UNIVERSITY OF DEBRECEN
Faculty of Natural Sciences
Department of Physical Geography

ANTHROPOGENIC ASPECTS OF LANDSCAPE TRANSFORMATIONS
1

Debrecen 2000

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1

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Attila Kerényi

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PREFACE

The Polish-Hungarian friendship have long traditions in the geographic sciences as well. It is almost of symbolic nature that after the Second Worls War the first guest from abroad in the Department of Physical Geography at the University of Debrecen arrived from Poland. The scientific co-operations were intensive all through the past half century.

The co-operation established ten years ago – which become official one year ago – with the Department of Physical Geography at the University of Silesia was a new dash in this relationship system. After several exchanges of scientific views, field consultations and papers published in joint publications, the two departments decided to present the most important research results within the framework of a relatively exclusive symposium in Autumn 2000 in Debrecen. One of the fundamental goals of the symposium is the promotion of future joint research programmes through the better acquaintance of each other's research activities.

The present publication includes the papers presented at the symposium. Due to the objectives, the topics are varied but the landscape changing impact of the society and the socio-economic impacts of the active landscaping forming processes appear as central questions in most of the papers.

The organisers of the symposium hope that the discussion of the papers will serve with useful lessons for the future fruitfull researches and co-operations. Our intention is that this symposium and publication would not only be a unique one but the preliminary of a series in the future.

Debrecen, October 2000

Prof. dr József Szabó
Head of the Department of Physical Geography of the University of Debrecen

Anthropogenic aspects of landscape: transformations	1	University of Debrecen Debrecen 2000	5–9

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ANTHROPOGENICALLY CONDITIONED AEOLIAN PROCESSES IN EASTERN SIBERIA

Contemporary aeolian processes in the area of eastern Siberia are characterised by rather wide, although in the majority of cases point distribution. Their occurrence is observed in different landscapes: from taiga, through forest-steppe to steppe one. The essential reason of these phenomena development in the area discussed was and is the human interference into the natural environment.

In the given elaboration we would pay attention to the above-mentioned processes, which occur: on Bratsk reservoir on the Angara, on Baikal shores, in Tunka Basin and in the Selenga and Chikoy interfluve (fig. 1; WIKA, SNYTKO, SZCZYPEK, 1997; MARTYANOVA, SNYTKO, SZCZYPEK, 1998; VYRKIN, 1998; BUJANTUJEW *et al.*, 1999; WIKA *et al.*, 1999, 2000 and others).

On Bratsk reservoir banks the contemporary aeolian processes are young: they have been developed under the influence of north-western and northern winds since 1967, i.e. the moment of finishing of this hydrotechnical object building. Formation of this reservoir has caused the abrasion of new created slopes, built of fine-grained sandy-dusty material, while significant water level fluctuations, reaching in maximum 10 m, uncover sandy area of near-bank shallow. The shallow, as well as undercut slopes are the source material for the aeolian processes. In result of them a new, relatively not so large dune forms 3 m high with classically developed slopes: windward, transit and leeward developed here. Different deflation forms as well as other small accumulative forms, as e.g. sand shadows of *nebkha* type accompany dunes, which cover up the edge of light east-Siberian birch taiga.

On Baikal the aeolian processes occur in different places, among others in an area of Sandy Bay on western lake bank as well as on Olkhon island shore. Heavy western, north-western and northern winds, connected with local atmospheric circulation at the border between mountain ranges and broad Baikal area, favour these processes.

In Sandy Bay the source material for aeolian processes, creating themselves in the taiga landscape is a mantle material from intensively degraded porphyre-like granite rapakiwi. The recreation activity favours aeolian modelling of mantle, because the

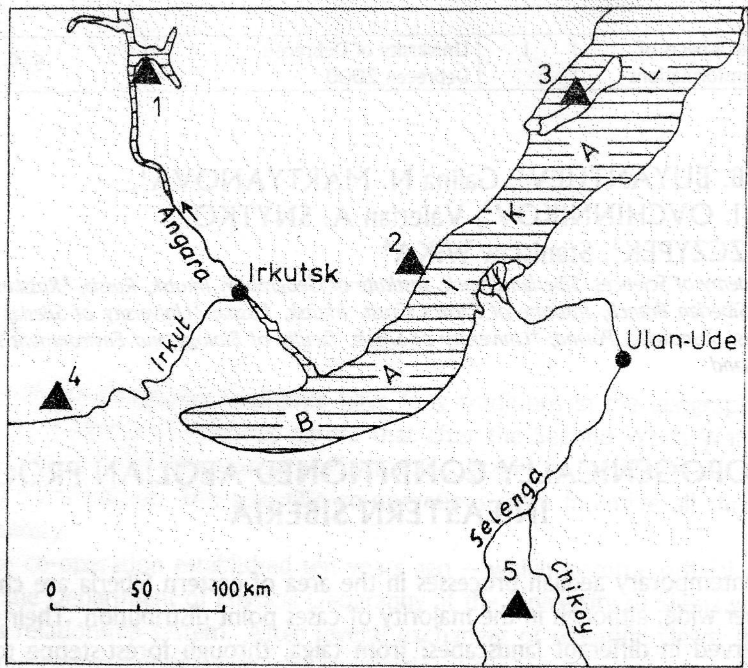

Fig. 1. Location of areas investigated:
1 – Bratsk Reservoir, 2 – Sandy Bay on Lake Baikal, 3 – Olkhon Island, 4 – Tunka Basin, 5 – Selenga-Chikoy interfluve

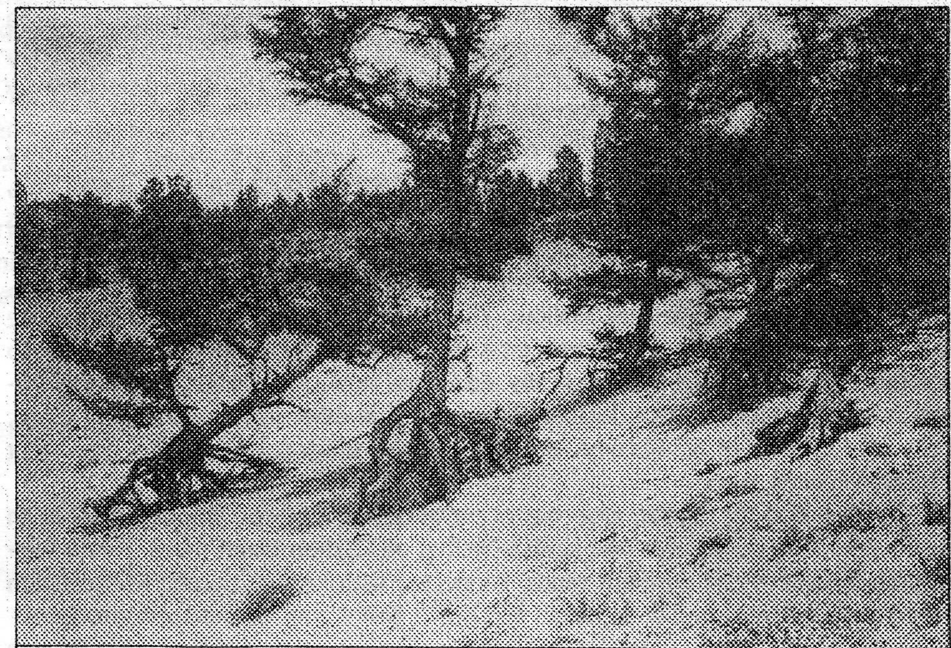

Photo 1. Sandy Bay on Lake Baikal – uncovered root systems of larch tree as a result of intensive deflation (phot. by T. Szczypek)

neighbourhood of the above-mentioned bay is a known centre for tourism and resting. In connection with it the cover blown by wind appeared, where single larches with root systems naked by deflation processes to the depth of 2.5 m still grow, whereas in granite mountain slope thick sandy aeolian cover appeared (photo 1).

On Olkhon Island aeolian processes are functioning in both taiga landscape and steppe one. The source material are Baikal beach deposits, shore Neogenian deposits as well as partly granitoide mantle.

Contemporarily in taiga landscape very diversified deflation type of aeolian relief is connected with intensive blowing of significantly older dune relief (may be from the turn of the Pleistocene and Holocene). The reason of the contemporary activation of aeolian processes was the extensive felling of pine-rhododendron taiga in connection with building of some settlements on island, and to-day dune sands cover up buildings of these settlements (photo 2).

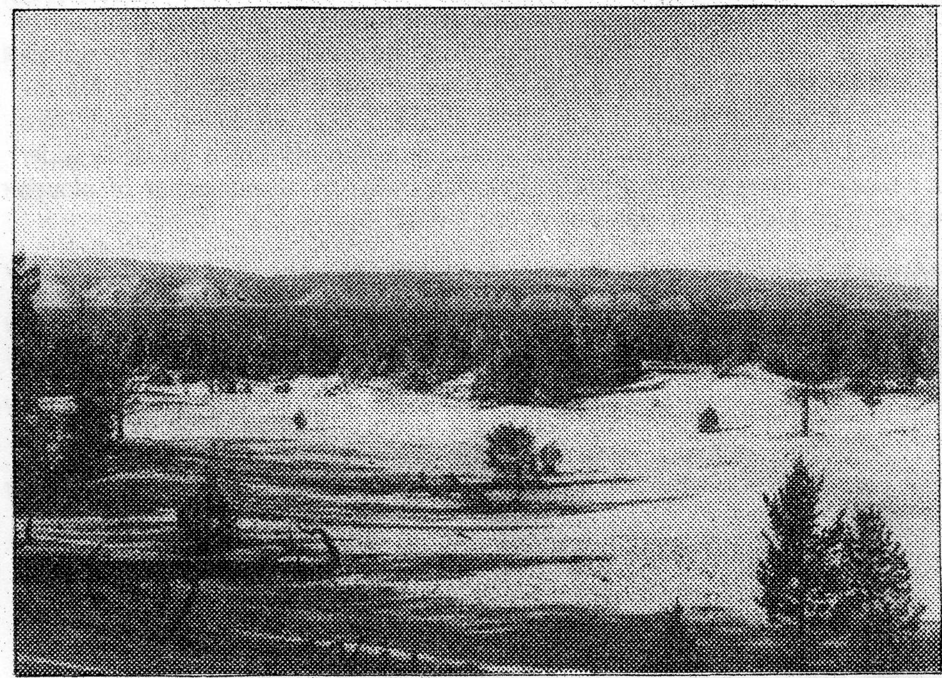

Photo 2. Landscape of aeolian deflation relief in Olkhon Island (phot. by Kirichenko)

In the steppe landscape of Olkhon exceptionally relief of deflation type in a form of developed. The processes of substratum material blowing out were initiated by extensive farming economy.

In Tunka Basin the anthropogenically influenced aeolian processes appeared in some points, generally in landscapes of taiga and forest-steppe. In western part of the basin, among others wide aeolian cover at the slope of Khayrkhan Mt. developed under the influence of western winds. Its area is varied by numerous deflation depressions and some rows of arc-like dunes. The source material are fluvial-lacustrine sands from the late Pleistocene. The activation of aeolian processes was caused by religious reasons: the mountain slope is a saint place of Buriats – it is still trodden during frequent ceremonies, what does not allow the taiga introducing.

In the central and eastern part of Tunka Basin under the influence of adverse winds: dominating eastern and rather essential western ones, the deflation relief has been created, it has been developed at remodelled the late-Pleistocene fluvial-lacustrine deposits. Concave forms decidedly dominate here, but convex ones are weaker developed. The reason of aeolian processes activation in the 18th century was the exploitation of taiga, connected with the building of local military fortresses.

In the area of the Selenga and Chikoy interfluve at the border of Russia-Mongolia the contemporary aeolian processes are very often phenomenon. They develop under the influence of north-western and northern winds, and the Pleistocene fluvial-lacustrine material undergoes blowing out. Presently the deflation-accumulative relief dominate here, but in the particular points it is differently shaped: from broad complexes of barkhan forms with accompanying them deflation forms to the single dunes with deflation forms (photo 3.). The development of agriculture favoured the appearance of these processes: steppes and forest-steppes conversion into plough lands and pastures. In the mid-20th century the aeolian processes developed decidedly wider than nowadays. Now they underwent limitation owing to abandonment of plough lands, which gradually are occupied by steppe forest.

Photo 3. Selenga – Chikoy interfluve. Dunes against a background of steppe vegetation (phot. by T. Szczypek)

The points discusses are characterised by the different anthropogenic reasons of aeolian sands activation. In result of them different forms have been created and they are still creating; they constantly undergo modification. The common feature of aeolian processes in Eastern Siberia is in principle the complete lack of these deposits grains abrasion, what betokens their raw character, short way and short time of these material translocation by wind.

Contemporarily occurring here aeolian processes have caused in the particular points the development of specific, new vegetation communities. They have their typical species, and wholly they more or less effectively try to fix mobile substratum. These communities, together with new aeolian processes, make about the character of the contemporary landscape of these areas.

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Anthropogenic aspects of landscape transformations	1	University of Debrecen Debrecen 2000	10–16

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TYPES OF URBAN LANDSCAPES (A CASE STUDY OF BYTOM AND RZESZÓW)

INTRODUCTION

Almost all landscapes in the Earth are now the environment of human life and work. In result of human activity in the natural landscapes the anthropogenic elements – settlements, industrial plants, communication routes and facilities as well as transformation of atmosphere, hydrosphere and lithosphere appeared. In many places the density of anthropogenic objects is so large, that using the term – anthropogenic landscape is well-founded. Urban areas mostly belong to it.

In the paper the landscapes of two towns of southern Poland – Bytom and Rzeszów are characterised (fig. 1). Urban landscape units are separated on the base of land use, applying the division of TIUTIUNNIK (1991) (table 1). This author defines the urban landscape as the connection of natural factors (relief, water reservoirs and vegetation) with urban built-up areas. The main role in these landscapes is played by anthropogenic components, to which engineering buildings and technical objects belong. TIUTIUNNIK (1991) is the follower of town landscape-seeing learning. By this notion he does not understand the influence of urbanisation on the natural environment and *vice versa* but the towns investigation as the phenomenon of complex physico-geographical reality. He considers that in such an attempt the urbanised areas are weakly known.

The aim of this elaboration is to present and to compare landscape types within two towns – both created in the Middle Ages but having different history and spatial development. Two towns have been chosen for analyses – one from the strongly urbanised area (Bytom) and the second from typical agricultural region (Rzeszów).

HISTORICAL DEVELOPMENT OF TOWNS INVESTIGATED

Bytom is located in the south-western part of Silesian Upland and it is a part of the Upper Silesian Industrial Region. It is one of the oldest urban and mine-metallurgical centres in the Upper Silesia. Its origination was connected with the location at important communication-trade routes and with the neighbourhood of rich ores and coal deposits. The first spatial regulation of town took probably place in the 13th century, when within the settlement in the form of oval the rectangular market square, chequered arrangement of streets and built-up blocks were delimited. Owing to wars, breaking down of mining and proprietary changes since the mid-14th century the town gradually declined and eco-

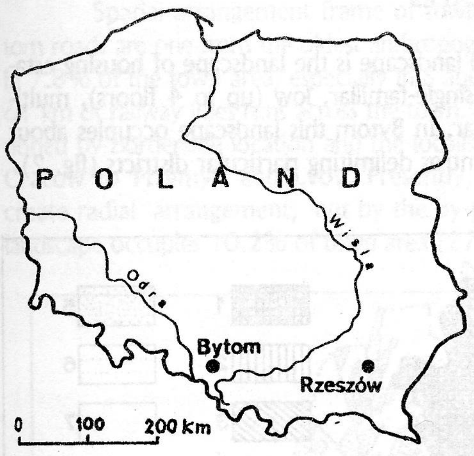

Fig. 1. Location of towns investigated

nomically weakened. At least at the beginning of the 19th century its situation radically changed owing to the intensive development of mining and metallurgical industry, to which the rapid increase in population num-ber accompanied. After 1870 Bytom was located within the Second German Reich, which promoted the coal, steel and colour metals production (for the needs of army industry) as well as the development of rail-way and road net. In 1945 Bytom returned to the borders of Polish country. Its area underwent essential increase after linking of the neighbouring rural communes. Presently Bytom occupies the area of 69.3 km^2 and it numbers 207.3 thousand inhabitants.

Table 1. Basic processes of anthropogenesis in the urbanised areas and typical for them urban landscapes (after Tiutiunnik, 1991 – slightly changed)

Landscape of:	Prevailing anthropogenic process
Housing estates (built-up areas)	Settlement
Transport	translocation of geomass
Industrial	industrial production
Mining	extraction of mineral resources
Dumping (storage)	resources, products and waste dumping
Agricultural	agricultural production
Water regions	water management
Garden-park	formation of green areas
Forest	Recreation

Rzeszów lies in the south-eastern part of Poland at the Carpathian Foothills. It is the capital of the Sub-Carpathian province – the important administrative, industrial, cultural and scientific centre. The first notes of the town originate from the mid-14th century. The town-forming centre was market square, which made the shopping centre and the centre of handicraftsman's plants. Firstly the development of town followed along main roads towards E and W and since the 17th century – in southern direction – towards castle – the second town-forming centre. In the latter part of the 19th century Rzeszów became the important railway knot, but the first two large industrial plants were formed at least in the 30s of the 20th century. It caused large consequence of industrial, storage areas development and exhaustion of places for settlement was the need of demolition, rebuilding of communication arrangement (through-routes N–S and W–E) and the introduction of house building into new areas. Presently Rzeszów occupies an area of 53.7 km^2 and it numbers 161.3 thousand of inhabitants.

The most characteristic form of urban landscape is the landscape of housing estates. It can be divided into three main types: single-familiar, low (up to 4 floors), multi-familiar and high (above 4 floors) multi-familiar. In Bytom this landscape occupies about 16.3% of town area and it is created by 9 centres delimiting particular districts (fig. 2).

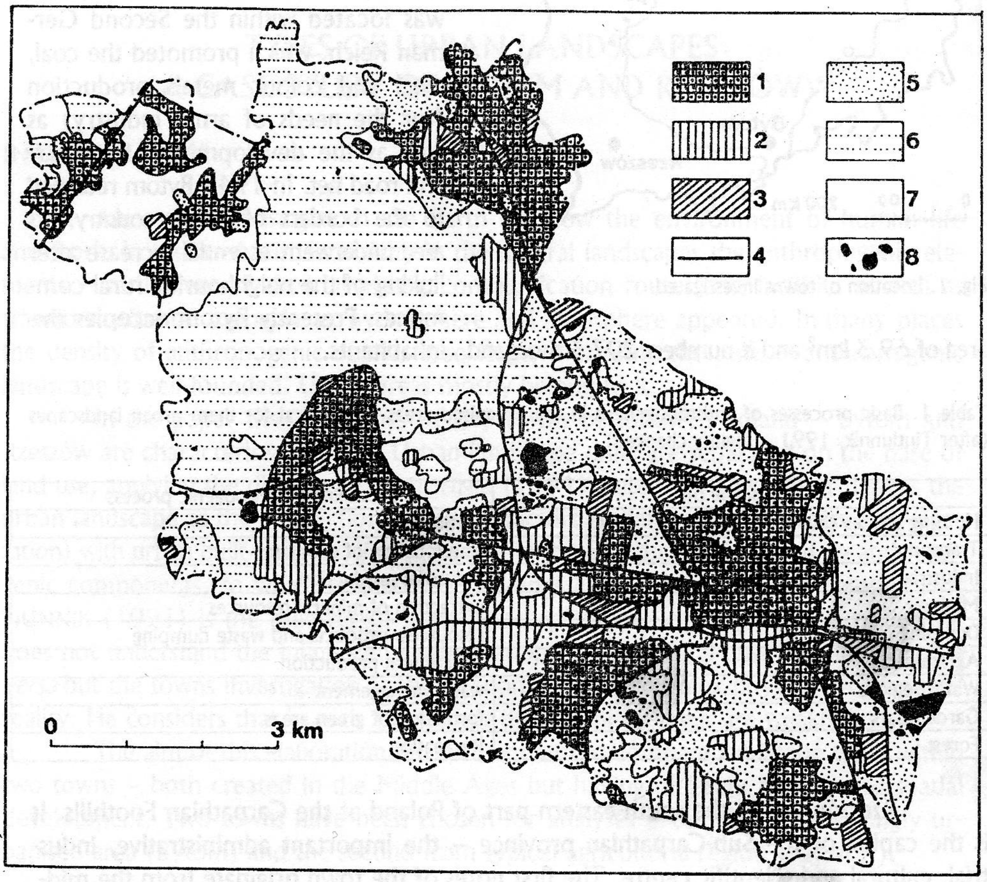

Fig. 2. Urban landscapes in Bytom:
1 – housing estates, 2 – industrial-mining, 3 – dumping, 4 – transport, 5 – garden-park and low disarranged green areas, 6 – forest, 7 – agricultural, 8 – water regions

This landscape in 64% is composed of low multi-familiar buildings with almost a half of buildings created before 1945. Single-familiar building is typical for the northern districts of town and its borders (32.6%), but high multi-familiar building is of marginal importance (GRABARCZYK, 2000). In Rzeszów the landscapes of housing estates occur in the town centre and at the axes of exit roads (fig. 3). They occupy 29.1% of its area, but at the peripheries the landscapes of single-familiar building exclusively occur and the centre is characterised by the building up to 4 floors. High multi-familiar houses occupy small area (ŁĘTEK, 2000).

Spatial arrangement frame of town is made by communication areas. In Bytom roads are one from the oldest anthropogenic forms and the transport landscape occurs in 7.8% of the town area, especially in S and central districts. Over 205 km of roads and 61 km of railway lines runs across the town. In Rzeszów the formation of roads was conditioned by borderside location and the localisation at the course of the parallel route from Cracow to Przemyśl and Lvov. Presently, after rebuilding, all communication series create radial arrangement, cut by the by-pass roads arrangement (fig. 3). Transport landscape occupies 10.2% of town area (275 km of roads and 17.4 km of railway lines).

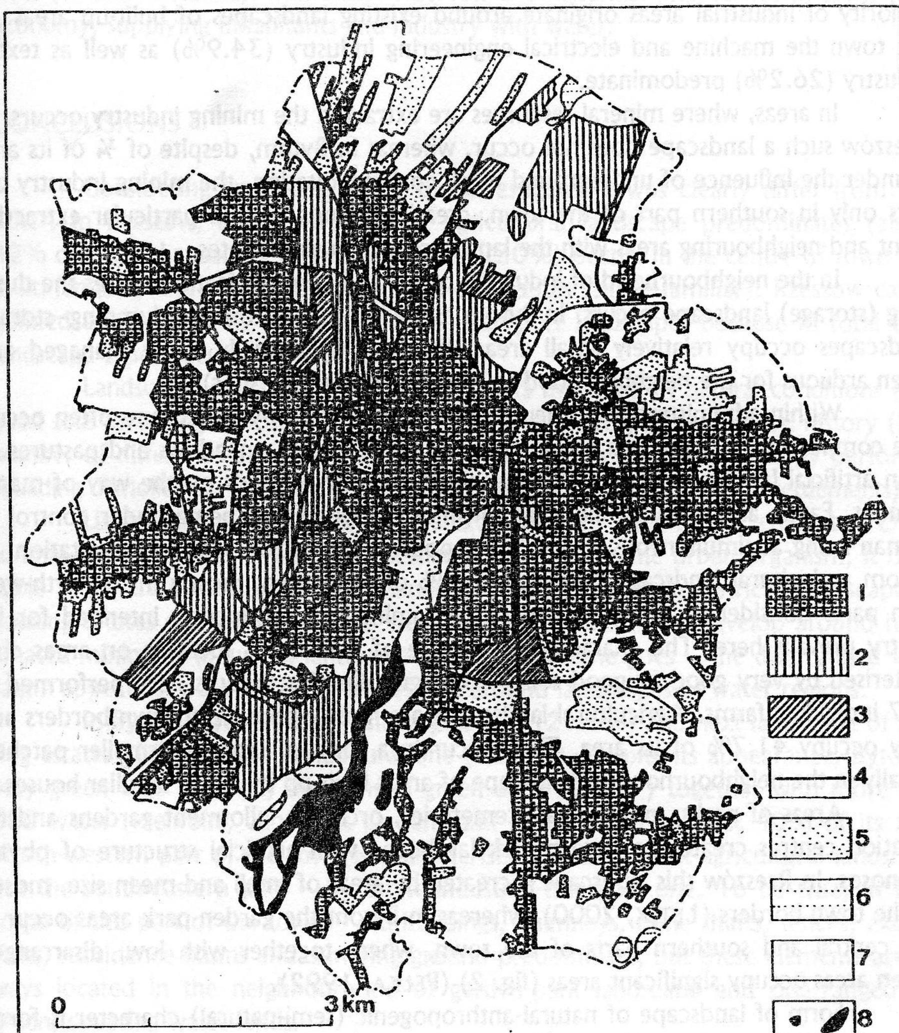

Fig. 3. Urban landscapes in Rzeszów:
1 – housing estates, 2 – industrial, 3 – dumping, 4 – transport, 5 – garden-park, 6 – forest, 7 – agricultural, 8 – water regions

Industrial landscape originates owing to artificial delimitation of space and intending it for the fulfilling of defined function, what is connected with the creation of technical objects and the essential interference into the natural environment. The characteristic feature of industrial areas is the clear border of them, delimited by high fences around plants. About 50 industrial plants, numbered mostly among mineral, processing and light industry work in Bytom. Typical industrial landscape occupies 8.9% of town area and it occurs in scattering – usually there are groups of 2–3 plants, mostly in southern and central parts of the town (GRABARCZYK, 2000). In Rzeszów industrial areas occur in some larger and smaller groups along direction SW–NE. The majority of industrial areas originate around existing landscapes of built-up areas. In the town the machine and electrical engineering industry (34.9%) as well as textile industry (26.2%) predominate.

In areas, where mineral resources are extracted the mining industry occurs. In Rzeszów such a landscape does not occur, whereas in Bytom, despite of ¾ of its area is under the influence of underground black coal exploitation, the mining industry occurs only in southern part of the town, creating islands around particular extractive plant and neighbouring areas with the landscape of housing estates.

In the neighbourhood of industrial plants and communication routes the dumping (storage) landscape occurs. In Bytom as well as in Rzeszów the dumping–storage landscapes occupy relatively small areas, but they are usually badly managed and often arduous for the neighbourhood (e.g. municipal landfill sites).

Within administrative borders of towns areas used by agriculture often occur. The components of agricultural landscape are plough lands, meadows and pastures. It is an artificial landscape of physiognomy which strictly depends on the way of management. Fauna and flora are here significantly organised and being under control of human being at simultaneous strong anthropogenic impact on soils and vegetation. In Bytom agricultural landscape occupies 16.2% of town area, mostly in its north-western part. Considering the environment contamination, production intended for industry prevails here. The characteristic feature of Rzeszów is location on areas characterised by very good or good soils – the agricultural activity is here performed in 687 individual farms. Agricultural landscapes are mostly popular at town borders and they occupy 41.7% of its area. They occur in a form of larger of smaller patches, usually in the neighbourhood of landscape of areas built-up by single familiar houses.

Areas of parks, green areas, cemeteries, orchards, allotment gardens and recreation centres create the garden-park landscape with artificial structure of phytocoenoses. In Rzeszów this landscape is created by areas of small and mean size, mostly at the town borders (ŁĘTEK, 2000), whereas in Bytom the garden-park areas occur in the central and southern parts of the town, where together with low, disarranged green areas occupy significant areas (fig. 2) (PEŁKA, 1992).

Form of landscape of natural-anthropogenic (semi-natural) character is forest landscape. It is not the „obligatory" form of urban landscapes and it makes the kind of certain link with landscapes spread beyond the town. Paradoxically in Bytom – town located in the centre of the large industrial centre, the forest is the domination form of landscape (21.5%) (in Rzeszów only 0.4% of its area). Forests in Bytom have secondary origination, i.e. they were planted in the last centuries by forest services, mostly at mining waste lands. Nevertheless, they fulfil important recreation role, the more so as they include forest reserve „Segiet", which protects beautiful beech tree stand.

Landscape of water regions is created by water reservoirs. In Bytom there are more than 300 lakes, but considering small areas they occupy only 1.5% of town area, mostly in its southern and eastern parts. They are of anthropogenic origin, in the majority – without drainage (86.7%), most of them are without economic importance (JANKOWSKI, 1991). In Rzeszów the landscape of water regions occurs in southern part of the town and it is connected with the retention reservoir at the Wisłok river (of area 68.2 ha). This water reservoir is of essential importance in town water economy, supplying inhabitants and industry with water.

CONCLUSIONS

Considering landscape types, the investigated towns clearly differ from each other. In Rzeszów, at its borders, the agricultural landscape predominates (almost 42% of area). Landscape of housing estates (30%) occurs in the centre of town (low multi-familiar) and along communication exit routes (single-familiar). Rzeszów can be defined as the town of agricultural-estate-transport landscape, because in total these landscape types occupy 81% of its area.

Landscapes of Rzeszów are among others the result of natural conditions (very good soils favouring agriculture), location (borderside area, railway knot), history (large number of different education and scientific centres) and spatial economy performed (building demolition, rebuilding of communication series, building of new settlements).

Urban landscapes of Bytom are characterised by large mosaic character. Owing to long-lasting process of linking of settlement units into one urban organism, it is possible to separate certain repeating landscape arrangements in districts: landscapes of housing estates and park-garden as well as communication net develop around newly created mining or industrial landscape and – as the time goes – the disarranged vegetation appears at post-industrial wastes and around landscapes of water regions.

In Bytom forests occupy the largest area (21.5%) and next landscape of housing estates (16.3%) and agricultural one (16.2%). Despite its appearance, Bytom is very green area – forest, disarranged green areas („wild") together with more than 300 water reservoirs, allotment gardens and parks occupy almost 40% of its area. North-western part of the town is characterised by calm forest-agricultural landscape, but the south-eastern part – by estate-industrial-transport one. To be true, in landscape of this part of the town – old buildings, chimneys, mine shafts, fences, excavations, subsidence basins and dumping ground predominate, but these elements are always located in the neighbourhood of garden-park landscape and disarranged low green, covering waste lands.

Classification of urban landscapes applied in the paper (TIUTIUNNIK, 1991) allowed to rightly present the character of centres analysed. The method to separate landscapes is simple and little work consuming. Homogenous criteria of particular landscape types separating (on the base of land use) allow comparing towns of different physiognomy. Simultaneously, thanks to details omitting, it is possible to find the most essential important features of landscape in the given town and to present in the cartographic way. The maps obtained can be the base to the further, more detailed research on the landscape.

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Anthropogenic aspects of Landscape transformations	1	University of Debrecen Debrecen 2000	17–23

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INFLUENCE OF LAND RECLAMATION ON NATURAL AND LANDSCAPE ATTRACTIVENESS OF THE AREAS TRANSFORMED BY HUMAN IMPACT IN THE SILESIAN PROVINCE

INTRODUCTION

The Silesian Province shows complex geology and diversified relief. It comprises mountainous areas of Silesian, Mały and Żywiec Beskidy Mountains, plateau areas of Carpathian Foothills, upland areas of Silesian and Kraków-Częstochowa Uplands and lowland areas of Racibórz Basin. Among the landforms, which originated as an effect of various endo- and exogenetic processes, there are many anthropogenic forms which resulted from human economic activity. These forms are associated with mining and metallurgy industries, which started in this area in Middle Ages. The largest number of anthropogenic forms occurs in the Upper Silesian Industrial Region. These forms in-clude industrial waste hips, surface excavations and forms associated with the distur-bing of formation stability such as subsidence basins, depressions and thresholds. The area of Upper Silesian Industrial Region shows the largest concentration of industrial plants and the largest population density in Poland.

Intensive industrialisation and urbanisation of Upper Silesian Industrial Region caused considerable deformation of geological structures, relief, water relations, devastation of vegetation cover and soil. This is intensified by air pollution which caused, for example, catastrophic forest health condition is some areas of the Silesian Province. However, side by side with the effects of environmental degradation caused by the industry, there are effects of environmental reclamation and regeneration carried out to protect the nature.

In the areas exposed to reclamation measures and also irrespective of these measures, regeneration processes of biocenotic systems occur and diversified natural and landscape complexes have developed (CELIŃSKI, CZYLOK, KUBAJAK, 1996). These processes occur in the areas associated with opencast mining of filling sand and on the anthropogenic forms associated with underground mining and metallurgy of zinc and lead ores. These areas, after reclamation and revitalisation measures, are included in the system of recreation areas of Upper Silesia.

TRANSFORMATION OF THE NATURAL ENVIRONMENT IN THE AREAS OF SAND EXPLOITATION

The oldest exploitation of filling sands was started in 1922 by French-Italian coal corporation. Now, this area is transformed into the artificial lake – Pogoria 1 situated in Dąbrowa Basin. More intensive exploitation of filling sand started in the 50s in the area between Ciężkowice, Szczakowa and Maczki and in the valleys of the Drama, Kłodnica and Bierawka rivers.

Opencast exploitation of mineral resources causes the largest transformation of the natural environment in terms of the area subjected to this activity. In the areas of filling sand exploitation, these transformations include:

- changes of relief (excavations of different shapes – from shallow basins to deep shafts – of the area from 19 to 1400 ha and depth from 5 to 45 m);
- changes of water relations (river channel shifting, drainage ditches and channels, lowering and raising of groundwater-table, deterioration of water in house wells which are situated in the area of depression cones);
- deterioration of vegetation and soil covers in mining areas;
- changes in land use structure;
- depreciation of landscape attractiveness;
- blowing off the sand from active areas and non-reclaimed excavations;
- microclimate changes in excavations and their surrounding.

TRANSFORMATIONS OF NATURAL ENVIRONMENT IN THE AREAS OF SAND EXPLOITATION AFTER RECLAMATION MEASURES

Scientific research on reclamation and land use of post-industrial wasteland (mainly hips of mining wastes) was started in Poland in 1954 by Committee for Upper Silesian Industrial Region, Polish Academy of Sciences. Problems of reclamation of sand excavations were investigated for the first time in 1961 by Department of Scientific Research for Upper Silesian Industrial Region, Polish Academy of Sciences in Zabrze.

Reclamation and afforestation of sand excavations which started in the 60s have still been continued. Every year, the reclaimed area equals the area taken to exploitation.

Planting, afforestation and introduction of artificial lakes are main programmes in reclamation and land use of sand excavations. By the year 2000, about 10 000 ha of sand pits were planted and afforested, and about 3 000 of excavations were transformed into recreation water reservoirs. Reclamation works are carried out depending on the exploitation method and temporary use of excavations. Some excavations are designed for central damping sites of mining and power industry wastes (DWUCET, KRAJEWSKI, WACH, 1992). The choice of a reclamation method depends on many factors such as type and class of the ground, its humidity, etc.

In the sand pits with gravitational drainage, afforestation is the main reclamation programme. In case of the excavations which are deeper than the groundwater-table, water reclamation is common. Floors and slopes of excavations are subjected to reclamation works.

An example of the natural environment regeneration due to reclamation measures is the area of the sand pit in Szczakowa which is situated in the eastern part of Silesian Upland. The total area of the active, closed and reclaimed (also under reclamation) excavations in all sand fields which were produced there until 1994, was 3 077 ha, including 1 565 ha of the reclaimed excavations (KAŹMIERCZYK et al., 1995). During

40 years of the sand pit works, over 1 500 trees were planted. Until 1980, mainly grey and black alder was planted; after 1980, the participation of alder decreased to 10% in favour of *Pinus sylvestris, Pinus nigra* and *Betula pendula.* Also *Salix acutifolia* was introduced. In biological lining of slopes, *Robinia pseudacacia, Padus serotina, Caragana arborescens* and *Eleagnus angustifolia* were planted (SZWEDO, WOŹNIAK, KUBAJAK, 1995).

Thorough reclamation measures and afforestation, process of nature recovery is considerably accelerated. In the areas of sand exploitation, the regeneration of the natural environment due to natural succession is also observed, but it takes place much slower. These processes occur in the zone of shallow groundwater-table (along streams and water seepage). New habitats of large biodiversity develop there. An example of such phenomena in the area of Szczakowa sand pit is a peatbog-alder complex which has developed along Prochownia Channel during the last 40 years, where the groundwater outflow of spring character caused development of flooded areas where numerous groups of protected species developed (eg. *Myricaria germanica* – plant of high mountain waterheads). Individual specimens of such protected species as *Centaurium erythreae, Epipactis palustris* and *Iris sibirica* may be observed. Grey heron lives in the neighbourhood.

These areas represent excellent scientific and teaching polygon where stages of plant and animal succession may be observed. Therefore, education natural paths were designed in these areas and some of them are protected by law.

Early stages of plant regeneration are observed also in other excavations in the eastern part of Silesian Upland, especially in places where the sand pits are flooded with water seepage which earlier penetrated Triassic or Jurassic limestones (CZYLOK, 1998).

Other programme of land reclamation in the areas of sand exploitation is water reclamation. Earlier, when no processes of reclamation were carried out in this area, some water reservoirs originated in natural way (eg. Dzierżno I, Czechowice, Przezchlebie, Pogoria I and II). These reservoirs showed unequal shoreline and uneven bottom, what did not favour their satisfactory use for recreation. Water reclamation of these reservoirs carried out according to the programme rules, included formation of reservoir bowls and escarpments, construction of hydrotechnical objects which would secure optimal height of water lifting and the arrangement and reclamation of the adjacent areas (WRONA, 1977). Water reservoirs established in the sand pits apart from their recreation function perform also functions of water retention and intake for municipal, agricultural and industrial needs. In general, water reservoirs in sand pits are oligotrophic, often deep basins with narrow zones of in-shore rushes with *Typha angustifolia* and *Phragmites australis.* In deeper parts of the phreatic zone, submerged plants with *Myriophyllum* sp. and *Potamogeton* sp. (CZYLOK, 1998).

The examples of such reservoirs include Dzierżno Małe, Dzierżno Duże, Pogoria I, II, III, Chechło-Nakło, Czechowice, Sosina and Pławniowice. Within the artificial shores, such forms as bars, sand tips, shore banks, active and inactive cliffs have developed. These are evidences of shore processes which occur there (RZĘTAŁA, 1994).

Among water reservoirs formed in sand pits, the reservoirs established in the catchment of the Pogoria river in the western part of Dąbrowa Górnicza is the most interesting.

These reservoirs compose a complex of lakes fed by water from the Pogoria river and additionally by the groundwater. Together with the adjacent coniferous and mixed forests, meadows, marshes and peatbogs in the Trzebyczka valley, they form a natural-landscape complex called „Pogoria". Three ecological grounds and six interesting natural areas were established there (CELIŃSKI, CZYLOK, KUBAJAK, 1996). All these reservoirs, apart from Pogoria II, have recreation function. The richest technical infrastructure with accommodation and sailing facilities is associated with Pogoria I reservoir. The most interesting reservoir in terms of its natural and landscape values is Pogoria II, which was established as the ecological ground in 1996. Numerous reedy areas, molinia meadows, and willow clusters are the places where many representatives of water fauna with numerous protected species (eg. little bittern, common sandpiper) and black-headed gull occur. In total, 84 species of vertebrates including 52 under total protection, 8 under hunting protection, 10 under fishing protection and 2 under periodical protection were found in the area of Pogoria II reservoir (CELIŃSKI, CZYLOK, 1995).

Another examples of the areas with the achievements in terms of water reclamation include „Rogoźnik" recreation area, Three Lakes Valley in Katowice, Hubert Lake recreation area in Mysłowice and Sosina recreation reservoir in Jaworzno.

NATURAL AND LANDSCAPE VALUES OF THE SELECTED AREAS ASSOCIATED WITH UNDERGROUND MINING IN THE SILESIAN PROVINCE

Underground mining in the Silesian Province is carried out in the mines which exploited hard coal and zinc and lead ores. The most important changes in surface morphology associated with mining activity (apart from numerous damping sites) are surface deformations in form of broad depressions, cones, subsidence basins and fissures.

The most unfavourable situation in terms of surface deformation occurs in the area of Bytom and Tarnowskie Góry where, below active and closed ore mines, coal mines work. As a result, the influences of coal and ore mines overlap with each other. In this area, the depressions reach 9–15m. In many of them local flooded areas developed (DWUCET, KRAJEWSKI, WACH, 1992).

Another result of mining and metallurgy in the Silesian Province are numerous waste heaps including the heaps produced during ore processing and enrichment, post-flotation waste heaps and post-smelting waste heaps. The heaps which are difficult to reclaim (eg. high heaps, heaps with steep slopes, thermally active heaps, heaps located close to the mines) are taken apart and rock material is used for economic purposes. The areas regained after dumping site liquidation are usually used for industrial and house building, parks, sport grounds and garages. Very few mining or post-flotation heaps are biologically reclaimed. In the 70s, the heaps of the following mines were planned to biological reclamation: Czerwona Gwardia in Czeladź, Katowice, Prezydent in Chorzów, Jankowice near Rybnik and post-flotation heaps of Mining-Metallurgical Works „Orzeł Biały" in Bytom.

At present, reclamation includes mainly waste dumping sides present in the subsidence depressions or in the post-exploitation excavations. An example of such a dumping site is Gołonóg II situated in the northern part of Pogoria III sand pit (fig. 1). After its reclamation and forest management it was incorporated in „Pogoria" recreation complex.

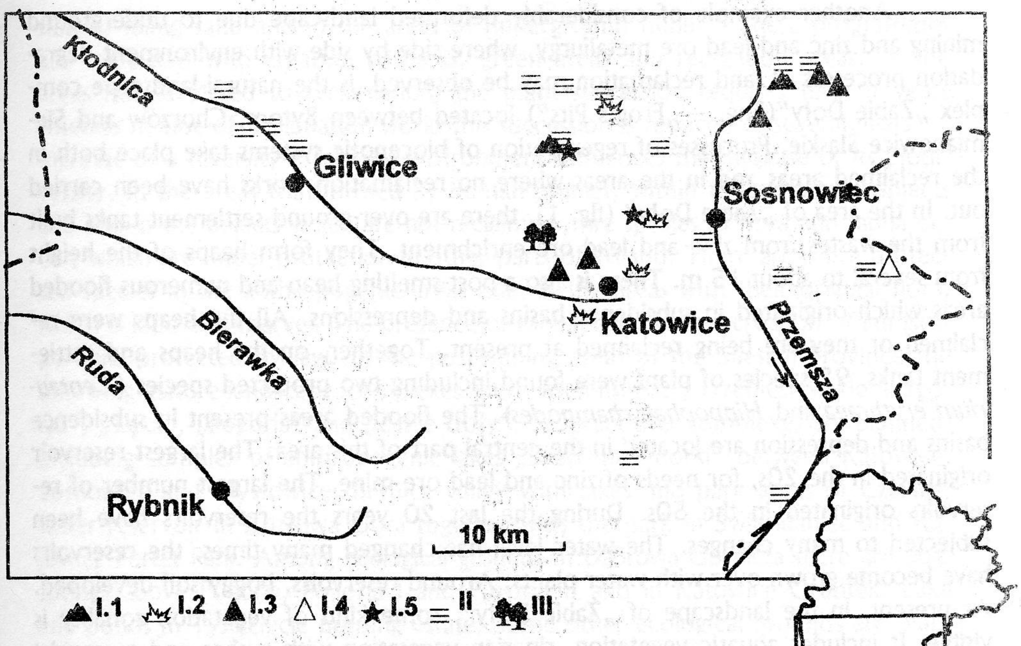

Fig. 1. Natural-landscape attractiveness of the areas transformed by human impact in the Silesian Province:

I. The areas protected by law in the post-exploitation areas: I.1 the established natural-landscape com-plexes: "Żabie Doły", "Pogoria"; I.2 – the planned natural-landscape complexes: complex of lakes Szopienice-Borki, the area of Brynica valley with sandy areas of Czeladź, water reservoir in Kozłowa Góra with Świerklaniec Park, Katowice Forest Park; I.3 – the established ecological grounds: water reservoir Pogoria II, bog-springs above Pogoria I, SE part of Pogoria I water reservoir, Grünfeld Lake in Katowice, lakes in Tysiąclecie housing estate; I.4 – the planned ecological grounds: peatbog in Jaworzno Szczakowa along the Prochownia Channel, water-head with false tamarisk in Bukowno; I.5 – documentation sites: part of "Blachówka" quarry in Sucha Góra near Bytom, Borzech Hill in Czeladź; II – important water reservoirs of recreation function created in sand excavations and subsidence depressions: Pogoria I, Pogoria III, Sosina, Balaton, Stawiki in Sosnowiec, Hubert in My-słowice, Rogoźnik, Kozłowa Góra, Dzierżno Małe, Dzierżno Duże, Paprocany, Planned natural-landscape complexes – pond complex of Szopienice-Borki, Brynica river valley, park areas in Czeladź, water reservoir in Kozłowa Góra and park in Świerklaniec, Katowice Forest Park, Pławniowice, Pniowiec in Tarnowskie Góry, complex of reservoirs in the area of „Żabie Doły", water reservoirs in Gorzyce, Czechowice lagoon in Gliwice, Nakło-Chechło, others; III. Recreation areas: - Provincial Park of Culture and Recreation in Chorzów

Another positive example of post-mining landscape reclamation is Provincial Park of Culture and Recreation in Chorzów (fig. 1). Reclamation works started here 40 years ago and they included regulation of water conditions, ground levelling, melioration and afforestation. At present, 227 species of trees and bushes grow there and the whole area with its cultural and recreation facilities, ZOO and amusement grounds is a place for relax and recreation of the Silesian Province inhabitants. The vegetation which has developed here in different ecological conditions makes a permanent experimental polygon of the research on landscape and vegetation reconstruction on the devastated areas (SZCZEPAŃSKA, 1977).

Another example of considerably deformed landscape due to underground mining and zinc and lead ore metallurgy, where side by side with environment degradation processes of land reclamation may be observed, is the natural-landscape complex „Żabie Doły"(Eng. – „Frog's Pits") located between Bytom, Chorzów and Siemianowice Śląskie. Processes of regeneration of biocenotic systems take place both in the reclaimed areas and in the areas where no reclamation works have been carried out. In the area of „Żabie Doły" (fig. 1), there are over-ground settlement tanks built from the wastes from zinc and lead ore enrichment. They form heaps of the height from several to about 15 m. There is also a post-smelting heap and numerous flooded areas which originated in subsidence basins and depressions. All the heaps were reclaimed or they are being reclaimed at present. Together, on the heaps and settlement tanks, 92 species of plant were found including two protected species (*Centaurium erythraea* and *Hippophae rhamnodes*). The flooded areas present in subsidence basins and depression are located in the central part of this area. The largest reservoir originated in the 20s, for needs of zinc and lead ore mine. The largest number of reservoirs originated in the 50s. During the last 20 years the reservoirs have been subjected to many changes. The water level has changed many times, the reservoirs have become grown over with water plants. Around reservoirs, boggy soil developed. At present, in the landscape of „Żabie Doły", some kind of vegetation zonality is visible. It includes aquatic vegetation, riparian vegetation with rushes and terrestrial vegetation.

The area of „Żabie Doły" containing 35 ha of water reservoirs, 7.6 ha of surface vegetation, 146.5 ha of fields and meadows and 45.5 ha of ruderal areas (heaps and settlement tanks) has become a habitat of considerable biodiversity. Ornithological research revealed that 121 species of birds occur these including such rare species as bittern, little owl and little bitter. Increase of density of breeding pairs of penduline tit has been also observed. Among other groups of animals there are numerous species of amphibians (which gave the name to that area) and mammals (eg. hedgehog, muskrat, hare, bat, hamster) (DOBOSZ et al., 1993).

Such large and diversified list of species, which are excellent bioindicators, evidences incredible natural value of this area. Therefore, the whole area of „Żabie Doły" (226.24 ha) is protected by low. It represents potential area for recreation and education (DWUCET, SOŁTYSIAK, 1997). Polish Fishing Association and Polish Hunting Association carry out their activity in this area.

CONCLUSIONS

- Water reservoirs and heaps are characteristic elements of the landscape of post-mining areas of the Silesian Province. Large number of anthropogenic reservoirs located in Upper Silesian Industrial Region is comparable to lakeland area in northern Poland. Most of the Silesian artificial lakes originated in natural way in subsidence basins, depressions or former sand pits and clay pits.
- Reclamation of post-industrial wastelands started in the 60s. Forest and water programmes of reclamation predominate both in the areas of opencast exploita-

- tion of filling sand and in the areas of underground mining. These programmes are associated with creation of parks, green areas and recreation areas. In the areas not subjected to reclamation, the plant succession requires tens of years whereas in case of reclamation works this succession is reduced to several years.
- Increase of a diversity of abiotic environment influences the increase of its biodiversity. In the areas transformed by human impact, within the reclaimed objects and also in the objects which are not reclaimed, rare species of flora and fauna occur, which are under protection in other parts of Poland. There are more protected species in the anthropogenic areas than in the areas with their original flora, which is kind of a marvel. The presence of rare species causes creation of landscape units protected by law. In the post-mining areas of the Silesian Province the following nature-landscape complexes were established: „Trzebiesławskie Wzgórza", „Łąka", „Pogoria" and „Żabie Doły". Several other complexes are planned, including complex of anthropogenic lakes „Szopienice-Borki" between Katowice, Sosnowiec and Mysłowice, Brynica valley with lakes and park areas of Czeladź, water reservoir in Kozłowa Góra together with the park in Świerklaniec and Katowice Forest Park. Among ecological grounds in Dąbrowa Górnicza there are bog-springs above Pogoria, Pogoria I and Pogoria II and in Katowice Grünfeld Lake and ponds in Tysiąclecie housing estate. Some other ecological grounds are planned. As a documentation site, the wall of a closed dolomite quarry „Blachówka" in Sucha Góra near Bytom is taken under protection.

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Anthropogenic aspects of Landscape transformations	1	University of Debrecen Debrecen 2000	24–32

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RESEARCH ON THE COMPOSITION OF THE SUSPENDED SEDIMENT TRANSPORTED BY WIND IN THE NORTHERN PART OF DEBRECEN, WITH SPECIAL RESPECT TO THE SPOROMORPH CONTENT

INTRODUCTION

Debrecen is a city situated in the eastern part of the Great Hungarian Plain, lying slightly northeast of the geometrical centre of the territory east of the river Tisza. Its height above sea level is 117 m. The city was built in a place where two small landscape-units with different geological structure meet: to the north and east, on the margin of the Nyír which is characterized by sand dunes, woodlands and galleries; to the west and southwest on the Hajdú ridge which is the agricultural arable-land of good quality of the loess ridge. In this city the annual precipitation reaches 550–600 mm and this amount equals the absolute extremes of the appearance of woodland and grassland vegetation. Therefore, Debrecen also lies on a vegetational boundary. In this area, most frequently the wind blows from northeast and southwest and very rarely northwest.

Particles with more than 5–10 μm in diameter have a significant role in the composition of solid contaminants in the air of the town. Coarser dust content (80–320 μm) mostly derives from the territory of dune sand in the Nyír while finer dust (50–20 μm) comes from the Hajdú ridge. Particles with more than 200 μm in diameter are suspended in the air for a while but soon are deposited – this is called falling dust. Particles with less than 5 μm in diameter form a colloidal mixture, a microheterogenous system in the air. To the north and northeast the town is bordered by heterogenous composition of planted acacia groves, Scotch fir-forest and natural sandy oak-forest, which can act as a certain air-filter, especially in the case of coarser particles. On the other hand, it is a serious source of air pollution as well, since periodically it produces great amounts of pollens and fills the air. Plants pollinated by wind emit thousand millions of pollens (5–250 μm) into the air where they can be suspended for a long time depending on weather conditions. On the other hand, this large quantity of pollens may form a significant part of fine-grained sediments, so by all means it is worth carrying out research on their behaviour, lastingness and sediment-forming features. On the other hand, dust and pollens are responsible for the illness of almost all of those people who suffer from allergic conditions. Therefore, research on their presence in the air can provide us with important information.

We have done research on the composition of the material falling from air with special respect to the presence of pollens. The aim of our work has been to determine the composition of air pollution in the northern part of the town taking into consideration the influence of the above mentioned sources of pollution.

METHODS

We tried to choose the most expediential method for measuring the dust content in the air. We had to choose from several possibilities. We needed both qualitative and quantitative measurements.

a) For exact measurements a vacuum pump pollen trap is the most suitable device which continuously sucks in measurable quantities of the air with the help of a motor and solid particles such as sporomorphs, adhere to a tape previously supplied with some glue.

However, in our case this method did not turn out to be ideal since we were interested in what kind of elements the material transported by wind contained. Independent of air movements the vacuum pump device shows the dust content in the given amount of air even in no wind conditions. That is why we have evolved a dust-collector which trapped the dust from the air according to the direction of wind. This device was made up of flacons set at three altitudes on a 2.5 m high bar, into which a pipe led (3 cm in diameter and bent at right angles). The bar turned to the direction of the prevailing wind with the help of a wind vane on top of the bar. The wind blew into the pipes and the dust from the instreaming air was trapped in the liquid that had been previously poured into the flacons. Only wind-blown material accumulated in this trap. Suspended dust could only be trapped when the wind blew. This device excluded the possibility of the spontaneous deposition of suspended and falling dust. We used a different method in this case (see later). At stated intervals we collected the material from the traps set at different altitudes and carried it to the laboratory for further examination. The device was set near a territory covered with trees and forests where we could measure the amount of precipitation, the direction of wind, the hours of sunshine and the temperature of the air, at the same time.

b) For quantitative determinations we used glyceric opened pollen traps which were suitable for the examination of sediments both falling from the air and blown by wind. The traps were set 20–50 m high above the surface of the earth, in the foliage, sheltered from rain. We collected the samples at stated intervals. We separated the sediment from dust-collectors by centrifuging the liquid, weighed the quantity on an assay balance and determined the composition under a microscope. We recovered dust, soot, pollen spore and other constitutive elements, identified the pollen grains and determined their size as well.

On wet and glyceric preparations we examined the content of the sediment under a Hund type research microscope with 250, 400, 650 magnification. We analyzed the results with the help of Tilia, Tilia graf 1.12 softver and Microsoft Excel table handling program. We illustrated the results on charts, diagrams and moreover fixed the microscopic image of typical contents.

MEASUREMENTS, RESULTS

In the beginning we trapped in one week periods. We had to experience how long the ideal period was during which we could collect a sufficient quantity of samples to be effective. Later we extended the period of collecting the samples, so that every month we weighed the quantity of the wind-blown material in the containers set at different levels. The quantity of the balanced material did not exceed the rate of slightly polluted air. At different heights similar quantities were accumulated: 0.16–0.26 mg/m^2. Therefore, we analyzed the results independent of altitudes.

We compared the quantities of the monthly balanced wind-blown material to the rates of precipitation and concluded that the highest concentration of dust in the air could be measured in drier periods. The concentration of the sediment can be characterized by three cusps in a year (Fig. 1, 2). We only could explain the reason for this when we examined and analyzed the contents of the sediment under a microscope. We illustrated the results of three years of measuring in a bar chart (Fig. 3).

After analyzing the combined histogram (Fig. 3) we concluded that,

1. In almost every season, solid clasts gave one or two third of the sediment and reached the highest percentages in winter-time which in fact did not exceed 0,16 mg/m^2. In winter months floating dust (particles more than 5–10 μm in diameter)

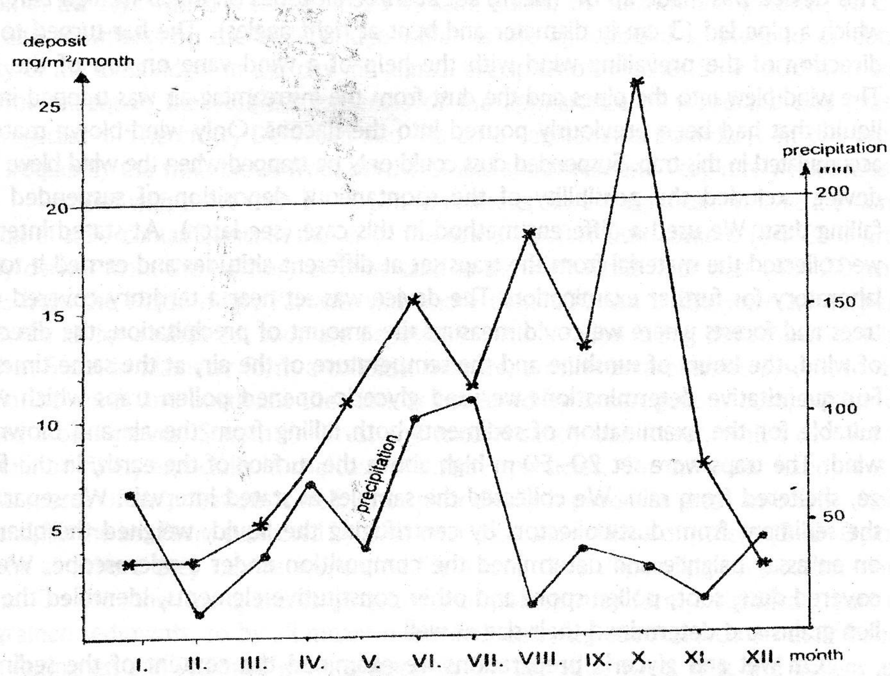

Fig. 1. Connection between the suspended dust and the rate of precipitation in the monthly averages of 1996-1999

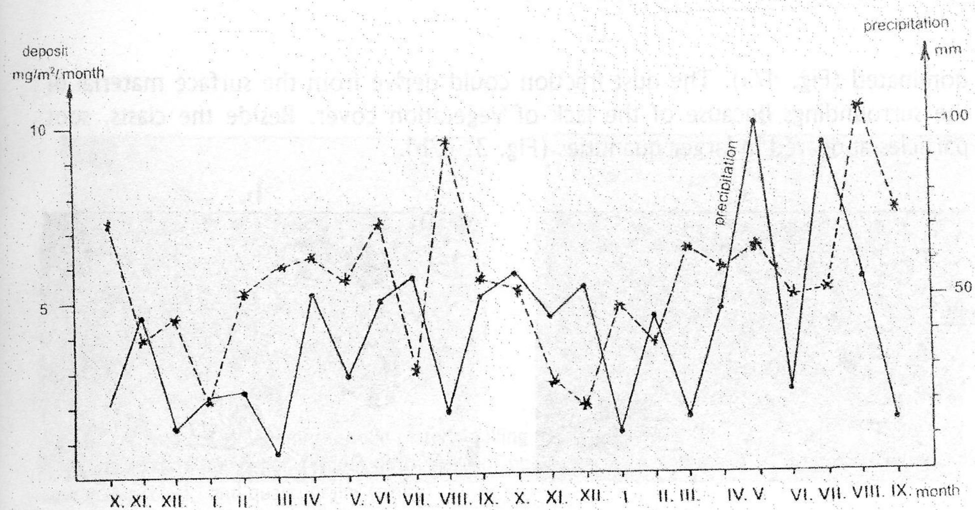

Fig. 2. Graph of the monthly rate of precipitation and the quantity of dust falling from air in 1997-1998

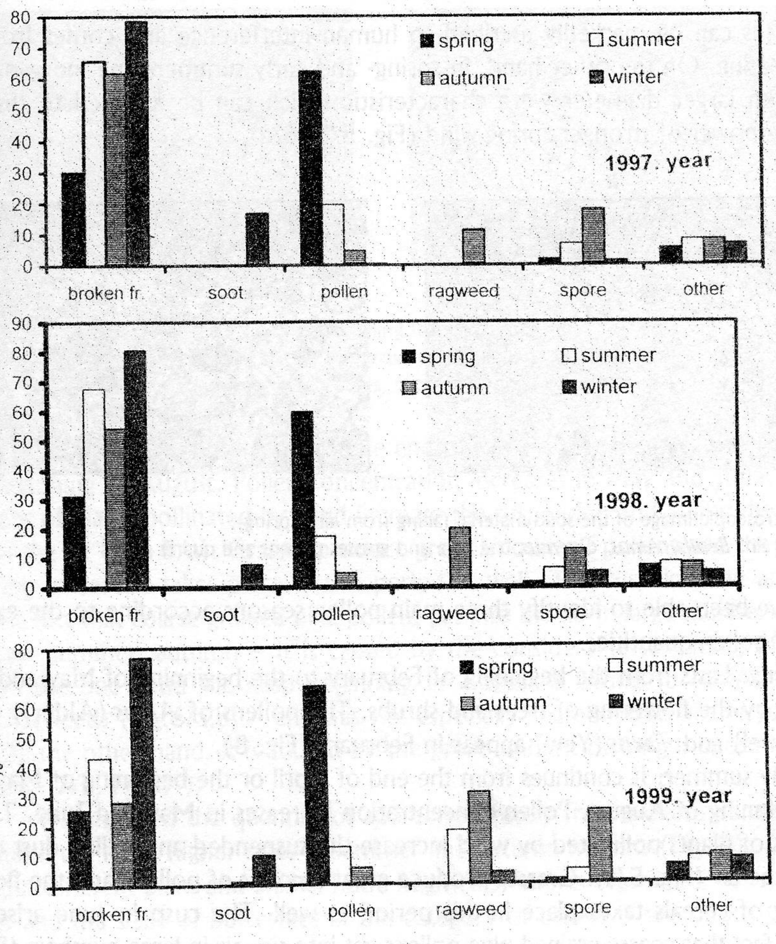

Fig. 3. Percentage of the material falling from air (1997-1999)

dominated (Fig. 4/a). The dust fraction could derive from the surface material of the surroundings because of the lack of vegetation cover. Beside the clasts, soot particles appeared in larger quantities (Fig. 3, 4/b).

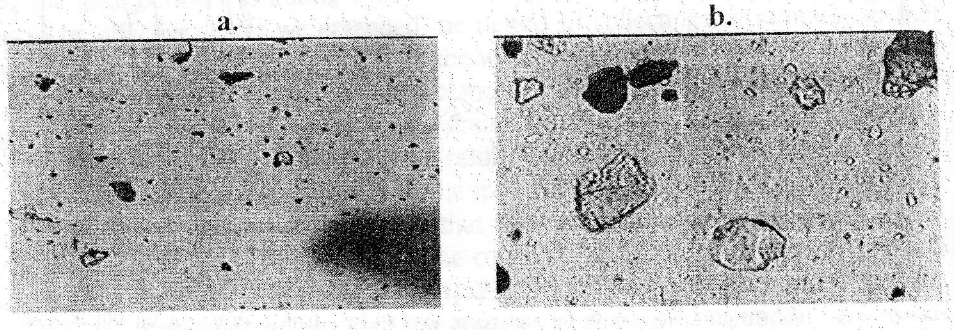

Fig. 4. Microscopic image of the solid material falling from air (Winter):
a – 54-10 μm broken fragment, b – black: soot grains, white: quartz grain

This can be markedly ascribed to human interference and comes from solid fuel heating. On the other hand, in spring- and early summer-time inorganic particles with larger diameter were characteristic which can be ascribed to the transporting power of stronger spring wind (Fig. 5/b, 6/a).

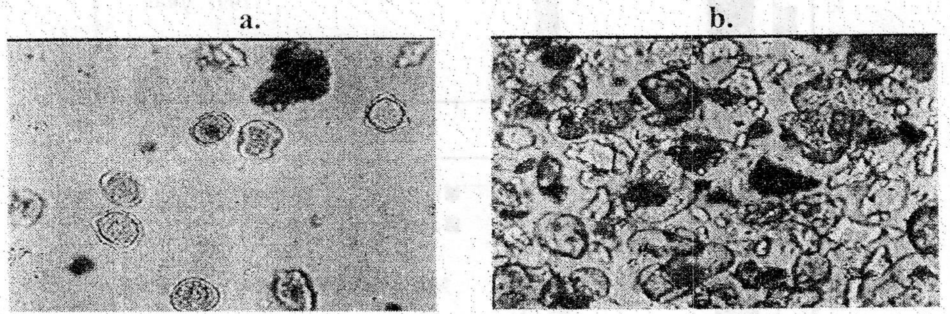

Fig. 5. Microscopic image of the solid material falling from air (Spring):
a – pollen grain: *Betula, Alnus, Quercus,* b – pine and grasses pollens and quartz grains

2. We have been able to identify three main pollen seasons according to the examination of pollen quantities.
   a. Spring: Lasts from the beginning of February to the beginning of May and is caused by the flowering of trees and shrubs. The pollens of *Alnus* (Alder), *Corylus* (Hazel) and *Taxus* (Yew) appear in February (Fig. 8).
   b) Early summer: It continues from the end of April or the beginning of May to the beginning of August. Pollen concentration increases in May and June. The pollens of plants pollinated by wind increase the suspended and falling dust content of the air (Fig. 5/a). Grasses produce great amount of pollens and the flowering of cereals takes place in this period as well. The cusp in June arises from the fact that coarse-grained pine-pollens get into the air in large numbers (Fig. 8).

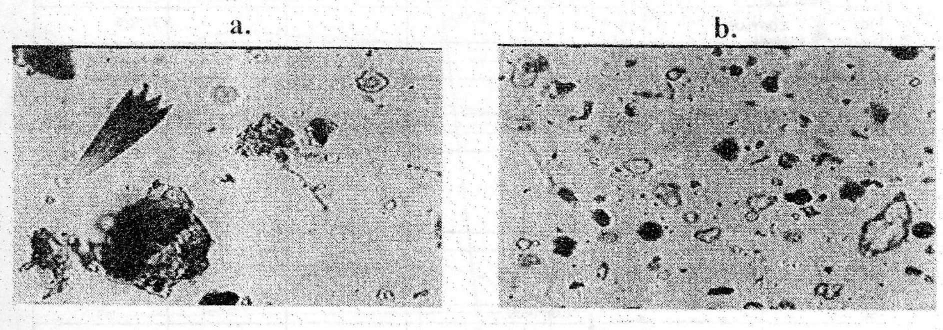

Fig. 6. Microscopic image of the solid material falling from air (Summer):
a – *Ambrosia elatior* pollen (little,round), scale of butterfly and alga (big). b – *Ambrosia elatior* pollen, soot grains (black) and quartz grains (white)

Fig. 7. Microscopic image of the solid material falling from air (Autumn):
a – quartz grains (white), soot grains (black), *Ambrosia elatior* pollen (little,round),
b – *Ambrosia elatior* pollen (round), ascoscospores, spores of fungus

b) Early summer: It continues from the end of April or the beginning of May to the beginning of August. Pollen concentration increases in May and June. The pollens of plants pollinated by wind increase the suspended and falling dust content of the air (Fig. 5/a). Grasses produce great amount of pollens and the flowering of cereals takes place in this period as well. The cusp in June arises from the fact that coarse-grained pine-pollens get into the air in large numbers (Fig. 8).

c) Late summer: autumn – It is caused by the considerable spreading of weeds – on the one hand the cusp beginning in August is owing to *Ambrosia elatior* (Ragweed) (Fig.6/a,b) – and this was especially characteristic of the year 1999. On the other hand, it is caused by the great amount of fungus spore in autumn (Fig. 7/b, Fig. 9).

We analyzed the quantity of spores separately from pollens since they polluted the air at higher rates in summer and autumn months (Fig. 9).

2. We put different plant and animal histic fragments, insects e.g. mites, hairs, flying devices and the scale of butterflies in the category of others – see photo (Fig. 6/a). In spring – from March to June – we continued examining the glyceric traps more

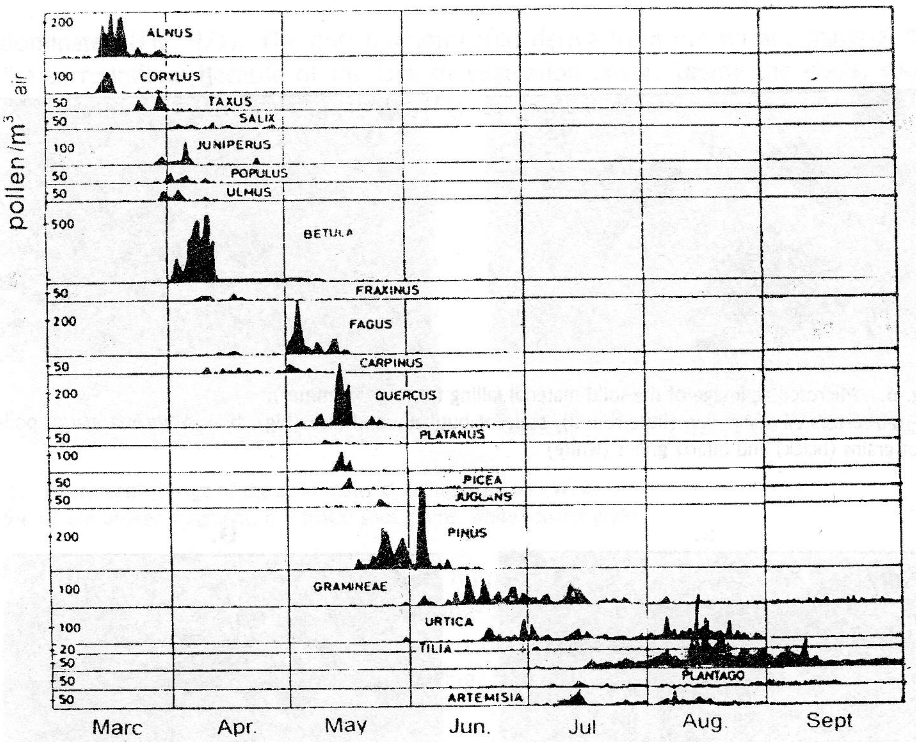

Fig. 8. Falling of pollen types from air in the averages of 1997-1999

often, when the vegetation pollinated by wind began to flower and in some cases it was worth looking at the content of the traps even every day. We could make qualitative measurements on these. In longer, dry, sunny periods, the amount of solid particles increased, since more suspended material got into the air and deposition could happen in several days time. Pollen production was characteristic mostly in day-time. For this reason the amount of falling dust in the air increased in that period and pollens accumulated at night. Clastic deposits got into the air depending on weather, especially because of wind, and were transported even to 50 m high. It was precipitation that washed out suspended particles from the air. Heavy rain consisting of larger drops washes out the air most effectively, while heavy rain with smaller drops and sudden rainstorms are less effective.

During the sedimentation, pollens only remain heterogenous from inorganic mineral fragments if they keep their original form, wholeness and are preserved under appropriate conditions. The cell-wall consists of sporopollenin which is very resistant, but like all other organic matter in nature it is not resistant against oxidation processes, fungi, microbes and decomposers. The transformation – disappearing – of pollens does not cause considerable change in the weight of the sediment (we can meet this phenomenon in the case of microscopic preparations which contain poorly preserved pollens.) In nature this leads to the appearance of detritus that can increase the organic

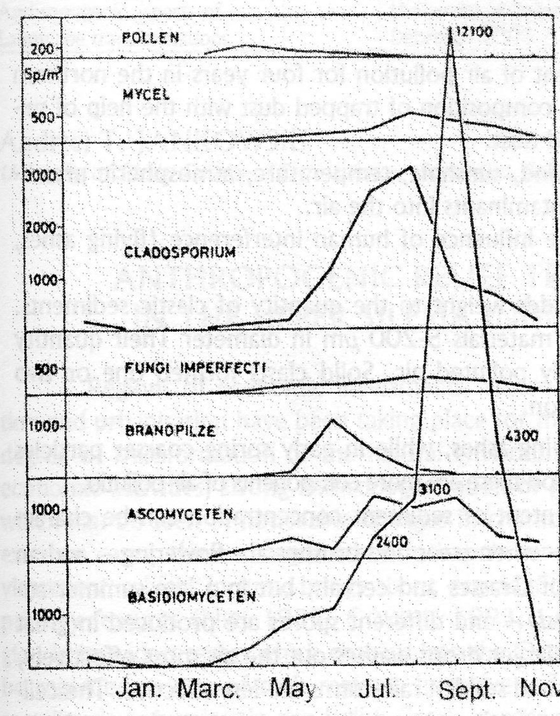

Fig. 9. Falling of sporomorphs from air with special respect to spore types in the averages of 1997-1999

matter content of the sediment. In many instances mineralization can take place together with other elements, as can be seen in the enclosed photos (Fig. 10/a,b) in the sediment of 1998 there are pollen particles, spores and the most resistant ones are visible (Fig. 10/b), while the least resistant have been decomposed. In the preparation of 1997 we can not see the pollen particles, only the mass and contour of the desintegrated fragments (Fig.10/a.).

1997 1998

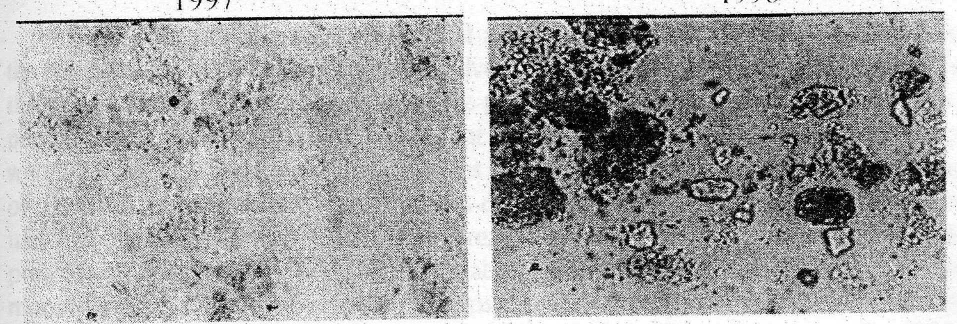

Fig. 10. Microscopic image of suspended dust containing oxidated, decomposed pollens

SUMMARY

We have examined the content of air pollution for four years in the northern part of Debrecen. We determined the composition of trapped dust with the help of microscopic analyzation of the suspended dust.

- Climatic elements of the seasons (wind, sunshine, temperature, atmospheric pressure) have a main role in passing contaminants into the air.
- Beside this we have to count on the influence of human interference (flying ashes, cereals, weeds).
- The deposition of suspended dust adds weight to the quantity of clastic sediments. Wind-blown dust consists of solid materials 5-200 μm in diameter Their quantity did not exceed the rate of slightly polluted air. Solid clasts formed one or two thirds of the sediment in each season.
- In winter-time finer particles and flying ashes, while in early spring coarser particles were visible. In the early summer period there are more components of air pollutio.
- In a one year period the pollen content of sediment concentration can be characterized by three cusps In a spring – when trees and brushes are flowering – and an early summer period the pollens of Grasses and cereals, but in a late summer-autumn period weeds – e.g. *Ambrosia* – and different spores are produced in great numbers. Heavy rain consisting of larger drops washes out the air most effectively, while heavy rain with smaller drops and sudden rainstorms are less effective. The cell--wall of the deposited pollens, if not getting to an oxigen-proof place, is unresistant against oxidation processes, fungi, microbes and decomposers, just like all the other organic matter in nature and is easily mineralized.

Anthropogenic aspects of Landscape transformations	1	University of Debrecen Debrecen 2000	33–36

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ANTHROPOGENIC RELIEF TRANSFORMATION IN THE UPPER SILESIA INDUSTRIAL REGION

Regions of economic investments, where intensive processes of industrialisation and urbanisation have been taking place for many years, are characterised by high degree of transformation of the natural environment. Throughout the centuries-long economic activities, strong anthropogenisation of geographic environment takes place, which can be seen in noticeable changes in character of its particular components. In extreme cases, these changes result in impairment of equilibrium of elements of environment, which, in turn, brings about degradation of some of them and losing their primary features (NIR, 1983; GOUDIE, 1993; LAW, 1984). The Upper-Silesian region in its widest sense, which changes into the Ostrava-Karvina industrial region, should be regarded as one of such regions. Intensive industrial activities, mainly mining and metallurgic industries, in this Polish-Czech border zone brought about extensive transformations (fig. 1).

A detailed analysis of changes in the relief has showed that the speed and magnitude of its anthropogenic transformations in mining regions are much bigger than transformations caused by natural factors. The process of urbanisation indicated by development of cities, industrial regions and transport routes, also contributes to creating many landforms, like levelled areas, slopes, mounds, or excavations, which would not have appeared but for the progressing process of urbanisation. Thus, relief transformations are the result of a series of processes initiated by human activities including both surface and underground works.

Obviously, the speed of industrial activity and area management was slow in the initial period, so it did not cause intensive transformations of the terrain. It was only the accelerated economic activities taking place throughout the current century, especially for the recent 50–60 years, that brought about noticeable changes. They were indicated by occurrence of new forms of the relief of terrain and transformations of the forms existing so far. That results in development or acceleration of morphodynamic processes which take place also in areas which lack anthropogenisation, but their progress is much slower and less noticeable. Hence, anthropogenic factors are of morphogenetic nature and two basic groups of their influence on environment can be distinguished, namely direct and indirect ones. The direct cause of influence of anthropogenic factors is indicated by either building or destructive human activity which leads to occurrence of concave or convex forms in the surface of the terrain. In this

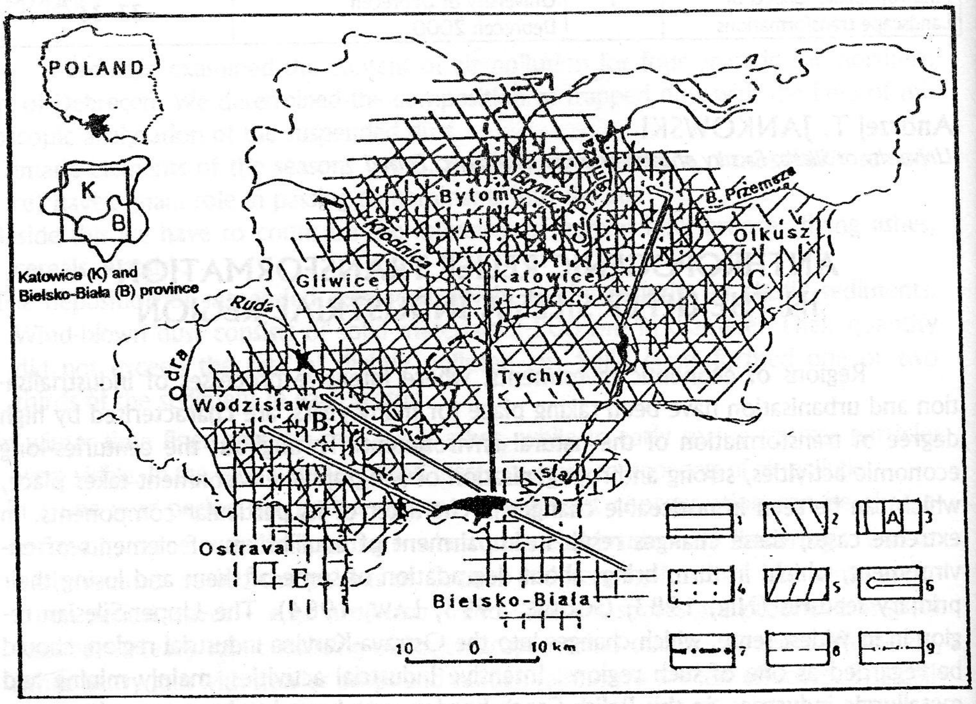

Fig. 1. Anthropogenic changes in the natural environment of Katowice province area (after Jankowski, 1994): 1 - range of intensive anthropogenic changes in relief, 2 - range of strong air pollution, 3 - area of strong industrial anthropopresion: A - Upper Silesian Industrial Region (U. S. I. R. - GOP), B - Rybnik Coal District (ROW), C - Olkusz-Chrzanów Industrial Region, D Bielsko-Biała Industrial Region, E - Ostrava-Karvina Industrial Region (Czech Republic), 4 - area of dense built-up areas, 5 - range of clear decrease in underground waters resources, caused by mining, 6 - main direction of water transfer, 7 - watershed dividing the Vistula and Oder drainage areas, 8 - border of province, 9 - border of country

case, changes in the relief take place simultaneously with activities that cause them, i.e. a cause and an effect occur at the same time. Effects of anthropopressure can be seen immediately on the surface, e.g. open-pit exploitation of resources, waste-dumps created as the result of heaping (dumping), or levelling works which lead to formation of flat surfaces in places where ones of diversified altitude existed.

That is documented by distribution of concave and convex forms over the central part of Upper Silesia (fig. 2A). Their farther transformation takes place as the result of occurring physical-geographical processes, e.g. blowing away (fig. 2B).

The other group includes indirect anthropogenic causes of changes in the relief. In this case, morphologic effects of man's activities on the relief can be seen after some time. Underground exploitation of resources, especially one using a method of leaving post-exploitation hollows, causes the ground subsidence. That occurs with some delay in relation to the time of exploitation and lasts until internal pressures of an orogen, disturbed by movements of overlying rock masses, return to the state of equilibrium. Also, after piling up a waste-dump, impressed formations are created at its foreland.

Fig. 2. Anthropogenic landforms and their potential transformations in the area of central part of Upper Silesia (after Szczypek, Wach, 1985):
A - occurrence of convex (1) and concave (2) forms, B - hypothetical areas of sedimentation of silt (1) and sand (2) which were blown out from the dumps of black coal mines

So, what anthropogenic forms occur in this region? The most common formation is dumps, which are the result of storing all kinds of post-production waste of various industries, mainly coal, zinc ore and lead ore mining, steelworks of iron and nonferrous metals, as well as chemical, energetic and municipal sewage industries. Dumps occur as mounds of various shapes and sizes, depending on the way waste material in stored. These are most usually low dumps up to 15 metres in height, with flat top surfaces. The exception is in case of cone-shaped dumps in the area of the Rybnik Coal Basin, which are up to 40-50 metres high, and even reach 80 m. in height in extreme cases. Dumps of this kind are no longer heaped up, as their steep slopes contributed to increased erosion-denudation processes.

Excavations are another common anthropogenic form of the relief of terrain. They are created as the result of surface exploitation of various resources. Sizes of excavation hollows range from a few tens square metres up to several dozen or even several hundred hectares.

Some of large-area excavations have been adapted for water management and become useful water reservoirs. Smaller excavation depressions either remain unused objects, or have been adapted as fish-keeping ponds after being slightly remodelled.

Surface deformations occur in areas where underground ore exploitation takes place. They are either continuous or discontinuous deformations. Continuous defor-

Fig. 3. Fragment of the map of anthropogenic modifications to the relief of Upper Silesia (after Jankowski, Havrlant, 1999):

1- extent of anthropogenic relief modification in % of the total area, 2 – dump, 3 – dry excavation, 4 – excavation, water-logged, 5 – dry sink, 6 – sink, water-logged, 7 – levelied ground or filled subsidence basin

mations are characterised by soft extensive depressions of the terrain called collapse synclines. They occur in places where ore exploitation takes place using a method of leaving post-exploitation hollows under the surface, which causes the overlying orogen to deform. A morphological effect of that is depression of surface of the terrain, mainly deflections of layers, without disrupting their continuity. Even in densely built areas, depressions reach 15 metres and more. As the result of surface flows, vast majority of them is filled with water and is used as water reservoirs. They resemble lakes with their look. They are depressions without outflows in most cases, but they also appear in river valleys, forming marshes in such situations.

Discontinuous deformations are created quite rapidly and occur in the form of craters, surface depressions, terrain cracks, clefts and ridges. Their characteristic feature is disruption of continuity of layers. These are most usually small formations – from less than twenty up to a few tens square metres of area. There are also other anthropogenic formations of the relief, like: mounds, dikes, embankments, ditches and small depression craters.

In order to catalogue the created anthopogenic formations and determine intensity of anthropogenisation of the relief, attempts have been made to grasp this matter in the Polish-Czech border zone using cartographic means. That has been taken up under the many-years-long scientific cooperation of the geographic centres situated near the border, namely the University of Ostrava and the University of Silesia (fig. 3).

In squares of 4 km^2 area, a degree of intensity of terrain transformation has been determined. This intensity is expressed in percentage. Prevailing relief formations of anthropogenic origin have been marked in these squares by means of symbols. As can be seen in the enclosed fragment of the map (fig. 3), there are areas – quite big ones – where the degree of terrain transformation reaches 100%. The relief in these areas is of entirely anthropogenic character. Thus, efforts concerning renaturisation are fully justified.

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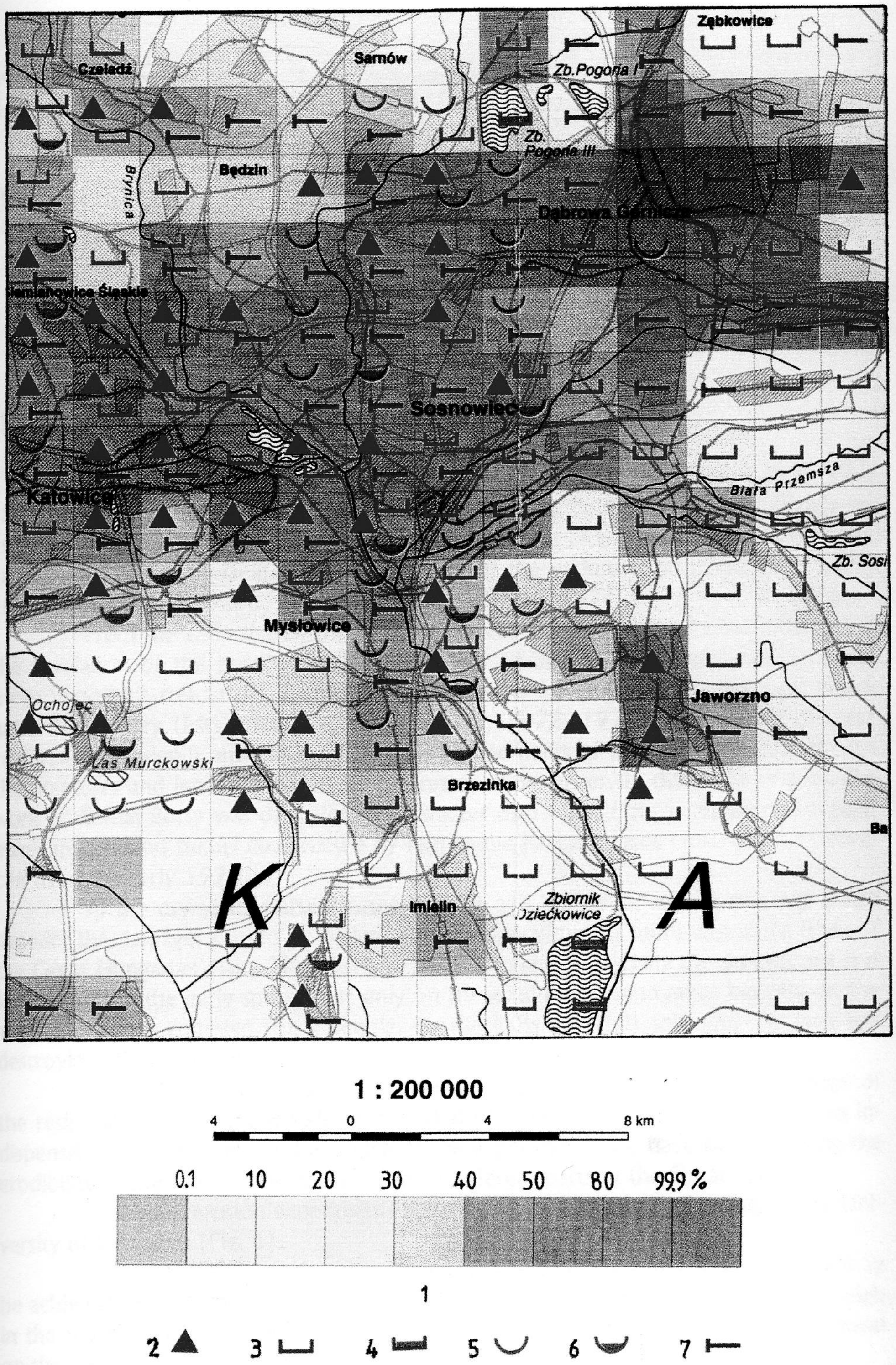

Anthropogenic aspects of Landscape transformations	1	University of Debrecen Debrecen 2000	37–43

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THE STUDY OF WIND EROSION ON DIFFERENT SOILS BY WIND TUNNEL

METHODS

For decades the study of wind erosion concentrated on the wind blown sand areas in the Hungarian geomorphologic researches. In the course of this, considerable results were produced in the description of the regularities of the wind blown sand movements and in the explanation of the genetics of the various wind blown sand forms (CHOLNOKY, 1910; KÁDÁR, 1935, 1956; BORSY, 1965, 1974, 1977; MAROSI, 1968).

From the early sixties, the study of the economic impacts of wind erosion and the revelation of the possibilities for protection against deflation received more and more important role in the geomorphologic research of the semi-cohesive sand blown areas of Hungary (Mrs BODOLAY, 1965; BORSY, 1972, 1974). The success of these researches was significantly increased by the amendments of the field observations with the measures and introduction of the laboratory experiences. In this latter respect, the work of Zoltán Borsy was of a pioneer character who carried out wind erosion experiences in the wind tunnel constructed by him at the Kossuth Lajos University of Debrecen from the early 1970s.

In the dry years started in the eighties and lasting for almost one and a half decade, the damages caused by deflation in the agriculture of more and more lands of the Great Hungarian Plain. They became more frequent (especially the dust storms and sand storms in the early spring) not only on the wind-blown sand areas but also on the areas with more cohesive (for example, on the loess covered) soils and the their soil destroying effect has strengthened.

For the elaboration of the proper protection procedures, the knowledge of the resistance of the various soils against wind erosion – deflation sensitivity - is an indispensable precondition. In the course of the experiments, we have been studying the erodibility of the soil samples collected from different parts of the Great Plain.

The wind erosion experiments were carried out in the wind tunnel of the University of Debrecen (Fig. 1).

In the tunnel, with the present cross-section, 14–15 m/s flowing speed may be achieved in the height of 10 cm. This is in comply with 16–17 m/s at 1 metre high in the nature. At this value, the wind may carry out an extremely strong soil removal on the attackable surfaces which are not satisfactorily protected by vegetation.

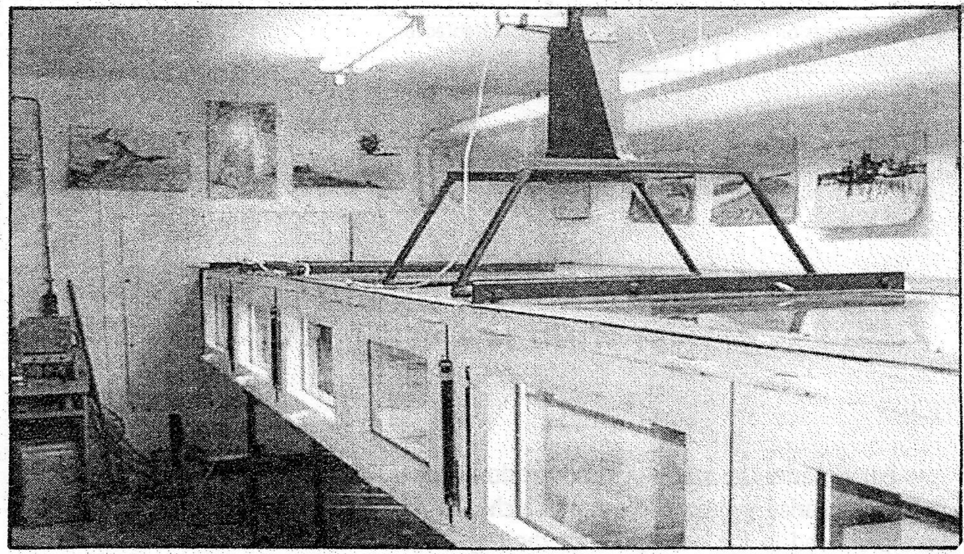

Fig. 1. The wind tunnel of the University of Debrecen

There is also opportunity for the determination of the temperature and humidity in the tunnel. During the experiments, the humidity values did not change significantly, therefore, they had no impact on the process of the erosion and sediment transportation.

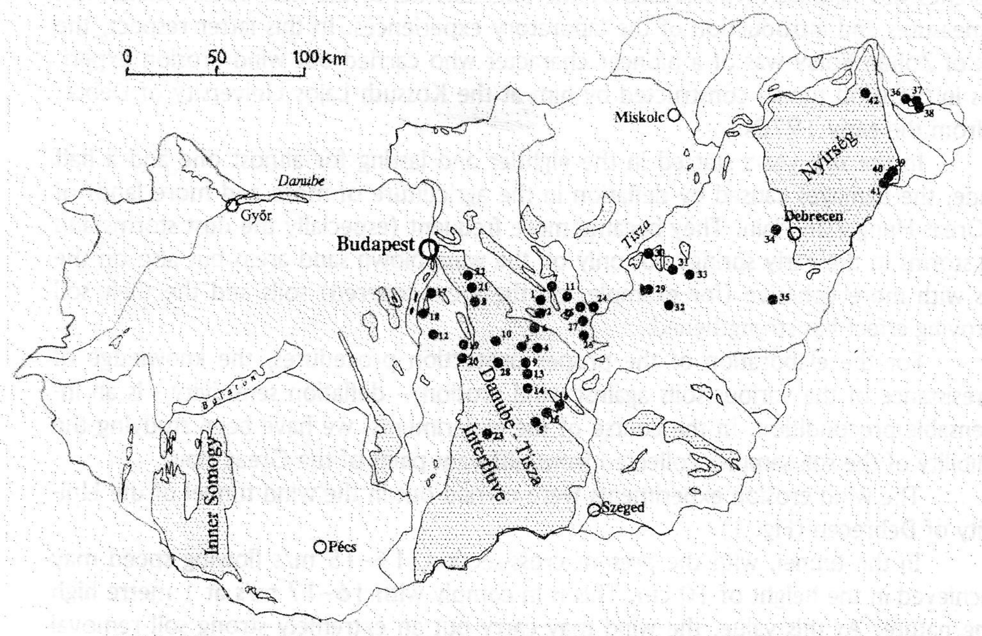

Fig. 2. The sample-taking places of the deflation sensitivity (the dotted areas demarcate the wind-blown sand areas of hungary)

For the wind tunnel experiments, we collected 42 samples from different areas of the Great Hungarian Plain (Fig. 2) from the surface soil layer. The soils with varying humidity content were dried in exsiccators then the pollution (stubble-remnants, weeds, roots, etc.) and the bigger soil blocks occurring in the soil were removed with the help of wire sieve with 2 mm holes.

The thus prepared dry soil was placed on 5 cm deep and 30x50 cm large metal trays in the wind tunnel. A slope with small angle was placed in front of the tray so that the air shall not bump against the perpendicular wall of the tray and the development of the turbulence caused by this would be eliminated.

The experiments were carried out at several rates of speed with measuring the velocity of the wind at different heights above the surface of the soil.

First, we made wind profile measures, then the critical starting speed of the various soil types were determined. We find the determination of the critical starting speed very important at the study of the erodibility of the soils. The starting of the first soil granules can be exactly determined on the line of light stretching in the longitudinal centre line of the tunnel. Thus, the wind speed may be determined for every soil types at which erosion begins. The varying roughness (the differences in friction) of the different soil types is well reflected by the wind profiles developing in the moment of the critical starting speeds.

Following the determination of the critical starting speed, the amount of the transported material was studied on four rates of speed for the sake of getting to know the agricultural soil damages more thoroughly. The 5 cm thick soil traps lying above each other are situated in the centre line of the tunnel. Therefore, at this series of measures, the wind speed could only be measured in the centre line of the tunnel, in the front, middle and end part of the sample-holding dish at four heights. The time duration of the experiments varied depending on the wind speed and size of deflation. The experiments usually lasted for 20 minutes on the first rate after the critical starting speed, while on the largest rate of speed it lasted for 5–10 minutes due to the large-scale of sediment transportation (the results, of course, were converted into the same time duration – 20 minutes).

DEFLATION SENSITIVITY OF DRY SOILS

The velocity of wind was measured on 36 points above the soils placed into the wind tunnel. With this series of experimentation, we measured the speed differences resulting from the differences in friction over the soils with varying granulometric composition.

The values of wind speed were different in the vertical cross-section of the wind tunnel. The changes of the values measured at different heights depended on the roughness of the soil. For the comparison of the soils, we chose the wind speeds measured over the centres of the sample-holding dishes. The averages of the speed values at the different soil types (Fig. 3) well demonstrate the variations caused by the granulometric composition and the roughness of the surface.

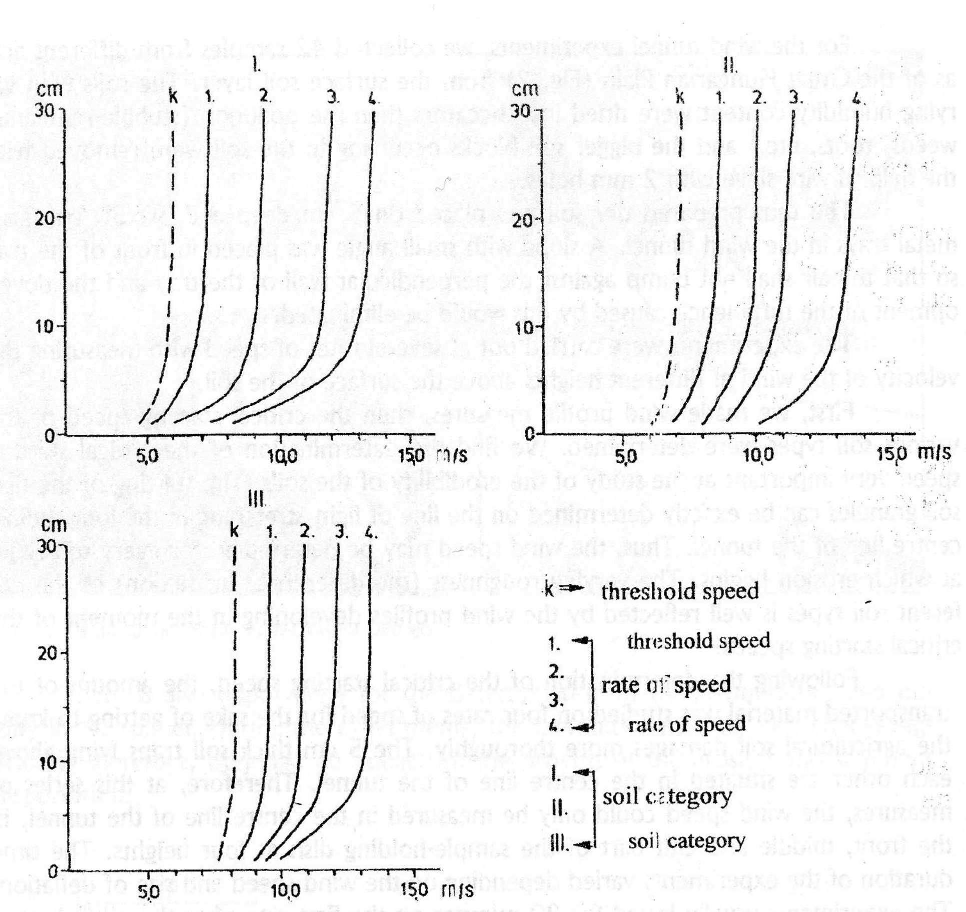

Fig. 3. Average wind speeds measured above the soils

Evaluating the wind profile curves of the soils, it may be established that with the increase of the wind speed, the speed decreasing effect of the surface asserts itself more effectively. On the smallest rate of speed of our experiments, the speed measured on the surface level hardly differed from the values measured in the 10–30 cm height range. This explains the steepness of the functions. With the acceleration of the speed, the speed decreasing effect of the roughness of the surface is more conspicuous, thus, the difference is considerable between the values measured close to the surface and in the bigger heights. It may be also established that as a consequence of the friction of the air to the surface, the speed increases more vigorously only for about 10 cm.

On the basis of our measures made in the wind tunnel, the samples collected were grouped into three categories. The steepness of the functions (I.) of the wind profiles of the sand soils with rough surface, in the 0–10 cm height range considerably decreases with the increasing of the wind speed. Above 9 m/s wind speed, the large amount of sediment transported saltating close to the surface (0–10 cm) also significantly decreases the energy of the wind. Therefore, the decrease in the wind sped may not only be explained by the roughness of the surface. Microforms are formed on the levelled surface in a short time which also influence the flow of the air.

The soils developed on loessy sand and sandy loess have smoother surface due to their granulometric composition, and because of the smaller friction the wind profile functions (II.) differ from that of the sand soils. In the 0–10 cm surface close range, the speed of the wind does not decrease with the same intensity as we experienced it in the case of the sand, therefore, its function is steeper. It must be noted here that due to the finer granularity, because of the cohesion between the granules, the erosion of the surface starts at a higher rate of speed but then the floating finer granules get higher than the saltating wind-blown sand. Thus, the sediment flows in the entire cross-section of the tunnel in such a way that the saltating granules close to the surface decrease the energy of the wind here as well. During our measures, we experienced differences between the samples depending on their small and medium sized granule contents but the average values were easily separated from those of the sand soils.

Those soils may be listed in the third category in which the sum of the clay and mud fractions exceeded 60%. We observed when preparing the samples that the formation of the aggregate is the most considerable in the case of these soils. The mud and clay granules cohered into larger scale soil granules – a part of which fell into pieces during the dry sieving. The surface of the levelled surface soils filled into the sample holders became smooth, therefore, the smallest friction could be observed in the case of these. The values of wind speed (III.) at the low rate were close to the values of the second category. The soil granules started a saltating movement at the highest speed used at the experiment like the wind-blown sand. They fell into pieces because of this and the large amount of fine fraction got into floated state.

The lowest critical starting speeds was measured in the case of the wind-blown sand collected in the neighbourhood of Fülöpháza – in the central part of the tray at the height of 10 cm and at the speed of 5.50 m/s. The critical starting speed of the sand soils varied between 5.50–6.00 m/s depending on the granulometric composition. Our measuring results refer to the fact that those samples in which the percentage value of fine sand is the highest are the less resistant against wind erosion.

The threshold speed values measured on the soils formed on loessy sand and sandy loess fell into the interval of 6.45–7.80 m/s. The higher values were measured in the case of those soils where the lower sand content was paired with higher mud and clay contents.

The bounded meadow and alluvial soils resist the best against the wind erosion in which the granules were started only by the 7.60–8.70 m/s winds.

The knowledge of the critical starting speed of the soils is very important in the protection against wind erosion. Our results also supported the generally known fact that o the unprotected loose sand surfaces even the weaker winds may move the granules.

The loessy sediments and the more bounded soils resist more the energy of the wind but if the speed of the wind exceeds the threshold speed necessary for the starting then erosion accelerates like an explosion. The fine granulometric composition fraction is very damaging from the aspect of environmental protection as well.

Analysing the data of erodibility (Fig. 4), the high erodibility value of sand soils becomes visible. We also noticed during the experimentation that there is difference between the deflation of the sands as well. The wind transported the highest amount from the samples which had low humus-content and contained lots of fine sand granu-

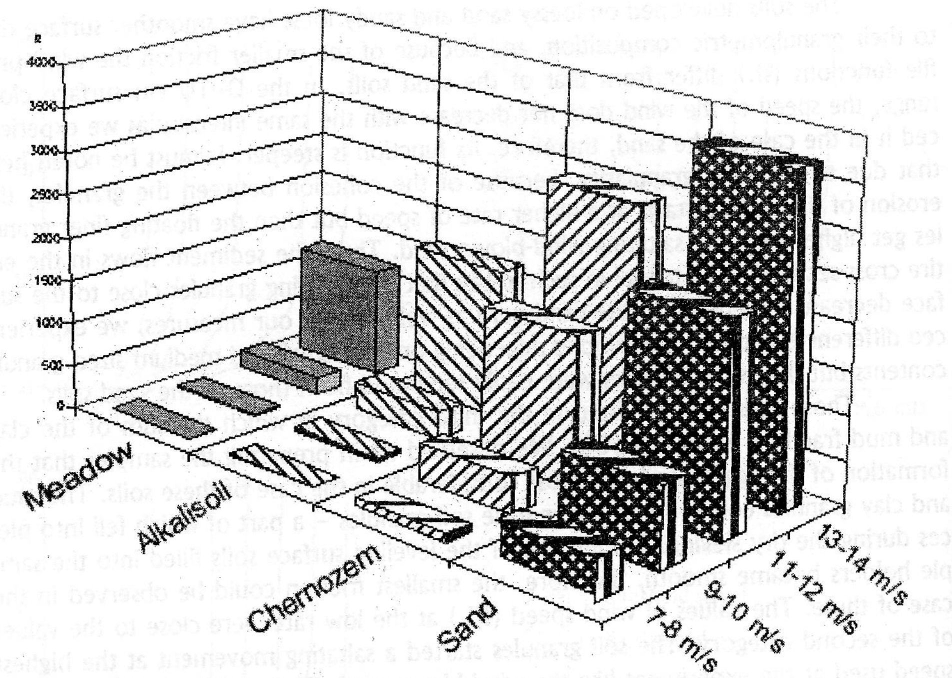

Fig. 4. Average weight of eroded soils at the four speed rates

les. At the highest speed rate (13–14 m/s), the weight of the eroded soil exceeded 4 kg. We got similar but smaller values in the case of the samples which had less humus and contained more fine sand fraction.

Further analysing the results of the wind tunnel experiment it may be established that there is a considerable difference between the erodibility of the chernoziom soils formed on the loessy sediments and the sand soils. During the experiments it became obvious first in that the samples containing loessy fractions started at a higher speed and secondly that less amount of material was moved at the different speed rates. Nevertheless, attention must be paid to the fact that there is a high quantitative change between the values measured at the third and fourth speed rates. This may be explained by the fact that the small and medium sized granules hitting with great force letting a large amount of fine fraction into the air.

Wind erosion has also been measured on the alkali soils of the Great Plain. The erodibility of the samples prepared in the laboratory similarly to the other soils was small at the first two speed rates but we could conclude from the amount of the material transported by stronger winds that potentially we have to take into account the danger of wind erosion in the case of these soils as well. Under natural circumstances without anthropogenic impact, these soils are more resistible against wind erosion but their ploughing and harrowing may increase their erodibility.

The danger of wind erosion is the smallest in the case of the alluvial and meadow soils. The experiences and results of the experiments demonstrate that the erosion measured in the cases of the alkali, meadow and alluvial soils depends on the mud, clay and calcareous content of the soil.

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Anthropogenic aspects of Landscape transformations	1	University of Debrecen Debrecen 2000	44–50

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TRANSFORMATIONS OF LANDSCAPE OWING TO PEAT EXPLOITATION (A CASE STUDY OF TSNA AND BEREZINA RIVER VALLEYS – NORTH-CENTRAL BELARUS)

Belarus Republic is a country of marshes and peatmoors. They occupy 12.4% of total country area (GURSKI, KUDLO, 1995) and they are practically distributed in its whole area, mostly concentrating in river valleys of different size (fig. 1). Five provinces of peatmoors occurrence have been divided: (1) northern – of highmoors in the hilly landscape with lakes, (2) western – of lowmoors in the landscape of frontal moraines, (3) central – of large low- and highmoors in the landscape of sloping ablation plain, (4) eastern – of small low- and highmoors in the landscape of loess-like covers, (5) southern – of large lowmoors in the landscape of Polesie (*Atlas...*, 1998). Among all peatmoors types in Belarus lowmoors with grass vegetation (80%) decidedly predominate. Industrial resources of peat amount to about 1.2 milliard tons. Mineral deposits of peat are of different thickness; the largest one reaches 11 m (GURSKI, KUDLO, 1995).

So significant distribution of marshes and peatmoors in an area of Belarus in certain period required to carry out widely conceived melioration works. It is estimated that they included about 2.8 million ha of lands, which were changed into plough lands or pastures. But it led to the significant soil degradation because e.g. processes of peat deflation reached 5–10 tons per ha per year (MARCINKEVICH, KLITSUNOVA, 1989).

The peat in Belarus is also the object of exploitation as an important material, which was formerly used for energy producing but now it is used for municipal economy and for agriculture (as composts and for fertilisers producing). It is exploited in many points, what leads to the defined changes in landscape. The purpose of this note, being the result of common Polish-Belarus scientific research is to present the landscape contrasts, which appeared owing to peat exploitation in peaty-marshy areas, located close to each other. The objects of research are as follows: peatmoor in the Tsna river valley and peatmoors in the upper course of the Berezina river within borders of the Berezina Biosphere Reserve (fig. 1, 2). Mean annual air temperature amounts here to 5.2°C and annual precipitation sums reaches 691 mm (STAVROVSKY, KOVALEV, 1996).

Both objects are located close to each other in distance of about 12 km, but the Berezina peatmoors are numbered among the above-mentioned northern province and peatmoors in the Tsna valley – among the western one. They are also incompa-

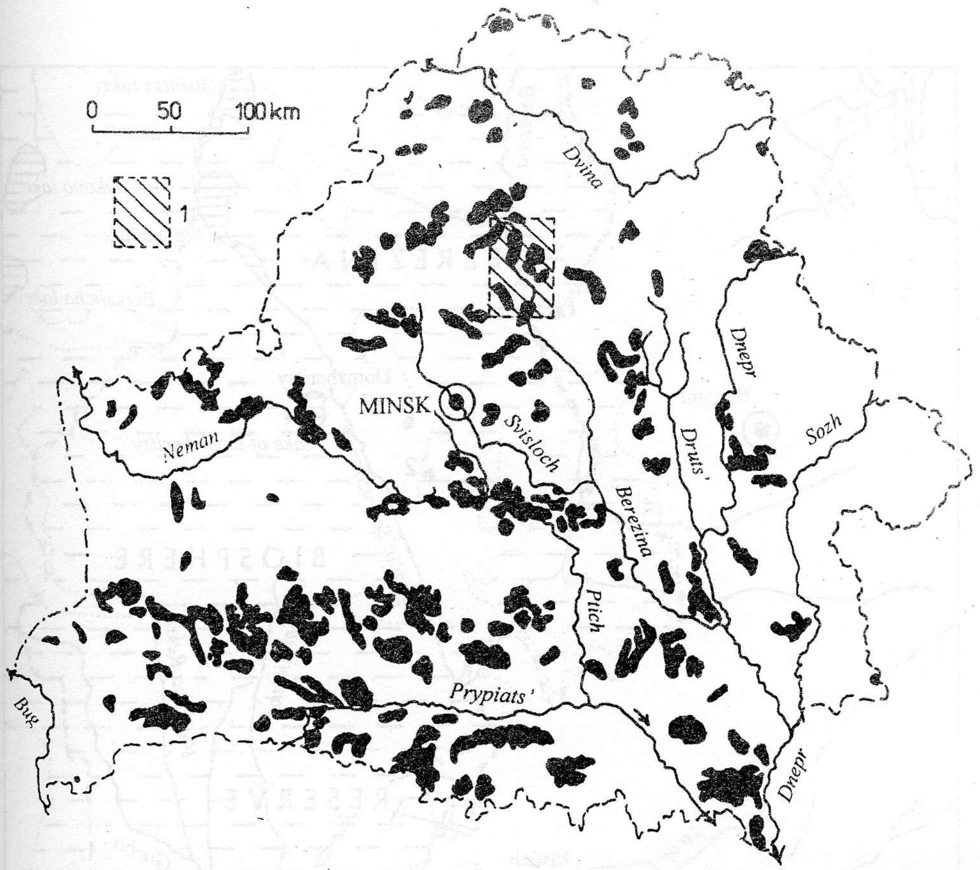


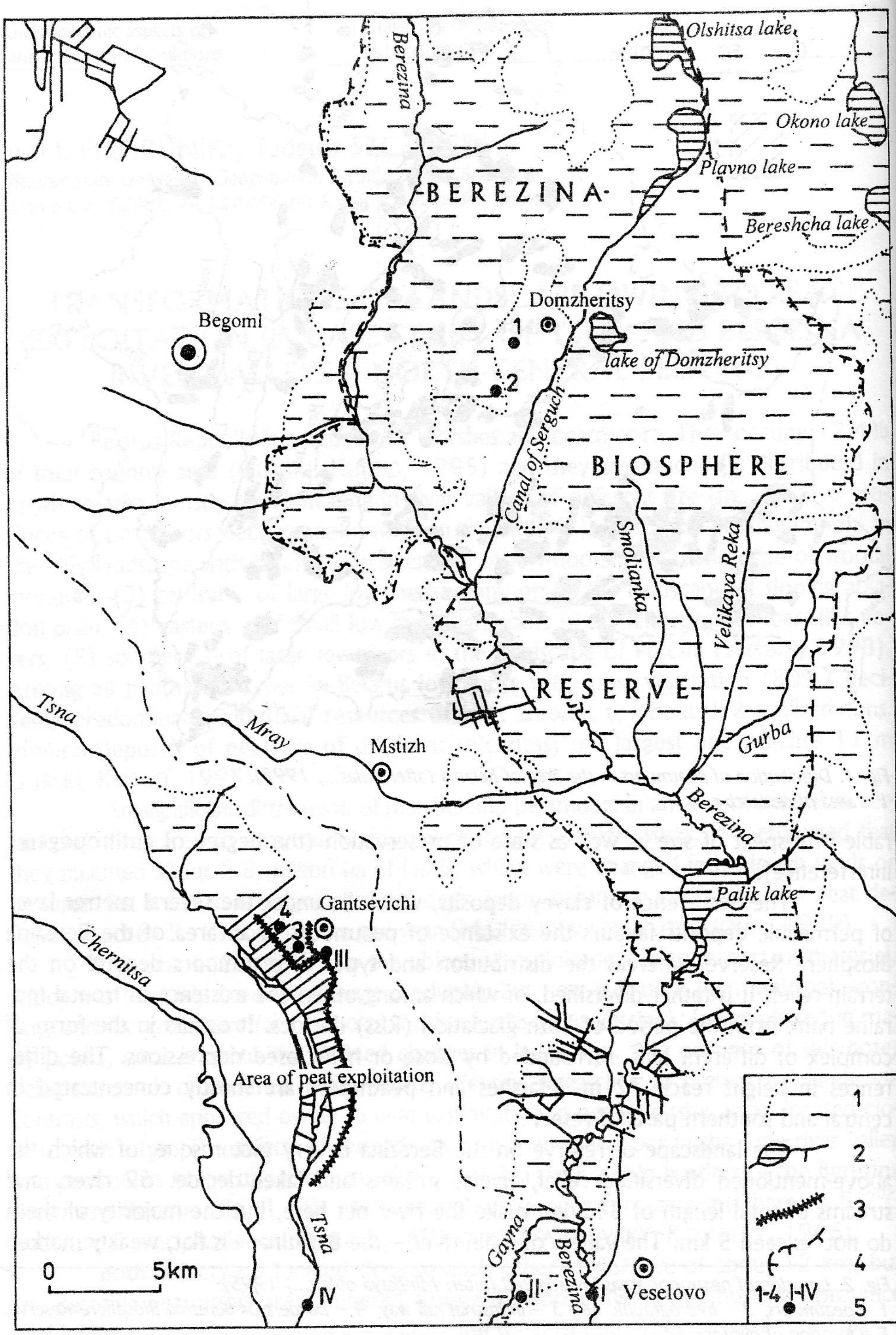
Fig. 1. Distribution of peatmoors in the area of Belarus (after Atlas..., 1998):
1 – area of research

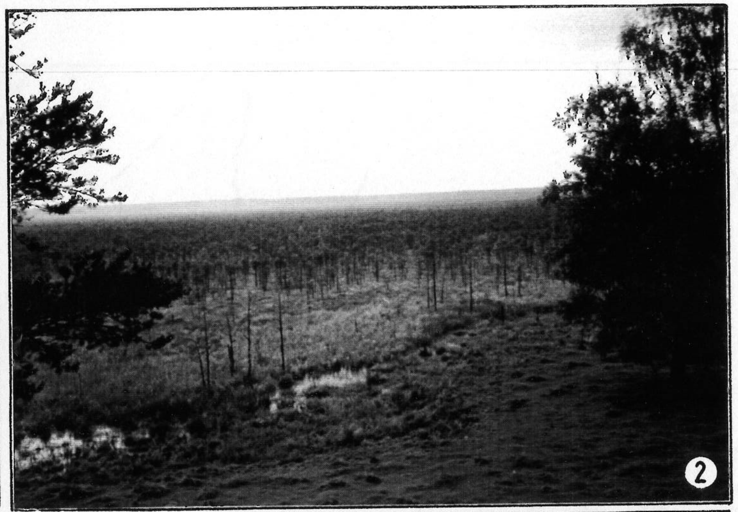
rable in respect of size as well as state of preservation (the degree of anthropogenic interference).

The occurrence of clayey deposits, which lie under the several metres layer of permeable deposits favours the existence of peatmoors in an area of the Berezina Biosphere Reserve, whereas the distribution and types of peatmoors depend on the terrain relief. It is rather diversified, of which among others the existence of frontal moraine bank from the period of Sozh glaciation (Riss) decides. It occurs in the form of complex of different hills, surrounded by close or half-closed depressions. The differences in height reach 72 m. Marshes and peatmoors are mostly concentrated in central and southern parts of reserve.

The landscape of reserve on the Berezina is very picturesque, of which the above-mentioned diversified relief, rivers, streams and lakes decide. 69 rivers and streams of total length of 315 km make the river net here, but the majority of them do not exceed 5 km. The valley of main river – the Berezina – is flat, weakly marked →

Fig. 2. Location of peatmoor areas investigated (after: Minskaya oblast..., 1995):
1 – peatmoors, 2 – hydrographic net, 3 – industrial rail way, 4 – borders of Berezina Biosphere Reserve, 5 – location of photos


Olshitsa lake
Berezina
Okono lake
Plavno lake
BEREZINA
Bereshcha lake
Domzheritsy
Begoml
1
lake of Domzheritsy
2
Canal of Serguch
BIOSPHERE
Smolianka
Velikaya Reka
RESERVE
Tsna
Mray
Mstizh
Gurba
Berezina
Palik lake
Gantsevichi
Chernitsa
4
3
III
Area of peat exploitation
1
2
3
4
Tsna
Gayna
Berezina
0
5km
II
I
Veselovo
IV
1-4 I-IV
5


1

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3

4

Photo. 1 Natural mixed forest in the Berezina Biosphere Reserve (photo by T. Szczypek)
Photo 2. Natural peatmoor in the Berezina Biosphere Reserve (photo by I. I. Pirozhnik)
Photo 3. Depression after peat exploitation in the neighbourhood of Gancevichi (photo by T. Szczypek)
Photo 4. Field of rapes in peat post-exploitation area in the neighbourhood of Gancevichi (photo by I. I. Pirozhnik)

in relief and it joins with adjacent marshy and forested plain. The mean width of this river flood terrace reaches 2–3 km and maximum – 6 km in the vicinity of Palik Lake. Lakes in the reserve occupy total area of 16.8 km^2. They are flat objects, have low marshy shores and – besides Palik lake – they clearly overgrow (STAVROVSKY, KOVALEV, 1996).

Area of forest complexes (photo 1), marshes and peatmoors (photo 2) on the Berezina belongs to almost completely not changed by anthropogenic activity, what is very rare in the area of Belarus. It was appreciated as a natural reserve in 1925 and the purpose and main task of its functioning was mostly a protection of local population of river beaver. In 1979 this object was entered on the international list of biosphere reserves (MARCINKEVICH, KLITSUNOVA, 1989; GURSKI, KUDLO, 1995; STAVROVSKY, KOVALEV, 1996). All types of peatmoors, which occupy almost 70% of reserve area, occur here, the high ones are appreciated as unique. Open peatmoors occupy only 10.3% of reserve area; the rest is covered with different forest complexes. Anyway forests are the dominating vegetation formation here, because they occupy 83.3% of reserve area. The pine forest prevail here (45.4%, including 60% at marshes), the following places birch-, spruce- and other forests occupy (MARCINKEVICH, KLITSUNOVA, 1989).

Under slightly stronger human pression are marshes and peatmoors in the Berezina valley below the biosphere reserve. Area, meliorated to a small degree and partly changed into hay-growing meadows, occurs here. The certain role in these areas degradation can play settlement, located near the Berezina bed. However, in sum, although this area is located under the human control, physionomically it is similar to the natural, only slightly changed by this man (photo I). Similar situation occurs in the lower section of the Gayna river valley, at the mouth to the Berezina. Although the human impact is here more visible (photo II).

Diametrically different landscape is observed in the lower course of Tsna river valley in the neighbourhood of Gancevichi locality (fig. 2). It is an area, which is separated from the Berezina valley by not very high and in many places very unclear watershed. Lowmoors of area of 6500 ha developed here (*Tsna*, 1986a, b; *Atlas...*, 1998). The river valley is 1–2 km wide, in some places – 3.5 km, whereas in the majority of cases the bed is regulated. The above-mentioned peatmoor has been exploited for more than 25 years, and peat is mostly used as the material for municipal economy. The thickness of peat layer reaches maximally 5.9 m and on average amounts to 2.4 m. Initial peat resources reached 27.4 million tones.

From fig. 2 results that before the mid-1990 about 50% of deposit area has been exploited. Owing to the exploitation the dense net of melioration ditches, draining terrain appeared. After exploitation in many places depression of different size filled with water (photo 3) appeared. Characteristic anthropogenic landscape elements are also lines of industrial railway, by means of which the peat is transported into processing plant. So in the physiognomy the clear lack of natural harmony is observed.

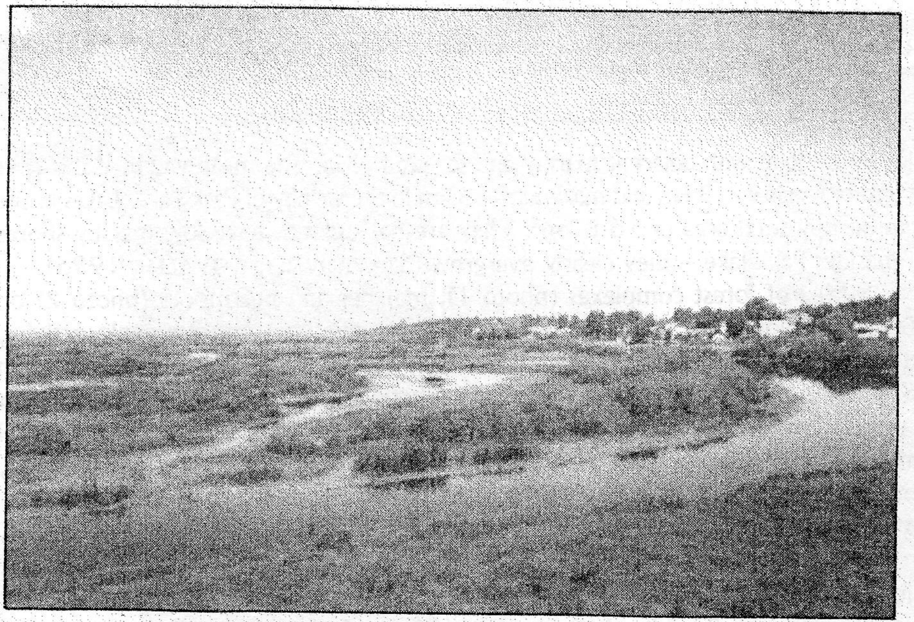

Photo I. The Berezina river valley in the neighbourhood of Veselovo (photo by I. I. Pirozhnik)

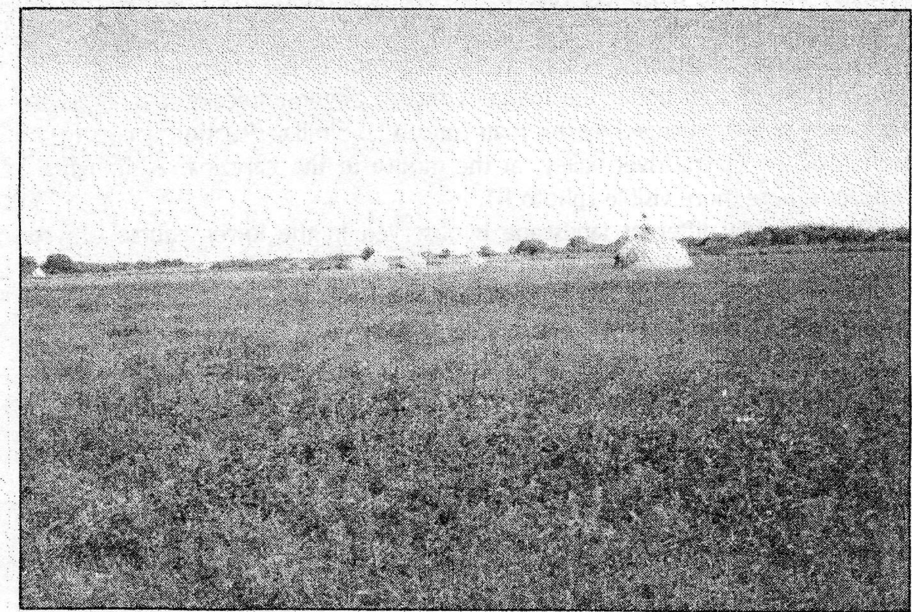

Photo II. Hay-growing meadows in the Gayna river valley (photo by T. Szczypek)

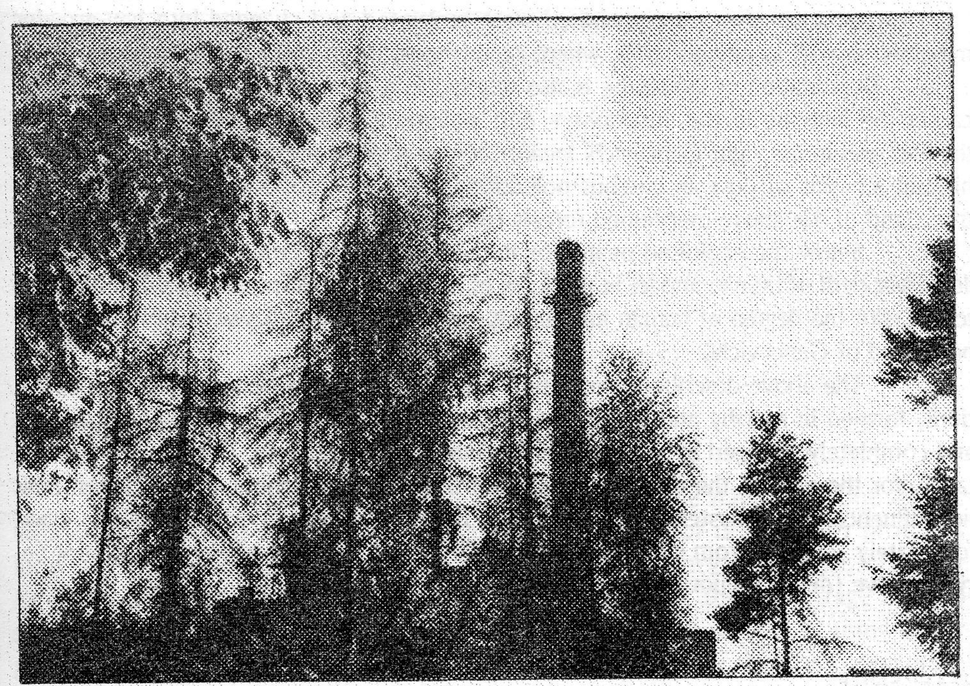

Photo III. Degradation of forest vegetation in the processing plant in the neighbourhood of Gancevichi (photo by T. Szczypek)

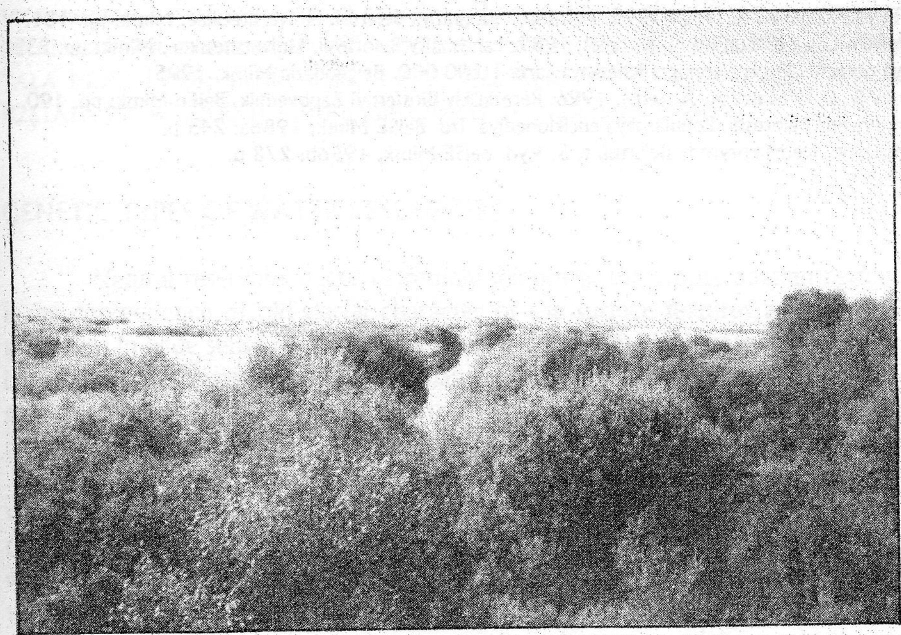

Photo IV. The Tsna river valley below the peat exploited (photo by T. Szczypek)

Larger areas after peat exploited were reclaimed and changed into hay-growing meadows as well as plough lands, where rape is most often cultivated (photo 4).

Degradation of landscape is also marked in a form of peat dust blowing, what causes the increase in the atmosphere dust pollution, pollution of forests, located to the east and in the right Gancevichi locality, whereas processing plant of peat emits significant amount of dust an gaseous pollutants to the atmosphere, which destroys the tree stand of the above-mentioned forests (photo III).

Below the exploited peatmoor in the Tsna valley, similarly to the Gayna valley, clear signs of human impact in the form of cultivated, dried meadows also exist (photo IV), but the degree of human influence is here incomparably lower than in the neighbourhood of Gancevichi.

The above-described situations show diametrically different landscape conditions, formed in marshy and peaty areas: natural, almost not touched by human arm, and completely changed by man owing to mining and agriculture. Despite of small distance, for the present the degraded landscape with lowered ground water horizon does not influence the geosystems of the Berezina Biosphere Reserve, what probably – and fortunately – results from their location in different watersheds as well as from not very intensive (deep) melioration.

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Anthropogenic aspects of landscape transformations	1	University of Debrecen Debrecen 2000	51–57

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SELECTED MATTERS OF PROTECTING WATER RESERVOIRS OF THE UPPER SILESIA REGION DUE TO THEIR GENETIC AND FUNCTIONAL DIVERSITY

INTRODUCTION

As the result of water deficiency characteristic for the watershed zone and development of mining and processing industries, as well as of urbanisation processes, local water resources have turned out to be insufficient, as they could only serve their functions sufficiently during the pre-industrial period and at the early stage of industrialisation. Water supply from rivers and existing reservoirs, as well as using underground waters turned out not to be sufficient enough to satisfy the water demand of the region as early as the end of the 19th century, when its shortage started to be clearly noticeable. Due to the development of industry and urbanisation, which were accompanied by increased demand for water, a few thousand genetically diversified water reservoirs have been created, which vary according to their areas and retention capacities as well as extremely different forms of functionality (e.g. RZĘTAŁA M., RZĘTAŁA M.A, 1998; JANKOWSKI, 1999; RZĘTAŁA, 1999; KOZYREVA, RZĘTAŁA M., RZĘTAŁA M. A., 2000) – from idle objects to multi-purpose ones.

GENETIC TYPES OF WATER RESERVOIRS

Natural reservoirs occur extremely seldom in the Upper-Silesian region. That is the consequence of old-glacial character of the surface features and its anthropogenisation in wide sense of this notion, among others. In fact, there are a minor number of water reservoirs that occur in natural depressions. Lakes of this type, e.g. reservoirs in deflation-type depressions surrounded by dunes which are reinforced by plants, can be found on the borders of the Silesian Upland.

Basins with anthropogenic origin prevail in the discussed region. Human activities contributed to their formation either directly or indirectly. Many reservoirs are characterised by complexity of processes that lead to the formation of a lake basin, which results in a multi-aspect procedure of carrying out a typological classification. Nevertheless, a few characteristic types of artificial water reservoirs can be distinguished, which serve the purpose of retention, i.e. storage of water, to a lower or higher degree.

Water reservoirs created in surface hollows that remain after exploitation of mineral resources are generally of less functional importance, and an interest in managing them and optimal utilisation of retained water is usually insignificant. That results from the fact that qualification of a post-exploitation hollow as a prospective water reservoir is a convenient act – frequently the only possible and economically most advantageous one in the context of land reclamation proceedings. This is a peculiar paradox, as a water reservoir is actually created basing on factors which are in favour of localisation of an open-pit mineral resources exploitation plant (RZĘTAŁA, 1998).

Dam reservoirs, created by means of erecting dams across river valleys, have been existing in the landscape of Upper Silesia for quite a long time. Creating them is fully justified by localisation factors, and new-created hydrological objects serve precisely defined purposes. In past centuries, these were relatively small objects in terms of area or retention capacity. Stored water was used for various purposes, e.g. it was necessary to ensure functioning of sawmills, water mills, etc. Nowadays, dam reservoirs are most usually built within the discussed area for multi-purpose utilisation. These are objects with diversified areas. Some of them are up to several square kilo-metres (e.g. Przeczyce, Kozłowa Góra), and the Goczałkowice reservoir in the valley of the so-called Mała Wisła river (Small Vistula), whose exploitation has already started, has a maximal area amounting to 32 km^2.

Reservoirs that have emerged as an unintentional effect of economic activities (e.g. reservoirs in depressions and collapse synclines), which are usually idle objects due to continuous deformation processes of the base ground, small area or capacity, and often due to insufficient quality of retained water, are a more serious problem (WACH, SZCZYPEK, 1996; JANKOWSKI, RZĘTAŁA, 1997a, 1997b).

Ponds, which are frequently regarded as dam reservoirs, should rather be treated as genetically distinct objects, not only because of differences between a dam and a dike, but also because of morphometric and exploitative distinctiveness. Morphometric distinct features include first of all differences in depth relations and properties of bottoms. Exploitative distinct features, in turn, mean first of all differences in water management determined by the course of a farming cycle.

Pools are small water reservoirs, which are most usually built near households. Their purpose is related to storage of water necessary for those households, but material obtained as the result of earthworks is usually treated as a sporadically utilised waste and has no economic use, contrary to the case of post-exploitation reservoirs.

Polish geographic, and even limnological, literature often describes water reservoirs that are built for the needs of industry or public utilities; they are mentioned as objects which are related to the production cycle of industrial plants, or they are called industrial reservoirs (which does not seem to be fully justified), or they are referred to as „other" (this name, although it is probably the most suitable one, is in turn too enigmatic and suggests a very wide range of characteristics of genetic types of artificial reservoirs). Regardless the general nomenclature employed for this group of objects (which have been built by man on purpose and are characterised by quite low values of morphometric parameters), one can distinguish: fire-fighting pools, swimming pools, settlement tanks of different kinds of water, reservoirs at purification plants, water reservoirs for industrial (e.g. for production processes) or municipal purposes and a number of other, less important ones.

FUNCTIONS OF WATER RESERVOIRS

Water reservoirs of the Upper-Silesian region, which are usually regarded as multifunctional objects, are of specified economic importance which, due to the specific character of this paper, will be discussed in detail below. Along with their immediate vicinity, they also serve important purposes concerning nature and landscape, e.g. diversity of ecological niches (biotopic niche, trophic niche); biodiversity; places of bird's hatching and nesting; places of occurrence of „new" species of plants or animals; changes in local climate – like soothing extreme temperatures, increase in wind speed, increase in fog occurrence frequency; shaping aesthetic values of the environment. Creation of reservoirs was to a great degree related to a particular demand for increased retention. Equally many reservoirs that are treated as unintentional effects of human activities are considered as idle objects or as objects that are used in a far different way than the original intentions.

Relatively many reservoirs in the discussed region have functions that are related to water storage for the needs of industry, public utilities, and less often of agriculture. Several artificial lakes that are among the biggest ones in the Silesia Province can be given as an example: Goczałkowice, Dziećkowice, Kozłowa Góra, Przeczyce, Pławniowice. In this respect, their utilisation is based on taking water directly from the lake basin through water pipes, or they play an indirect part in water supply by ensuring a minimal flow in a lower situated watercourse, which makes it possible to ensure operation of intakes of surface or infiltrating underground water that are installed there. The Dziećkowice reservoir is an extreme form of the discussed utilisation of retained water; it supplies water for industry and urban utilities in the central part of the Silesia Province basing on waters transferred from the catchments of the Soła and Skawa, and for that reason it is treated first of all as an element of the system of clean water transfer.

A big group of water reservoirs, especially ones that are bigger in terms of capacity, serve flood control purposes, protecting areas situated in lower parts of the catchment, i.e. areas below these reservoirs, from flooding or inundation. Artificial water reservoirs of the Upper Silesia region overtake and relieve the character of high water waves by decreasing maximal flows to the level which is safe for a valley thanks to their flood-control reserves, and increase the retention capacity of the catchment. The consequence of an increased demand for water on the one hand, and a need to work out efficient flood-control solutions on the other hand, is that projects which emphasise both the importance of big existing and prospective retaining objects and the role of so-called small retention in human life and economic activities are extremely successful.

A big amount of water reservoirs in a region which is characterised by high values of population density rates is a very advantageous solution as far possibilities of rest and recreation are concerned. Theoretically, rest and recreation are possible using any water area; in practise, however, there is a number of restrictions concerning not only insufficient water quality, but also legal prohibition of such forms of activities near some objects, e.g. reservoirs of potable water. Nevertheless, there are water reservoirs within the Silesian Upland and adjacent areas, which are treated mainly as places of weekend recreation (Dzierżno Duże, Pławniowice, Pogoria III, Pogoria I, Rogoźnik, Chechło, Sosina, Balaton, Stawiki, Czechowice). Longer stays at the lakes are rather sporadic and are usually the result of being not able to organise a rest in other parts of the country or abroad. Impetuosity of such a recreation is a separate matter. Insufficient catering background and lack of inexpensive sleeping facilities which would be able to compete with prices in popular resorts determine people to stay for a short time, most usually on unlicensed camping sites. That evokes a wide range of consequent problems: leaving rubbish, water pollution, noise, etc.

In spite of large quantity and area of water reservoirs, they are of insignificant transport importance as far as transportation of both people and goods is concerned. Yet, there are reservoirs whose functions are indirectly related to transportation. For example, co-operation of three reservoirs in the catchment area of the Kłodnica (Dzierżno Duże, Dzierżno Małe, Pławniowice) serves the purpose of supplying water to sections of the Gliwice Canal situated below the Dzierżno sluice and, indirectly, improving sailing conditions on the Oder (Odra) river.

Exploitation of mineral resources from water reservoirs in the discussed region is of entirely negligible importance and is mainly related to relatively short time of their functioning, which in turn indicates the early phase of development of the lake basins. The Dzierżno Duże reservoir is a makeshift of exploitative function of reservoirs in the Upper Silesian region; a large-sized delta was formed in its eastern part, which was built from coal-dust carried by the Kłodnica and is periodically exploited in the process of purifying the reservoir. It should be emphasised that the notion „exploitation of mineral resources" is meant exclusively as exploitation of the material which is genetically related to a lake. In this respect, sand carried by near-shore currents to a cove of a lake, which is a material of exploitation, will indicate its exploitative functions, while sand mined within an open pit which is successively filled with water will not.

Utilisation of water reservoirs for farming purposes dominates especially in areas adjacent to the southern borders of the Silesian Upland (e.g. Dolina Małej Wisły Small Vistula Valley – Small Vistula Valley). In the remaining part of the upland, reservoirs also serve farming purposes, but to much smaller degree, which is indicated by much lower number of objects of that type; that may be related to the high level of water contamination. The discussed aspect of functionality of reservoirs concerns mainly fish farming, yet few examples of activities are known which suggest wider range of use in this respect. Reservoirs that are used for farming purposes are specific due to high level of water fertility and the character of water management they are subjected to – in vast majority of cases a basin is filled in spring and emptied in autumn. Some doubts concerning the functionality of water reservoirs can be raised by the fact of feeding, growth-controlling and catching (angling) fish in big multi-function reservoirs, e.g. Kozłowa Góra, Przeczyce, Pogoria III, Pogoria I etc. Due to the character of these activities (angling meant in terms of sports and recreation) as well as statutory tasks of institutions that organise them (most usually local branches of the Polish Angling Union), reservoirs under discussion should be regarded as ones with sports-recreation- and rest functions rather than ones with farming functions, contrary to what is commonly assumed.

Few artificial reservoirs serve power-generating purposes. In fact, there is no other so spectacular utilisation apart from the pumped-storage power plant built on the eastern slope of the Soła valley (Żar Peak in the Small Beskids Mts.), yet there are water-damming objects which make it possible to generate small amounts of electric energy. A specific example of indirect energetic function of lakes is a dam reservoir Rybnicki, whose retention is utilised for chilling power units of the thermal power plant situated nearby.

SELECTED MATTERS OF PROTECTION

Artificial water reservoirs of the Upper Silesia region, in spite of their localisation indicating pollution which far exceeds norms defined by legal codes, are subject to various forms of legal protection. Admittedly, they are not under the natural protection scheme as a part of national parks, as the latter do not exist within the discussed region, yet they are objects of special treatment as they are situated within natural preserves (e.g. Łężczok ponds), landscape parks (reservoirs in the Landscape Park „Cistercian Landscape Composition of Rudy Wielkie" – „Cysterskie Kompozycje Krajobrazowe Rud Wielkich"), or regions of protected landscape. A „record station" and a „monument of nature" as legal forms of protection of environment do not concern the water reservoirs under discussion, but they are all subject to both plant and animal species protection if only such species occur there. A relatively frequent form of protection of environment in the Upper Silesia region is an ecological ground, created on the basis of a decree of the province mayor or by a resolution of a borough council. Its major aim is to protect an ecosystem which is essential for preserving unique genetic resources and types of environment. Examples of ecological grounds are fragments of shores and water areas of the reservoirs Pogoria I and Pogoria II in Dąbrowa Górnicza, or the Grűnfeld pond in Katowice. Another, more and more common legal form of environmental protection in the discussed region is so-called nature-landscape complexes – created on the basis of administrative regulations, just like in case of ecological grounds – whose aim is to preserve aesthetic values of particularly precious fragments of natural and cultural landscape. An example in this respect is an existing nature-landscape complex in the Lubomia borough, or a planned one in the area of the park and the adjacent reservoir in the Świerklaniec borough.

A number of protection possibilities are provided by existing regulations and recommended systems of lake quality assessment. However, presence of these legal regulations is not always clearly related to obeying and using them in practice.

Some doubts emerge regarding using the same criteria for the quality of both standing and running surface waters, which are mentioned in the Decree of Minister of Environmental Protection, Natural Resources and Forestry of 5th November 1991 concerning water classification and conditions that should be met by sewage discharged to waters and to ground. The aforementioned decree treats lakes in a special way as objects of special protection, forbidding sewage discharge to inland lakes or to lakes and their tributaries in distances of 3 km from their mouths if sewage has not been discharged to them so far. Although such a solution is justified, it does not seem to be fully satisfactory, especially considering a wide range of legal possibilities of exemption from an obligation of strict obeying to them.

Differences between specification of environment of standing waters and that of flowing waters are a foundation for searching for another possibilities of assessing lakes as territorial environmental systems. Methods and solutions that are already in existence are often adapted. The system of lake quality assessment worked out in the PIOŚ (now IOŚ) enjoys common acknowledgement (KUDELSKA, CYDZIK, SOSZKA, 1994). Conclusions as to rational management, protection and reclamation of lake waters are drawn basing on results of lake quality assessment according to two criteria, namely degradability and a water purity level. While assessing degradability, the following factors are take into account: average depth of a lake, a ratio of capacity of a lake to the length of its shoreline, percentage of water stratification, quotient of active bottom area, percentage of yearly water exchange, Schindler factor and methods of management of direct catchment. When determining the class of purity of lake waters, in turn, it is not several dozen factors that are used (like in case of the aforementioned ordinance of Minister of Environmental Protection, Natural Resources and Forestry), but eighteen basic ones (e.g. average oxygen saturation of hypolimnion, dissolved oxygen, ChZT, BZT_5, phosphates, total nitrogen, electrolytic conductivity), whose values – provided that recommended time and place of taking samples of water for analysis are observed – give the most overall and representative result of assessment.

Artificial water reservoirs of the Upper Silesia region are subject to indirect protection due to execution of statutory targets of municipal institutions and agencies which administer lake waters. There are water bodies or their parts where administrators forbid e.g. traffic of engine-driven watercraft, bathing, angling, using watercraft, etc. Special protective regulations concerning lake waters are those that concern fishing, e.g. prohibition of: crossbow fishing with aqualung, angling in the zone of surface outflow, catching fish that do not meet size criteria, fishing during close season, etc. Generally, the presence of wide and mutually-related competence range in standing surface water management and administration system can be assessed positively in the context of lake protection, but there often happen conflicts of decisions as early as the phase of planning investment activities, e.g. one institution is interested in removing near-shore fauna while another one champions the cause of its protection.

CONCLUSIONS

The considerations undertaken hereinbefore, concerning selected aspects of protecting water reservoirs of the Upper Silesian region, allow for formulating several conclusions of general character. Problems of both exploitation and protection result from a number of separate conditions; their background should often be sought in diversified functionality of the objects. Large number of reservoirs indicates a clearly defined demand for water that is retained in them, but is also creates an impression of an investment chaos indicated by: „dispersion" of water area; presence of a big number of idle water objects; only fragmentary utilisation of few reservoirs built in the adjacent area, as opposed to an alternative of building a single one with a complex character of management. That indicates lack of rational and complex management methods on the one hand, and reflects complexity of priorities in the region with elaborate structure of the decisive-administrative system on the other hand. The situation in that respect is additionally complicated by the fact that many conflicts occur on the level of purposes and functions a particular reservoir is intended to serve in the highly industrialised and urbanised region. Functional conflicts are particularly noticeable. For example, a reservoir cannot be based on highly contaminated waters and serve recreational purposes or ensure a supply of potable water at the same time. Undoubtedly, some threat can be seen in existing and potential conflicts of institutional character (where an institution is meant as an administrator of a water area), which is increased by the fact that more than one institution have decision-making rights concerning a given object. Priorities of one institution turn out to be an obstacle for executing a management concept suggested by a co-user. That causes a peculiar ambivalence of utilisation concepts, especially ones concerning protection of water reservoirs. Still another matter is adjustment of the legal system of protection and utilisation of reservoir waters to regulations which are in force in the European Union, which is not always easily reflected in the practise of legislating and obeying them.

That does not change the fact that in the commonly perceived vision of the Upper Silesian region, there is a tendency to describe it as an ecologically polluted area where degradation of environment has reached the level which far exceeds any allowable limits. Such an opinion seems a bit exaggerated nowadays, as the environment being under the strong influence of human activities begins to regenerate spontaneously there, and people themselves realise their previous mistreatments and restore some of its values. That also concerns water environment, especially many water reservoirs.

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Anthropogenic aspects of Landscape transformations	1	University of Debrecen Debrecen 2000	58–65

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THE PROTECTION OF GEOLOGICAL AND GEOMORPHOLOGICAL VALUES IN THE BÜKK NATIONAL PARK AND ITS NORTHERN FOREGROUND

INTRODUCTION

The presentation of natural values and development of tourism become more important among functions of national parks nowadays. The IUCN renewed the zoning of national parks in 1993 (IUCN Conference, Genf, Sept. 1993), which could be used as mainly planning and management tool (DIJKEN, 1994) in order to that they could be suitable for more complex tasks. Namely, the zoning must be formed that based on concrete problems and ecological basis besides of the nature conservation management activities and control related to international categories. It must include the complex connection-system of biotic (botanical, zoological) and abiotic (geological, geomorphological, climatic, hydrological, pedological) factors.

What makes the issue current, the deficiencies seem to appear concerning in the survey of the geological and geomorphological values in the area of Bükk National Park and its surroundings have been intended to complete for the last few years. The purpose of our research started two years ago in coorporation with the experts of the BNP is to work out the base of the geological and geomorphological survey of the BNP and to execute the assessment of the data still required complemented by the vicinity of the BNP.

During the geological, geomorphological mapping carried out in the area of Tardona hills many phenomena and features have been revealed that could complete the data base of BNP. Because of the large horizontal extension of the coal seams, mining became a determining factor in the landscape evolution of the Tardona hills. We have to take into consideration that this strongly disturbed, non-recultivated, industrially polluted area is a transition belt between the Bükk National Park and the industrial axis along the Sajó valley. The vicinity of the national park makes it possible to preserve values of the Tardona hills while developing the area.

PROBLEMS OF GEOLOGICAL AND GEOMORPHOLOGICAL VALUES IN THE BÜKK NATIONAL PARK

The Bükk National Park that comprises an area of 41 835 ha at present is the first mountainous national park in Hungary. It is rich in geological and geomorphologi-

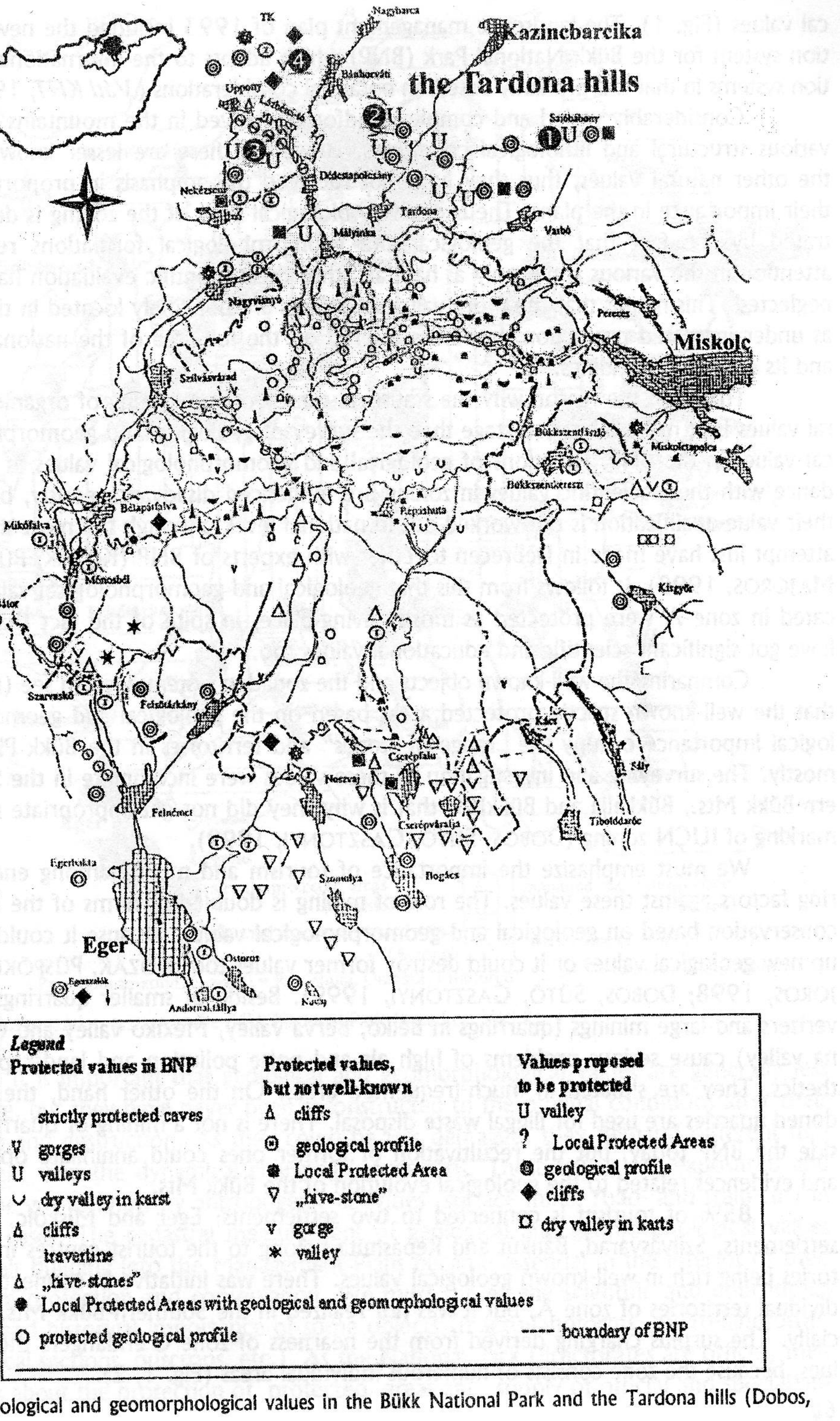

Fig. 1. Geological and geomorphological values in the Bükk National Park and the Tardona hills (Dobos, Sütő, 1999)

cal values (Fig. 1). The landscape management plan of 1993 included the new zonation system for the Bükk National Park (BNP) which adapts to the international zonation systems in that it is primarily based on botanical considerations (*Váti KHT*, 1998).

Considerably varied and complex landforms evolved in the mountains due to various structural and lithological conditions. However, these are lesser known than the other natural values, thus they have not received the emphasis in proportion to their importance in the plans. The exclusively biological basis of the zoning is demonstrated by the fact that the geological and geomorphological formations received attention in the various zones only as habitats, thus their scientific evaluation has been neglected. This means that the more valuable objects are not solely located in the areas under increased protection, but are scattered on the full area of the national park and its direct surroundings.

That is of the reason why the statistical survey or monitoring of organic natural values is at more advanced stage than the survey of geological and geomorphological values in the BNP. Functions of geological and geomorphological values in accordance with these scientific values in zoning are influenced disadvantageously, because their value-qualification is not worked out in national level, although the most through attempt just have made in Debrecen together with experts of BNP (Kozák, Püspöki, Majoros, 1998). It follows from this that geological and geomorphological values located in zone A were protected as mostly living-place, in spite of the fact that they have got significant scientific and educational values too.

Comparing the well-known objects and the zonation system, we can see (Fig. 2) that the well-known strictly protected areas based on the geological and geomorphological importance occupy the „range of stones" and territories in the Bükk Plateaus mostly. The surveying and investigation of these values were incomplete in the Southern-Bükk Mts., Bükkalja and Bükklába that is why they did not get appropriate role in marking of IUCN zoning (Dobos, Sütö, Gasztonyi, 1999).

We must emphasize the importance of tourism and mining among endangering factors against these values. The role of mining is doubled in terms of the nature conservation based on geological and geomorphological values, because it could open up new geological values or it could destroy former values too (Kozák, Püspöki, Majoros, 1998; Dobos, Sütö, Gasztonyi, 1999). Beside of smaller quarrings, pulverizers and large minings (quarrings in Bélkő, Berva valley, Mexikó valley and Garadna valley) cause serious problems of high air and noise pollution and landscape aesthetics. They are situated in much-frequented areas. On the other hand, the abandoned quarries are used for illegal waste disposal. There is not a mining or quarring inside the BNP today, but the recultivation of former ones could annihilate openings and evidences related to the geological evolution of the Bükk Mts.

85% of tourism is connected to two settlements: Eger and Miskolc. These settlements, Szilvásvárad, Bánkút and Répáshuta belong to the tourist centres in territories being rich in well-known geological values. There was initiative in connecting individual territories of zone A, but it was not realized in the Southern-Bükk Mts. especially. The surplus charging derived from the nearness of zone C endangers these values, because the zone consists of numerous individual areas (Fig. 1, 2).

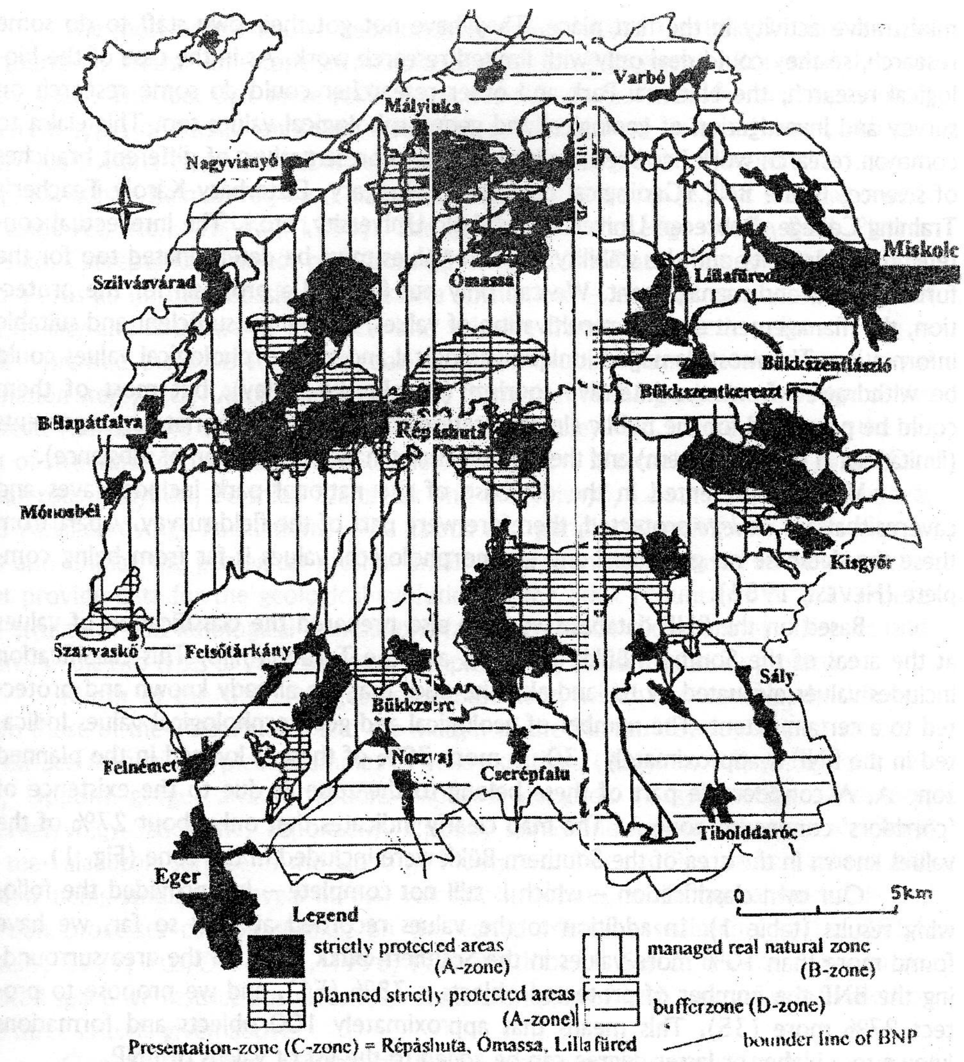

Fig. 2. The zonantion system in the Bükk National Park (based on Váti Rt, 1998)

It is important that geological and geomorphological values are generally less injurable, but they have never been reconstructed to the original conditions after their damage and destruction. As they could be less demaged, they demand different management than the dynamical changing biocoenosis. These values are exposured and could be got to know by antropogenic activities (surface mine, road- and train-cut) in special cases. The cadastral measurement of geological and geomorphological values and their building into the Management Plans became essential in the interest of their effective protection and conservation. We must survey the scientific and educational values and historical importance of some objects (macro-landforms, micro-landforms, geological sections, outcrops, etc.). As the National Park Directorates are offices, their work is about the protection of protected areas and supply of official and special administrative activity in the first place. They have not got their own staff to do some research, so they could deal only with limited research work. As in the case of the biological research, the National Park and outer researcher could do some research on survey and investigation of geological and geomorphological values too. This claim to common research work has been realized among representatives of different branches of sciences in the BNP (Geological Institute of Hungary, Eszterházy Károly Teacher's Training College, Debrecen University, Miskolc University, etc.). The intellectual content, the injurability and the stability of some values must be determinated too for the further works and management. We can only put forward a proposal for the protection, the management and the recultivation of values, if we have sufficient and suitable information. The most damaged, unique geological and geomorphological values could be withdrawed from the intensive tourism (Ablakos-kő valley), but most of them could be presented for the public (interpretation trails) with appropriate arrangements (limitations in land use-system) and the periodic maintenance (protection of substance).

Values represented in the database of the national park include caves and caverns that are *ex lege* protected, therefore were part of the field-survey. Apart from these the database on geological and geomorphological values is far from being complete (HEVESI, 1986).

Based on the BNP database we have also prepared the classification of values at the areas of the Southern-Bükk, Bükkalja, and the Tardona hills. This classification includes values evaluated by us, and also the ones that are already known and protected to a certain extent. The number of geological and geomorphological values indicated in the BNP is approximately 130. A more 39% of these is located in the planned zone A. A considerable part of these belong to the zone A due to the existence of 'corridors' connecting zone A. The map clearly indicates that only about 27% of the values known in the area of the Southern-Bükk were included in this zone (Fig. 1).

Our own classification – which is still not complete – has provided the following results (table 1). In addition to the values recorded at BNP so far, we have found more than 10% more values in the Southern-Bükk (13). In the area surrounding the BNP the number of protected objects is 38% (51), and we propose to protect 27% more (35). This means that approximately 100 objects and formations known to a higher or lesser degree can be added to the list of valeus of BNP.

TYPES OF GEOMORPHOLOGICAL VALUES PROTECTED OR PROPOSED FOR PROTECTION IN THE BNP AND THE TARDONA HILLS

In order to evaluate the different forms (uniqueness, type, display, degree of disturbance, etc.) it is sensible to cassify them according to geological age, the litostratigraphic unit that carries the value, and the process that developed the geomorphological value. In my view, scientific classification should be preferred to assessment based on points while preparing the survey. In the second stage, already having a survey as completed as possible is worth to process a point system, that helps the practical protection and being giver in money, and also based on professional information.

The most widely known geomorphological values of the Bükk Mountains can be found on Triassic limestone formations (Kisfennsík, Bükkfennsík, Rónabükk Formations, etc.). The fact that these rocks were well-soluble favoured the development of different types of karstic landforms - solution drills, elevated dolines (Nagy-, Hársas-, Tányéros-, Zsérci-Nagy-Déli-teber, etc.), ruined caverns (Pes-kő, Tar-kő, etc.), avens (e.g. Kis-kőhát, Kálmán-rét, etc.) and valleys with doline-series (e.g. at the Nagymező, or Zsidó-rét, etc.) (HEVESI, 1986). The „stones" of the edge of the Bükk Plateau (Pes-kő, Cserepes-kő, Tar-kő, or Három-kő on the Bükk Plateau limestone formation, and Vörös-kő on the Répáshuta Limestone Formation) – evolved as a consequence of the quality and structure of the rock; and valuable from an aesthetic point of view as well - provide the basis for periglacial landforms (rubble funnels, talus cones, cryoplanation steps, etc.). At the same time the formation of the *gorges* at the edge of the plateau (Ablakos-kő valley, Csondró-valley, Leány-valley, etc.) were primarily the result of structural-geological changes in the Palaeozoic – Mesozoic boundary zone (Carboniferous Mályinka, Permian Szentlélek and Nagyvisnyó, Lower Triassic Gerennavár and Ablakoskővölgy Formations). The karstic and periglacial rock forms and valley sides also display the geological profiles under protection or proposed to be protected that provide data for the geological evolution of the Bükk Mountains. In this respect, the structural and lithological foundations facilitate the development of different landforms, so the two types of value represent complementary values eligible for protection.

North of the BNP the geological basement, which are completely different from those of the Bükk Plateau and the margin of the Plateau developed another types of surface features. Typical examples of valley sections (Rágyincs valley, Csernely valley, Uppony gorge) and formations exposed alongside (Rágyincsvölgy Sandstone, Csernelyvölgy Sandstone, Tapolcsány, Uppony Limestone Formation, etc.) are found on the Palaeozoic surface of the Upponyi Mountains. The profiles of the Tardona hills – now being studied – reveal hidden volcanic structures, while typical land-slide and erosion processes can be studied on the varied Miocene sediments (PEJA, 1956; SZABÓ, 1979; PÜSPÖKI et al., 1998; PÜSPÖKI, KOZÁK, SÜTŐ, 1998;). Due to the limited space we restrict ourselves to present examples of each type of value based on the three criteria given above.

One of the most spectacular fluvial sequences is situated to the north of Miskolc, and it can be studied at the entrance of the cellars constructed in the rock at Sajóbábony, or the nearby Kő valley (Fig. 1 (1)) (KOZÁK, PÜSPÖKI, 1996). In the Miocene, when the climate was warmer, rather Mediterranean torrential watercourses settled their sediments ranging from fine sand to coarse gravel. Remnants of gravelled stream channels, pebbly bars, cross stratification referring to displacement of bars and channel side, clayey sediments deposited in dead water environments and limonitic weathered cover referring to dry periods can be observed in the profile. The sedimentation of these was interrupted by rhyolite and andesite type volcanic activity taking place 10–12 million years ago. As a result of weathering gravel, sand, and tuff stripes were exposed. The gravels consisting of crumble-stones and clayey-tuffs indicate nearby centres of eruption, while limestone pebbles were brought here by watercourses from the Bükk Mts. (KOZÁK, PÜSPÖKI, 1996).

The volcanic sediments formed during the Miocene crust movements solidified between neritic and fluvial sediments. Depending on the characteristics of the surface evolution these may be exposed in various landforms. The Fehér valley situated to the north of Tardona (Fig. 1(2)) is a typical element of the drainage network still developing today. It exposes a volcanic- subvolcanic body on its sidewall (DIJKEN, 1994). The andesite subvolcanic body began to crop out in the course of the erosion that started at the end of the Miocene. Meanders, alluvial cones and bars that developed according to the dynamics of the watercourses are distinguishable in the narrow valley. The plane-banked divided, column-shaped andesite lava formed of angular andesite slabs and amydale pieces can be excellently studied at the side of the valley. At the parts that meet the sedimentary environments the dyke penetrating the wet sediment was weathered, thus forming loose, pale-yellow tuff-like andesite-hyaloclast (DIJKEN, 1994).

The Rágyincs valley (Fig. 1(3)) of the Uppony Mountains is a perfect example of the processes of valley-formation. Although the valley belongs to the Lázbérc Protected Landscape area, the scientific evaluation of the valley-section types give further supports to the protection of the area. These valley-section types are characterised by landforms based on the structural features of the area. These characteristics are applicable to similar valleys in the Palaeozoic surface. The sliver fronts are connected by heavily asymmetrical valley sections well distinguishable on the terrace-remnants, valley sides, and riverbank walls also, which obviously prove the sliver-front under-cutting of the stream. Along the transverse faults almost symmetrical valley-sides and frequently outcropped rock crests were formed (SZALAI, MCINTOSH, GÖNCZY,1999).

Although erosion by watercourses also contributed to the evolution of the next form, its present shape was developed due to mass movement. One such form is the *Damasa abyss* (Fig. 1(4)) at the edge of the Lázbérc Protected Landscape area. Its special scientific significance is attributed to the fact that it was formed in the last century as a result of a block slide (KOVÁCS, 1995). During the uplifting in the Late Quaternary the Csom stream formed its gorge-like valley in the area. It gradually cut into the loose Miocene sediment series, thus denuding the marine clay, marl, the loose fluvial sand and gravel layers, and also the volcanic structures imbedded in them on the side of the valley. The stream gradually hollowed out the rigid andesite breccia-cover. The sandy and clayey beds facilitated the slide of the andesite blocks. After several smaller movements, when the shear stress exceeded the critical value a large-scale block slide occurred and thus the abyss wall of several metres height was formed in 1834. A multi-layer channel system was created among the blocks moving at different speeds. The evolution of this channel system has been proceeding since then by way of rock fall and rotational slide (KOVÁCS, 1995). The limonitic encrustation and limonitic balls could be seen on the failure.

We are well aware that it is not possible to ensure a high-degree of protection for all values, as the relevant international regulations strictly consider the rate of human impact on the environment. From among the tourist centres considered for further development by the area north of BNP: Tardona, and Varbó, the large number and density of values justify a field and status survey, because if the area does not become protected due to the increasing scale of human activity its values will be increasingly endangered. The professional evaluation of these values may serve as a basis to provide protection for larger continuous areas, according to our proposal in the planned C-, namely Presentation-zone in the zonation system of BNP.

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Anthropogenic aspects of Landscape transformations	1	University of Debrecen Debrecen 2000	66–67

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APPLICATIONS OF GIS IN A HUNGARIAN HILLY COUNTRY

From the first applications to nowadays the applications of the Geographical Information System (GIS) have expanded significantly. This fact is due to the development of two specialties:

1.

- In these days the satellite image is not only a single photograph in the geographical researches but with the GIS methods it is a complex database. The extended usage proves its importance usage from crop assessing to disaster-surveys to city planning.
- The used satellite-images were made by the LANDSAT satellite in 1984 and 1992. The two images show the same area, thus we can do comparative interpretations. The most spectacular task we can carry out with the help of these satellite images is the comparison and analysis of the changes of the vegetation, but we can define the condition of the waters and (partly) the soil-types.
- As a result of socialism the collective farms evolved (contrasted with Poland, where the small parcels stayed in majority) which treated huge homogeneous tillage. After the political change these collective farms desintegrated and small estates became prominent. It is an exciting task to track the changes of this process from a chronological and a spatial aspect.
- My chosen area– among other things - because of its physical capability is in a relative disadvantageous position among the Hungarian region, where agriculture could not produce in high quality, thus the mentioned changes are not too conspicuous here.
- Nevertheless, the changes of the forests (usually their decrease) are well – followable.

2.

- The development of informatics brought about the easy handling of the huge databases, thus the developing of the efficient Geographical Information System became possible. The application of GIS – similarly to with Remote Sensing – is increasingly extending. With the help of these systems we can make digitized maps. Although the input of the data is a slow process and we have to be very precise, the complete database is suitable for further processing and provides us with fast and spectacular results. For example we

- can make terrain aspect, terrain slope maps or we can join the data to the spatial objects and make thematic maps.
- It is exciting to manipulate the Digital Elevation Model (DEM): we can treat the satellite- image as a rubbersheet and cover it over the DEM. Thus we can see the image in its „original" position.

The poster shows the central part of the Cserehát Mountains from the northeast region of Hungary. The Cserehát is a low mountain composed of Tertiary (mainly Miocene) and Quaternary matters such as sand, clay and fluvial sediments.

The maps were made with GIS-software, e.g. AutoCAD Map, IDRISI and Surfer. The further explanations are next to the maps.

Anthropogenic aspects of Landscape transformations	1	University of Debrecen Debrecen 2000	68–76

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PROBLEMS OF REACTIVATED LANDSLIDES
(on the example of a Hungarian case study)

INTRODUCTION

Observing the appropriate statistical records, it is obvious that nowadays the number and the severity of natural (among others geomorphologic) disasters will not decrease, indeed – partly because of the rapid globalisation of telecommunication – it would seem to increase. This tendency is surprising if we consider that, on one hand, energies that human society can make available for and draw into defence against disasters increase exponentially. On the other hand, mostly because of the development of sciences, the chances for prediction and prevention against most of the types of disasters theoretically improve. Of course there are also effects of a negative indication, among which we should emphasise first that human activity has spread over more and more territories threatened by various natural catastrophes. Secondly this activity – often secondarily – has its own role in generating natural disasters. It is principally true in the case of floods and mass movements.

Mass movements, especially landslides, are not among those disasters that cause many deaths (cp. e.g. JONES, 1995) but the damage they cause and their frequency – mainly because of human influence – is increasing strongly. This is especially sad since most landslides could be prevented or at least we could reduce the damage produced by the movements already started.

Slide processes are rather specific factors in the evolution of natural landscapes. They take part in the geomorphologic development of several landscape types and indeed they can have main role in the case of certain types. Since these processes owing to their nature are discontinuous in time, their occasional triggering is regular on these kinds of landscapes and only the exact place and date of the movements can be surprising. On these territories the geomorphological activity of societies can very easily break down the sensitive equilibrium of the originally unstable slopes. Then the question of the responsibility of the different levels of society for the landslides leading to catastrophes can be raised. The role of sciences should be examined as well. Did (or could) sciences reveal that the given area had a dangerous character in this respect? If they did, was this fact notified in advance with sufficient „emphasis"?

This case study intends to sum up the circumstances and the processes of landslides that have occurred – as today we can see clearly: renewed – during the past eighteen months in the northernmost settlement of Hungary (Hollóháza – 1500 inhabitants), and the steps and results of defence carried out up to now. Furthermore, we summarise the lessons that can be learnt according to the points of view described above in general. The survey is facilitated by the fact that beside the author's own researches – indeed in larger extension than these – the Keviterv-Plusz Ltd, in collaboration with specialists of several businesses and institutions, at the request of the local govern-ment of the village, made a thorough analysis on the landslides that damaged the community (SZABÓ, 1999; *Keviterv-Plusz*, 1999; ZELENKA, TRAUER, 1999).

DISCUSSION

The environment and the conditions of mass movements

Hollóháza lies in the northern part of the volcanic Tokaj-Zemplén Mountains in the immediate neighbourhood of the Slovakian border in the Török valley of nearly NNW–SSE direction (Fig. 1). The settlement stretches 2.5 km along the valley but its width is only a few hundred meters. The height of the valley floor decreases from 360 to 280 m in the area of the village and the surrounding hills are 450–520 m above sea level.

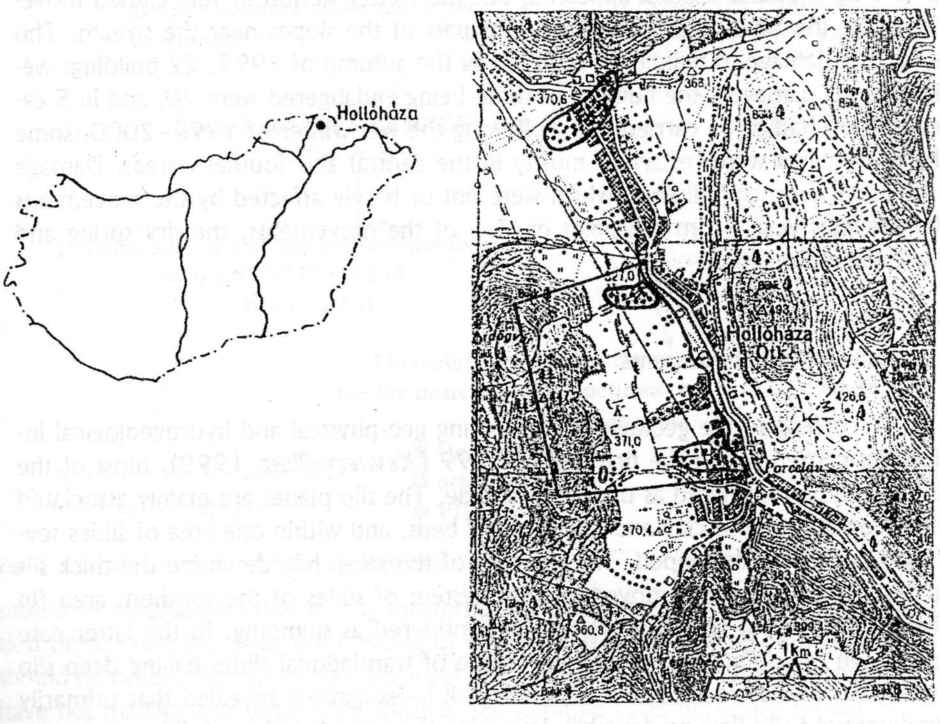

Fig. 1. Hollóháza and hisenvironment on the topographical map – emphasized the areas with significant damages by the landslides in years 1999 and 2000. In frame the area of the fig. 4.

According to geological surveys (ZELENKA, TRAUER, 1999) watersheds around the village are actually the barriers of a Miocene caldera and Hollóháza is situated in its natural crater where „rhyolite tuff and clayey marine sediments with different thickness superimpose the underlying andesite". Their layers dip in the direction of the valley thus they appear as natural pervious layers. Their other important characteristic is the montmorillonite content of the bentonitic rhyolite tuff, but that of the clays is also outstandingly high (40–50%). The upper part of the tuff and clay layers with swelling capacity occurring repeatedly above each other lean mainly against the steep slopes of the mountains built up of lava stones and they receive a considerable part of their water content at the line meeting the surface.

The process of the movements

The movements began on 5th March 1999. following a wet winter – unexpectedly, but not without any antecedents. These caused damage in buildings and roads first in the northern, then until April in the central (in the neighbourhood of the church) and the southern (in the neighbourhood of the nursery) parts of the village. Most of the movements took place during a short period of time (a few days), but follow-up movements continued until middle spring. From April, the weather became dryer and signs of stabilization appeared, but the wetter period in July caused movements again, this time mostly at the bottom part of the slopes near the stream. This time, further damage to buildings occurred. By the autumn of 1999, 22 buildings were significantly damaged, the number of those being endangered were 70, and in 5 cases evacuation had to be carried out. Following the wet winter of 1999–2000, some of the movements were restarted, mostly in the central and southern areas. Damage also appeared on such buildings, which were not or barely affected by the movements of the previous year. From the point of view of the movements, the dry spring and summer elapsed quietly.

The character of the movements

According to the geological, engineering geo-physical and hydrogeological investigations carried out in the first half of 1999 (*Keviterv-Plusz,* 1999), most of the landslides can be considered as translational slide. The slip planes are mainly associated with the contact zone of clay and rhyolitic tuff beds, and within one area of slides several slip planes were developed. The top part of the steep hillside where the thick silt layer (Hungarian *„nyirok")* moved and the system of slides of the southern area (in the neighbourhood of the nursery) can be considered as slumping. In the latter case however – in my point of view – the presence of translational slides having deep slip plane can not be excluded. The hydrogeological investigations revealed that primarily the underground rills flowing downhill determine the exact location of slides.

Precautions, provisions

Following the first movements, the local government immediately effectuated actions of rescue and precaution. Fig. 2 outlines the actual measures implemented in 1999 to prevent damages and prevent the repeat of movements. Among these it

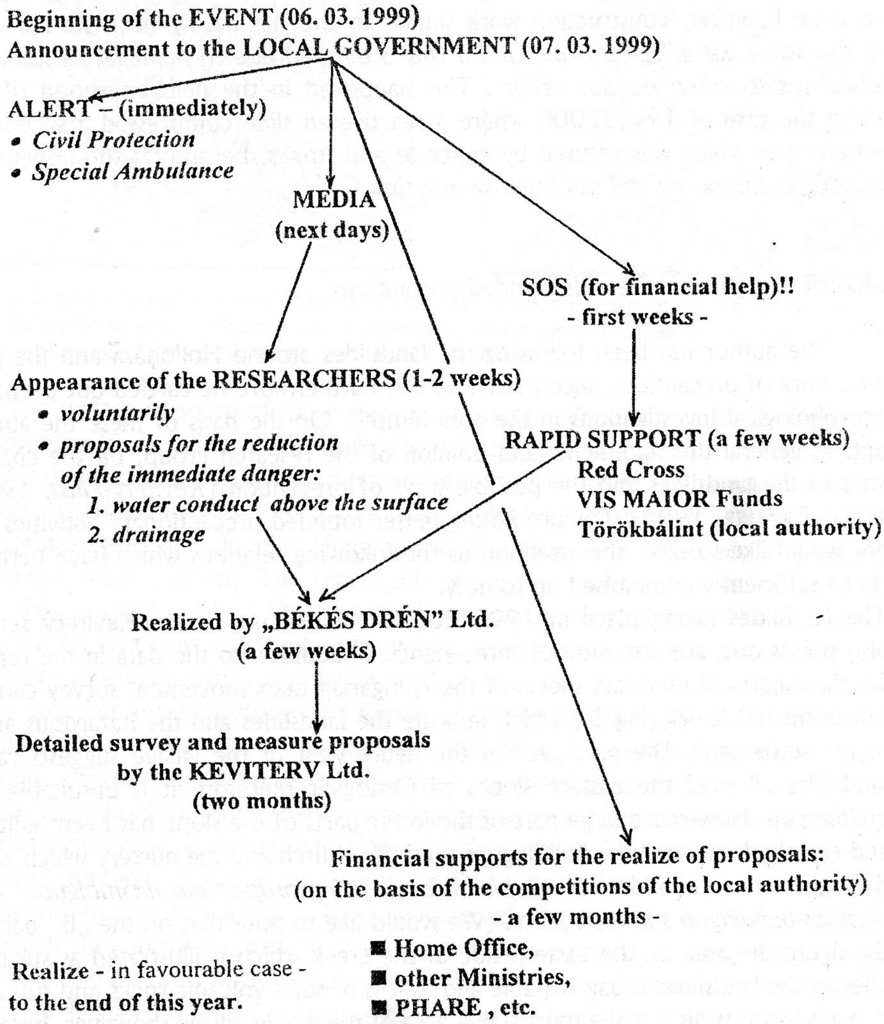

Fig. 2. Course of avert of the disaster in Hollóháza

should be emphasised, that during the spring the above-mentioned scientific investigation began, together with the building of ramparts, based on its recommendations. It should be noted, that up to now the local government, despite numerous applications, have not managed to obtain one third of the minimal costs necessary (about 50 million HUF) from the various funds involved in prevention of catastrophes. This can be related to the fact (not totally accidentally) that the landslides that afflicted the village coincided in time with the largest-scale flooding at the end of the century in Hungary.

Despite all of this, in the northern area the system of girdle-ditches intended to decrease the water output of the slopes and partly the drainage ditches and the drain pipes have already been completed. The regulation of the watercourse has been carried out in a considerable part of the village, the water removal wells have been and are being built. In the central and southern part of the village, especially at the upper parts of the slope however, construction work similar to this has hardly been started. *The preventive work has a logical order and if this is delayed due to financial reasons, the successful results often do not occur* . This happened in the neighbourhood of the church at the turn of 1999/2000 where a reactivated slide compressed a section of the watercourse which was secured by concrete and stones, because at the upper part of the slope drainage was still not built by that time.

Additional thoughts for the well founded precautions

The author has been following the landslides around Hollóháza and the performed work of precaution, since March 1999. Furthermore he carried out primarily geomorphological investigations in the area himself. On the basis of these the author accepts in general the statements and opinion of the research group, on the characteristics of the landslides and the possible ways of prevention (*Keviterv-Plusz*, 1999, ZELENKA, TRAUER, 1999). For promoting better founded precautionary activities the author would like to draw the attention to the following relations which have perhaps not been sufficiently emphasised up to now.

1. The landslides taking place in 1999/2000 in Hollóháza, as the Keviterv report also points out, are not without antecedents. In addition to the data in the report we show parts of two data sheets of the Hungarian mass movement survey carried out in the 1970-ies (Fig 3.) which indicate the landslides and the hazardous areas in the settlement. The part „A" of the figure west of the village suggests rapid landslides all over the eastern slopes of Ördögvár therefore it is unsuitable for building up. However a large part of the lower parts of the slope has been built up and exactly these were the buildings around the church and the nursery which were damaged by recent slides. *So despite science giving proper and unambiguous predictions building in still took place.* (We would like to note that on the „B" part of the figure the area on the eastern side of the creek which is illustrated as strongly affected by landslides today is stable and as it is of solid volcanic rocks and tuff and in parts forms walls it is the most stable area of the whole village, however, because of its steepness it can be classed as unsuitable for building up).
2. The Keviterv report regards the zone between the slide areas around the nursery and the church – which is not affected by recent movements – as stable, because „once flown rhyolite lava – which is not shown on former geological maps – covers the rhyolitic tuff and the clay" (ZELENKA, TRAUER, 1999). On the basis of my detailed geomorphological survey (Fig. 4) I regard this stability as very relative. According to the measurements carried out by laser theodolite it is clear that there are significant steps on the slope above the football pitch, completely covered by forest and depicted as uniformly steep on the most detailed topographical maps.

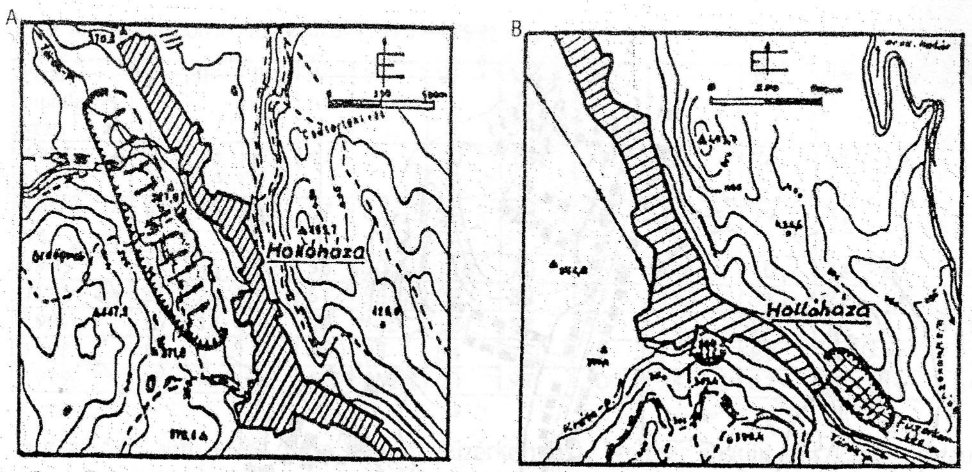

Fig. 3. Details of inclusion-sheet of cadastral survey of landslides in Hungary in the 70s (the survey was carried out by the Uvaterv – Miskolc). „A" – landslides area on the west margin of the village, „B" – in the vicinity of the porcelain factory on the south part of the village.

The surface of some of these steps is of counter-slope with a partly enclosed depression in the middle. The background is the curved and steep cliff of Ördögvár. All these form the typical features of the former landslide taking place in the volcanic material. Such stabilised (partly fossil) slides were found in the inner slopes of reconstructed calderas in other Hungarian volcanic mountains (Börzsöny, Visegrad mountains – SZABÓ, 1996). The eastern side of the twin peaks (the taller, northern part is 439 m-s high) north of Ördögvár is also a typical failure. The well observable asymmetrical lava cone (329 m) in front of it, which is shown on the map also, encloses two former swampy depression in which occasionally we can still find water. These together are the features of a former significant landslide. We can find slide steps, similar to the slide steps on the southern area, along the eastern slope of the cone (on both sides of the Rákóczi street), and these are about the same height as well. On the eastern side of the street there is a spring line along the bottom of the step with N–S direction including at least half a dozen active springs. This spring line is the evidence of the rapid change in the drainage of the strata under the step, which is a typical feature in case of landslides. The specific point of this step is an asymmetrical cone which rises above the surface of the step by a few metres, ends in a steep wall towards the creek, is made of huge lava blocks and it can be regarded as a block slide in the feature system of the whole slope. *On the basis of the above mentioned, my opinion is that although this part of the slope is relatively stable (compared to its surroundings), this stability is due to former landslides.* These slides took place a very long time ago, and their age could only be estimated with uncertainty at best on the basis of analogies (at the beginning of the Holocene?). Their reactivation is unlikely (although the mass of the slide under Ördögvár, which got stuck in the upper zone of the slope, gives a bit of uncertainty). The presence of former slides among active ones suggests *that mass movement was a dominant process of slope development on the western side of the village over a relatively long interval even in geological time. The recent movements fit well in the evolution history.*

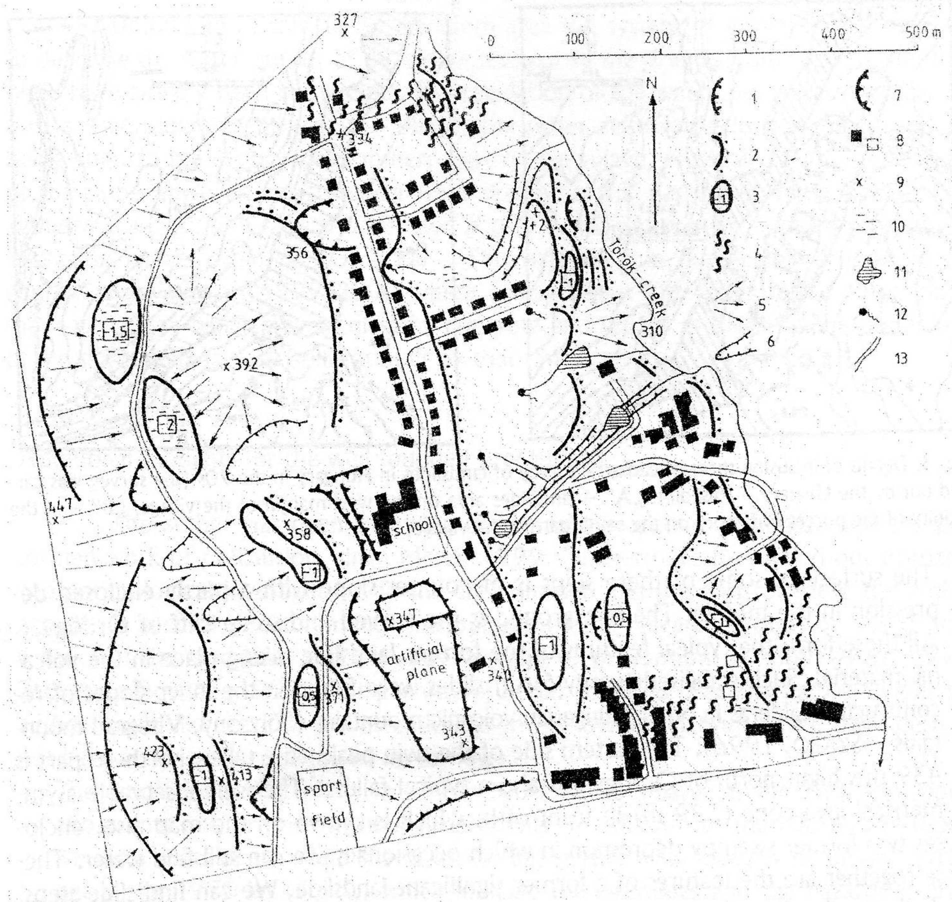

Fig. 4. Geomorphological map from the midwest part of the village emphasized the forms of landslides (edited by the author):
1 – failure fronts of landslides, 2 – edges of landslide-steps, 3 – closed depressions of landslides (the deep in meters), 4 – surfaces with active landslide movements, 5 – main slope directions, 6 – erosional valleys, 7 – artificial walls, edges, steps, 8 – buildings (empty quadrilateral – demolished building) – the ground-plan of the buildings isn't correct, 9 – height points, 10 – wet depressions, 11 – artificial lakes, 12 – springs, 13 – roads, streets. The empty (white) sections are almost flat or slightly wavy surfaces.

3. The data indicating movements of the last decades mean serious warning for reactivation in the future, however, the same thing happened in Hollóháza as elsewhere, namely as the geomorphological hazard occurs periodically, *the natural pause in activation reduces the alertness of the inhabitants to the danger.*

Although there is no precipitation registering station in Hollóháza, 2.5 km south in Füzérkomlós (230 m) and 5 km to the north in László-tanya (665 m), longer series of data can be examined. By interpolation of the data series from the two stations, the precipitation conditions for Hollóháza can also be established with relative accuracy. Taking the average altitude of the community as 350 m, the average yearly rainfall for the 15 years between 1975–89 (the two neighbouring stations have parallel data series for this period – Table 1) can be.

Table 1. Precipitation in Füzérkomlós (1975 - 1999)

Period: months years	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Total
1975 – 89	39	28	43	47	74	90	74	73	46	36	42	40	633
1990 – 94	12	29	24	57	61	58	59	44	46	79	41	38	544
1995	17	45	30	56	30	116	20	152	101	10	32	40	648
1996	22	24	28	51	55	29	88	87	146	55	21	43	649
1997	16	17	6	40	100	121	88	36	16	24	78	41	582
1998	17	3	12	87	95	84	150	69	71	87	76	27	778
1999	17	76	30	62	45	60	97	100	24	27	65	44	647

put at 665 mm (5% more than at Füzérkomlós). Neither should this value deviate much from the data for a longer period, as for example the 70 year average precipitation of Füzérkomlós (634 mm) is nearly equivalent to the 15 year average. This is why the dry period in the first half of the 1990-ies (1990–1994) when precipitation was only 86% (544 mm) of the average over many years, is so striking. The wintertime precipitation, which is so important in the aspect of landslides, reduced even within the lower total amount of precipitation (from 17% to 14.5%). Obviously the tendencies in Hollóháza were the same as above, thus the stabilisation of the former landslides in that period of time was not to be wondered at. As the amount of precipitation also stayed under the average in 1995–1997 and wintertime precipitation was only 77% of the average, it is of no surprise that the *problem of mass movements fell out of the focus of the inhabitants. Thus there could have been no question of such developments serving for prevention, the funding for which could not be found even after the catastrophes occurred.*

The situation began to change in 1998. According to data from Füzérkomlós, although the first half of the year was emphatically dry, as only 280 mm of precipitation was measured in the first 6 months (86% of the 15 year's average), but the weather started to change from July. In the second half of the year, precipitation exceeded the average by 51%, and the winter period was unusually wet as well. This wetter period, which intervened relatively abruptly and continued in 1999, caused the first movements, then the summer rainfalls following the desiccation associated with the soil shrinkage taken place in spring, caused the movements occurred in July, due to swelling and *reduction of stability* of the layers prone to move. This was repeated at the turn of 1999/2000, and this caused further damage.

CONCLUSIONS

2000 will not be the last period of landslides in Hollóháza. Their recurrence should be anticipated even if in the future a drier period occurs which results in stabilization. In turn, wetter periods than the last two years are not excluded, when larger areas than today can become unstable on the slope. Even the movement of the newly fixed landslide forms at the western part of the village is not excluded.

The community assumes a responsible standpoint against landslide processes,

- if we consciously undertake sacrifices in support of such research from which the areas which come under the danger of landslides to various degrees can be indicated with high reliability,
- if the results of this research are known, recorded and utilised by the applicable local municipal, administrative, etc. organisations,
- if the preventative landslide protection is still ensured (maintained) even when there is not direct danger,
- if the magnitude of the risk factor is taken into account in utilisation of the area and when planning future utilisation, and the methods of use still regarded as rentable are decided upon in the knowledge of the degree of danger. Protection against landslides is extremely expensive, and it cannot be expected that the community will make unrealistically big sacrifices for the protection of a relatively modest value.

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Anthropogenic aspects of Landscape transformations	1	University of Debrecen Debrecen 2000	77–85

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RESEARCH ON THE LANDSCAPE EVOLUTION OF ALKALI TERRITORIES IN THE HORTOBÁGY

INTRODUCTION

According to the data of the latest surveys and soil mapping, the extension of alkali soils in Hungary reaches almost one million hectares which means that 10–11% of the country is covered by them (ÁBRAHÁM, BOCSKAI, 1971). These solonetz and solontchak type alkali soils with unfavourable endowments can be found mainly in central Hungary (between the Danube and the river Tisza) and east of the river Tisza, but smaller patches also appear in the areas of Transdanubia with higher groundwater table. Agriculturists have already been engaged in the melioration of these hardly arable alkali lands that produce poor harvest results, since the end of the 18th century. The first who attempted this was Sámuel Tessedik. He got the research on the Hungarian alkali areas moving by his experiments started in Szarvas in 1780 (ARANY, 1956). Very many names could be mentioned here, of those people who continued this work (Treitz, Strömpl, Szabolcs, Stefanovits, Vámos, Rakonczai). Thus, the agrochemical surveys of the alkali lands date back to the long past. A characteristic erosional process is in progress on these territories preserved in a natural state and were not cultivated with land improvement or melioration. This flat land erosion causes an extremely varied micro-relief, on which research from geomorphological point of view, has been dealt with far fewer people up to now.

AIMS OF THE WORK

One of the most extensive homogeneous alkali areas in Hungary is the former flood plain of the river Tisza, the so-called Hortobágy. The first national park in our country was founded on this small landscape unit in 1973. This territory is rich in pedological, geomorphological, botanical, zoological and cultural-historical values. I started my geomorphological research on the southern lowland plain of the Hortobágy National Park, in Ágota-puszta (Fig. 1) and my aims were to examine alkali macro-forms, the factors that formed salt berm lands, the pedological, botanical aspects and the pace of the development of these types.

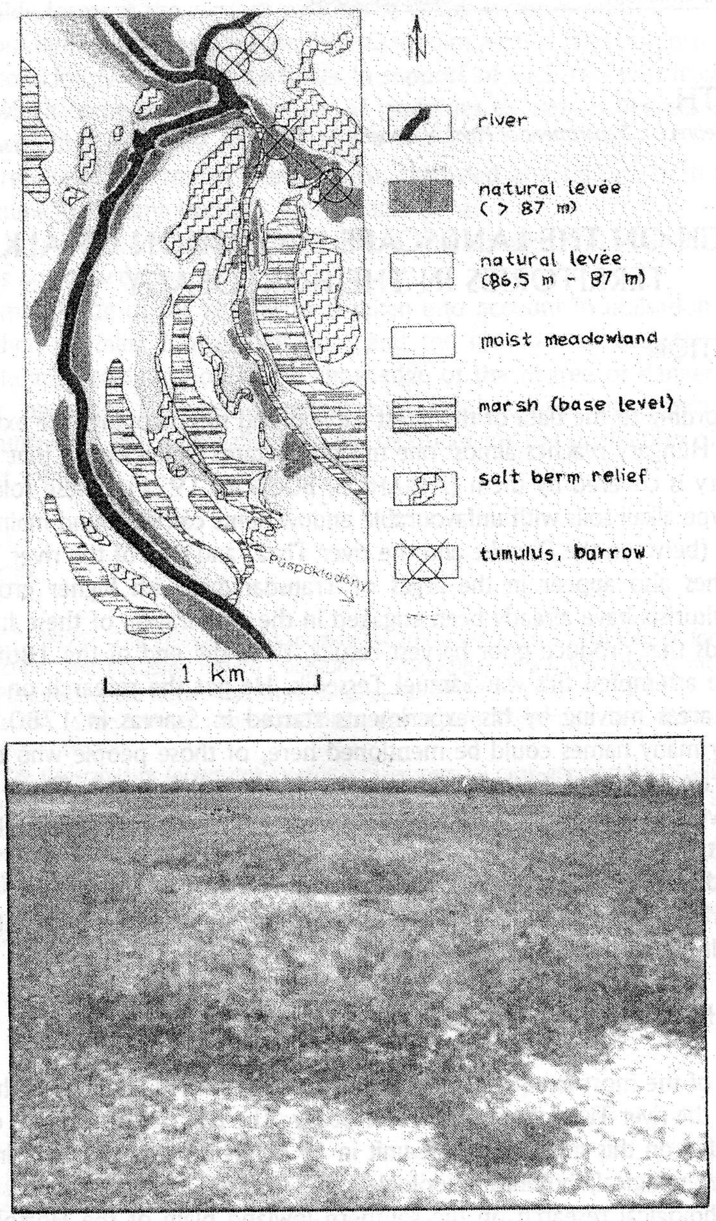

Fig. 1. Geomorphological sketch map of the research area and a typical patch with salt berms (Hortobágy National Park - Ágota-puszta)

ANTECEDENTS OF THE RESEARCH ON ALKALI GEOMORPHOLOGY

First of all, we have to clear up what the term salt berm means. Salt berm is a generally 5–30 cm high break down (with edges of different angles of slope – salt berm) of the ground which has unbroken soil profile and is richly covered by various alkali plant associations (berm roof) to a lower level which lost the „A" horizon of the soil (berm foreground) (Fig. 2). So, salt berm is a form combination of the roof, the edge and the berm foreground. The surface of the berm foreground has very unfavourable endowments from a pedological point of view since „B" horizon of the soil (which is highly argilliferous and saline) comes to the surface because of the erosion of the humic „A" horizon. That's why only extremely xerophilous and halophyte vegetation is able to establish itself in these places.

If examining the Hungarian bibliography on alkali lands we can conclude that certain scientists explain the development of salt berms in different ways. The first who dealt with this problem was Péter Treitz, an agrogeologist, and he explained the development of salt berms by the collective settling of the surface accompanied by decrease in volume. So, he gave the following explanation: the evolution of these forms was owing to the dissolving of salts, humus- and clay colloids in rainwater and their transport along the cracks (TREITZ, 1924). STRÖMPL (1931) also interpreted the evolution of alkali forms with by dissolving, but he did not attach an important role to the transport of the dissolved material. Furthermore, MAGYAR (1928) emphasized the mechanical work of rainwater flowing in the cracks of the soil, beside dissolving. ARANY (1956) explained the appearance of salt berms with flat land soil erosion. He said that the surface not covered by vegetation was attacked and eroded by superficial waters mainly along the cracks. According to STEFANOVITS (1981), ero-sion brought to existence these forms but their development was often started by animal hoof-prints and paths across the fields deepening into the surface.

After all, the formation of these alkali forms can be considered as a complex process, since beside the mechanical effect of rainwater going down the slope, water can erode the surface by its dissolving capacity as well, if the soil is soaked through for a long period (DÖVÉNYI et al., 1977; TÓTH, 1981).

METHODS

I made the geomorphological map of the most southern lowland plain of the Hortobágy National Park, the so-called Ágota-puszta, with detailed field work, to a scale of 1:10 000. I determined four model areas in the puszta. In two territories salt berms formed under natural conditions but on the remaining two under probable human influence. Before starting the alkali erosional measurements we made a general plan map of the area to a scale of 1:500, then levelled them in a 25 x 25 cm grid with a laser-theodolite. We made a stereoscopic model of each area with the help of Winsurfer software. I used a device called „profilometer" for the measuring of the changes in the surface (SIRVENT et al., 1997) with the help of which we could follow the changes with mm accuracy. This device was a wooden frame of 1.1 x 0.8m size, in the framework of which 64 pieces of aluminium rods were positioned. These rods, after falling on the surface, drew the contour of salt berms thus we could exactly read off the erosion or possible deposition on the surface with the help of a squared plotting paper set in the background. I made erosional measurements every three months in 1998 and every month in 1999 and 2000.

RESULTS

Geographical situation of salt berm areas

Observing the geomorphological map of Ágota-puszta it is obvious that berm areas formed by erosion almost always appear on the edge of levées. So, they evolved in places where relief differences were the highest, that is, the roof-level of the levée suddenly sank in the direction of the base level. The narrow belt where these erosional forms may develop can be characterized by absolute limit values of heights between 86.5 and 87 m above sea level. In this altitude range we can find moderately thick and thick meadow solonetz soils susceptible to erosion, in the formation of which 2–3 m deep groundwater with high salinity has an important role. Through the capillary zone, this groundwater has some influence on the formation of the whole alkali soil profile. In the territories situated lower than this transitional belt we can find meadow soils where groundwater is close to the surface during the whole year therefore considerable capillary zone cannot evolve. In areas higher than 87 m above sea level, however, meadow solonetz soils of better quality developing into steppe appear and groundwater level is so deep under the surface that it cannot take part in the formation of alkali soil levels sensitive to erosion.

Alkali landscape evolution under natural conditions

Observing the edge of the abandoned river channel in the centre of Ágota-puszta we can conclude that certain points of the area are not eroded in the same intensity. This means that within this small catchment area various stages of alkali landscape evolution can be found. There are patches where the traces of linear erosion can be observed only along some cracks. In other places, rills some meters long, and one – one and a half meter wide lead rainwater down the slope. Rarely these alkali rivulets joining together and forming widespread erosional surfaces where the „A" horizon of the solonetz soil cannot be found any more and only the highly saline, cohesive „B" horizon with unfavourable endowments appears on the surface. According to my observations the following stages of landscape evolution can be distinguished (Fig. 2).

Formation of cracked surface. Alkali solonetz soils are cohesive and rich in clay minerals (illite, montmorillonite). They swell in moist periods but contract in dry periods

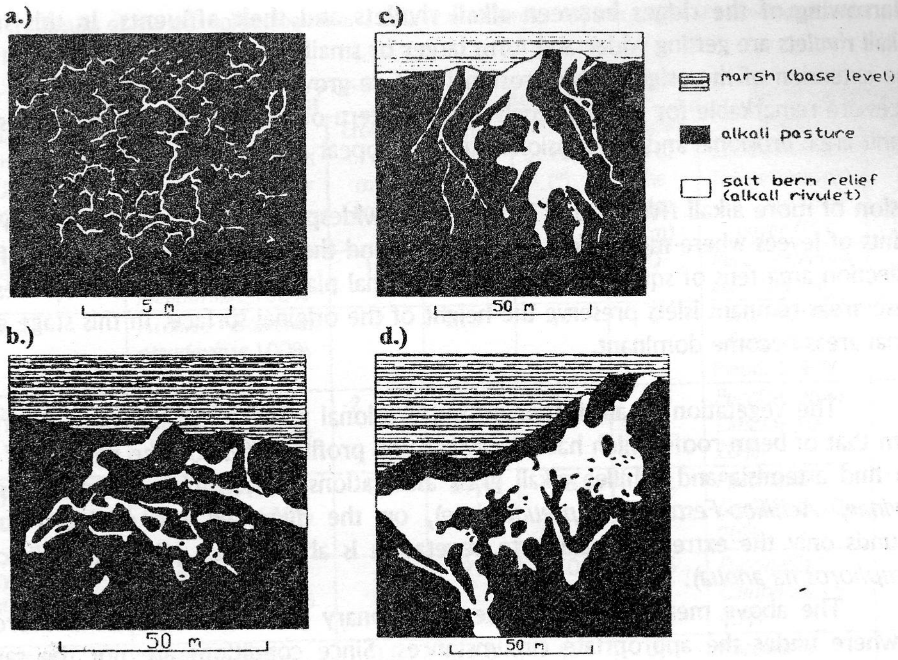

Fig. 2. Stages of the alkali landscape evolution

and that is why cracks are formed. If these cracks are only a few millimeter wide and deep we call them periodical forms. In a moist period they close up and in the next dry period they open again in a new form. If they become 2–3 cm wide and 10–15 cm deep they are said to become stable forms. They represent an initial point for erosion both in horizontal and vertical directions. In the catchment area I observed purely cracked surfaces appearing only in a few places.

Formation of alkali rivulets and depressions without an outlet. Linear erosion starting along cracks causes the development of alkali rivulets which become longer continuously by headward erosion thus they can become as much as 25–30 cm long and 1–2 m wide. These 20–30 cm deep negativ forms meander in the direction of base level like a long snake. In some parts of these small channels we can detect the remnants of the original surface as tiny islands. In several places of the research area we can find surfaces dissected by alkali rivulets which are easily visible because of their fresh green patches. In many cases alkali rivulets have not evolved in the lower levée sections where there is smaller relief difference between the ridge and the base level. In these places vertical transport of the material is dominant along the cracks since precipitation falling on the ground cannot flow down to the base level. Consequently, rounded, oval and longish depressions are formed on the surface. These forms appear on the pieces of the ground where, taking a surface unit, reliefs not influenced by erosion dominate.

Narrowing of the ridges between alkali rivulets and their affluents. In this stage alkali rivulets are getting wider and form larger or smaller embayments. Consequently, the extension of the original, not erosional surface grows less. From above, these surfaces are remarkable for the extremely fancy pattern of berm roofs and alkali flats. In a unit area: erosional and not erosional surfaces appear almost to the same extent.

Fusion of more alkali rivulets and formation of widespread erosional surfaces. In the points of levées where more alkali rivulets meet and these linked ones run to the final collection area tens of square metres large erosional plains develop. In some places of these areas remnant islets preserve the height of the original surface. In this stage erosional areas become dominant.

The vegetation of alkali rivulets and erosional plains is considerably different from that of berm roofs which have unbroken soil profile. While on the berm roof we can find artemisia and achiliea alkali grass associations (*Artemisio-Festucetum pseudovinae, Achilleo-Festucetum pseudovinae*), on the degraded soil of berm foregrounds only the extremely halophyte vegetation is able to live (*Puccinellia limosa, Camphorosma annua*).

The above mentioned landscape evolutionary process can act in this order anywhere under the appropriate circumstances. Since conditions are not the same everywhere (relief energy, rate and intensity of precipitation, pedological differences) the speed of the process can vary. That's why we can find other salt berm areas beside each in different stages of evolution.

The intensity of alkali erosional processes under natural consitions

I observed two model areas for three years and could conclude that the yearly rate of erosion was low, capable of destroying the surface at a rate of only cm-s. Since the two areas have different relief endowments, they are in different stages of evolution (TÓTH, NOVÁK, 1999). The so-called „Hatos" model area lies on the flat bank of a bog where the relief difference does not reach 40 cm in 100 m. This territory is in the second stage of evolution, which means that the surface is dissected by alkali rivulets and smaller depressions without an outlet. Moving farther from the bog we made erosional measurements on three berms.

The so-called „Nagy-Dögös" model parcel pointed out in the frontier section, lies on a sharper levée territory where the difference between the highest and the deepest points is larger (100 m/60 cm). This area is in the third stage of evolution since alkali rivulets widen out in more places which causes a far stronger dissection of the surface. We made erosional measurements at three points on a half-basin type berm surface: on a northern, a western and a southern exposed berm. The table below summarises the erosional values measured on the two model areas from 1997. 11. 05 to 2000. 07. 31.

Table 1. Results of the geomorphological and botanical research on berm territoties developed under natural circumstances

	Berm roof		Berm edge			Berm foreground	
Period of the observation: 1997.11.05. - 2000. 07.31.	Plant associations and the percentages of vegetation cover (%)	Erosion of the roof (cm)	Altitude (cm)	Angle of slope (°)	Headward of the edge (cm)	Plant associations and the percentages of vegetation cover (%)	Accumulation (cm)
Hatos1.	*Artemisio-Festuc. Pseudovinae* 100%	-1,5	8	15	0	*Pucc. Artemisia* ass. 10-25%	+0,5
Hatos 2.	*Achilleo-Festucetum pseudovinae* 100%	-2	13	17	0	*Puccinellia* lim. -*Festucet.* Pseud. 5-40%	0
Hatos 3.	*Artemisio-Festuc. Pseudovinae* 100%	-2 - +2	16	18	0,5	*Puccinellietum Limosae* 10-20%	0
Nagy-dögös Northern berm	*Artemisio-Festuc. Pseudovinae* 100%	-0,5	29,9	75	4,2	*Puccinellia Camph.*ass.10-20%	+2
Nagy-dögös Western berm	*Artemisio-Festuc. Pseudovinae* 100%	-1	29	80	1,5	*Puccinellia Camph.*ass.15-40%	+2
Nag-Dögös Southern berm	*Artemisio-Festuc. Pseudovinae* 100%	-0,5	22,8	45	0,9	*Puccinellia Camph.* ass.5-10 %	-0,5

Alkali landscape evolution under human influence

We can meet alkali micro forms in the outer buffer zone of the Hortobágy National Park but their rate of evolution can be influenced by human economic activity, Anthropogeneous type salt berm areas mainly appear on the edge of artificial hollows (trenches, pits), where the suddenly increased relief difference can start erosion. In moist periods, wheel-tarcks of cars can also become the starting points of alkali erosion. The intense trampling by animals (sheep- and stock-farming) can similarly start and strenghten this process. The extension of berm areas formed under human influence is limited to the immediate environment of the interference (Fig. 3). The results of the research on forms evolved in this way show that they develop many times faster than under natural conditions. The cause of this may be the fact that active components appear more concentrated in these areas.

The two model areas I studied, each lie along artificial trenches. The first is on the so-called „Makkod" frontier section where a rainwater drainage ditch excavated beside a subsidiary road, which led to a sheep-shed in the beginning of the 70s initiated an erosional process. I chose the other salt berm model area on the so-called „Farkassziget" along a borrow pit. A dike was built from the material of the pit in 1970 while on the edge linear and areal erosion started. The table below summarizes the results of the measurements on the two territories.

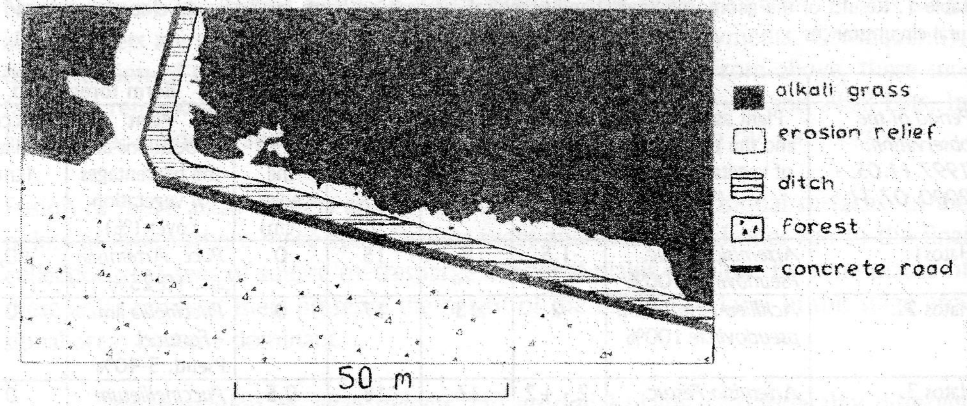

Fig. 3. Sketch map of the salt berm surface evolved along an artificial trench excavated at the beginning of the 70s (Ágota-puszta - Makkod)

Table 2. Results of the geomorphological and botanical research on berm territories developed under human influence

	Berm roof		*Berm edge*			Berm foreground	
Period of the observation: 1997.11.05. - 2000. 07.31	Plant associations and the percentages of vegetation cover (%)	Erosion of the roof (cm)	Altitude (cm)	Angle of slope (°)	Headward of the edge (cm)	Plant associations and the percentages of vegetation cover (%)	Accu-mulation (cm)
Makkod Upper berm	*Puccinellietum limosae* 5-50 %	-3 – -6	7,5	30	20,6	*Puccinellietum Limosae* 0-20 %	-5
Makkod Lower berm	*Artemisio-Festuc.* Pseud. 20-30 %	-3 – -6	24	72	8,2	*Pucc.lim-Festucet.* pseudovin.20-25%	+2,5
Farkassziget Northern berm	*Artemisio -Festuc.* Pseud. 25-50%	± 1	19	80	5,2	*Puccinellietum Limosae* 0-5%	+1
Farkassziget Eastern berm	*Achilleo -Festuc.* pseud. 25-50 %	± 1	22	65	2,4	*Pucc.lim-Festucet.* pseudovin.10-20%	+2,5

SUMMARY

Hortobágy is one of the most ideal lowland landscape units in Hungary, the monotonous surface of which is coloured by the extarordinary variety of alkali erosional micro-forms. These salt berm grounds formed almost without exeption on the sloping marginal zone of levées, between the absolute heights of 86.5 and 87 m above sea level, due to the linear and areal erosion of rainwater flowing down the slope. These forms can develop under human influence as well if man creates considerable relief differences or intensively raise animals on areas of alkali soils. The results of my almost three year long erosion measurements show that strongly dissected, mosaic salt berm territories need several centuries to develop under natural conditions. The maxi-

mum headward of salt berms was 4.2 cm in a three-year period under the most suitable weather conditions (extermely rainy years). However, if we examine the results of human interference made thirty years ago, we see that erosional processes can become more rapid and intensive under human influence. This is proved well by the higher values of salt berm headward in „Makkod" and „Farkassziget" model areas. In this way, only one half or third of the time is needed for the evolution of the forms, than under natural conditions.

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Anthropogenic aspects of Landscape. transformations	1	University of Debrecen Debrecen 2000	86–94

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ADDITIONS FOR EXAMINATION OF THE CEREDI-BASIN DRAINAGE (WATERWAY) NETWORK

INTRODUCTION

The Ceredi-basin is a lesser examined peripheral area divided in two by the Hungarian-Slovakian border, which in spite of its variegated natural values has escaped the attention of researchers up until now, with more significant examinations only having been pursued in the Medves region. This paper intends to provide additions for the Quaternary development history of the region's drainage (waterway) network, and attempts to reconstruct the last, significant change in direction.

According to the opinions of today to understand the recent development of the drainage (waterway) network, we have to go back 2–3 million years in time. At that time the Ceredi-basin formed a more or less uniform waterway network; it had a less divided up, terrain sloping to the SE, with its waters meeting in the Zabar region and the Tarna river forming from their flowing together broke through the sandstone ranges towards the lowlands. The northern and eastern edges of the basin were closed by Pliocene basal volcanic ranges (Ajnácskői-mountain range, Hajnacka Vrchovina). Later since the Sajó-valley sunk more strongly than the Hevesi-depression establishing the Tarna etching, the retreat of the ancient Gortva commenced in the northern part of the volcanic range. The break through occurred at Ajnácskő (Hajnacka) (since the basalt covering was also thinner here originally), then advancing progressively towards SW in space and time a whole series of river captures conquered all of the significant sources of the Tarna. The early obstruction of the Básti-basin also strengthened this process, since the middle section of the rivers subsided, thus its lower sections became dry beds. All of this was described by SZÉKELY (1954, 1958), however he did not provided concrete evidence. This paper intends to confirm these assumptions with morphometric methods. Morphometry in general does not provide decisive evidence, but supplemented by other examinations, much data pointing in the same direction can strengthen our assumptions.

The most unambiguous evidence would be if basalt gravel were to be found in the ridge between the Tarna and the Gortva; namely, at present this area does not obtain water recharge from the Medves (due to the Básti-basin), thus the presence of basalt gravel would undoubtedly certify the flow-through of the Medvesalja stream at that time. Up to now unfortunately discovery of gravel has not been successful, thus we are left with indirect verification.

POSITIONING OF THE SMALL REGION

The Ceredi-basin appears in literature as a new concept. Its definition as a small region is justified by its strikingly outlined character, its well definable limits, and (one time) hydrographic unity. In actual fact a basin hilly range is in question, where the relative relief is a maximum of 80–100 m/km^2. It is of dual division, divided in two in the NE–SW direction by the ridge between the Tarna-Gortva.

a. Its northern part belongs to the Gortva gathering ground, the central part of which is the early subsidence area of the extensive Básti-basin (Bastianska Kotlina). In the SE direction it is bounded by the ridge between the Tarna-Gortva with a steep lip, its northern and western boundaries are provided by the Medves, and its continuation, the Ajnácskői-mountains (Hajnacka Vrchovina) (these are Pliocene basalt volcanic ranges of 500–600 m average height), and to the East is closed by a lower sandstone area.

b. Its southern part is in actual fact the Tarna valley, which widening out at Zabar created the so-called Zabar-hollow. Here the direction of the river changes from W–E to N–S, and with a narrows, breaks through between the inter-Upper-Tarna-Zagyva-hills bounding the area to the south and the Heves-Borsodi-hills (both are made up of upper-Oligocene sandstone) (Fig 5.)

The topographic divide between the two rivers runs on the ridge between the Tarna-Gortva in the basin's central part, and its height relative to the bed of the valley is on average 60–80m, but in some places is significantly lower than this (for more details see the analysis of the drainage network-outline).

METHODS

The analyses presented in the article were made based on mapping measurements, supplemented with terrain observations. The basic map was a 1:50 000 scale topographical map prepared by digitalisation with Autocad 14 software, with 20 metres between altitude lines (in the figures they are less closely spaced to make them easier to study). For constructing the longitudinal profiles of the rivers I used a 1:25 000 scale topographical map, and the profiles of bed bottom height above sea level of streams over 5 km long were constructed with readings made every 100 metres, similarly with Autocad 14 software.

For the maps of relative relief and the connecting maximums and minimums, the altitude data readings – matching the topographical map's kilometre grid – were made on a 1 x 1 km grid. The maps were prepared with contour line process with the Surfer 7.0 programme.

EXAMINATIONS

The morphometric examinations covered four areas, which were the following:

- outline characteristics and flow directions of the drainage network,

- analysis of the thalwegs,
- the question of surfaces,
- examination of the relative relief.

1. The drainage network's contour, supplemented by examination of the direction of the valleys, almost immediately provides the supposition that the rivers arriving from Medvesalja, at one time met at Zabar. The valleys in their initial sections unambiguously display this SW centripetal direction, however when leaving the mountains they immediately pour into the SW-NE directional Gortva. This arrangement in itself still does not prove the Gortva's captures, but if in our imagination we extend the valleys, we find the continuation of the valleys on the Básti-basin side. At present there are either just small streams in these continuations, or they are dry valleys, but they are relatively wide and deep compared with the recent surface forming processes (Fig. 1). The supposed onetine valleys, moving from East to West are the following:

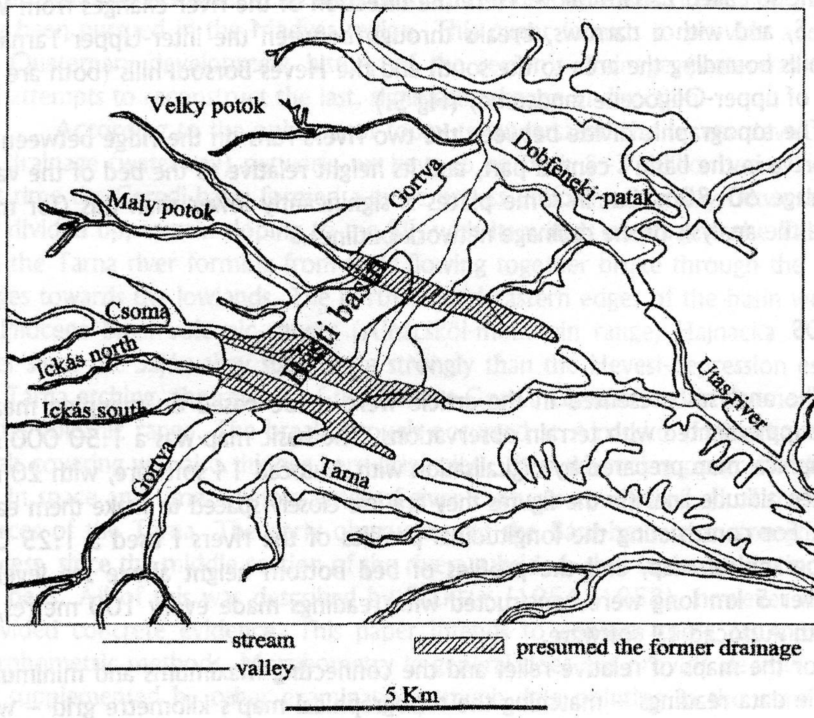

Fig. 1. The drainage system of the Ceredi basin

- Ickás northern stream – valley under the Mise-mountain,
- Csoma – Utas-stream branch valley (- Utas-stream),
- Nagy-stream (Velky potok) – Bakófalva (Bakov) – Utas-stream branch valley (Utas-stream),
- Dobfeneki-stream's initial section – Utas-stream.

This latter is the most interesting, and according to SZÉKELY (1958) this was the one-time main valley. The path of the Dobfeneki-stream is rather irregular: having its source to the South of Almágy (Bemerky Jablonec), a few hundred metres from a smaller breakthrough of the Gortva, then contrary to the general flow relations of today, advances to the S in a wide valley, then making an enormous bend, turning to the N, empties into the Gorta a few hundred metres north of its source.

2. The subsidence of the Básti-basin and the change in the drainage network arising from this, is supported by analysing the thalwegs of the larger waterways in the Medvesalja (Fig 2). It is known that if the erosion basis level falls, then this appears in the form of a break at the thalweg, which with the passing of time (if we regard the

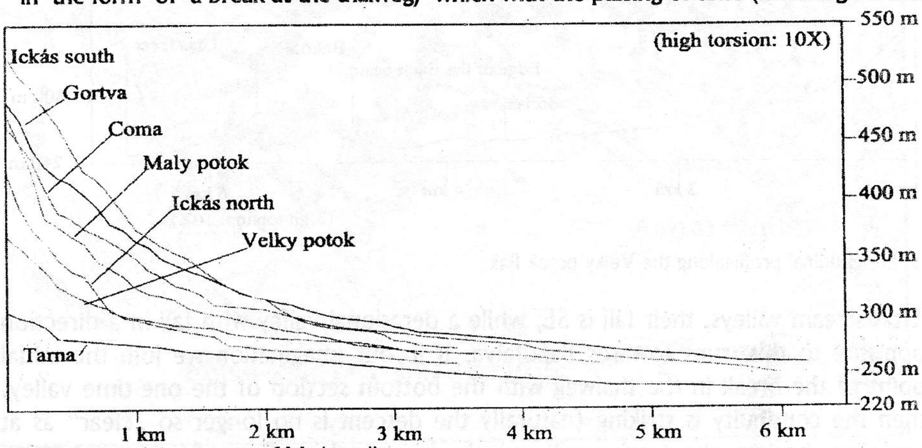

Fig. 2. Thalwegs of the streams of Medwesalja

further suppositions as unchanged) flattens out, just as the regression evens out the difference. Naturally there could be other causes of this break (e.g. epigenetic valley development), but in the area examined by us, the petrographical characteristics in the critical area can be regarded as homogenous. Besides the several smaller breaks in the thalwegs of the streams leaving Medvesalja and running in a south-eastern direction, a bigger one can be clearly observed, in every case at 300–320 m above sea level, evidencing well the one-time subsidence of the erosion basis (Básti-basin) level. The Tarna does not fit into this picture, the curve of which starts with a short convex section (which is generally characteristic of the early sections), then continues with an almost straight, uniform slope (the Tarna is only depicted as far as the Zabar-hollow!). However, precisely this exception strengthens our supposition, namely that the Gortva with its many captures, conquered the Tarna sources. If we compare this break position with the topographical map, we can see that at the change in character of the section, the direction of the river also changes significantly: changing from S–N to W–E. From all this we can conclude that the present main tributary was at one time just an insignificant branch, which became the main branch after the loss of the other more significant source branches. All this is supported by the height conditions: the Tarna approaches the Gortva most closely at the change in direction, the divide ground's relative height is only 4 m. A definite break can similarly be observed in the community of Almágy, on the lower section of the Gortva (which is depicted as far as Ajnácskő). The river leaves the Básti-basin area here, but still remains within the curve of the Ajnácskő-mountains, and its fall increases from 2‰ to 10‰ on a section of a few hundred metres. This also evidences the increase in capture, that is to say, firstly the river just broke through the basalt contour, and later passed into the Básti-basin.

The lengthways section of one of the supposed one-time valleys is shown in fig. 3. We can still find constant water flows at present in the Velky-potok and the

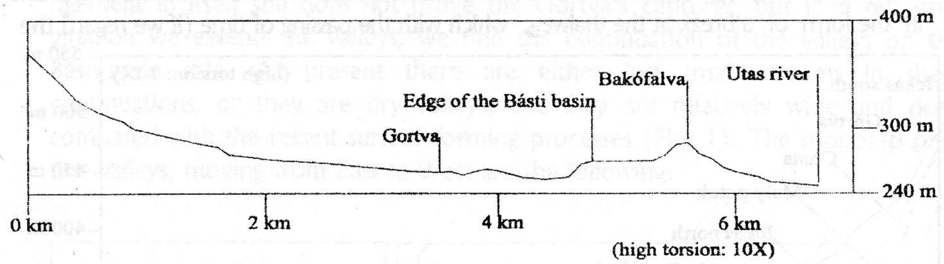

Fig. 3. Longitudinal profilealong the Velky potok Bak

Utas-stream valleys, their fall is SE, while a derasional valley with fall in a direction opposite to this, runs towards Bakófalva. If in our imagination we join the initial point of the break in the thalweg with the bottom section of the one-time valley, then the continuity is striking (naturally the descent is no longer so „clear" as at one-time, because the erosion still actively deepens the valleys of the source branches at present, while in the deserted valley sections, the process has slowed down strongly because of the termination of additional supplies of water.)

3. At this point the question of *levels* is connected in. The Medvesalja can be divided into 6–7 height levels, among which the most extensive is that between 300–320 m, which is marked by the grey colour on the contoured map (Fig. 4).

The Básti-basin is surrounded by this extensive surface 300–320 m above sea level, which although broken up by the outflowing streams, but has remained in wide bands between the valleys. In connection with the thalwegs it can be observed that the start of the above mentioned fault and the last mentioned surface are positioned at generally the same height (the surface is slightly higher). It could already be seen in fig. 4. that the Básti-basin slopes rise gently in steps in the NW direction, while it is bounded in the SE direction by steeper steps of 30-40 m relative height (Photo 1).

Summarising the altitude conditions we obtain the following picture: in the south-eastern foreground of Medvesalja, lies an extensive surface safeguarding the remains of the one-time basin-plane, which slopes down relatively gently into the young subsidence of the Básti-basin. Advancing further to the SE, in the direction of the one-time drainage, the one-time basin-plane can similarly be found on the ridge between the Gortva-Tarna, which breaks off with a steep lip in the north-west direction. The NW side is broken up by derasion valleys, while to the south-east it is characterised by erosion valleys with a slight slope. Larger derasion valleys are only found on the left bank of the Tarna's middle section (of 50–100 m maximum length).

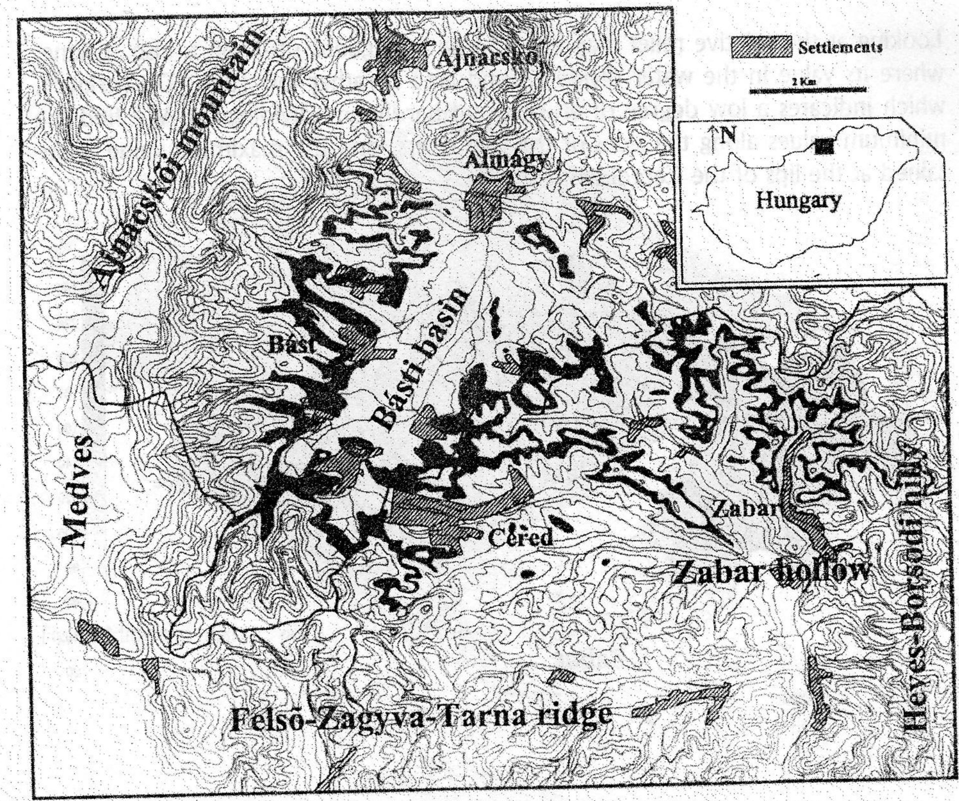

Fig. 4. Topography of the Ceredi basin

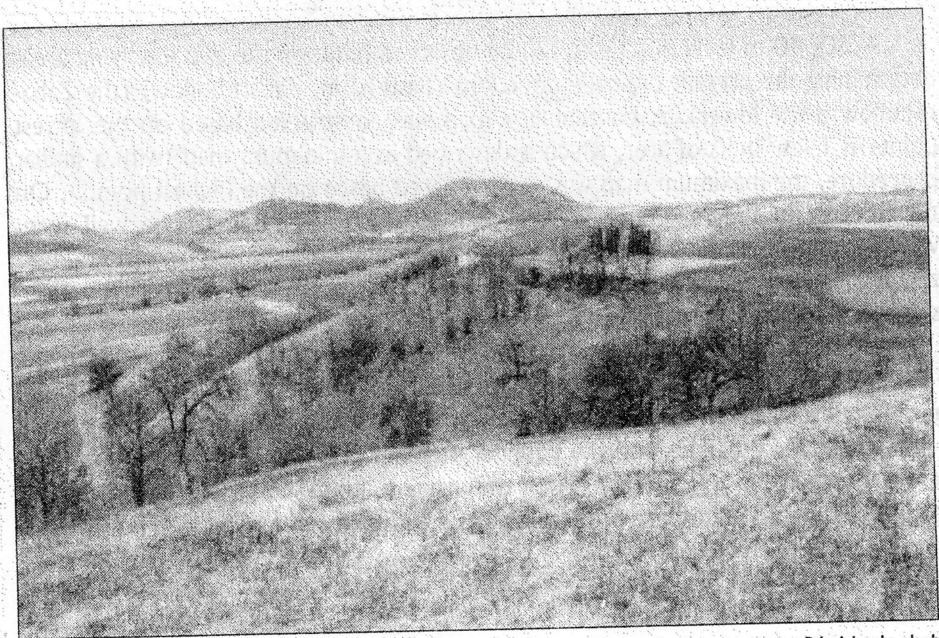

Photo. 1. The steep eastern edge of the Básti basin (in the background to the north the Básti basin, behind it the Ajnácskö mountain can be seen)

3. Looking at the relative relief map (Fig. 5) he ambiguous situation is also striking, where its value in the water divide ground area is rather low (80–100 m/km^2), which indicates a low degree of erosion and hardly any dividing up. We find the minimum values along the sides of the two rivers, and the maximum value is obtained at the lips of the Ceredi-basin.

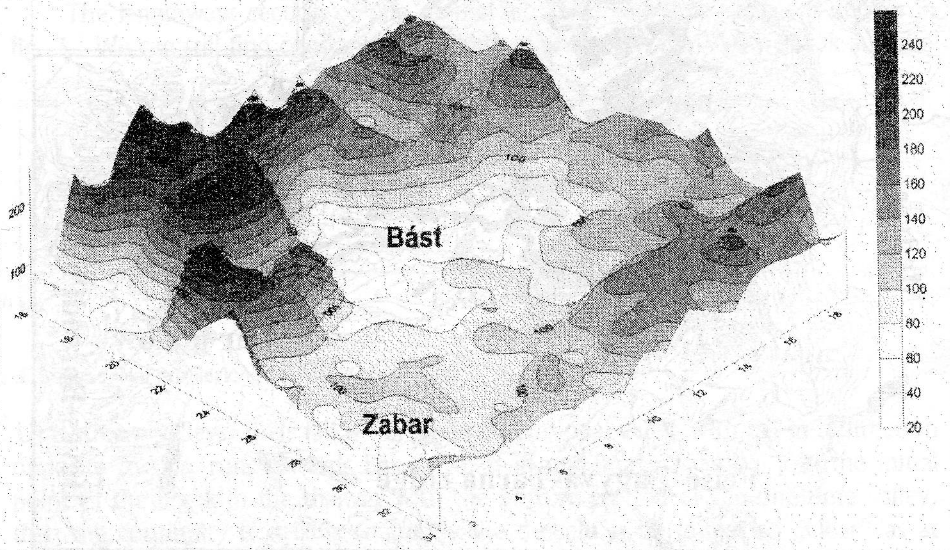

Fig. 5. Relative relief of the Ceredi basin (m/km^2)

A 30–40 m level difference can be observed between the two low lying areas determining the present drainage directions (Básti-basin, Zabari-hollow) (the Zabari-hollow is the lower). A contour line map was constructed based on the lowest points in 1 km^2 units of area, which is described as a minimum map (with a similar procedure, the maximum map was also prepared based on the highest points). On the SE part of the minimum map, a concentric arrangement can be well seen, which in accordance with the recent drainage conditions, points towards Zabar; and this pattern is continued towards the Básti-basin, although here the strong subsidence disturbed the regular arrangement (Fig. 6).

We obtain a different pattern on the maximum map: the ridge between the two low areas almost disappears, and the one-time main direction of slope is outlined even more clearly, which similarly points towards Zabar. The highest sections maintain the one-time surface heights and the younger etchings only divided these up, but the lowering of these is much slower, so the original state could be reconstructed (naturally the young subsidence of the Básti-basin is disturbing here also) (Fig. 7).

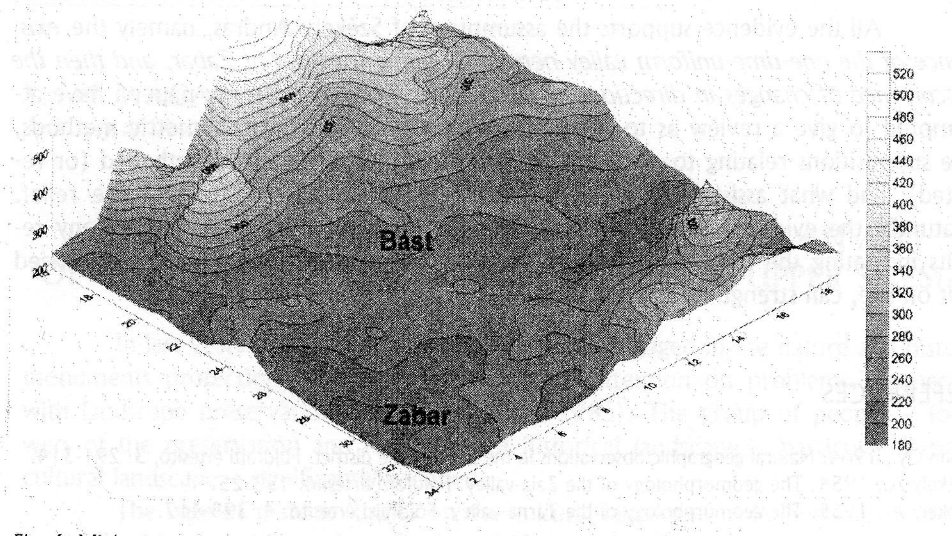

Fig. 6. Minimum map

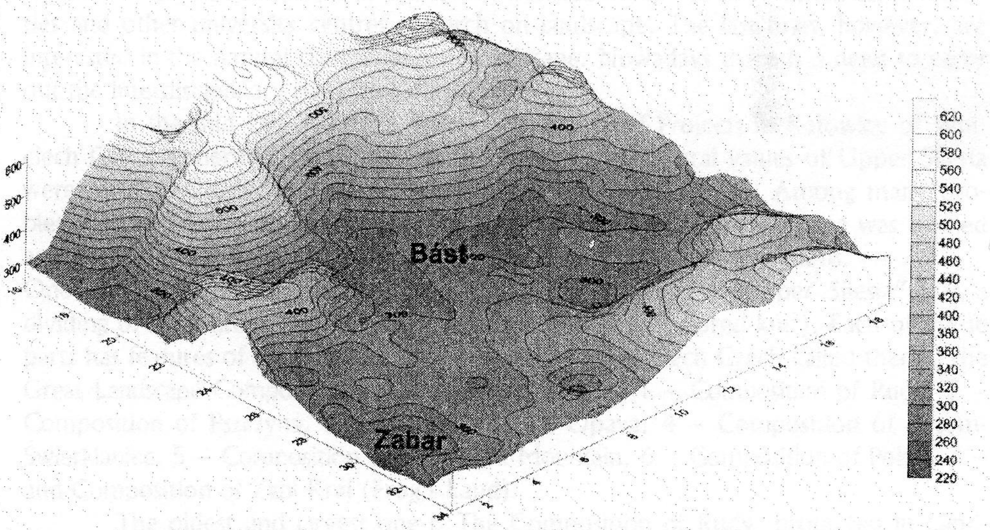

Fig. 7. Maximum map

SUMMATION

All the evidence supports the assumption of Székely András, namely the *existence of the one-time uniform valley network running together at Zabar, and then the occurrence of changes in directions of water flows (captures).* In my paper I have attempted to give a review as to how, using for the majority morphometric methods, the suppositions relating to development history of a given area strengthened (or refuted), and what assistance can be provided for quantitative analysis of the relief. Naturally the evidence listed here are not sufficient in themselves, but the many results indicating the same direction, of course supplemented by examinations carried out on site, can strengthen our assumptions.

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Anthropogenic aspects of Landscape transformations	1	University of Debrecen Debrecen 2000	95–98

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THE GREAT LANDSCAPE COMPOSITIONS AS AN AIM OF STUDIES ON CULTURAL LANDSCAPES IN UPPER SILESIA

In last years some scientists and institutions, engaged in the nature and historic monuments protection, started to pay common attention on problems, connected with landscape preservation (MICHAŁOWSKI, 1998a). The group of people – followers of the preservation and restitution of historical landscape – particular form of cultural landscape – significantly widened.

The base of general studies on the cultural landscape of Poland was prepared by the landscape architects from Technical Universities (BOGDANOWSKI, 1968; BOGDANOWSKI, ŁUCZYŃSKA-BRUZDA, NOVAK, 1979; BOGDANOWSKI, 1996a, 1996b). For the long time the important role in that aspect plays the Centre for the Preservation of Historic Landscape in Warsaw (MICHAŁOWSKI, 1998b). Technical universities and other university centres research on landscape. The last ones, however, are interested in the natural components of landscape. Nowadays there is a need to carry out the interdisciplinary research on this problem.

In the mid-1980s in the Voivodship Office of Projects in Katowice of Wojciech Czech leadership the studies on the natural and cultural values of Upper Silesia were started (CZECH, RATAJSKI, 1984; *Opracowania...*, 1998). Among many problems discussed the landscape was the centre of attention. The landscape was treated as a form of recording of human activity, stimulated by natural conditions.
One of results of the program: „Evaluation of the space in Upper Silesia" was a dividing of large urban structures (most often of several hundred km^2). Each of the-se parts has features of aesthetic composition (Fig. 1). Wojciech Czech called them „The Great Landscape Compositions". They were as follows: 1 – Composition of Rudy, 2 – Composition of Pszczyna, 3 – Composition of Opava, 4 – Composition of Bytom-Świerklaniec, 5 – Composition of Saint Ann Mountain, 6 – Composition of Pokój, 7 – and Composition of Żabi Kraj (Frog's Land).

The oldest and largest one is The Composition of Rudy, protected in Landscape Park, which name comes from the composition founders: Cistercian Landscape Compositions of Rudy Wielkie (KONOPKA, 1994; WAGA, 1995, 1996). The Park also includes an area, which is older than Cistercian foundation in Rudy – Woszczyce near Żory. The most advanced studies on this composition showed that in the 19th century the Ratibor (Racibórz) dukes – owners of post-cistercian lands – were very active in organisation of the Rudy Composition.

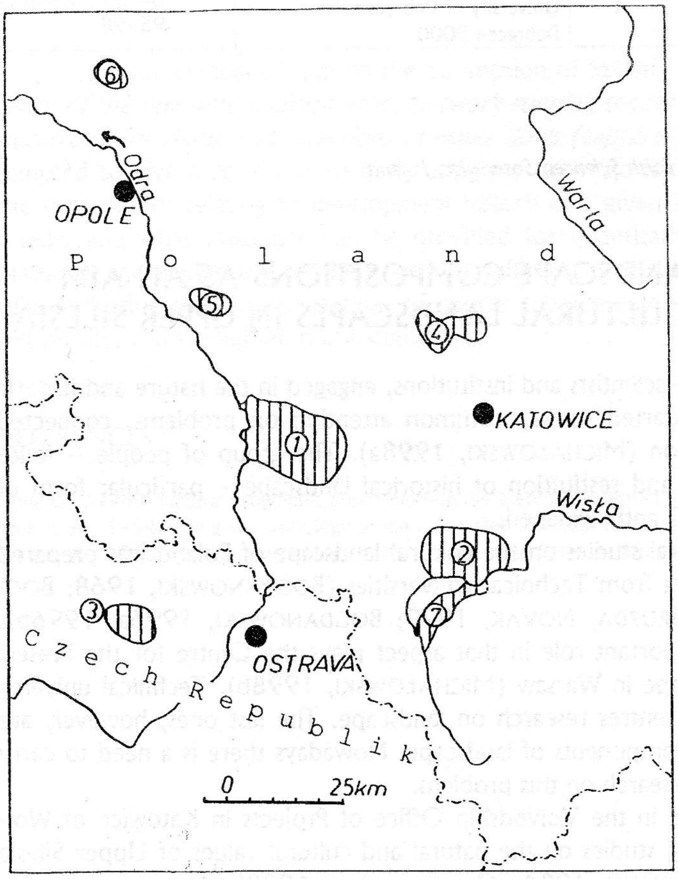

Fig. 1. Location of „The Great Landscape Compositions":
1 – Composition of Rudy, 2 – Composition of Pszczyna, 3 – Composition of Opava, 4 – Composition of Bytom-Świerklaniec, 5 – Composition of Saint Ann Mountain, 6 – Composition of Pokój, 7 – Composition of Żabi Kraj (Frog's Land)

The Composition of Rudy occupies an area of about 300 km^2 and it makes the only in Europe example of Cistercian abbey organisation, created in forest areas, where the forest, not land, was the main economic domain. Besides forestry the Cistercians were also occupied in fish-farming, mining of iron ore, metallurgy of iron and copper, production of glass, agriculture, gardening, grapes cultivating, production of beer and alcoholic drinks, they also kept scriptorium, managed library, schools and organised cultural events. For efficient management it was necessary to extend the arrangement of roads. Roads converge radially from 9 directions in one point – the place of monastery location and cut radially neighbouring villages. The whole looks like spider's web. At the cross-roads the founders situated: forester's lodges, villages, farms, forges and other objects. Besides economic values the composition had also its own aesthetic program – architectonic objects, alleys, trees group and scheme of view axes. After the monastery was suppressed Dukes of Ratibor in this place set up the park of area of 100 hectares, zoological garden, hunting lodges, forester's lodges, mounds and monumental obelisks, numerous alleys with trees. They transformed the monastery into a magnate residence.

The Composition of Rudy is one of most interesting aesthetic and usable town-planning structures with stable functions. The natural structures have still strong influence, like during Cistercian and Ratibor dukes' activity. The Composition is worth carrying out model landscape researches.

In case of Composition of Pszczyna the researches, done for needs of projected Pszczyna Landscape Park (MIESZKOWSKA-RUTKOWSKA, WAGA, 1998; KONOPKA, 1998) confirmed the significant transformation of the landscape by its older owners – Dukes of Pszczyna, who established some small structures, which finally formed that Composition. Each of these structures has an area of tens km^2. W. Czech called them as the composing surroundings. In Pszczyna the surroundings were joined by view alleys, converged radially in Pszczyna. Especially worthy is the surrounding range located in the middle Pszczynka valley between Kolonia Widaki and Stenclówka and Pszczyna centre with duke's palace and park. The great natural values remained in part of Pszczyna Primeval Forest on the Gostynia, Korzeniec and Pszczynka Rivers and on the southern bank of Goczałkowice Reservoir. These districts are cut by agricultural area with valuable rural complexes. The large document collection about Pszczyna Region needs the synthetic analysis and systematisation.

The Composition of Opava was set up at the borderland between Głubczyce Plateau, the Opava River valley and the Jeseniki Mountains. The morphological contrast of terrain – mountains covered with forests and loessy plateau occupied by arable lands, favoured existing different species of game animals in the ecotone zone. Owing to it the Composition was organised according to hunting criterion. An additional importance had a neighbouring pilgrimaging centre – Karniów and cultural one – Opava – situated in a beautiful area at the borderland of two types of landscape. Finally the Lichnowski family realised the composition near Opavian Hradec. This picturesque composition needs the detailed researches.

The Composition of Bytom-Świerklaniec (also defined as Bytom-Tarnowskie Góry-Świerklaniec Composition) includes the part of the Middle Triassic Questa with the gap of the Brynica River. It is mostly a part of land, which formerly belonged to the Donnersmarck family. Despite of some well prepared partly materials about this subject, the general and detailed studies are necessary.

The Composition of Saint Ann Mountain – the smallest of separated – was organised according to cult and religion criterion around Saint Ann sanctuary. The sanctuary was intended to pilgrimaging movement and religion holidays. It was also equipped with Calvary – The Passion of Christ. It is located within the Landscape Park of Saint Ann Mountain, nevertheless in the 30s and 40s of the 20th century this part did not oppose the decision about course of A-4 motorway. This composition has good historical documentary evidence but the systematising landscape studies are still necessary.

The Composition of Pokój – rather small and young (18th–19th century) consists of inner-forest settlement situated in Bory Dolnośląskie together with forest and ponds complex. The geometric scheme of roads in the settlement, based on radial model, is particularly interesting. Roads run from the central square of locality. Composition needs basic and detailed studies.

The Composition of Żabi Kraj (Frog's Land) in Upper Silesia consists of part of the Upper Vistula catchment from Skoczów to Goczałkowice, with continuation in Małopolska near Zator. The criterion of composition setting up is connected with economic and aesthetic value of local fish farms. The act of this composition separating needs the confirmation during basic and detailed studies on landscape.

Later CZECH (1999) separated the following landscape compositions: Cieszyn, Karniów, Nysa and Żywiec.

Thus, the problem of setting up of the great landscape compositions in Upper Silesia was usually connected with existing magnate lands. Their owners thoughtfully created the changes in landscape and could join economic and aesthetic aims. The scale of affairs is surprising. The owners realised very important activities basing on family wealth and European cultural model. Apart from great compositions we can divide a lot of small town-planning-aesthetic-composed surroundings, to which belong: Jasna Góra, Złoty Potok, Pilica, Bełk, Moszna and Giszowiec. The reasons of their setting up are the same like for great compositions. On the one hand both of them developed in the 19th century thanks to profits from industry. But on the other hand on the turn of the 19th century the industry was the reason of these splendid landscape composition destruction.

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