GDP/head (thousand HUF)
Győr-Moson-Sopron	426	4,062	41,030	42,197	114,210	6.5	575
Vas	272	3,337	21,878	32,724	77,816	7.1	574
Zala	301	3,784	32,960	17,709	77,772	9.4	522
West Transd. Total	999	11,183	95,868	92,630	269,798	7.6	559
Komárom-Esztergom	312	2,251	29,469	22,980	69,328	10.7	481
Fejér	426	4,373	41,030	44,891	102,748	10.2	535
Veszprém	378	4,639	40,035	19,676	91,618	10.0	473
Central Transd. total	1,116	11,263	110,534	87,547	263,694	10.3	499
North Transd. Total	2,115	22,446	206,402	180,177	533,492	8.7	529
Share within national total %	20.7	24.2	19.7	22.8	21.2	83.6	97.3

Source: Regional Statistical Yearbook, 1995

As you can see in *Table 2*, the region has a remarkable share in the national resources of labour and *economic basis*. In the centrally planed system, this area concentrated sizeable industrial capacities. The mining, manufacturing and food industry had been settled here since the 1960s. These sectors became *crisis* industries in the early 1990s, and their organisational and structural transformation has been started. Skilled labour having considerable professional experience was concentrated in the region. The level of infrastructure provision was spatially differentiated, but the region as a whole exceeded the national average in many respects. Economic and social relations were getting closer with Austria in the 1970s that has become the basis of the economic activity and the rapid increase of Austrian investments in the region since 1989. The relatively high level of urbanisation promoted the development of the service sector (particularly in county seats), saving the bourgeois identity and mentality and offering the facilities of a higher quality of life.

The spatial distribution of foreign investments (amount of the influx of capital per1000 inhabitants) by counties between 1991 and 1995 is presented in *Figure 1*. By the end of this period, there were 25,000 companies with 1308 billion HUF foreign capital share in Hungary altogether. The largest concentration of the foreign capital is in Budapest. Half of the economic organisations settled and about 60% of the invested capital arrived there in 1993. Since then, there has been a substantial increase in the investments in the agglomeration of the capital (particularly in its western part). The data of Pest County illustrate the trend: the amount of foreign capital was 10 times higher in 1995 than in 1991 that made the area the most dynamic one in Hungary after Budapest.

The concentration spatially is a consequence of the *polarised* Hungarian spatial structure *dominated by the capital*. The most important elements of the economic and social development appeared in Budapest in the past 80 years. The city is in the focus of the transportation system. It is the centre of the public administration, far the largest concentration of R&D activities and higher education, furthermore, this city offers a wide spectrum of advanced services (*Table 3*). The present settlement network is a blueprint of the historical processes that resulted in the dominance of Budapest. This centrality was put into new context after the transformation. The good accessibility (motorway linking Budapest and Vienna, the only international airport in the country), large size of the local market (2 million inhabitants) and the concentration of decision making centres attracted a number of foreign investors. Their headquarters are settled in Budapest, because they may be in daily contact with their business partners, that promotes co-operation, a wide range of business services is available and the needs of the management could be satisfied (large spectrum of consumer services).

Table 3. New joint ventures with foreign share registered in 1996 in the North Transdanubian Region

County, region	Number of enterprises	Registered capital (million HUF)	Foreign investment (million HUF)	Invested foreign capital/enterprise (million HUF)
Győr-Moson-Sopron	173	4,550.2	4,482.2	25.9
Vas	89	339.3	308.5	3.5
Zala	74	797.0	182.8	2.5
West Transdanubia total	336	5,686.5	4,973.5	14.8
Fejér	73	4,207.6	3,602.2	49.3
Komárom-Esztergom	116	1,757.2	1,465.4	12.6
Veszprém	85	430.6	332.8	3.9
Central Transdanubia total	274	6,395.4	5,400.4	19.7
North Transdanubia total	610	12,081.9	10,373.9	17.0
Share within the national total (%)	14.9	30.3	34.4	229.7
Share within the provincial total (%)	36.7	68.1	70.7	191.1

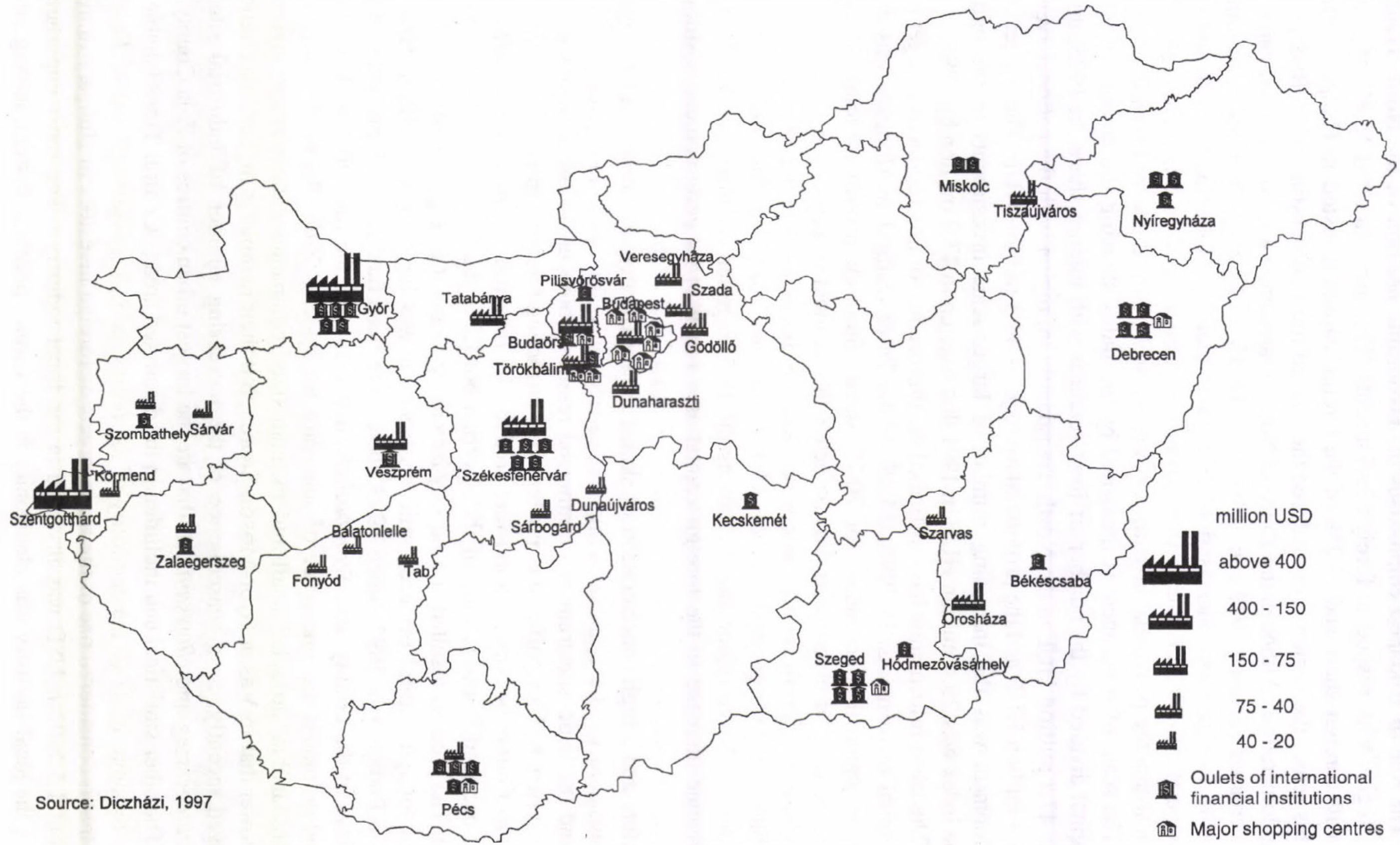

Fig. 1. Spatial distribution of major greenfield investments

The role of Budapest emphasises the favourable position of the North Transdanubian Region with respect to foreign investments. This area attracted 18,8% of joint ventures with foreign share and 17,2% of the foreign capital invested in Hungary until 1995. In his sense, the region is considered the second most successful one to Budapest and its agglomeration. Although the share of North Transdanubia in the invested capital slightly decreased between 1989 and 1995 (from 18,3% to 17,2%), the number of joint ventures with foreign share increased (4,2%) faster than in provincial areas (counties extra Budapest). 16-17% of foreign investment was implemented in this region, and its proportion within the provincial investments was 35-44% in the discussed period.

The scale of investment is measured by the index showing the amount of imported capital divided by the number of joint ventures with foreign share. In 1995, this index was 47.8 million HUF in the North Transdanubian, region with the national average of 52.4 million HUF and the provincial average of 44.3 million HUF. The trigger of the development was the increasing number of larger-scale investments in the mid-1990s: the index was 29.4 million HUF in 1991 that rose up to 47.8 million by 1995.

The latest information has confirmed the importance of this region as a target of foreign capital investments. In 1996, 34.4% of the latter realised in Hungary was directed to the region that accounted for 70.7% share within the provincial total. At the same time, the scale of investments was far below the national average.

There are significant differences between the discussed counties regarding spatial distribution of foreign capital. *Győr–Moson–Sopron County* was the main target of the investors inside the region and the among the 19 Hungarian counties as well. There was a dynamic increase in the foreign capital as a result of its geographical position (proximity of the western state border), the fairly high level of industrial and communal infrastructure and a high concentration of skilled labour (particularly in manufacturing). The privatisation of the manufacturing was carried only smoothly and quickly. This process and the wide spectrum of commercial relations built up in the former socio–economic system had a significant contribution to attracting foreign capital.

Vas County became an important area for the investors as well. Large scale investments occurred in the vicinity of the Austrian border in the first years of the transformation. The process resulted in a rapidly increasing share of foreign investments. The amount of foreign capital per economic organisation was higher (26,2 million HUF) than that in Budapest in 1992. Since 1993, there have been further developments in the surroundings of the county seat, *Szombathely*, that enhanced the industrial basis of the county and promoted the emergence of subcontractor systems. *Zala*, the third county of West Transdanubia, attracted small and medium sized companies. The scale of investments is lower that in Vas or Győr-Moson-Sopron, but their number is higher. This trend has changed recently, as a consequence of the increasing number of industrial sites nearby *Zalaegerszeg* and *Nagykanizsa*, that are the largest urban centres of Zala County.

The other statistical unit included in the discussed area is Central Transdanubia. The most dynamic node of the economy of the region is *Székesfehérvár* (seat of *Fejér County*), that is considered one of the main targets of foreign investors in Hungary (until 1996, about 1,5 billion USD was invested in the local industry). The most important element of the local industry was electronics in the former political system, having undergone a deep crisis in the early 1990s. The economic basis of the city recovered in a few years. The process was stimulated by the surviving economic relations and by the local government that initiated a wide range of actions to improve the infrastructure (establishment of industrial parks), offered long-term preferences (local taxes for new companies suspended for five years) and set up a city marketing strategy. These steps made the city one of the most attractive targets for industrial investors in Eastern Europe. Joint ventures and greenfield investments setting up subcontractor systems appeared in other settlements of the county.

The main elements of the economic basis of *Komárom-Esztergom County* were mining, building material industry, oil refining, heavy engineering and wood processing. This basis has been heavily eroded in the early 1990s. The geographical position of the county is favourable, it is part of the Vienna-Budapest corridor. This potential was exploited by local governments for promoting the economic development. *Tatabánya*, the county seat followed the *Székesfehérvár model*, offering wide range of preferences and industrial sites for the foreign investors. These measures have attracted major investments (such as the largest wheel-bend factory in Europe) and raised the share of the county in foreign investments significantly.

Veszprém County also offers favourable conditions for the potential investors, but its share is still rather small in foreign investments. One of the main reasons for lagging behind the other counties of the region is the lack of a consistent policy towards supply of real estates and industrial sites. There was an attempt to set up a comprehensive marketing strategy to enhance the supply of such sites in *Veszprém*, the county seat in the mid-1990s. The plan is based on endogeneous resources (industrial basis, transportation links, the local university, R&D capacities) and the expansion of the Székesfehérvár industrial agglomeration that will probably include Veszprém in the nearest future.

SECTORAL AND SPATIAL CHARACTERISTICS OF GREENFIELD INVESTMENTS

Greenfield investments have key role in regional and local economies, because they involve technological regeneration, stimulate the development of local enterprises and enhance employment facilities. The spatial context of foreign investments could be described and explained through surveying the regional distribution of producer capacities, services and trading activities (*Figure 1*).

New industrial capacities included 220 projects of 3.05 billion USD value that comprised 20% of foreign investments in Hungary. According to the amount of the invested capital, capital exporting countries rank as follows: the USA (41%), Germany (32%), Japan (10%), the Netherlands (5,5%) and Austria (5,5%). German investors implemented the largest number of industrial projects, but they and the Austrian companies established mostly small and medium scale businesses. American capital is involved in large-scale investments. About 70% of greenfield investments were realised in the

North Transdanubian region including 103 large projects (each over 1 million USD). About 80% of the annual industrial growth is related to greenfield investments at national level. Therefore, the region in concern highly contributed to the stability and regeneration of the Hungarian economy.

Two thirds of the industrial investments were realised in the *manufacturing* and *electronics* (production of fittings and assembling). Furthermore, foreign capital has a substantial role in manufacturing of plastics and food processing and packaging, The scale of job creation was rather small (50 thousand, at national level) compared to the economic performance of the new enterprises (600–700 billion HUF turnover per year). The main centres of industrial investments are the largest urban centres of the region (Győr, Székesfehérvár, Szombathely, Veszprém and Tatabánya). Small provincial towns also attracted similar projects, such as the Opel GM plant in Szentgotthárd which was stimulated by the vicinity of the Austrian-Hungarian border; German investments in Mór based on personal (ethnic) relations; the successful industrial park in Sárvár; the industrial investments in Mosonmagyaróvár and Körmend (also located near the border); the Suzuki plant in Esztergom, attracted by the proximity of Budapest and the availability of skilled labour. Successful small towns and villages are concentrated along the western border.

Multinational companies, the main investors are followed by their subcontractors. The process is supported by large-scale companies through providing sites. As a consequence of this trend, the present spatial structure will probably not be modified substantially, the nodes of industrial output will be recent concentrations of foreign capital. This involves the problem of insufficient capacities, particularly in respect of available skilled labour. The supply is not adequate in Győr and Székesfehérvár already, number of commuters is increasing that is reducing industrial competitiveness.

In the *commercial* sector, greenfield investments involved the appearance and diffusion of new distributive networks including shopping centres, retail warehouses, superstores and supermarkets. The majority of new forms of retailing and wholesaling is concentrated in Budapest, but multinational chains have been expanding in provincial towns as well. The starting point of the expansion was usually Budapest or large and medium size towns close to the western border (Metro). Other chains purchased declining retail networks using them as the basis of their network (Tesco, Julius Meinl, Tengelmann group) or built up a completely new net of supermarkets or stores (Spar, REWE). Since the logistic centres of retail network are settled in the North Transdanubian region, the first elements of their networks appeared here first. These steps were inspired by the relatively high incomes of the population, yielding fairly high profit quickly involving further expansion.

As a consequence of the spatial concentration of advanced *producer services* and decision making centres in Budapest, international companies, such as banks, insurance companies and exchange services set up their headquarters in the capital, to make use of the easy access to information and personal contacts. The North Transdanubian region is in an advanced position considering the diffusion of such services and expansion of international organisations. They are attracted by the concentration of the local economic potential, particularly that of foreign investors. By the mid-1990s, expansion of service networks reached the eastern part of the country. New outlets were opened in county seats.

Logistics, office renting and *building* sector have been favoured targets of foreign investors since the beginning of the 1990s. The majority of investments occurred in Budapest and its surroundings. Foreign companies were attracted by the large and expanding office market and the available sites with good accessibility. About 90% (50) of new office buildings were constructed in Budapest. Győr, Szombathely and Székesfehérvár also attracted developers, but their activities are scarce outside the North Transdanubian region.

MAIN FACTORS ATTRACTING INVESTORS

Conditions offered by a region or a settlement for a new project that would effect its operation are always considered by the investor. The range and quality of such factors, their presence or absence in distinct settlements or regions have raised the issue of regional competition. Since the requirements of new industries are changing, importance of these factors may decline or increase that involves perpetual re-evaluation of regions. The range of attractive factors may be enhanced improving the conditions of the investments that results in further competition.

In the followings, the main factors considered by foreign investors when setting up a long-term strategy are enlisted. The factors include a number of elements and their structure depends on the specific demand of industries. National and international economic and social factors should be accounted with, which are completed by specific motivations influencing the choice of a location.

The systematisation of main factors attracting investors and the comparative analysis of the aggregated data at regional level makes it possible to give a sketch of the present situation in Hungary. Decisions about the location of investments are made in a multi-variable system. The comparison at county and regional level will give an explanation of the advanced position of the North Transdanubian region and provide a method to set up strategic planning proposals for the region (*Table 4*).

The first group of factors included data referring to the *labour supply* in the regions (change in the number of population between 1990 and 1994, migration balance between 1980 and 1989 and the number of retired people, showing the economic activity of the population).

The region as whole is characterised by favourable demographic trends. There is a constant immigration (that exceeds the emigration from the region) stimulating consumption and the labour market (through enhancing the supply). Fejér County is characterised by the most favourable parameters. Since the average age of the population is fairly low, there is a considerable labour asset in the region, particularly in the villages and small towns.

The *cost and qualifications of labour* are measured by average wages, ratio of professionals within the active population and number of students in higher education.

Table 4. Some indices of spatial disparities (1994)

Factors	Minimum		Maximum		Deviance from the national average	Deviance from the county average
	value	county	value	county		
GDP (thousand HUF per head)	252	Szabolcs–Szatmár–Bereg	767	Budapest	3.04	1.78
Increase of investments (1994/91, %)	119.6	Komárom–Esztergom	326	Győr–Moson–Sopron	2.73	
Unemployment (January 1995, %)	5.7	Budapest	21.3	Szabolcs–Szatmár–Bereg	3.74	2.80
Industrial export (%)	13.1	Baranya	52.9	Vas	4.04	
Industrial employment (%)	18.8	Budapest	43.4	Fejér	2.31	1.85
Service employment (%)	42.1	Fejér	76.3	Budapest	1.81	1.42
Business services employment (%)	2.9	Vas	9.4	Budapest	3.25	1.72
Density of bank outlets (persons per outlet)	7,046	Győr–Moson–Sopron	18,161	Szabolcs–Szatmár–Bereg	2.58	
Increase in the number of enterprises (1994–91 per 1000 inhabitants)	275.4	Nógrád	392.4	Baranya	1.42	
Increase in the number of enterpreneurs (1994–91 per 1000 inhabitants	115.3	Heves	262.3	Tolna	2.27	
Foreign investment (thousand HUF per head)	7.0	Tolna	142.4	Budapest	20.34	7.94
Monthly gross wages (thousand HUF)	26.9	Nógrád	43.1	Budapest	1.60	1.27
Retail turnover (thousand HUF per head)	111.4	Szabolcs–Szatmár–Bereg	227.7	Győr	2.04	
Personal income tax (thousand HUF per head)	13.3	Szabolcs–Szatmár–Bereg	43.8	Budapest	3.30	1.81
Density of motorcars (number of cars per 1000 heads)	139.1	Jász–Nagykun–Szolnok	267.8	Budapest	1.93	1.66
Density of telephones lines (lines per 100 heads)	5.6	Szabolcs–Szatmár–Bereg	27.9	Budapest	4.98	2.67
Sewerage supply (ratio of linked dwellings, %)	16.3	Pest	89.4	Budapest	5.48	3,15
Waste disposal (ratio of linked dwellings, %)	36.1	Szabolcs–Szatmár–Bereg	100.0	Budapest	2.77	2,59
Number of registered patients	11	Vas	3,820	Budapest	342.63	26.16
Persons with academic degree per 1000 heads	0.3	Nógrád	45.6	Budapest	152	89.3
Enterprises involved in R&D (number per 1000 enterprises)	1.5	Nógrád	14.2	Budapest	9.46	4.60

In this respect, the region is spatially segmented. The qualifications of labour is above the national average in Vas and Győr–Moson–Sopron County, but assets of the labour market of the largest urban centres are exploited full. The rest of the counties in the region still have manpower capacities and the qualifications are acceptable for the investors. Wages are below the national average and reserves of workforce are concentrated in villages and small provincial towns.

The factor of *transportation and communications* includes elements, such as the proportion of first rank arterial roads in the whole network, motorcar and telephone provision, and the accessibility of Budapest and the county seat. The quantity and quality of the road network are lagged behind the dynamics of the regional economy. The regional average of telephone supply has exceeded the national average recently, but there are significant spatial differences that effect the accessibility and so the economic performance of several small regions and towns badly. As a consequence of the favourable geographical position of the region, the accessibility of Budapest and European metropolises is good. The northern-southern links are weak, neither the quality, nor the quantity are sufficient for servicing of the expanding regional and international relations.

The infrastructure provision of the settlements can be measured by housing conditions, such as number of dwellings, sewage supply, consumption of electricity and proportion of dwellings integrated into the system of domestic waste disposal service. The aggregated index of the region exceeds the national average, particularly in the case of waste and sewage treatment. The provision is below the average in Vas and Zala counties that disguises considerable differences. In this sense, Fejér is also a backward county: the average level of the infrastructure is particularly low in the rural areas that may exert a negative impact on the competitiveness of the whole county.

The provision of *social infrastructure* in the region is at the level of the national average, in terms of the number of general practitioners and specialist doctors, and of the number of elementary school teachers. The region is above the average in respect of capacities of hospitals. Since the existing network of institutions is a result of an earlier equalizing policy, there are no significant differences between counties. Existing capacities provide a framework for satisfying the needs of population at a fairly high level, but increasing costs of the operation of institutions may enhance the process of spatial differentiation.

Devices for *promotion of local economies*, in terms of number and extension of (duty-) free industrial and business parks, of proportion of settlements gaining revenues from industrial and commercial taxes, and of the amount of financial support gained from national funds are spatially differentiated in the region. Advanced producer services of the market are developing and expanding which increases the supply of sites available for economic activities (industrial parks in Győr, Ajka, Szentgotthárd, Székesfehérvár and incubation centres for local enterprises in Szombathely, Veszprém, Zalaegerszeg and Székesfehérvár). Local governments also promote local enterprises (supplying industrial and commercial sites, promoting infrastructure development, setting local taxation preferences and organising local economic promotion programs) and they have increasing role in gaining support from national economic promotion funds.

The factor of *local economic activity* includes retail turnover, monthly gross expenditure of households, housing prices in the county seats, personal income taxes, housing construction and proportion of accumulation and costs of capital transactions of local governmental expenditures. The region as a whole is above the national average considering these elements except the average household expenditure. Demand on the local markets is inspired by the fairly high incomes (on the level of households, local governments and enterprises as well). Looking at these trends, it may be predicted that the recent level of consumption of quality goods and services will be stabilised or increase. Public expenses are also additional, stabilising element to the local demand. The Central Transdanubian region is spatially differentiated. The economic activity is below the national average. The reasons for this performance are the rather low level of consumption (Fejér County) and incomes, furthermore, the decline of construction activities (Komárom-Esztergom County). The spatial division may result in increasing tensions in the North Transdanubian region.

Living standards are evaluated through the quality of environment (protected areas), level of cultural services (number of visitors of theatres and exhibitions), public security (rate of crimes), and vitality of community life (number of civil societies and foundations and amount of individual donations). Standards are above the national level, cultural environment and community life are colourful and lively. Traditions of civil communities survived in the former political system that is an attractive element for entrepreneurs. This favourable picture is spoilt by the weaknesses of the cultural background (due to a lack of institutions and a lower level of consumption) and by the less vivid community life in Vas and Komárom-Esztergom counties. Living standards in Fejér County are lagging behind as compared with the economic performance. It is a consequence of the proximity of Budapest that offers a wide range of cultural facilities and absorbs the demand of the county (*Table 4*).

FUTURE TRENDS

The North Transdanubian region, particularly the counties in the vicinity of the western border and in the area along the Vienna–Budapest axis are distinct targets of foreign investors. Decisions about locations have been determined by the economic relations established in the former system of central planning. The labour force supply and its qualification are also higher than the national provincial (extra-Budapest) average. Transportation links and infrastructure provision of the settlements in the region facilitated the development of modern industrial and commercial sites. Local governments have also supported new businesses through local economic preferences and promotion of infrastructure development. In this way, the economic success of the region is explained by its favourable geographical position, concentration of skilled labour, extensive economic relations and local promotion of economic development.

To carry on this process, local and regional policies should be changed by the end of the 1990s. The majority of international investors react to the changing conditions (such as increasing labour costs or taxes) of production quickly, since their technological systems based on mass production. This may result in the relocation of production capacities into other regions or countries that offer lower costs. At present such areas are abundant in Eastern Europe. Local and regional policies should grasp the interest of foreign investors. For this purpose, subcontractor system should be widened, institution of education and vocational training should be adjusted to the needs of the labour market, industrial sites and commercial premises should be extended and the range of producer services also ought to be widened. Furthermore, living standards must be improved, to offer pleasant and attractive environment for the foreign management. Some urban centres of the North Transdanubian regions have already fulfilled these requirements. Local governments of these settlements should set up a strategy for stabilising the existing capacities and keeping foreign investors. Such interventions in the local and regional development have long-term effects. In this way, the only right answer to the new challenges is forming a deliberate concept for the future.

REFERENCES

Antalóczy K., Ludányi A., Salgó I., and Sass M. (1996). Kelet-Európa és Magyarország tőkevonzási képessége (Capital attraction potential of Hungary and Eastern Europe). Európa Fórum, 2. pp. 3-23.

Diczházi, B. (1997). A külföldi tőkebefektetések hatása a regionális gazdaságra (The impact of foreign investments on regional development. Tér és Társadalom, 2. pp. 67-870.

Éltető A., Sass M. (1997). A külföldi befektetőket döntéseit és a vállalati működést befolyásoló tényezők az exporttevékenységek tükrében (Factors influencing foreign investors: decisions and enterprise operation in Hungary reflected by export activities) Közgazdasági Szemle, 6. pp. 531-547.

Voszka É. (1997). Csontvázak a szekrényben (Skeletons in the Cupboard). Privatizáció, 1996 (Privatisation 1996). pp. 407-426.

Regional Statistical Yearbook (1995). Central Statistical Office, Budapest 1996

L. Bassa–Á. Kertész (eds): Windows on Hungarian Geography
Studies in Geography in Hungary 28 Geographical Research Inst. HAS, Budapest 1998, pp. 199–209

THE QUESTION MARKS OF THE RELATIVELY FAVOURABLE RATE OF FEMALE UNEMPLOYMENT IN HUNGARY[1]

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INTRODUCTION

"Gender at work" is perhaps the most popular research subject of feminist geography abroad. Even if we confine ourselves to wage-earning proper, there is a vast quantity of international literature available analysing the inequality between men and women on the labour market. In market economies a typical aspect of this social inequality is women's higher unemployment rate compared to men's.

Studying unemployment has been in the frontline of human geography in the 1990s in Hungary, too, which is no wonder as it is a new phenomenon in the country undergoing socio-economic transition. Moreover, it is a major indicator of an increasingly unequal regional development. It reflects the growing contrast between the economic development of the western regions and that of the eastern ones as well as the urban-rural dichotomy. Several studies highlight this geographical feature, namely, that unemployment in Hungary is rather a rural than an urban phenomenon. The other feature, unique compared not only to West Europe but the surrounding East Central European countries as well, notably, that women in Hungary are underrepresented among the unemployed, does not interest geographers. There are hardly any examples of their paying attention to this feature (see Dövényi, Z. 1993, 1994), let alone their looking for its causes.

The lack of interest is not restricted to this aspect of unemployment. Hungarian geography completely lacks feminist research. Possible explanations are being pondered over (Timár, J. 1993), and the very fact that this paper is published in this volume may be considered a step forward. However, the fact remains that there are no studies adopting feminist approach or dealing with this subject. Nor can the present study

[1] The present study contains some results of the research topic No. T020443. sponsored by the Hungarian National Research Fund (OTKA).

promise to answer the question of why women in Hungary are hit less hard by unemployment than men.

Satisfactory explanations cannot be offered even by the disciplines that are more common to "accept" the feminist approach. Sociology has raised the issue only to formulate hypotheses. The most thorough study of the interrelationship between the gender division of employment and that of unemployment was carried out by Frey (1993). She attributes the lower rate of unemployed women mainly to structural causes. At least in 1992 she found the markedly lower proportion of unskilled workers (40.0%) among women compared to active wage-earners (49.2%) to be the most logical explanation. She attaches some importance to the statistical methods of computation of unemployment rate, too, as those on child care leave or benefit are registered as employed. They are the ones that are the least needed on the labour market and the majority of whom are women. Finally, she arrives at the conclusion that the relative cheapness of female labour, together with all its disadvantageous implications concerning unemployment benefit, provides women with more protection against losing their jobs and enables them to get employment more easily. What completely falls outside her scope of investigation is the spatial aspect.

Focusing basically on rural women's situation, Kulcsár points out a geographical difference worth considering. According to his 1994 summary data, the higher we get in the settlement hierarchy, the larger the proportion of the female unemployed is. It is 39.4% in villages and 43.8% in big cities, whereas the picture in Budapest is just the opposite: it is women that form the majority of the unemployed (51.0%). He thinks that "many rural women do not register because they stay at home and manage the household and garden, or work on their private farms" (Kulcsár, L. 1997).

These data and the summary conclusion, even if not supported by the results of empirical studies or perhaps just for that very reason, necessitate further research taking geographical aspects into consideration as well as exploring the gender differences and inequalities of unemployment more thoroughly. The present study is aimed to contribute to such empirical explorations of facts. As a first step toward studies looking for the causes of lower female unemployment, it only endeavours to analyse the data available considering a single county (Békés County[2]) in Hungary. These data are, however, more detailed in some respect than the ones published so far. It intends to fathom whether it is indeed women that are the least hit by unemployment, to apply a critical approach to the computation of the unemployment rate and to examine, within the framework at its disposal, what regional differences lie behind the general picture of the county.

[2] Békés County is situated in the Great Hungarian Plain and characterised basically by farming economy. Thus, during the socio-economic restructuring, it was the crisis of agriculture that resulted in an extremely high unemployment. In the past years Békés was one of the counties with the lowest proportion of women among unemployed.

THE PROBLEMS OF INTERPRETING THE UNEMPLOYMENT RATE

Given the present system of data supply and collection in Hungary, studies analysing the state of employment and unemployment can rely on two sources of data: the data sets released by labour centres concerning the unemployed and the data of the Central Statistical Office (CSO) concerning employment and economic activity. The combination of these two databases form the most important data of analyses, thus, among other things, the so-called (official) unemployment rate, too. The most recent information based on a full-scale survey concerning employment is supplied by the data of the 1990 census. These data, however, despite annual readjustments, are inadequate to analyse current processes as radical socio-economic changes have taken place in the past decade.

During our study, therefore, we relied on the 1996 (CSO) microcensus based on representative sampling, which, though by no means complete, provides more recent, detailed and accurate data than other sources. Another further advantage of this database is that unemployment and employment data, previously handled in separate databases, were simultaneously surveyed in a standardised questionnaire using precisely defined terms[3]. The unemployment data of the labour office were used partly to check up on the data of the microcensus, partly to analyse gender differences in various groups of the unemployed.

The considerable differences between the data - like in other developed countries - result from the different interpretations of the terms and definitions used (the detailed analysis of which, however, goes beyond the limits of this study[4]). Despite this uncertainty factor, however, both databases unambiguously testify that there are significantly fewer women among the unemployed (i.e. 34.6% and 36.3%, respectively: (*Table 1*).

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[3] A survey conducted in 1995 on the commission of Ministry of Labour unambiguously proved that the employment status of approximately 500–700,000 persons in Hungary were not accounted for by domestic statistics earlier (Velkey, 1995).

[4] The labour survey – in accordance with the definitions accepted by ILO – defines unemployed persons as active age people out of job, seeking a job and claiming they are or will be available for work either immediately or within a period of two weeks. Accordingly, the category of unemployed does not feature as unemployed:

- the pensioners, or those on child care benefit, and looking for work and
- the ones on unemployment benefit who conduct wage-earning activites, or did not intend to find a job in the reference period, or renounced active job-seeking, or declared that they would not be available for work within two weeks.

Contrary to this, those persons who are out of job and are not carrying on wage-earning activities and did not use the services of the Labour Centre, but made inquiries in order to get a job through other channels (job offices, personal interviews or correspondence with employers, job advertisements, inquiries and requests through relatives and friends) are considered as unemployed.

Table 1. Unemployment data in Békés County by the CSO labour survey (a) and by the Labour Centre survey (b) (March 1996)

	Total	Male	Female
a. unemployed	22,261	14,551	7,710
b. unemployed	25,560	15,983	9,292

Source: Central Statistical Office Békés County Directorate, Békés County Labour Center

Conspicuous and significant gender differences can be observed at first sight in the groups of economically active population, inactive earners and dependents (*Table 2*). Although in the official computation of unemployment rate only the differing groups of economically active population play a role, a circumspect analysis of the *employment (opportunities)* of women indicates the more detailed examination of different groups of inactive earners and dependents, too, according to gender.

Table 2. The combined data of the 1996 microcensus according to gender (Békés County)

		Total	Male	Female
Active wage-earners	a	125,570	70,430	55,140
Persons on child care leave, allowance or benefit, in work at the same time	b	597	0	597
Pensioners, in work at the same time	c	6,020	3,046	2,974
Employed	**d=a+b+c**	**132,187**	**73,476**	**58,711**
Unemployed	e	22,261	14,551	7,710
Economically active population	**f=d+e**	**154,448**	**88,027**	**66,421**
Persons on child care leave, allowance or benefit, not in work[5]	g	11,725	77	11,648
Pensioners on their own right, not in work	h	113,374	50,872	62,502
Pensioners on spouses' right, not in work	i	8,957	293	8,664
Other inactive earners	j	4,659	3,151	1,508
Inactive earners	**k=g+h+i+j**	**138,715**	**54,393**	**84,322**
Day school students	l	62,180	31,760	30,420
Other dependents	m	46,411	20,871	25,540
Total dependents	**n=l+m**	**108,591**	**52,631**	**55,960**
Economically non-active population	**o=k+n**	**247,306**	**107,024**	**140,282**
Total	f+o	401,754	195,051	206,703
Unemployment rate	**e/f**	**14.4 %**	**16.5 %**	**11,6 %**

Source: Central Statistical Office Békés County Directorate

[5] Earlier this group was included in the economically active population.

Table 3. Inactive earners according to active age[6] and non-active age and gender (1996 microcensus - Békés County)

	Total	Male	Female
1. Persons on child care leave, allowance or benefit, not in work	11,725	77	11,648
2. Pensioners, non-active age, not in work	88,662	31,453	57,209
3. Pensioners, active age, not in work	33,669	19,712	13,957
4. Persons on unemployment benefit, not qualified as unemployed[7]	3,867	2,489	1,378
5. Other non-active age inactive earners[8]	249	144	105
6. Other active age inactive earners	543	518	25

Source: Central Statistical Office Békés County Directorate

Based on employment status, *inactive earners* fall into two large categories: (1) those with a stable income and (2) those not definitely settled. Those with a stable income can be said to be in a settled position. This group includes pensioners and others drawing a pension-like allowance (*Table 3*: Groups 2,3,5 and 6).

Those on child care leave, allowance or benefit are almost exclusively women, and the ones on unemployment benefit qualified as inactive earners draw only a temporary income not arising from "productive work", therefore their employment position is not definitely secured. This, however, does not necessarily involve that the person on child care leave, after her term expires, will automatically become unemployed. At the same time it seems to be clear that – in contrast with their current "sheltered" position – later they will be exposed to the risk of becoming unemployed. Those on unemployment benefit and categorised as inactive earners were actually out of job but were not available for work in the reference period.

Table 4. Dependents according to age (active and non-active age) and gender (1996 microcensus - Békés County)

	Total	Male	Female
7. Day school students	62,180	31,760	30,420
8. Child age persons on social welfare	80	31	49
9. Active age persons on social welfare	3,728	1,695	2,033
10. Elderly, non-active age persons on social welfare	547	80	467
11. Child age dependent, not at school	31,579	15,741	15,838
12. Active age dependent, not at school	9,304	3,324	5,980
Elderly, non-active age dependent, not at school	1,173	0	1,173

Source: Central Statistical Office Békés County Directorate

[6] In the case of women 15–55 years, in the case of men 15–60 years

[7] Owing to their lack of availability or active job-seeking, the persons in this group do not qualify as unemployed. As they are not wage earners, but draw an unemployment benefit, they may be regarded as inactive earners.

[8] Other inactive earners include the persons drawing a pension-like, regular monthly allowance provided by the state (such as partially disabled people).

From the point of view of employment, *dependents* fall into two larger categories: those with a settled status (students, children and the elderly) and those still in an active age without a stable status, thus employable theoretically (*Table 4*: active age on social welfare, active age dependent not at school). The ones in the latter group as they do not draw an income arising from wage-earning activities are actually out of job but they are not seeking a job or are not available for work.

Table 5. Economically active population (active age and non-active age) (1996 microcensus - Békés County)

	Total	Male	Female
14. Wage earners, non-active age	489	79	410
15. Wage earners, active age	122,189	68,033	54,156
16. Casual workers, non-active age	253	207	46
17. Casual workers, active age	2,112	1,721	391
18. Wage earners on unemployment benefit[9]	224	128	96
19. Unemployed not qualifying as unemployed undertaking casual jobs[10]	97	97	0
20. Unemployed casual workers	1,381	1,311	70
21. Persons on unemployment benefit	11,202	7,063	4,139
22. Unemployed on social welfare	4,613	2,771	1,842
23. Unemployed without income	5,065	3,406	1,659
24. Pensioners, non-active age, in work at the same time	3,165	1,786	1,379
25. Pensioners, active age, in work at the same time	2,896	1,260	1,636
26. Persons on child care leave, allowance or benefit, in work at the same time	597	0	597
27. Casual workers on social welfare	103	103	0
28. Other inactive earners undertaking casual jobs	62	62	0

Source: Central Statistical Office Békés County Directorate

From the point of view of defining the rate of unemployment, the *economically active population* is especially important. Labour force surveys include the unemployed undertaking casual labour in the numerator of the unemployment rate, i.e. in the unemployed. We think that the employment position of this group does not, in fact, differ from that of casual workers on social welfare, other inactive persons, or the unemployed not qualifying as unemployed, undertaking casual jobs. Thus this group, only 5% of which are women, should belong to the active wage earners rather than the unemployed (*Table 5*).

It is women who form the majority of the wage earners in non-active age (82%). They are the ones that have reached retirement age and are eligible for old-age

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[9] Persons in this group include the ones who admit conducting regular wage-earning acivity along with the unemployment benefit.

[10] Persons in this group do not qualify as unemployed owing to their lack of availability for work or active job-seeking. They may be regarded as active earners as they conduct wage-earning activity.

pensions, but have not retired yet. Among the pensioners still working women are underrepresented (43%). It is valid for either of these two groups that if the ones belonging to them were not wage earners, they would belong to the inactive earners, i.e. they would have regular monthly incomes. In their case work is a means of getting higher incomes or complementing their incomes. Thus, if they lost their jobs, they would not be left without income. The same is true of those on child care leave, allowance or benefit. In Békés County they are exclusively women.

As a consequence, including these latter groups in the economically active population making up the denominator of the unemployment rate - likewise including the unemployed undertaking casual jobs in the numerator - renders a distorted picture of unemployment. As each of these distortions shows women's position more favourable as the reality, the official rate shows higher differences between genders than justified. By means of this correction male unemployment rate falls to 15.6%, whereas female unemployment rate rises to 12.3%.

The *actual male and female employment situation* is better illustrated by the following ratio than the official or our corrected unemployment ratio. The denominator includes all active age persons not drawing pension or any income of similar nature or child care benefit. They are the ones for whom becoming unemployed may be an imminent danger. We include people not carrying on wage-earning activities in the nominator. Accordingly, when computing the rate, we include group *4* from inactive earners, groups *9* and *12* from dependents and groups *15, 17, 18, 19, 20, 21, 22, 23 and 27* from the economically active population in the denominator, whereas groups *4, 9, 12, 21, 22* and *23* in the nominator (Tables 3, 4 and 5).

As a result of this computation, we can say that during the reference period there were 164,160 active age persons who did not draw pension or any income of the kind or child care benefit. Of them 56.2% were men and 43.8% were women. 38,013 people, i.e. 23.2%, did not carry on wage-earning activities, thus they were, in fact, unemployed. 55.0% in this group were males and 45.0% were females. Therefore, 22.7% of the males and 23.8% of the females potentially endangered with unemployment at any time were actually jobless.

To sum it up: opinion that the differences between unemployment rates indicate that female employment position is more favourable are erroneous. The present official computation of the unemployment rate hides the real chances and problems of several social strata in difficult situations. This attitute affects women especially badly, misinforms society and leads to false conclusions.

TAKING STOCK OF SPATIAL DIFFERENCES

In order to interpret the gender distribution of the unemployed, it is essential to complement the above analysis with the consideration of regional aspects. In the present stage of research, not being able, to explain the relationship between settlement characteristics and the gender distribution of unemployment accurately, we would like to draw attention to the significance of the geographical aspect through some examples. Such an analysis is supported by the data of the county microcensus according to settlement size groups as well as the data base of the Labour Force Centre broken down into settlements.

Even the official unemployment data of the 1996 microcensus have shown that lower female unemployment rate cannot be considered as universally valid in all parts of the county. In Békéscsaba, the county seat and the single settlement with over 50,000 inhabitants, the situation is just the opposite. Here women were not less hit by unemployment, on the contrary, they constituted the numerical majority of the unemployed in spite of their lower employment level. Thus the simplification that in Hungary and Békés county, respectively, women have an advantage over men concerning unemployment simply does not stand its ground in Békéscsaba, home to one in six inhabitants in Békés county. The advantages of the county seat that appear in a wider offer of jobs, too, were primarily enjoyed by men, and it is owing to their relatively good chances to obtain (and retain) jobs that the city excels with its lowest unemployment rate in the county.

If our "adjusted" rates reflecting the actual employment situation are compared in each settlement group the picture will become more differentiated than the above one. Except for large villages and small towns, in every settlement category relatively more women are actually jobless among those potentially endangered with unemployment at any time. Not only in Békéscsaba but in villages with less than 1000 inhabitants, too, women constituted the majority of the actually unemployed.

These villages are typically located in backward areas along the border or in the internal periphery. The inhabitants most often earn a living in agriculture, and usually do unskilled manual work locally. It would require a detailed research to find out how the presumably agricultural activity of "dependent" housewives here contributes to family income and how large a part of them would be available for paid work if they were given a chance (the probability of which is of course very low). It would also take a thorough research to explore why the relative employment situation of women, as compared to that of men, has remained the most favourable in large villages. Anyway, it seems to be clear that changes in gender inequality of actual employment situation do not follow the settlement hierarchy.

Changes in the gender distribution of unemployment may also be influenced by the differences in the way and intensity of job seeking. Only the minority of the clients visiting the Labour Centre[11] of Békés County until 1997 were women in all settlement categories. (Their underrepresentation, however, as projected to the economically active population, is not significant, a mere 2–4%.) Their rate of "reporting at the office" grew

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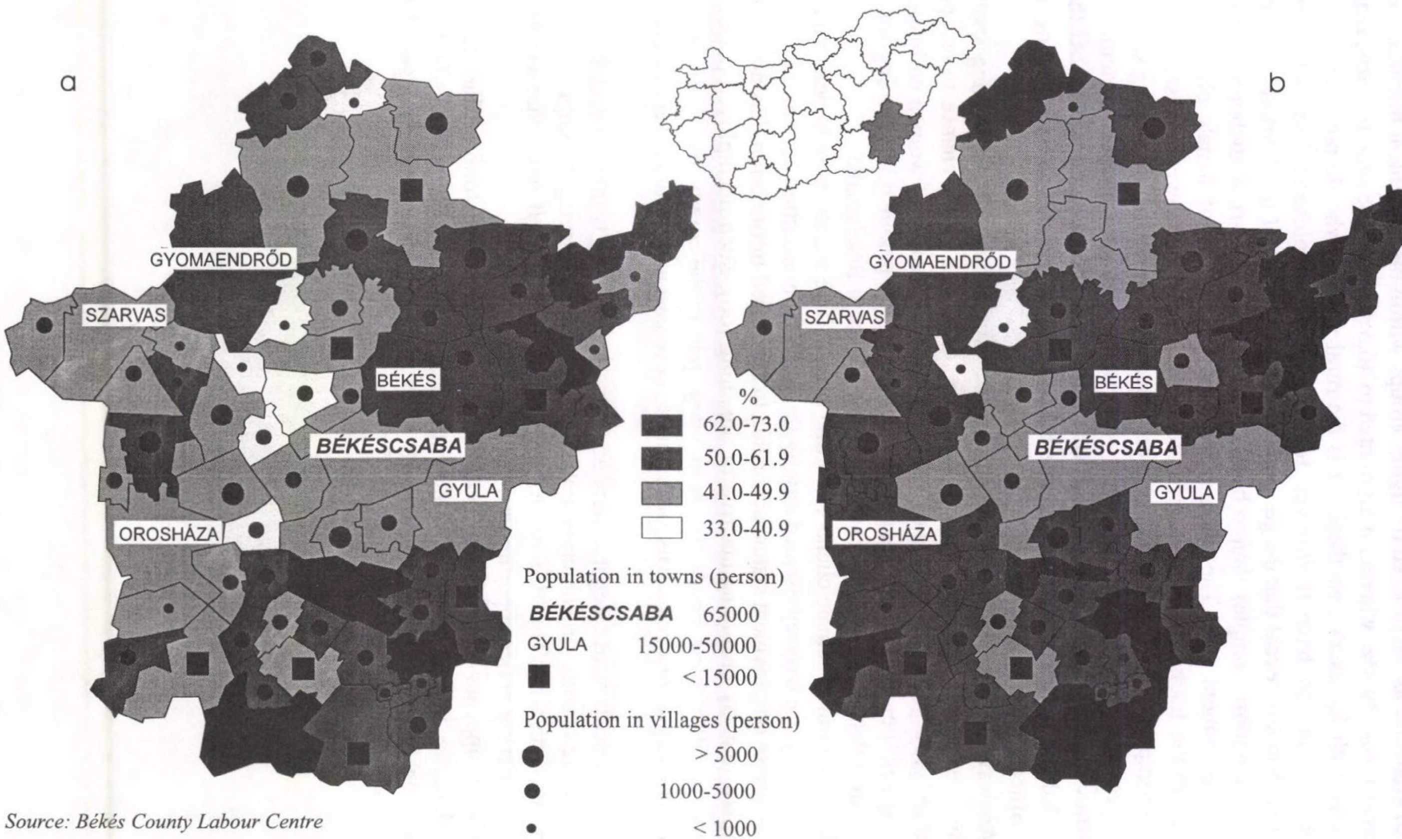
[11] This includes every unemployed person who contacted Békés County Labour Centre or any of its branch offices until 30 October, 1997. One person is processed into the data base only once. On second registration, some data are overwritten while others remain in the data base. Thus the data of the clients and the attached notes enabled us to reproduce the individual's unemployment history.



Source: Békés County Labour Centre

Fig. 1. The percentage of men (a) and women (b) in unsettled conditions among male (a) and female (b) clients reported at the Békés County Labour Centre until 30 October, 1997

slightly and gradually as we proceed to higher groups within the settlement hierarchy: in small villages it was 39.4%, whereas it amounted to 46.5% in Békéscsaba. Is it true that, in accordance with Kulcsár's hypothesis, it is the rural women who do not want to (or cannot) do anything to have themselves registered as unemployed? The individual analysis of settlements reveal that the geographical determinants of the "attitude" to job-seeking are much more complex than to be restricted to the urban-rural dichotomy or to categories of settlement size. The villages with the fewest rate of female clients are concentrated in the backward northeastern area with hardly any towns and struggling with heavy unemployment. In the southern area, however, though also displaying several small villages and similar disadvantages, but with more favourable agricultural characteristics, such an underrepresentation of women is far from being typical. At the same time, half of the 9 settlements with the highest rate of female clients reporting at the labour office are not towns.

Anyway, the women who have chosen the official way of job-seeking show more endurance in their struggle for work than men, or have a worse chance to escape into casual or "grey" jobs than their male counterparts. The number of women no longer on unemployment benefit but still keeping in touch with the labour office hoping for a job is larger than that of men in every settlement type, except Békéscsaba.

The situation of female clients reporting at the office seems more hopeless than that of men as they are overrepresented among the persons in unsettled conditions. They are the ones whose employment status, according to registered information, has not at all been stabilised (e.g. by becoming inactive or obtaining job). Such unemployed persons proper constitute 50-60% of female clients in a large part of the county, especially in the disadvantaged villages, or even towns, of the north, northeast and south of Békés County (*Figure 1*).

In every settlement category, there are numerically more women undertaking to participation in retraining or voluntary public work than men trying to improve their chances in the same way. This difference, however, manifests itself most characteristically in cities offering better opportunities.

Thus it appears that differing settlement potentials do not only influence the chances and, partly, intentions of the whole population to obtain jobs but also affect the relative position of men and women as well as their opportunities and strategies for solving their problems.

REFERENCES

Dövényi, Z. (1993). Unemployment as a new phenomenon of the transition. In: Hajdú, Z. (ed), *Hungary: Society, State, Economy and Regional Structure in Transition*, Pécs: Centre for Regional Studies, pp. 185-208.

Dövényi, Z. (1994). Transition and Unemployment - The Case of Hungary. *GeoJournal,* 4, pp. 393-398..

Frey, M. (1993). Nők a munkaerőpiacon. (Women on the labour market.) *Társadalmi Szemle*, 3, pp. 26-36.

Kulcsár, L. (1997). Case study of Hungary. In: National action plans for the integration of rural women in development. Rome: Regional Office for Europe and the Women in Development Service/Sustainable Development Department, FAO, pp. 1-14.

Timár, J. (1993). A nők tanulmányozása a földrajzban, avagy: van-e létjogosultsága a feminista geográfiának Magyarországon? (Studying women in geography, or: does feminist geography have grounds in Hungary?) *Tér és Társadalom*, 1-2, pp. 1-18.

Velkey, G. (1995). A foglalkoztatásra vonatkozó adatgyűjtések, adatok vizsgálata a hiányzó szegmensek meghatározása érdekében. (Investigation of data collection and data related to employment in order to determine the missing segments.) Manuscript, Békéscsaba: Centre for Regional Studies

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