UNIVERSITY OF SILESIA
Faculty of Earth Sciences

ANTHROPOGENIC ASPECTS OF LANDSCAPE TRANSFORMATIONS

2

Edited by
Tadeusz Szczypek & Jerzy Wach

Sosnowiec 2002

Editor of dissertations of Faculty of Earth Sciences, University of Silesia
Andrzej T. Jankowski

Dissertations of Faculty of Earth Sciences, University of Silesia No 18

Reviever
Bolesław NOWACZYK

Photo on the cover by T. Szczypek

Financed by Faculty of Earth Sciences, University of Silesia

ISBN 83-87431- 40 - 0

Printed by Wydawnictwo Archidiecezjalne „Regina Poloniae"
ul. Ogrodowa 24/44, 42-200 Częstochowa, Phone 0-prefix-34-368-05-60

Contents

INTRODUCTION

This volume presents the collection of papers prepared to the following geographical Polish-Hungarian Symposium „Anthropogenic aspects of landscape transformations" which took place in Faculty of Earth Sciences of University of Silesia in Sosnowiec (13–15 May 2002). It was a result of agreement of co-operation between University of Silesia in Katowice and University of Debrecen.

The papers prepared concern all signs of human impact which are observed in eastern part of Hungary as well as in Silesian Upland in Southern Poland.

Editors

Anthropogenic aspects of landscape transformations	2	University of Silesia Faculty of Earth Sciences Sosnowiec 2002	5–14

Damian ABSALON, Andrzej T. JANKOWSKI
University of Silesia, Faculty of Earth Sciences, Sosnowiec, Poland

CHANGES IN RIVER RUNOFF UNDER THE INFLUENCE OF HUMAN IMPACT – SELECTED EXAMPLES FROM KATOWICE PROVINCE

Introduction

Katowice Province (Silesian Voivodeship) – administrative unit created as a result of the new administrative division of Poland takes up the area of 12 300 km² (3,9% of the area of Poland) and is inhabited by nearly 4,9 million people (12,6% of the total number of Poland's inhabitants). Population density is 397 persons/km² and is 3,2 times higher than Poland's average. Katowice Province is the most densely populated region in Poland and it also has the highest urbanization rate in Poland – 79,6%. The industrial character of this region is emphasised by high number of employment in industry and building – 805 800 people, which constitutes 46,8% of the total number of employed.

As far as landscape is concerned we deal with very varied units: from mountain areas and foothills in the south to limestone uplands in the north-eastern part. In the centre of the province there are heavily urbanized and industrialized areas.

As far as hydrography is concerned in the area of the province there is first order watershed, separating river basins of the Vistula and Odra (Oder) rivers.

This paper is the effect of analysis of a large quantity of hydrometeorological data, which was prepared for the requirements of Mapa Hydrograficzna Polski (Hydrographic Map of Poland) scale 1:50 000 (sheets from the area of the middle part of Katowice Province – Absalon, Jankowski, Leśniok, 2001a-g). This was the reason of restricted access to essential long-term hydrological characteristics (encompassing many years) – without the possibility of access to more detailed data (because of considerable cost of getting the basic and processed measurement information from the Institute of Meteorology and Water Management).

For this reason our findings concern only the following hydrological parameters: variability of characteristic runoff in a year, the amount of specific runoff and relation between runoff index and precipitation.

This paper does not aspire to being a monograph and it only indicates that certain negative changes are present in river runoff regime in the area of Katowice Province.

Ten catchments have been chosen for the research (both from the Vistula and Odra river basins) of different size and degree of anthropogenic transformation of water relations. In the case of two rivers: Brynica and Kłodnica, 2 and 3 gauge-stations were chosen respectively, closing individual parts of their basins. Basic information about the chosen catchments was presented in table 1, and their location was presented in fig. 1.

Table 1. Basic information about the researched catchments

No	River gauge-station (period)	Catch ment area A [km²]	Average annual discharge from the period in $m^3 \times s^{-1}$	Catchment characteristics	Comments
1.	Korzenica Międzyrzecze (1967-2000)	72,5	0,62	quasi-natural (sylvan and agricultural)	
2.	Pogoria Dąbrowa Górnicza (1961-1999)	37,3	1,21	anthropogenic (industrial)	water reservoirs in the catchment above the gauge-station
3.	Brynica Brynica (1961-1999)	98,2	0,52	quasi-natural (sylvan and agricultural)	
4.	Brynica Szabelnia (1961-1999)	482,7	5,70	varied (upper part of the catchment – quasi-natural, lower part– anthropogenic)	
5.	Ruda Ruda Kozielska (1961-1999)	381,9	3,25	varied (upper part of the catchment – anthropogenic, lower part – quasi-natural)	large water reservoir above the gauge-station
6.	Nacyna Rybnik (1979-1999)	63,6	0,83	anthropogenic (industry, urbanization)	
7.	Kłodnica Kłodnica (1961-1996)	72,9	0,90	anthropogenic (industry, urbanization)	
8.	Kłodnica Gliwice (1961-1999)	444,0	6,41	varied	
9.	Kłodnica Lenartowice (1961-1999)	1054,6	7,03	varied	large water reservoirs above the gauge-station
10.	Bytomka Gliwice (1961-1999)	136,5	2,61	anthropogenic (industry, urbanization)	

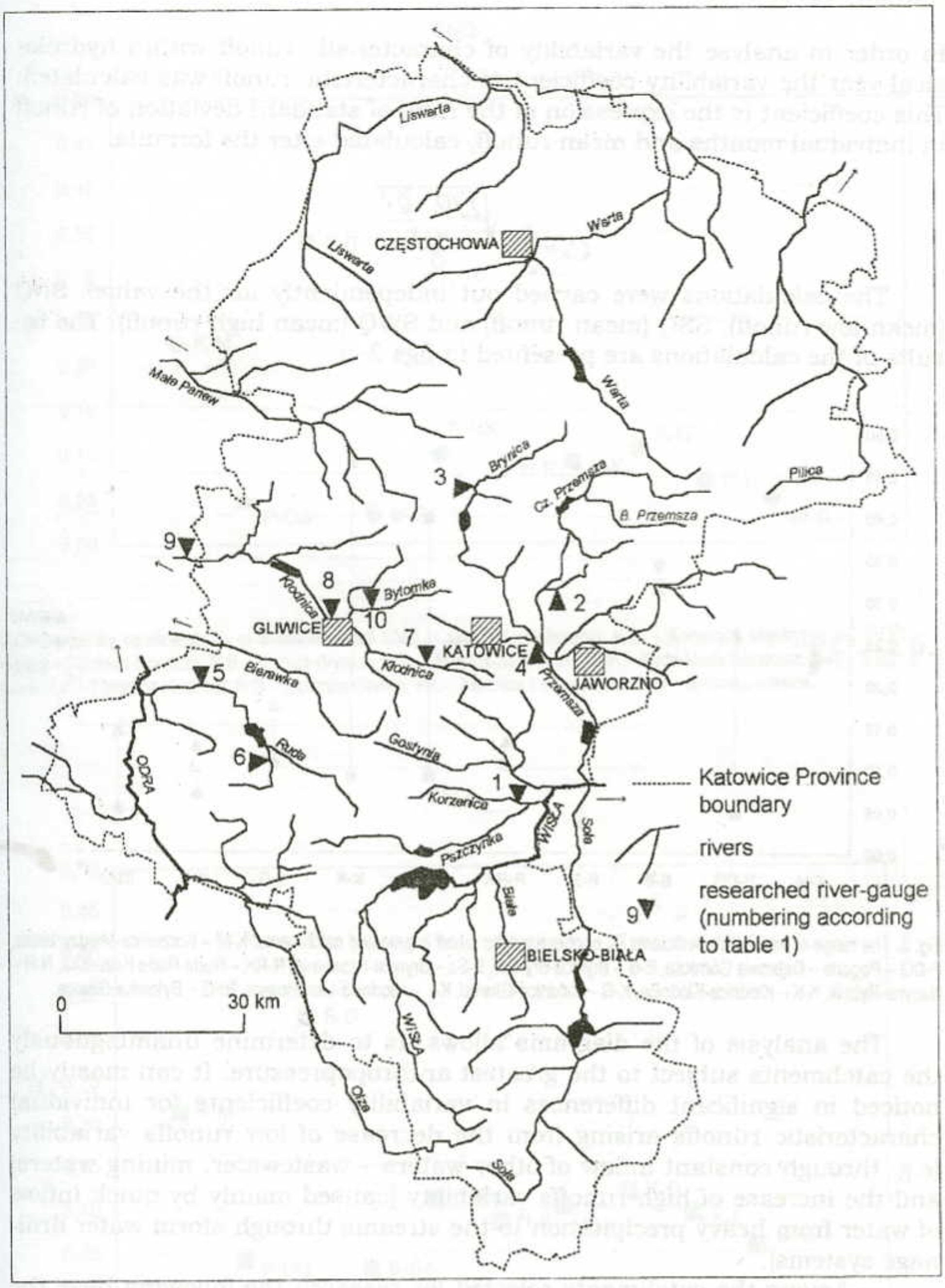


Fig. 1. Location of the researched catchments.

Annual course of characteristic runoff

In order to analyse the variability of characteristic runoff within hydrological year the variability coefficient of characteristic runoff was calculated. This coefficient is the expression of the ratio of standard deviation of runoff in individual months and mean runoff, calculated after the formula:

$$C_v = \frac{\delta}{\overline{Q}} = \frac{\sqrt{\frac{\sum (Q_i - \overline{Q})^2}{n-1}}}{\overline{Q}}$$

The calculations were carried out independently for the values SNQ (mean low runoff), SSQ (mean runoff) and SWQ (mean high runoff). The results of the calculations are presented in figs 2–5.

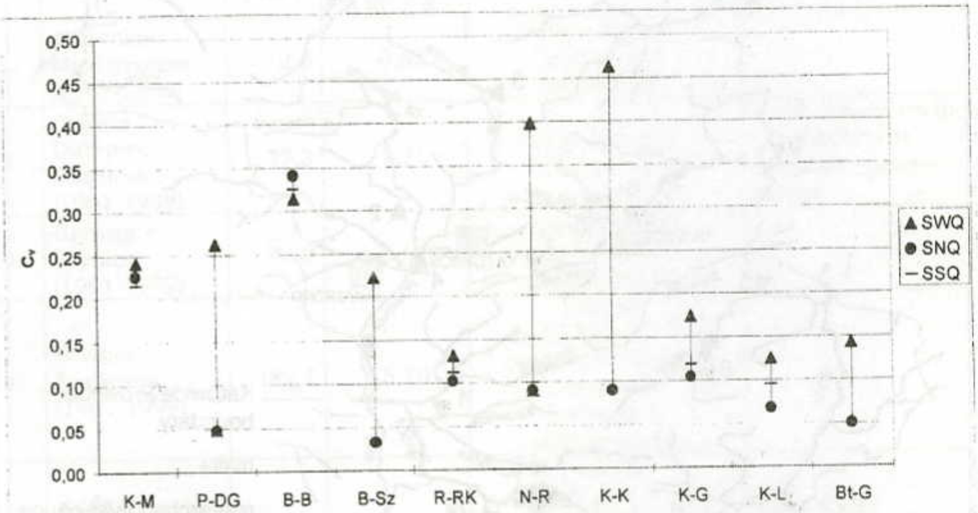


Fig. 2. The range of variability coefficients C_v of characteristic runoff in selected catchments: K-M – Korzenica-Międzyrzecze, P-DG – Pogoria – Dąbrowa Górnicza, B-B – Brynica-Brynica, B-Sz – Brynica-Szabelnia, R-RK – Ruda-Ruda Kozielska, N-R – Nacyna-Rybnik, K-K – Kłodnica-Kłodnica, K-G – Kłodnica-Gliwice, K-L – Kłodnica-Lenartowice, Bt-G – Bytomka-Gliwice.

The analysis of the diagrams allows us to determine unambiguously the catchments subject to the greatest anthropopressure. It can mostly be noticed in significant differences in variability coefficients for individual characteristic runoffs arising from the decrease of low runoffs variability (e.g. through constant inflow of other waters – wastewater, mining waters) and the increase of high runoffs variability (caused mainly by quick inflow of water from heavy precipitation to the streams through storm water drainage systems).

Among the catchments selected for research the following have the widest range of variability coefficients for characteristic runoff: Kłodnica catchment to Kłodnica gauge-station, Nacyna catchment to Rybnik gauge-station, Pogoria catchment to Dąbrowa Górnicza gauge-station and Brynica

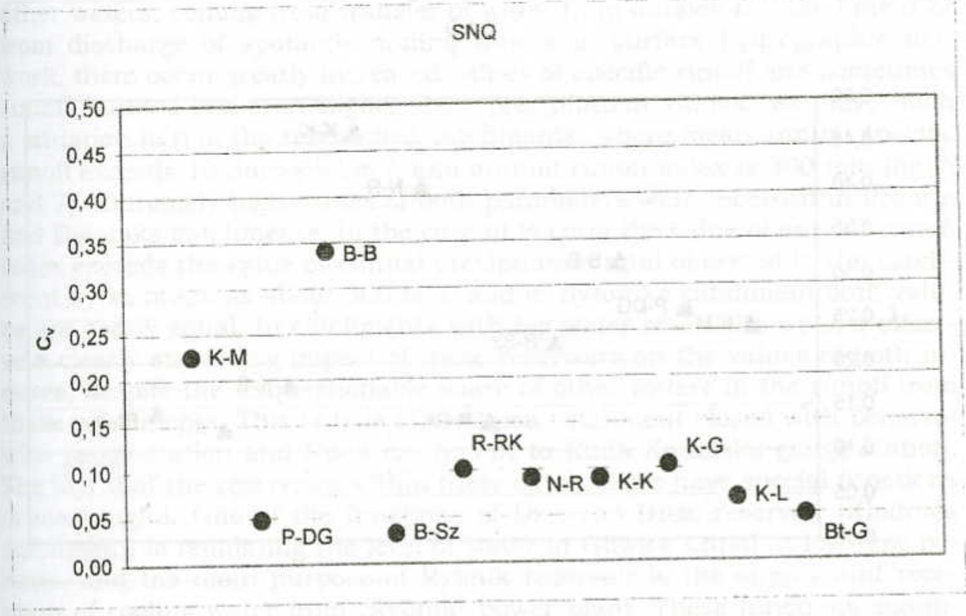


Fig. 3. Variability coefficients C_v of minimum runoff SNQ in selected catchments: K-M – Korzenica-Międzyrzecze, P-DG – Pogoria – Dąbrowa Górnicza, B-B – Brynica-Brynica, B-Sz – Brynica-Szabelnia, R-RK – Ruda-Ruda Kozielska, N-R – Nacyna-Rybnik, K-K – Kłodnica-Kłodnica, K-G – Kłodnica-Gliwice, K-L – Kłodnica-Lenartowice, Bt-G – Bytomka-Gliwice.

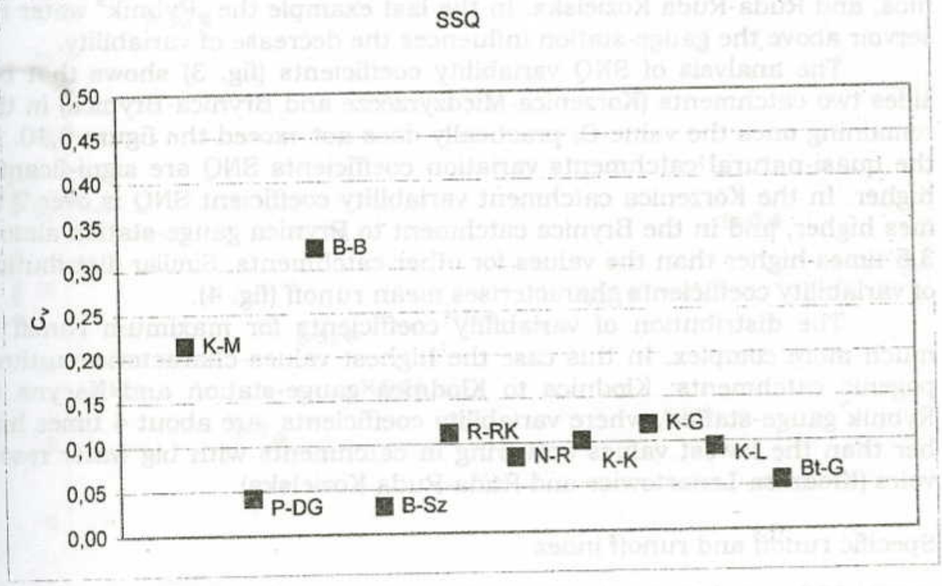


Fig. 4. Variability coefficients C_v of mean runoff SSQ in selected catchments: K-M – Korzenica-Międzyrzecze, P-DG – Pogoria – Dąbrowa Górnicza, B-B – Brynica-Brynica, B-Sz – Brynica-Szabelnia, R-RK – Ruda-Ruda Kozielska, N-R – Nacyna-Rybnik, K-K – Kłodnica-Kłodnica, K-G – Kłodnica-Gliwice, K-L – Kłodnica-Lenartowice, Bt-G – Bytomka-Gliwice.

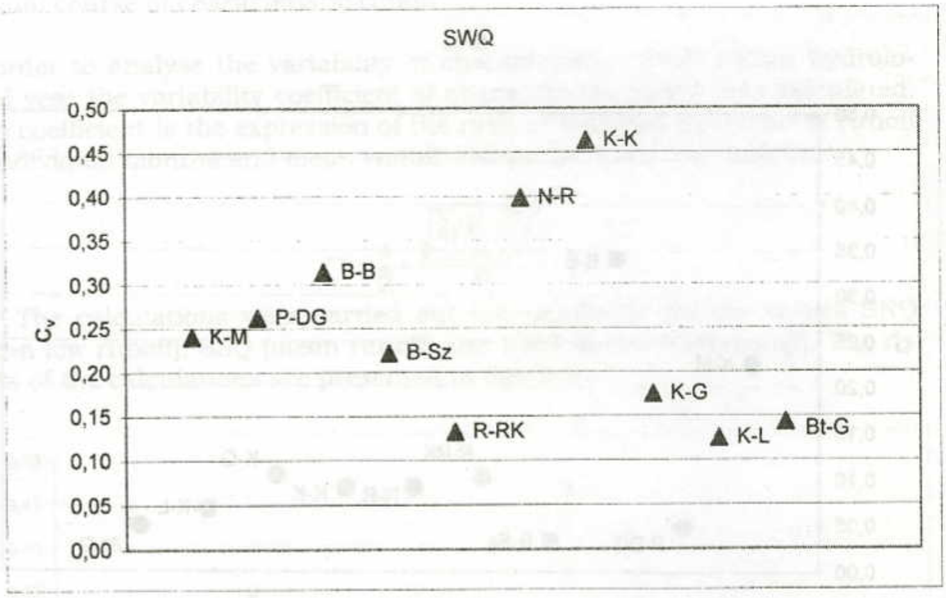


Fig. 5. Variability coefficients C_v of maximum runoff SWQ in selected catchments: K-M – Korzenica-Międzyrzecze, P-DG – Pogoria – Dąbrowa Górnicza, B-B – Brynica-Brynica, B-Sz – Brynica-Szabelnia, R-RK – Ruda-Ruda Kozielska, N-R – Nacyna-Rybnik, K-K – Kłodnica-Kłodnica, K-G – Kłodnica-Gliwice, K-L – Kłodnica-Lenartowice, Bt-G – Bytomka-Gliwice.

catchment to Szabelnia gauge-station. And the smallest variability characterises the following catchments: Korzenica-Międzyrzecze, Brynica-Brynica, and Ruda-Ruda Kozielska. In the last example the „Rybnik" water reservoir above the gauge-station influences the decrease of variability.

The analysis of SNQ variability coefficients (fig. 3) shows that besides two catchments (Korzenica-Międzyrzecze and Brynica-Brynica) in the remaining ones the value C_v practically does not exceed the figure 0,10. In the quasi-natural catchments variation coefficients SNQ are signi-ficantly higher. In the Korzenica catchment variability coefficient SNQ is over 2 times higher, and in the Brynica catchment to Brynica gauge-station almost 3,5 times higher than the values for other catchments. Similar distribution of variability coefficients characterises mean runoff (fig. 4).

The distribution of variability coefficients for maximum runoff is much more complex. In this case the highest values characterise anthropogenic catchments: Kłodnica to Kłodnica gauge-station and Nacyna to Rybnik gauge-station, where variability coefficients are about 4 times higher than the lowest values occurring in catchments with big water reservoirs (Kłodnica-Lenartowice and Ruda-Ruda Kozielska).

Specific runoff and runoff index

The influence of anthropogenic factors on the volume of runoff in the catchment is very clearly reflected in the values of mean annual specific runoff and in annual runoff index. In catchments with significant share of other waters, coming from transfer of water from outside the catchment or from discharge of apotamic mining waters to surface hydrographic network, there occur greatly increased values of specific runoff and sometimes runoff indexes are even higher than precipitation values. We have such a situation in 6 of the researched catchments, where mean annual specific runoff exceeds 10 $dm^3 \times s^{-1} \times km^{-2}$, and annual runoff index is 300 mm (fig. 6 and 7). Extremely high values of both parameters were recorded in Pogoria and Bytomka catchments. In the case of Pogoria the value of annual runoff index exceeds the value of annual precipitation total observed in the catchment by as much as about 300 mm, and in Bytomka catchment both values are nearly equal. In catchments with big water reservoirs we can observe a clearly stabilising impact of these reservoirs on the values of both indexes, despite the unquestionable share of other waters in the runoff from these catchments. This is true of Kłodnica catchment closed with Lenartowice gauge-station and Ruda catchment to Ruda Kozielska gauge-station. The fact that the reservoirs within these catchments have special functions is meaningful. One of the functions of Dzierżno Duże reservoir (Kłodnica catchment) is regulating the level of water in Gliwice Canal in low-flow periods, and the main purpose of Rybnik reservoir is the supply and reception of cooling water from „Rybnik" power plant. These functions significantly influence the volume of water losses, e.g. in the process of increased evaporation (Absalon, 1998).

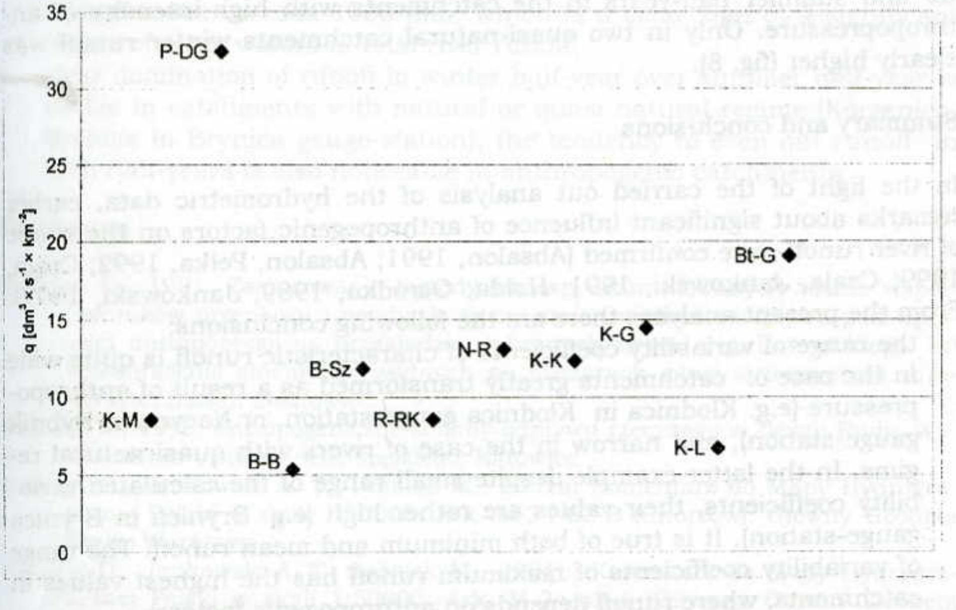


Fig. 6. Mean long-term annual specific runoff in selected catchments: K-M – Korzenica-Międzyrzecze, P-DG – Pogoria – Dąbrowa Górnicza, B-B – Brynica-Brynica, B-Sz – Brynica-Szabelnia, R-RK – Ruda-Ruda Kozielska, N-R – Nacyna-Rybnik, K-K – Kłodnica-Kłodnica, K-G – Kłodnica-Gliwice, K-L – Kłodnica-Lenartowice, Bt-G – Bytomka-Gliwice.

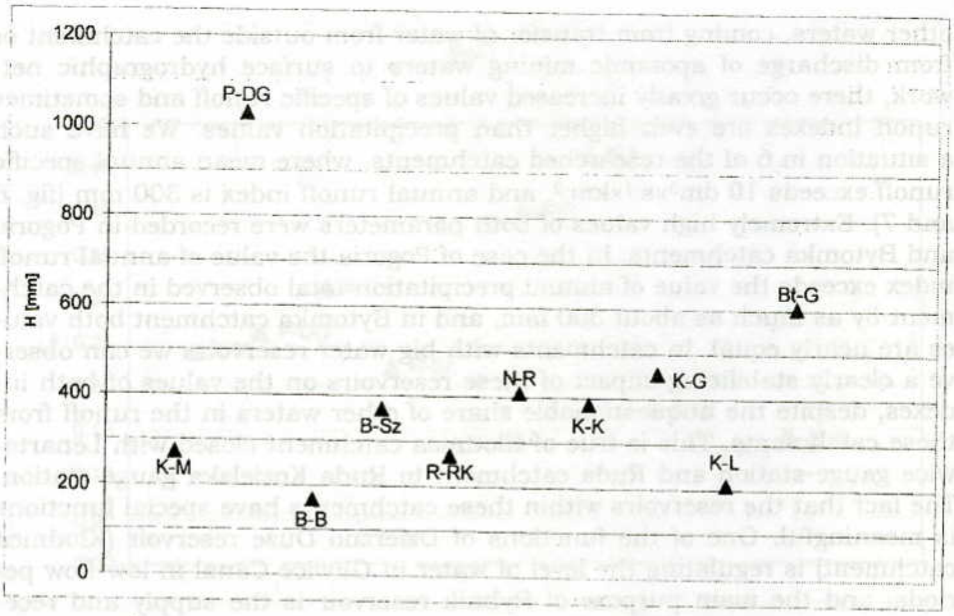


Fig. 7. Mean long-term annual runoff index in selected catchments: K-M – Korzenica-Międzyrzecze, P-DG – Pogoria – Dąbrowa Górnicza, B-B – Brynica-Brynica, B-Sz – Brynica-Szabelnia, R-RK – Ruda-Ruda Kozielska, N-R – Nacyna-Rybnik, K-K – Kłodnica-Kłodnica, K-G – Kłodnica-Gliwice, K-L – Kłodnica-Lenartowice, Bt-G – Bytomka-Gliwice.

Other recorded regularity is the tendency to even out runoff in winter and summer half-years in the catchments with high-intensity of anthropopressure. Only in two quasi-natural catchments winter runoff was clearly higher (fig. 8).

Summary and conclusions

In the light of the carried out analysis of the hydrometric data, earlier remarks about significant influence of anthropogenic factors on the shape of river runoff were confirmed (Absalon, 1991; Absalon, Pełka, 1992; Czaja, 1999; Czaja, Jankowski, 1991; Hołda, Ośródka, 1989; Jankowski, 1997). From the present analyses there are the following conclusions:

- the range of variability coefficients of characteristic runoff is quite wide in the case of catchments greatly transformed as a result of anthropopressure (e.g. Kłodnica in Kłodnica gauge-station, or Nacyna in Rybnik gauge-station), and narrow in the case of rivers with quasi-natural regime. In the latter example despite small range of the calculated variability coefficients, their values are rather high (e.g. Brynica in Brynica gauge-station). It is true of both minimum and mean runoff. The range of variability coefficients of maximum runoff has the highest values in catchments, where runoff depends on anthropogenic factors;
- clear influence of anthropogenic factors on shaping runoff is visible in the values of specific runoff and runoff index. Pogoria specific runoff in

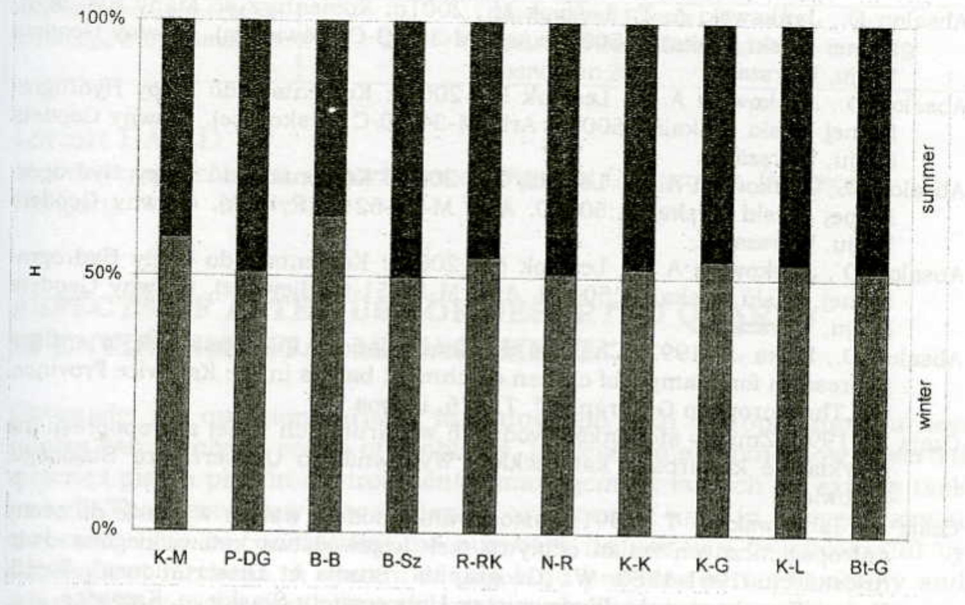


Fig. 8. Share of winter and summer seasons (half-year) in runoff index in selected catchments: K-M – Korzenica-Międzyrzecze, P-DG – Pogoria – Dąbrowa Górnicza, B-B – Brynica-Brynica, B-Sz – Brynica-Szabelnia, R-RK – Ruda-Ruda Kozielska, N-R – Nacyna-Rybnik, K-K – Kłodnica-Kłodnica, K-G – Kłodnica-Gliwice, K-L – Kłodnica-Lenartowice, Bt-G – Bytomka-Gliwice.

Dąbrowa Górnicza gauge-station equals over 32 $dm^3 \times s^{-1} \times km^{-2}$ and the runoff index exceeds 1000 mm, which is a clear sign of a significant share of other waters in total river runoff;

- clear domination of runoff in winter half-year over summer half-year is visible in catchments with natural or quasi-natural regime (Korzenica, Brynica in Brynica gauge-station), the tendency to even out runoff in both half-years is also noticeable in anthropogenic catchments.

References

Absalon D., 1991: Zastosowanie metody krzywej skumulowanych różnic współczynników przepływu i opadu do oceny zmian wielkości odpływu pod wpływem antropopresji na przykładzie wybranych zlewni woj. Katowickiego. In: Przeobrażenia stosunków wodnych na obszarach silnej antropopresji. Uniwersytet Śląski, Sosnowiec.

Absalon D., 1998: Antropogeniczne zmiany odpływu rzecznego w zlewni Rudy. Wydawnictwo Uniwersytetu Śląskiego, Katowice.

Absalon D., Jankowski A. T., Leśniok M., 2001a: Komentarz do Mapy Hydrograficznej Polski w skali 1:50000. Ark. M-34-62-B (Chorzów). Główny Geodeta Kraju, Warszawa.

Absalon D., Jankowski A. T., Leśniok M., 2001b: Komentarz do Mapy Hydrograficznej Polski w skali 1:50000. Ark. M-34-62-A (Gliwice). Główny Geodeta Kraju, Warszawa.

Absalon D., Jankowski A. T., Leśniok M., 2001c: Komentarz do Mapy Hydrograficznej Polski w skali 1:50000. Ark. M-34-63-A (Katowice). Główny Geodeta Kraju, Warszawa.

Absalon D., Jankowski A. T., Leśniok M., 2001d: Komentarz do Mapy Hydrograficznej Polski w skali 1:50000. Ark. M-34-63-C (Oświęcim). Główny Geodeta Kraju, Warszawa.

Absalon D., Jankowski A. T., Leśniok M., 2001e: Komentarz do Mapy Hydrograficznej Polski w skali 1:50000. Ark. M-34-50-C (Pyskowice). Główny Geodeta Kraju, Warszawa.

Absalon D., Jankowski A. T., Leśniok M., 2001f: Komentarz do Mapy Hydrograficznej Polski w skali 1:50000. Ark. M-34-62-C (Rybnik). Główny Geodeta Kraju, Warszawa.

Absalon D., Jankowski A. T., Leśniok M., 2001g: Komentarz do Mapy Hydrograficznej Polski w skali 1:50000. Ark. M-34-51-C (Siewierz). Główny Geodeta Kraju, Warszawa.

Absalon D., Pełka J., 1992: Changes in water relations in areas liable to anthropopression for example of chosen catchment basins in the Katowice Province. In: „The European Geographer". T. 5/6, Lisboa.

Czaja S., 1999: Zmiany stosunków wodnych w warunkach silnej antropopresji (na przykładzie konurbacji katowickiej). Wydawnictwo Uniwersytetu Śląskiego, Katowice.

Czaja S., Jankowski A. T., 1991: Zastosowanie modelu wahań w czasie do oceny antropogenicznych zmian odpływu rzek województwa katowickiego w dwudziestoleciu 1961-1980. W: „Geographia. Studia et Dissertationes". T. 13. Red. J. Trembaczowski. Wydawnictwo Uniwersytetu Śląskiego, Katowice.

Hołda I., Ośródka L., 1989: Próba określenia odpływu antropogenicznego wybranych rzek województwa katowickiego. In: Archiwum Ochrony Środowiska. Nr 1-2. Wydawnictwo PAN, Wrocław.

Jankowski A. T., 1987: Antropogeniczne zmiany stosunków wodnych na obszarze uprzemysławianym i urbanizowanym (na przykładzie Rybnickiego Okręgu Węglowego. Wydawnictwo Uniwersytetu Śląskiego, Katowice.

Anthropogenic aspects of landscape transformations	2	University of Silesia Faculty of Earth Sciences Sosnowiec 2002	15–19

Lóránt DÁVID
University of Debrecen, Department of Physical Geography, Debrecen, Hungary

ASPECTS OF AFTER-USE OF DESERTED QUARRY IN ENVIRONMENTAL MANAGEMENT[1]

Obviously, the questions arising in connection with the opening of a new quarry can involve a series of problems, however to examine how deserted quarries play a part in environmental management is such an exiting task as well. There are many cases when an area can be used in several ways at the same time or considering the purposes its use can be successful by subsequent methods. A system of this kind provides better flexibility and adaptability for the case when circumstances change but an after-use specialized considerably can satisfy an unique function much more efficiently. At the same time various uses have to be planned when neither of them would be realizable alone. The ways of use below, can be combined with each other successfully, for example the resting and the relaxing with the sylviculture, the water storage or the nature protection. The agriculture (except for grazing) can`t be connected with other kind of use.

On the basis of the international experiences the possibilities of after-use of deserted quarry can be classified as follows

Agriculture

Certain types of agricultural use can occur on areas of former quarry, which are extensive or situated directly on the border of a cultivated area, supposing that the soil and relief conditions are sufficient. In the case of a fairly short time extraction, where the arable soil was stored and replaced to the place of extraction (which can be filled and unfilled as well) it is possible to return to the cultivation almost every time. In other cases when it was not possible to protect the upper layer of the soil the agricultural activity becomes hard. There is an exception when it is possible to obtain the upper layer of the soil in the course of further progressive cultivation, possibly from another quarry or there is an alternative plant that can live under these conditions. From the cultivation to the milking cow or beef-cattle and sheep-farming, series of possibilities present themselves. Apart from the features of the area, the only condition is to connect with the local customs in management in a kind of way. For example the grazing animal husbandry took possession of several deserted quarries in Great Britain.

[1]Supported by OTKA D 38473

The possible way of after-use of the place of extraction submerged under water is the pisciculture. For the fish-breeding, water well supplied with oxygen, which is chemically and biologically clear as well, is required. A use of this kind will rise sooner or later, practically, in the case of every deserted quarry, where water can be found.

Sylviculture

On areas, where soils of poor quality can be found, the afforestation of extractional purpose can be an alternative of the tilling of arable land. This provides valuable resource, and utilizes an area which otherwise would have little value. Even in the case, when the quality of cut of timber is not pretty good, with forming of a forest the area can be suitable for resting and relaxing and recreational-oriented use. We can find several examples, when an area is simply planted by vegetation after the landscaping. For example, the same happened to the rehabilitation of Nesher Quarry in Israel, in 1970-71, which was interpreted as a experimental program for selecting of the proper vegetation (Naveh, Valero, Shadmi, 1983). The afforestation of deserted quarries is really popular in Canada where modern practice in sylviculture is widely used (Bauer, 1970).

Nature protection, protection and teaching of wildlife communities

The stocking of several deserted quarries (especially chalk and limestones quarries) by different species, lead to the developing of various communities of plant, animals and insects which are rich in species. The appearance of uniquely rare or local species can increase the value of old quarries. This process rather occurs accidentally than planned and it takes place without human-agency after abandoning of the quarry. However the designed introduction of these unclaimed areas for protection of animal living in the state of nature is another chance (Davis, 1979). These kind of areas can be used in education, we can examine the natural ecosystems that include the relationships between the flora, fauna and geology (Usher, 1979). The biologically most valuable areas usually developed in quarries surrounded by areas also valuable in this kind of view. For example, natural parks marked out the margin of Trowbarrow Quarry and Warton Crag Quarry on the border of Lancashire and Cumbria, North-west England (Dávid, Patric, 1999). In Hungary, besides Celldömölk, the volcanic crater of Ság hill explored by quarrying provides an excellent examples.

Construction of flacts and industry

The depleted quarries and excavations, situated besides urban areas or inside them, can offer a place, frequently, for forming of dwelling belts or industrial plants. The landforms of the quarry can be ideal for hiding of undesirable forms, especially, if some kind of building was already established or forest belt was formed earlier to shelter the active quarry itself. Kerr`s Quarry in Australia is an excellent example which was integrated to the urban environment as a landscape. Building sites were marked out on slopes with terraces and area was also provided for industrial establishment and recreational belts (Eliot, 1976). We can find several similar examples in Canada (Bauer, 1970) and in the United Kingdom (Bennett, Doyle, 1999) as well, where, for instance, in Clithore, in Salthill Quarry an industrial unit was established in a deserted quarry in a way that the wall face of geological value was protected for the purpose of science and education as a natural „showroom". In Sweden, besides Malmö in the environment of Limhamn Quarry a regional development project of great volume has been planned (SCANSTAD).

Trade and amusement

There are many resent examples, mainly in Great-Britain for the case when commercial centre (hiper- and supermarkets) are being built outside of cities in old quarries and associated with them amusement units (parks, multiplex cinemas, amusement arcades, concert halls, discos, galleries, artistic centres, ect.) are being constructed as well (Bennett, Doyle, 1999). The Blue Water Shopping Centre in, Dartford, situated besides the traffic junction number 2. of ringroad M25 surrounding London, provides the most spectacular example which is advertised as a service centre of this character. The investment of imposing appearance inside and outside was constructed in 1995-99 on the areas of deserted Blue Circle Chalk Quarry. There is an another example from Edinburgh where a monumental shopping centre was built by J. S. Sainsbury, the great founder of supermarkets, in Carboniferous Craigleath Quarry. The rocks extracted locally were used mostly for the construction (Bennett, Doyle, 1999). Near Würzburg, in Germany, a resting place for drivers and a lorry parking lot were formed in a deserted quarry (Dávid, 2000).

Water storage and water management

The deep quarries, in which water can be found, are suitable for water storage, canalization or directly water extraction. The increasing difficulties of forming of water basins including the costs of earthwork made the authorities of water conservancy focus, more and more, to the greater or smaller lakes of these kind. The shallow queries are less useable only for water storage but they can be combined with other utilize for the purpose of recreation that is why the use of multi purpose is a feasible arrangement in this kind of situation. We can find examples in the centre-west part of the United States, Ilinois, where former queries were submerged under water and developed into attractive hunting-ground and fishing-place (Rosenbery, Klimstra, 1965; Nir, 1983).

Filling and dumping of waste

Cities and industrial centers produce a huge amount of rubbish and waste. The close place for dumping of waste are really valuable but only a few of them are available. The fact if quarry are appropriate for filling and dumping of waste depends on the geological conditions, of course, the fact that there are enough waste. The filled areas can be used for other purposes as well, but the work plans of filling have to take this fact into consideration outlining the final state so that it can be equivalent with the expectations of after-use. Related to the filling and the dumping of waste, to face opposition of inhabitance during the work of filling is a problem arising frequently, as gases and bad smell can be produced inside of the dumping material (Bennett, Doyle,1999).

Sports and active relaxing

Any kind of deserted quarries situated near the cities and built up areas can provide a series of possibilities for programmed and free relaxing, mostly for youngsters. In many cases, the local inhabitance themselves take possession of deserted queries for walking, picnic, games, taking dogs for a walk, cycling, motorcycling, and war-games. These can be dangerous in deserted state but removing the useless and impracticable buildings and vegetation, minimal construction work is needed and they can be ideal site for the free relaxing.

Using a formal way of solution the disused queries provide excellent site for sport activities, for example playground, golf-course, race ground, shooting-range (rifles and archery), cycle and motorcycles competitions etc. Queries submerged under water can be suitable for boating, sailing, canoeing, swimming, fishing and water skiing. In North-west England, on the border of Lancashire and Cumbria, in the deep lake of the deserted Overhead Quarry submerged under water, a training centre for fancy divers is developed (Dávid, Patrick,1999). In the quarries parking places can be formed, they can be suitable for picnic, walking and they can take a great deal of burden off the natural but much more sensitive areas.

Some quarries are amphitheatre-shaped in their original state that is why on their margin sites can be formed for theatrical performances and organisation of concert. In Hungary, the monumental cave-system of the limestones quarry in Fertőrákos is well known as a opera and movie set.

Operating the parks as areas which are suitable for relaxing and resting valuable recreational belt can be formed near the big cities and extensive areas can provide sites for the a wide range of activities. In many country region the old quarries provide good facilities for general recreation, in the same way as it has been mentioned in the case of quarries in the urban environment. Areas in Great Britain which are not greater than 25 acre typically and providing places for diverse communities can be developed into parks with water surfaces, natural parks and steppes. Parking places and caravans, for example Scout Crag Quarry in North-west England, on the border of Lancashire and Cumbria (Dávid, Patric, 1999), and public convenience can be in them as well as walking roads, natural path ways and touring, fishing, boating and riding and other facilities. Some places show special landforms, for example rocky wall for rock climber and ecological, archeological and petrological features which are worth protection, and they can use for teaching and propagation of general knowledge. The quarries situated on the border of Lancashire and Cumbria, North-west England provide excellent examples for these cases (Dávid, Patrick, 1999). When we develop parks having water as well, we have to consider the fact that coastal areas have to be various, natural slopes have to lead down to the water and we may also need other landscape – forming. This needs proper material for the filling which can be extracted locally or we have to deliver from another place. The accessibility and (it is usually pretty good in the case of old quarries) and the safety (stabilize of rockywall, debris) can be required as well (Dávid, 2000).

References

Bauer A. M., 1970: A guide to site development rehabilitation of pits and quarries, IMR 33, Ontario Department of Mines, Toronto, Canada, 123p.

Bennett M. R., Doyle P., 1999: Environmental Geology, John Wiley and Sons, Chichester, 501p.

Davis B. N. K., 1979: Chalk and limestone quarries as wildlife habitats, Minerals and the Environment 1., pp. 48-56.

Dávid L., Patrick C., 1999: Problems of quarry restoration: general considerations and some examples from North-West England and Hungary, In: Modern nature use and anthropogenic processes, University of Silesia, Faculty of Earth Sciences, Sosnowiec, Academy of Sciences, Irkutsk, pp. 29-33.

Dávid L., 2000: A kőbányászat, mint felszínalakító tevékenység tájvédelmi, tájrendezési és területfejlesztési vonatkozásai Mátra-hegységi példák alapján, PhD disszertáció Debreceni Egyetem, Debrecen, 160. p. + Függelék

Elliott R. J., 1976: The Kerr Quarry Project, In: Landscape and land use planning as related to mining operation, Australian Institute of Mining and Metallurgy, Victoria, pp. 177-228.

Naveh Z., Valero R., Shadmi A., 1983: The rehabilitation of "Nesher Quarry", In: The rehabilitation of technogenous areas, (Edited by Szegi, J.), Mátraalja Coal Mining Company, Gyöngyös, pp. 311-315.

Nir D., 1983: Man, a geomorphological agent, Keter Publishing House, Jerusalem, Boston, London, 165p.

Rosenbery J. L., Klimstra W. D., 1965: Recreational activities on Illinois strip-mined areas, Journal of Soil and Water Conservation 19., pp. 107-110.

Usher M. B., 1979: Natural communities of plants and animals in disused quarries, Journal of Environmental Management 8., pp. 223-237.

Anthropogenic aspects of landscape transformations	2	University of Silesia Faculty of Earth Sciences Sosnowiec 2002	20–26

Renata DULIAS, Jolanta PEŁKA-GOŚCINIAK, Jolanta RADOSZ
University of Silesia, Department of Physical Geography, Sosnowiec, Poland

SOIL DEGRADATION IN OLKUSZ-CHRZANÓW REGION

Changes in soil environment, which influence on decrease in its biological, chemical and physical activities are called degradation. Among its basic signs are numbered: acidity, alkalisation and soil salinity, pollution by phytotoxic components and heavy metals, waterlogging and drying, and impoverishment from soil nutrient (Siuta, 1978). But for the most harmful are considered pollution by heavy metals, because they can occur in soils during hundreds or even thousands years. Among anthropogenic sources of these metals pollution are mentioned: industrial dust and gas emission, fumes from car engines, waste dumping grounds, mining and raw materials processing and extensive agriculture chemicalisation.

Especially toxic heavy metals are cadmium and lead. They can be numbered among so-called ecotoxines, i.e. environment poisons, which are the threat to the global ecosystem (biosphere) (Sokół, 1992). At acid soil reaction both cadmium and lead are more mobile and easier accumulated in plants (Kucharski, Marchwińska, Gzyl, Sajdak, 1992). Therefore the most endangered are these areas, where heavy metals emission is accompanied by acid rains (Migula, 1993).

In Silesian Region high contamination of soil by heavy metals was stated in areas of present and former zinc and lead ores mining and metallurgy – Tarnowskie Góry, Bytom, Olkusz and Chrzanów. In the paper are presented results of soil and plants monitoring in communes Bukowno, Olkusz, Chrzanów, Trzebinia, Bolesław and Sławków, so in area of activity of 3 Zn-Pb ores mines – "Olkusz", "Pomorzany" and "Trzebionka", Mining-Metallurgical Plant "Bolesław" in Bukowno and metallurgical plant in Trzebinia.

One of sources of soil contamination in Olkusz-Chrzanów region are wastes accumulated in dumping grounds and settlement tanks (fig. 1). In large post-flotation ponds located between Bolesław and Bukowno 32 million tons of wastes were already accumulated. The main mass is built of material of fine fraction, which after overdrying easily undergoes wind erosion. Dust with metals blowing from here causes pollution of soil and plants even in a radius of 7-8 km (Szczypek, Wach, 1991). The essential source of substratum pollution by cadmium and lead are also mining waters and waters over deposits from post flotation ponds, which are discharged into the Sztoła and Biała Przemsza rivers through system of canals. Suspension, which is transported in these waters is rich of heavy metals, and during floods it is settled on floodplains (Klimek, Niewdana, 1998).

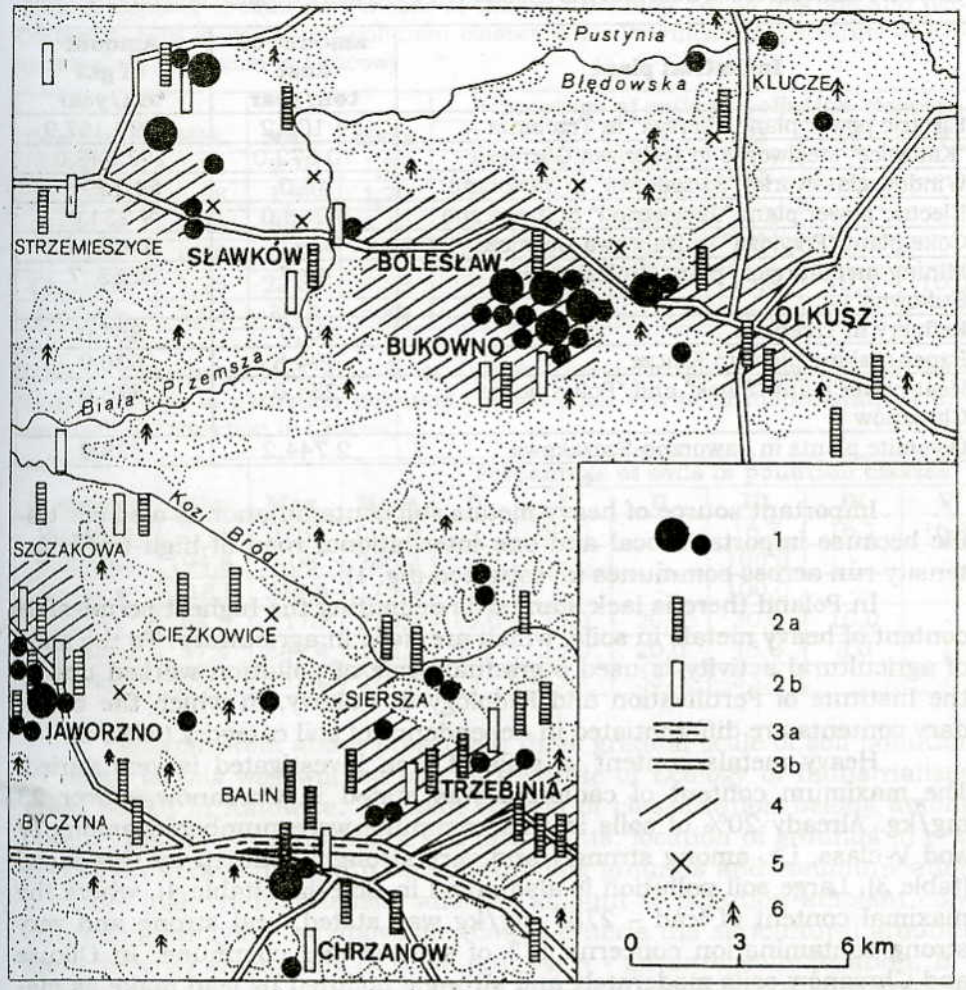


Fig. 1. Main sources of soil pollution in Olkusz-Chrzanów region (basing on Mapa sozologiczna...., 1995 and Raport..., 1997): 1/ dumping grounds of industrial waste (metallurgical, energetistic, chemical and mining), 2/ emitters of industrial and municipal dust and gases: a/ without electrofilters, b/ with electrofilters, 3/ roads of large traffic intensity: a/ international, b/ local; 4/ grounds of C category of total limitation to produce food after IETU Katowice; 5/ other places of toxic soils occurrence; 6/ forest areas including anthropogenic forests

From researches carried by OBiKŚ in Katowice results that since the 90s in Olkusz-Chrzanów region the exceeding of permissible concentration of cadmium in the air has been noted but permissible concentration of lead is exceeded in Bukowno and Olkusz to relatively small degree. But there is no doubt that in the earlier period polluted air was one of the main sources of soil contamination by heavy metals. Besides pollution from local plants on the quality of atmospheric air in area investigated also influencec pollution inflowing here from Upper Silesian Industrial Region (table 1), what is favoured by the predominance of winds from western sector (40-48% in the year). Whole area analysed is located in the zone of exceeding of permissible concentration of sulphur dioxide and suspended dust.

Table 1. Main sources of dust and gas emission in 1993 (after Absalon and others, 1995)

Industrial plant	amount of dust ton/year	amount of gas ton/year
Electric power plant "Siersza" in Trzebinia	4 103,2	1 899 167,9
"Katowice" steelworks in Dąbrowa Górnicza	10 572,0	147 048,0
Window glassworks "Szczakowa" in Jaworzno	45,0	64 120,6
Electric power plant "Jaworzno I" in Jaworzno	4 788,0	9 234,0
Coke plant "Przyjaźń" in Dąbrowa Górnicza	639,0	6 420, 7
Mining-metallurgical plant "Bolesław" in Bukowno	42,7	3565, 7
Refinery in Trzebinia	52,0	857,0
Paper-making plant in Klucze	494,8	630,9
Heat power plant "Śląsk" and "Południe" in Chrzanów	254,0	473,0
Dolomite plants in Jaworzno-Szczakowa	2 744,2	333,9

Important source of heavy metals soil contamination is also car traffic because important local and one international road of high traffic intensity run across communes investigated (fig. 1).

In Poland there is lack standards delimiting the highest permissible content of heavy metals in soils, which are used in agriculture. To the aims of agricultural activity is used 6-gradual scale of pollution worked out by the Institute of Fertilisation and Pedology in Puławy, in which the boundary contents are differentiated in dependence of soil category (table 2).

Heavy metals content in soils of area investigated is very varied. The maximum content of cadmium was stated in Chrzanów – over 23 mg/kg. Already 20% of soils in this commune were numbered among IV and V class, i.e. among strongly and very strongly polluted by this metal (table 3). Large soil pollution is also noted in Bolesław (table 4), where the maximal content of lead – 2787 mg/kg was stated, and strong and very strong contamination concerns 1/3 of soils of this commune. In Olkusz and Chrzanów soils moderately and strongly polluted by lead make as many as 40-50% of the total area of grounds (Tokarz, Turzański, 1999).

Table 2. Quality classes of light and heavy soils in respect of cadmium and lead contamination (based on the Institute of Fertilisation and Pedology in Puławy)

Metal	Degree of soil pollution in mg/kg					
	0 – natural content	I – increased content	II – weak pollution	III – medium pollution	IV – strong pollution	V – very strong pollution
Cadmium	0,3 - 1,0	1,0 – 3,0	2,0 – 5,0	3,0 – 10,0	5,0 – 20,0	> 5 - > 20
Lead	30 - 70	70 - 200	100 – 500	500 – 2000	2500 - 7000	>2500 – > 7000

Table 3. Content of cadmium in soils of Olkusz-Chrzanów region (mg/kg) and percentage of soils in particular pollution classes (after Provincial Inspectorate of Environmental Protection in Cracow)

Commune	Min.	Max.	Mean	Percentage of soils in pollution classes					
				0	I	II	III	IV	V
Bolesław	1,28	2,70	1,89	-	33,3	50,0	16,7	-	-
Bukowno	1,58	1,96	1,76	-	-	100,0	-	-	-
Sławków	1,48	8,40	4,19	-	-	33,4	33,3	33,3	-
Olkusz	0,56	4,00	1,93	10,0	50,0	30,0	10,0	-	-
Chrzanów	1,25	23,36	4,59	-	20,0	45,0	15,0	10,0	10,0
Trzebinia	3,92	8,15	5,89	-	-	-	66,7	33,3	-

Table 4. Content of lead in soils of Olkusz-Chrzanów region (mg/kg) and percentage of soils in particular pollution classes (after Privincial Inspectorate of Environmental Protection in Cracow)

Commune	Min.	Max.	Mean	Percentage of soils in pollution classes					
				0	I	II	III	IV	V
Bolesław	77,5	2787	667,8	-	50,0	-	16,7	16,7	16,6
Bukowno	194,8	408	286,7	-	-	-	100,0	-	-
Sławków	118,8	289,5	179,9	-	-	-	100,0	-	-
Olkusz	54,3	2178	320,2	10,0	30,0	20,0	30,0	10,0	-
Chrzanów	37,9	589,4	295,2	5,0	25,0	20,0	45,0	5,0	-
Trzebinia	151,6	353,9	247,5	-	33,4	33,3	33,3	-	-

Different from above-presented, three gradual scale of soil pollution by heavy metals was worked out by Institute of Ecology of Industrialised Areas (IETU) in Katowice. To main criteria of classification belong among others: content of pollutants in soil and plants, location of grounds in respect of emitters of dust with metal, dumping grounds and communication routes of high traffic intensity and the amount of pollution ambient concentration. Applying the above-mentioned criteria the agricultural grounds are numbered among one of three groups: A - advantageous location, B – disadvantageous location and C – strongly disadvantageous location (Raport... 1997).

In area investigated there is no grounds of A group, i.e. these, where slight soil and air contamination allows to carry out agricultural production without limitation. Grounds of B type, which contain the increased amount of harmful substances, predominate here. Applying the proper agrotechny there is the possibility to cultivate crops, leguminous plants, fruit trees and bushes. From cultivation are excluded among others root and leaf vegetables, potatoes or strawberries (Agroekologiczne..., 1992). The worst grounds (C) occur between Bukowno, Bolesław and Sławków and in Olkusz and Trzebinia (fig. 1) The production of edible and forage plants is here non-allowable, cultivation of industrial and decorative plants are here only permitted.

Heavy metals are very toxic for human organism. Cadmium is mainly cumulated in kidneys and lungs, it also causes neoplasm diseases of bones. To the toxic lead activity are especially exposed kidneys, marrow and in children – brain (Migula, 1993). As cadmium and lead are delivered to a large degree to human organisms by food road it is highly risky to eat plants cultivated in areas polluted by heavy metals. Among the diseases closely related with environmental pollution in areas affected by of lead, cadmium and zinc pollution are also numbered heart conditions, allergies, deficient cellular immunity and chromosomal disorders (Osuch-Jaczewska, Baczyńska-Szymocha, 1991).

Heavy metal pollution is particularly dangerous for the health and development of children. These pollutants occur in particularly high concentration in the areas around the non-ferrous metals smelters, which emits lead, cadmium and zinc, causing environmental pollution including contamination of foodstuffs. Research by R. Osuch-Jaczewska and H. Baczyńska-Szymocha (1992) on concentration of lead and cadmium in the blood fluids of mothers and in the umbilical blood and meconium of their new-born babies showed concentration in the new-born four times higher than in the mothers. It can thus be assumed that mothers relieve of the toxic agents via their foetuses.

In the 80s in Olkusz-Chrzanów region the determination of lead and cadmium content in vegetables from allotment gardens and in green fodder of plant origin was carried out. Results presented in fig 2 indicate that in all vegetables even minimal value from noted contents of cadmium and lead exceeded the permissible concentrations. Whereas the maximal values exceed the permissible values even ten times, e. g. in Olkusz the cadmium content in celery leaves is exceeded 90 times, lead - 45 times and the content of cadmium in beets cultivated in Bukowno exceeds permissible standards 58 times (Marchwińska, Kucharski, 1995).

Fodder contamination by heavy metals is rather varied. For example, in commune Bukowno the permissible cadmium contamination was exceeded in all samples of hay, green fodder and beets leaves and in 95% of samples of mangel roots. Whereas in Chrzanów in any of 6 kinds of investigated fodder the pollution by lead was not noted, but standards of cadmium content in beets leaves were exceeded many times. In general fodder is less polluted by heavy metals than vegetables (Marchwińska, Kucharski, 1995).

From above-presented data results that in Olkusz-Chrzanów region soils strongly polluted by cadmium and lead in the majority of cases exclude production of food which can be safe for population health. It was proved by many analyses and published in specialistic scientific elaborations. But the social consciousness of this fact is very small – in almost every garden attached to a homestead vegetables for own needs are cultivated (Kucharski, Marchwińska, Gzyl, Sajdak, 1992). Therefore it seems that results of scientific researches should be used by proper administration organs to wider degree in actions propagating ecological agriculture.

There are also some opportunities to reduce the threat of soil contamination. Uptake of lead and cadmium by plants from the soil depends on the acidity of the soil as well as on content of organic and phosphorous

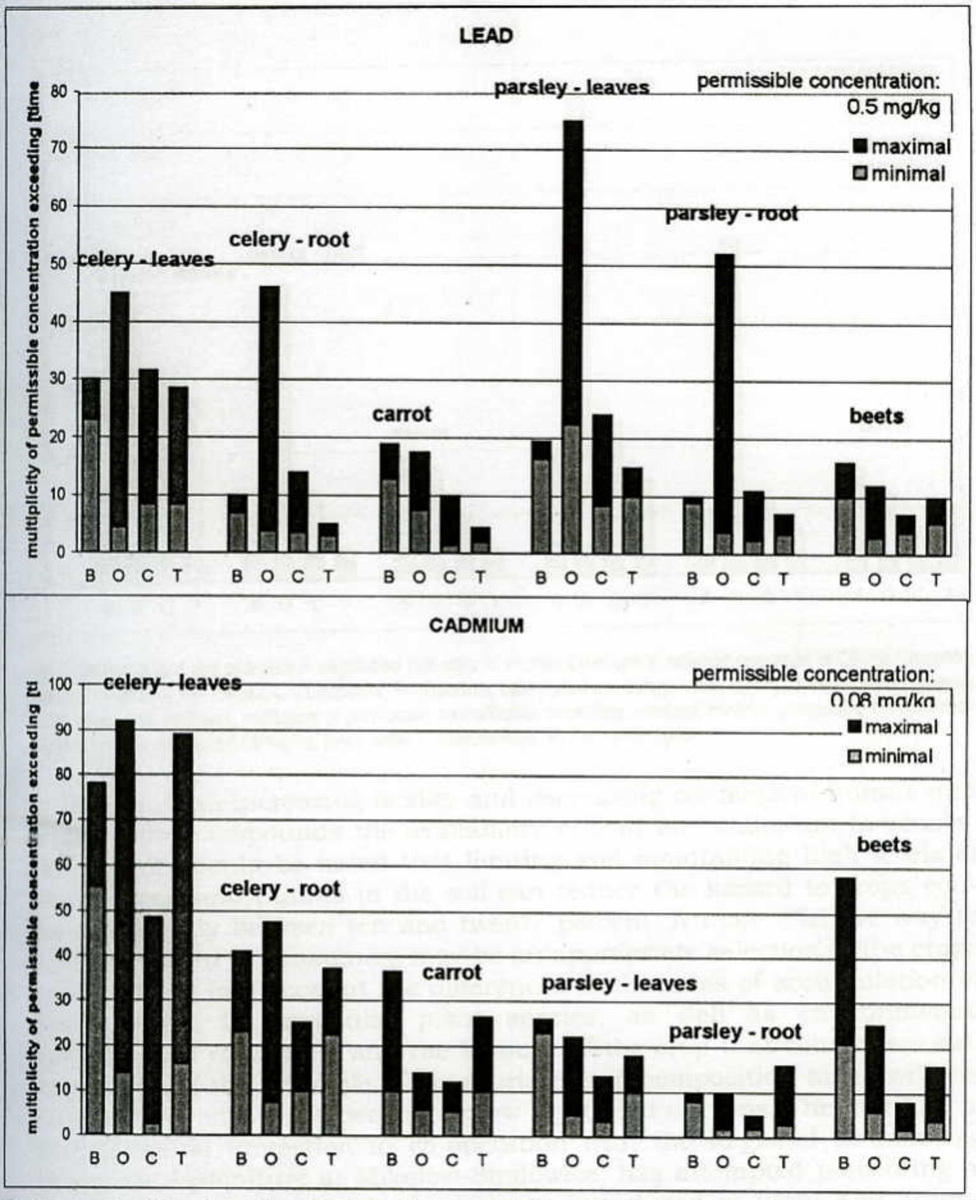


Fig.2. Content of lead and cadmium in vegetables cultivated in allotment gardens in selected communes of Olkusz-Chrzanów region.
B – Bukowwno, O – Olkusz, C – Chrzanów, T - Trzebinia

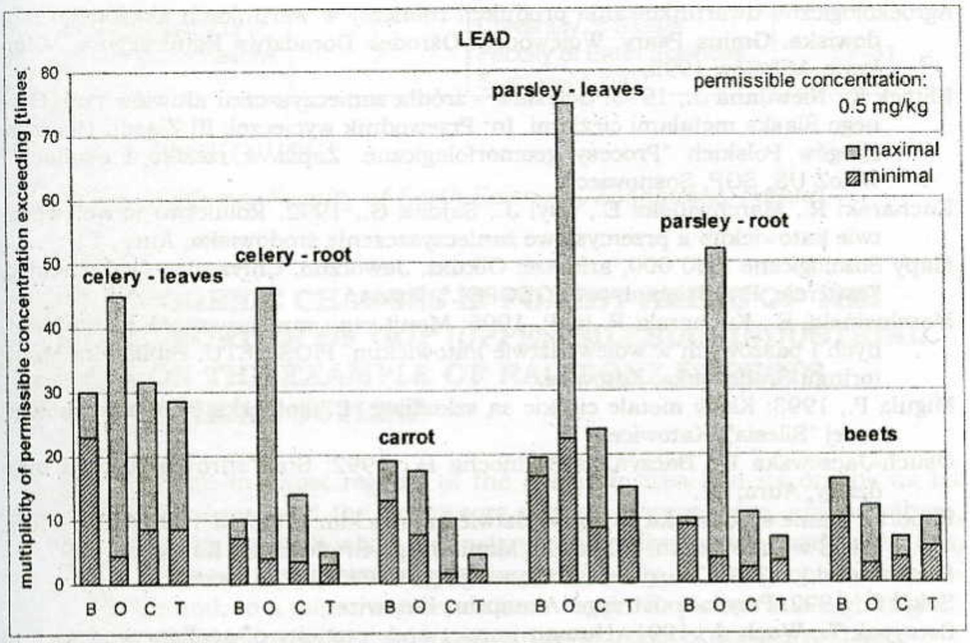


Fig. 2. Content of lead and cadmium in vegetables cultivated in allotment gardens in selected commues of Olkusz-Chrzanów region: B – Bukowno, O – Olkusz, C – Chrzanów, T – Trzebinia, celery – leaves, celery – root, carrot, parsley – leaves, parsley – root, beets, lead, cadmium, multiplicity of permissible concentration exceeding: maximal, minimal, permissible concentration – lead: 0.5 mg/kg, cadmium 0.08 mg/kg, times (after E. Marchwińska, R. Kucharski, 1995)

in the soil. With increasing acidity and decreasing contents of humus and phosphorous compounds the availability of lead and cadmium increases. However, it should be noted that limiting and maintaining high levels of phosphorous and humus in the soil can reduce the hazard to crops consumers by only between ten and twenty percent. A more effective way to omit the hazard to consumers may be an appropriate selection of the crops grown, taking into account the differences in the rates of accumulation of heavy metals by particular plant species, as well as environmental pollution, soil conditions and the amount of the crop that consumers eat. Application of the principle of appropriate crop composition alone will not be enough to encourage people to grow right kind of crops. The Institute of Environmental Protection in co-operation with the Regional Counselling Centre for Agriculture at Mikołów-Śmiłowice, has attempted presenting of economic account in which changes are introduced in plant and animal production, taking environmental pollution and the suitability of agricultural soils into account (Kucharski, Marchwińska, Gzyl, Sajdak, 1992).

References:

Absalon D., Jankowski A.T., Leśniok M., Wika S., 1995: Komentarze do Map Sozologicznych 1: 50 000, arkusze: Olkusz, Jaworzno, Chrzanów, Ogrodzieniec, Zawiercie, Przedsiębiorstwo "GEOPOL" Poznań.

Agroekologiczne uwarunkowania produkcji rolniczej w warunkach skażonego środowiska. Gmina Psary. Wojewódzki Ośrodek Doradztwa Rolniczego w Mikołowie, Mikołów 1992.

Klimek K., Niewdana J., 1995: Bolesław – źródła zanieczyszczeń aluwiów rzek Górnego Śląska metalami ciężkimi. In: Przewodnik wycieczek III Zjazdu Geomorfologów Polskich "Procesy geomorfologiczne. Zapis w rzeźbie i osadach"" WNoZ UŚ, SGP, Sosnowiec.

Kucharski R., Marchwińska E., Gzyl J., Sajdak G., 1992: Rolnictwo w województwie katowickim a przemysłowe zanieczyszczenie środowiska, Aura, 11.

Mapy Sozologiczne 1:50 000, arkusze: Olkusz, Jaworzno, Chrzanów, Ogrodzieniec, Zawiercie, Przedsiębiorstwo "GEOPOL", Poznań.

Marchwińska E., Kucharski R. (red), 1995: Monitoring zanieczyszczeń roślin jadalnych i paszowych w województwie katowickim. PIOŚ, IETU. Biblioteka Monitoringu Środowiska, Katowice.

Migula P., 1993: Kiedy metale ciężkie są szkodliwe. Biblioteczka Fundacji Ekologicznej "Silesia", Katowice.

Osuch-Jaczewska R., Baczyńska-Szymocha H., 1992: Stan zdrowia dzieci i młodzieży, Aura, 11.

Raport o stanie środowiska w województwie katowickim w latach 1995-1997. PIOŚ, WIOŚ w Katowicach. Biblioteka Monitoringu Środowiska, Katowice, 1997.

Siuta J. (red.), 1978: Ochrona i rekultywacja gleb. PWRiL, Warszawa.

Sokół S., 1992: Przyroda ostrzega. Almaprint Katowice.

Szczypek T., Wach J., 1991: Human impact and intensity of aeolian processes in the Silesian-Cracow Upland (Southern Poland). In: Kozarski S. (ed.) Late Vistulian (=Weischelian) and Holocene Aeolian Phenomena in Central and Northern Europe. Z. Geomorph., N.F. Suppl., Bd. 90.

Tokarz M., Turzański K.P. (red.) 1999: Ocena stanu zanieczyszczenia gleb województwa małopolskiego metalami ciężkimi i siarką. Wojewódzki Inpektorat Ochrony Środowiska w Krakowie. Okręgowa Stacja Chemiczno-Rolnicza w Krakowie. Biblioteka Monitoringu Środowiska, Kraków.

Anthropogenic aspects of landscape transformations	2	University of Silesia Faculty of Earth Sciences Sosnowiec 2002	27–31

Grzegorz JANKOWSKI
University of Silesia, Faculty of Earth Sciences, Sosnowiec, Poland

ANTHROPOGENIC CHANGES IN FOREST AREAS OF THE WESTERN BORDER OF GOP (UPPER-SILESIAN INDUSTRIAL REGION) ON THE EXAMPLE OF RACIBÓRZ FORESTS – THE HISTORICAL OUTLINE

Anthropopressure in forest regions of the research area had its origins as far back as Middle Ages, and the precursors of that process were, among others, Cistercians of the Rudy Wielkie monastery. Their diverse economic activities, carried out on large areas, had a great impact mainly on the generic composition of forests and, to a minor degree, on their range. Exploited to a high degree, the primary stand of trees changed its structure in terms of species and age.

In the past the Upper-Silesian forests were not uniform in qualitative terms, which is indicated by papers, not only historical ones (seventeenth-century urbars and journals) but also environmental ones (both archival and contemporary). Basing on analyses of cartographic materials, Czech and German literature and rich Polish papers, Nyrek (1975) divided the Upper-Silesian forests into following categories of different generic composition: forests of uplands and hills, forests of river valleys (mainly alder and riverside carrs), and coniferous or mixed forests of the north-western and central parts of Upper Silesia.

Prevailing species in upland forests included: beeches, oaks, hornbeams, sycamores and maples. Additionally, there occurred pines, larches, firs and spruces. That composition caused intense deforestation, especially of oaks and beeches as the highest quality material. Riverside valley forests included mainly alders, aspens, willows, birches and, on drier areas, oaks. Decrease in forest area of that type was caused by activities related to river regulation (embankments, channelization, land drainage etc.) as well as by intense forest grazing. Mixed and coniferous forests of the research area (present Racibórz Forests) consist of conifer with an addition (especially in the northern part) of deciduous trees (Nyrek, 1975).

In mid-17th century, an additional classification of Upper Silesian forests was implemented in order to obtain more detailed pricing of harvested timber. Two classes were distinguished – one with prevailing „hard" trees, like oaks, hornbeams and beeches, the other with majority of „soft" trees like spruces, firs, pines, birches and alders) (Nyrek, 1992).

Forests in the discussed area were entirely owned by the Rudy monastery, however the methods of management and exploitation of those resources were the same as in other (in terms of administration and ownership) forest areas of Upper Silesia. Monastery administration decided quite freely on the ways of using their forest resources.

In the course of time, few free people could manage their own pieces of forests, which were turned into ploughlands or pond areas, especially during colonization.

Main branches of forest management include:

- ground flora gathering – the primary form of obtaining food by man has changed its nature with time. The range of gathering includes not only ground flora, but also some species of shrubs and trees (e.g. junipers, willows, elms or birches);
- bee-keeping – this type of activities developed on forests areas adjacent to forest settlements or near villages. Tyszkiewicz (1976) points to the necessity to carry out studies in that matter concerning development of, settlement, beekeepers' organizations and legal forms characteristic for that type of forest management activities;
- hunting – the most problematic forest activity (hunting privileges typically concerned forest owners or managers);
- forest grazing – this is the oldest form of using the forest resources. Man has grazed cows, sheep, goats and even pigs practically ever since the Neolithic Age;
- timber harvesting and related activities – timber gathering was the basic forest management activity. Intensity of that type of activities depended on the type of forest, its generic composition, and the transportation infrastructure. Birch tar, tar and charcoal production was of no less importance. The monastery had numerous charcoal kilns and wood distillers' works, the largest ones being situated in Rudy, Jankowice, Stanowice, Zwonowice and Bargłówka.

The above forms of forest management were put in a kind of administrative-legal scheme resulting from laws of the king, the prince and the monastery (as the owner of those lands). As soon as the early part of the 14th century, the so-called „forest order" was put into force in Silesia; it was patterned after some laws (even common ones) valid in the Czech Republic (Nyrek, 1972).

Rudy's Cistercians organized the forest service after the example of above-mentioned princely service. Initially, monastery servicemen's duty was to organize hunting and care for animals. It was not until the late part of the 16th century that caring for existing stand of trees and its rational use were included into the most important duties. Thus the forest service duties included controlling the quantity and quality of timber as well as the place it was harvested from. They started to charge fees for almost every economic activity that was carried out in forest areas. The subjects therefore were made to pay (by means of money, work or farm products) for timber (both as a building material and as fire-wood), cattle grazing, grass mowing, ground flora gathering, fishing (in forest ponds), and also for using the forest tracks. Village administrators provided much help in supervising and organizing the forest management. They also exercised control over exploitation of forest resources in forests given by the monastery to particular villages or communes (Nyrek, 1972).

The main recipients of timber from the Cistercian forests were all works that were directly or indirectly subject to the monastery. And so the aforementioned charcoal kilns and wood distillers' works, as well as charcoal iron furnaces, ironworks, monastery breweries and bakeries contributed to deforestation of vast areas by their constantly growing demands for timber. In order to rationally manage the material and, as it turned out to be necessary later, protect forest areas, the monastery administration started implementing numerous decrees, which were patterned after similar secular acts. It was forbidden as early as 16th century to use healthy timber (i.e. timber obtained from healthy and well-growing trees) for firing and in distilleries or bakeries. That decree also favoured removing windbreaks, snowbreaks and otherwise uprooted trees (Nyrek, 1972).

In 17th century regulations concerning protection of Silesian forests were put into force and observed rigorously. Their main purpose was to protect the species of particular value in hunting management or bee-keeping (16th-, 17th- and even 18th-century instructions imposed particular protection of so-called honey-yielding species, that is limes, hawthorns, sycamores and a few other species of fruit-bearing trees and shrubs, and some species that were necessary for proper activities of other branches of forest management. And so, from the point of view of water management, the larch was a particularly important species (pipes and hydrotechnical devices which had permanent contact with water), although the instructions also mentioned oak, fir and pine wood. On the other hand, ash, lime, oak and red osier were particularly precious species for handicraft (Nyrek, 1975).

The following table shows how large the demand for wood in selected years of 18th and 19th centuries was (in spite of the above described activities aimed at protection and reclamation of forest areas).

Table 1. Wood demand in selected years

Year	**Demand in m³**
1756	22.835
1759	19.274
1760	16.358
1801	15.673
1802	19.895
1806	21.882
1809	17.463
1810	21.924

Source: M. Sufryd, J. Winiewski (1987).

Large contribution of Cistercians into organizing and managing the forest areas and into organizing the forest administration was lasted for long enough for its effects to be noticeable even nowadays. What has remained up to the present is the post-Cistercian division of some forest areas (called Racibórz Forests nowadays) into regular clearings and remainders of structures whose purpose was to provide fire-protection or to give facilities for extinguishing fires (remains of canals, crosscuts and dikes).

In mid-19th century, forest economy underwent transformation which caused that wood was no longer the most important energetic material and trends in forest management that ruled Europe at that time forced new owners to make changes in administration and economy. There appeared large areas of spatially ordered coniferous monocultures of equal-age stands of trees. That type of activities reduces non-forest (but formerly afforested) areas and predestines the forest as a „wood factory", but at the same time it has a degrading impact on the stand of trees itself (next generations of the same species are weaker than their predecessors), as well as on the soil condition.

Cistercian forest heritage, which came under administration of Racibórz-Pszczyna princes after monastery's annulment in 1810, was so perfectly organized, and documentation so precise, that it is currently possible to carry out quite detailed analyses of the forest area of the region.

According to Szabla (1994) effects of that several-hundred-year-long anthropopressure include mainly:

- higher proneness of trees to fires;
- increase in pest activity;
- thinning out of stands of trees;
- decrease in trees' resistance to unfavourable meteorological conditions (droughts, strong winds);
- changes in the composition of the ground flora (deterioration of vegetation characteristic for particular habitats;
- unfavourable changes in chemistry of forest soils resulting in disturbed nutrient uptake by plants.

The forests of the research area are not currently being exploited so intensely, although their condition is clearly influenced by industrial activities of the surrounding regions: Rybnik and Upper Silesian ones. The whole area of the Rudy Raciborskie forest division is exposed to the highest in Poland precipitation of dusts like: cadmium, lead, manganese, copper, chromium or arsenic, and the ambient concentration levels for SO_2 and NO_X compounds have been exceeding acceptable norms for forest areas for many years now (Szabla, 1994).

Another element which is highly dangerous for the condition of stands of trees (especially between the Ruda and the Bierawka rivers) is the depression sink of the exploitation hollow of „Kotlarnia" sandpit. Continuous drainage of the bottom of the exploitation hollow results in changes in hydrological conditions of these areas (lowered level of ground waters), which, combined with periods of rainless weather, brings about high fire risk (e.g. in 2000, humidity of forests in the Rudy Raciborskie forest division did not exceed 16 per cent on May 1st).

The above unfavourable changes and threats have also been confirmed by forestry services, who carry out activities aimed at improving the condition of forests in the discussed region (maintaining the continuity of forest production mainly from sanitation felling, afforestation with species that suit the habitat, preferring the seed tree method, or various proceedings aimed at improving the quality of timber).

References

Nyrek A., 1972: Stan praktyki i wiedzy leśnej na Śląsku do połowy XIX wieku (Forest practice and knowledge in Silesia until mid-19th century). Śląski Kwartalnik Historyczny „Sobótka", Zakład im. Ossolińskich, Wrocław: 413-432.

Nyrek A., 1975: Gospodarka leśna na Górnym Śląsku od poł. XVII do poł. XIX w. (Forect economy in Upper Silesia between mid-17th and mid-19th centuries). Prace Wrocławskiego Towarzystwa Naukowego, seria A, nr 168, Wrocław.

Nyrek A., 1992: Kultura użytkowania gruntów uprawnych, lasów i wód na Śląsku od XV do XX wieku (Culture of utilizing the ploughlands, forests and waters in Silesia between 15th and 20th centuries). Wyd. Uniwersytetu Wrocławskiego, Wrocław.

Panic I., 1992: Historia osadnictwa w Księstwie Opolskim we wczesnym średniowieczu (History of settlement in the Duchy of Opole in early Middle Ages). Muzeum Śląskie, Katowice.

Rybandt S., 1977: Średniowieczne opactwo cystersów w Rudach (The mediaeval Cistercian Abbey in Rudy). Prace Wrocławskiego Towarzystwa Naukowego, Wrocław.

Sufryd M., Winiewski J., 1987: Opactwo cystersów w Rudach 1258-1810 (The Cistercian Abbey in Rudy 1258-1810). Centralny Ośrodek Informacji Turystycznej Oddział Katowice. Katowice.

Szabla K., 1994: Koncepcja przebudowy „Lasów Rudzkich" (The concept of rearrangement of „Rudy Forests"). In: Scripta Rudensia, vol. 1, PK CKKRW, Rudy Wielkie: 135-144.

Tyszkiewicz J., 1976: Nauki historyczne i przyrodnicze w badaniach lasów na Ziemiach Polskich (Historical and environmental sciences in forest researches on Polish Lands). In: Ziemia i ludzie dawnej Polski. Studia z geografii historycznej (Land and people of old Poland. Historical geography studies). Prace Wrocławiego Towarzystwa Naukowego, series A, nr 179, Wrocław: 7-36.

Tyszkiewicz J., 1981: Człowiek w środowisku geograficznym Polski średniowiecznej (Man in the geographic environment of mediaeval Poland). Wyd. Uniwersytetu Warszawskiego, Warszawa.

Anthropogenic aspects of landscape transformations	2	University of Silesia Faculty of Earth Sciences Sosnowiec 2002	32–35

Marzena LAMPARSKA-WIELAND, Jan Maciej WAGA

University of Silesia, Department of Physical Geography, Sosnowiec, Poland

SIGNIFICANCE OF SLAG DUMPING AREAS IN THE UPPER SILESIA AND WEST MAŁOPOLSKA LANDSCAPE

Anthropogenic forms are important components of the Upper Silesian and western Małopolska landscape. Among them the slag and spoil dumps of coal, ferrous and non-ferrous metals have an extraordinary aesthetic and documental value – they evidence the history of industrialisation of this region. Most often they modify or mask the natural morphology. Such a landscape is commonly a result of repeated changes of the Earth surface. The landscape metamorphoses caused by mining are especially characteristic for the Upper Silesian Coal Basin, Rybnik Coal Basin and the ore industrial districts: Olkusz-Bolesławiec and Zawiercie-Częstochowa. Having analysed the changes in position and morphology of the anthropogenic forms it can be stated out that since the end of 80-ies (Grygierczyk, Sendobry, Waga, 1989) most of the slag dumps have been closed or remodelled. Big dumps, so-called central dumping grounds, have used to enlarge proportionally to the exploitation rate of supplying mines. Waste rock being exploited nowadays as well as the material having rested for tens of years, sometimes even more than a hundred, are used for solid stowing, building industry, and for surface levelling (Skarżyńska, 1997).

Nevertheless the biggest forms are the most significant ones, their size is not the exclusive criterion for their visual importance. The colour, cover of the surface, spatial relations to the neighbouring artificial and natural forms are the noteworthy indications. Apart from shapes and morphometric parameters. It is most often assumed that artificial forms – as being strangers – reduce the visual value of the space. However even large dumps, if properly created and arranged in the surrounding – do not have to degrade the landscape, but in contrary they can make it more attractive (Bogdanowski, 1988).

Anthropogenic forms building the elevations, slag dumps among them, can be devided into the following landscape components, according to visual criteria:

1. hidden elements
2. temper elements (neutral)
3. distinct elements.

The latter can be additionally divided into:

a) conflict-prone – disfiguring the landscape

b) non-conflictive – bringing new, easy acceptable visual values

c) counterpoints – new, contrasting but interactive and interesting landscape elements.

The hidden forms resemble the natural ones. They are usually their direct continuation; therefore they are difficult to distinguish from the natural forms or parts of them. These forms are as follows: artificial terraces superstructed or attached to the river terraces or fan-shaped dumps in the foothill areas. The terraces of the Olza tributaries near Wodzisław and the Nacyna valley in Rybnik are the best examples of hidden forms.

The neutral forms are easier to identify. They also resemble the natural forms, however they are situated solely. At times they stylistically maintain the surrounding forms, or they are the exact replication of the neighbourhood. The ideal example of that kind is the biggest dump in Poland, which reminds one of monadnocks – the dump of black coal mine "Bolesław Śmiały", located in Łaziska Górne in the foreland of Mikołowski Horst. The post-exploitation dump of the ferrous ore in Rudniki near Zawiercie is also a good example.

The forms of the third type forms are most often noted as fans, multistage truncated fans, piles, banks, inclined planes or domes. The best example of the conflict-prone form – decidedly degrading the landscape – is a slag dump of carbon coal shales of the KWK Center in Bytom, situated within the former dumping ground of the zinc and lead ores mine "Orzeł Biały".

The dumps of waste rock in Dębieńsko in Czerwionka-Leszczyny commune are the good examples of non-conflictive forms, bringing some vivacity in the landscape.

A set of dumps in Rydułtowy (Szafer et al., 1997) might resembling the pyramids situated on the Rybnik Plateau is the example of aesthetic-perspective counterpoint.

Waste rock accumulated in the dumping areas might be a source of utilizable material, thus the existence of most of the dumps is the transitional phenomenon. However a part of forms built from the rocks of low technical parameters have pretty big chance to remain. It happens in Western Europe that some of the dumps are, left in the landscape as the evidence monument of history. They are usually spectacular object treated as the nature monuments. The fan-shaped dumps in Nord-Pas de Calais in France are the most characteristic ones. Usually such forms undergo some esthetical interventions, and they are protected from gravity mass movements and self-ignition. Some of the dumps are adapted to scenic or recreational-parking functions. The old dumps are used as sport objects – the artificial, igelite downhill routes. The projects of stepwise cultivation of the dumping grounds by the Prosper III mine, and Beckstrasse in Bottrop (Radomski, Zerressen, 1993) are ideal examples of multifunctional management of the dumps, and practical exposing them in the landscape. Dumps near Sheffield are different in character – they are much lower and more extensive. According to the national plan of increasing forestry of the Great Britain, this direction of land reclamation dominates. In this respect the mine areas have the chance to be naturally revitalised.

On the study area there are at least a few sets of slag dumps deserving the treatment described above. These are for example the dumps in Dębieńsko, Rydułtowy, Łaziska Górne. Most of them had already been elaborated fixing attention to very interesting recultivation plans (Bogdanowski, 1988; Szafer et al., 1997). According to the authors a dump of "Dębieńsko" mine in Czerwionka deserves a special attention. The coal had been exploited in the mine for 102 years. A set of six fan-shaped dumps of Carboniferous shales of about 30 ha of area became a significant element of the whole surrounding, making the landscape a tipical post-mining character. From the bottom of the Bierawka Valley, near the "Dębieńsko" mine, to the summits of the highest dumps is 112 m. Four dumping grounds are quite low (41-70 m high); they are covered with trees and bushes, planted in result of planned afforestation. Two highest fan-shaped dumps – the Fan III and Fan IV are going to be closed. The overheated Carboniferous shales are being exploited from the Fan III. This raw material is not of good quality, however it suits the standards, and is used for building the embankments of roads or railways ect. (Ocena..., 1998). The landscape of the "Dębieńsko" mine, apart from the dumps mentioned above, consists of the dumping grounds of flotation tailings and spoil. They cover the area of 100 ha. Theses days the flotation tailining dump is being land reclamation on the area of two (from the four existed) closed mud basins. This dump is 7-17 m high, with the area of 12 ha, and they are sloped. The works will focus on reducing of the scarp slope, filling-in all the ground irregularities with waste debris, drainage of the area and introducing the biological casting.

Floristic cataloguing on the Fan III showed, that in spite of the poor conditions, many species of the herbs, bushes and trees survived, moreover the floristic communities have the chance to become more and more natural (Ocena..., 1998). The area of dumps and dumping grounds is covered by the following species: *Betula pendula, Robinia pseudoacacia, Populus canadensis, Fraxinus excelsior* and occurring soldom: *Acer pseudoplatanus, Larix europaea, Sorbus aucuparia, Quercus robur, Alnus glutinosa, Tilia cordata, Fagus silvatica.* Among the bushes the most popular are *Philadelphus coronaries, Symphoricarpos albus, Sambucus nigra,* and *S. Racemosa, Prunus serotina, Caragana sp., Rubus sp. Rosa rugosa, Salix.* It is worth mentioning that most of plants originated naturally from self-seeding. 30-40 years after the reforestation process the southern shape was covered by relatively dense forest communities consisting of *Populus canadensis, Quercus rubra, Fraxinus excelsior, Acer pseudoplatanus, Pinus nigra.* Above the herb communities with Philadelphus coronarius and *Symphoricarpos albus* dominate. Similar species are noted on all the neighbouring dumps. What is more, the dumps became a home for many animals that have found good living conditions herein – some seat birds and numerous rodents.

During atmospherics lows the gas emission, mainly carbon dioxide coming from the shales burning inside, is occasionally noted even on the dumps completely covered by plants. Regardless of this fact the dumps are still the interesting accent of the agricultural and forest landscape of the surrounding of Czerwionka, characterised by large geodiversity. Without doubt it is a symbol of cultural heritage of this place, well visible from the highway A1 being under construction. It is going to be a place absorbing the attention of travellers, together with the entirely presentation of precious objects and places as for instance the XIX and XX – century mine buildings, trading estates, a park and a site of high geological value, outcropped due to exploitation of Carboniferous shales and sands, and mining areas under naturalisation. One should remember that they document the cultural and nature development of the Upper Silesia – and therefore they are the best and the most meaningful example in the whole region. It is question if the dumps should be remained in the landscape, at last the parts covered by natural succession of plants. They are most characteristic elements of the present-day cultural landscape of Czerwionka–Leszczyny. This is post-mining landscape. Now this dumps are one document after big coal mine "Dębieńsko", with its long traditional mining land-use. Now this post- mining landscape is in transformation.

REFERENCES

Forest Plan August, South Yorkshire Forest – Thornclife Park, Chapeltown, Scheffield, 1994.

Ocena oddziaływania środowisko rozbiórki hałdy Stożek nr III w rejonie zwałowiska kamienia i mułów popłuczkowych KWK „Dębieńsko"; 1998. Zakład Projektowania Ochrony Środowiska „DUDEK", Gliwice.

Radomski S., Zerressen M., (red.) 1993: Katalog zum Stand der Projekte Frühjar 1993 IBA Emscher Park, Gelsenkirchen.

Rekultywacja zwałowiska odpadów poflotacyjnych na terenie nieczynnych osadników mułowych nr III i IV. Ocena oddziaływania na środowisko. Ekotest 1998, Gliwice.

Sendobry K., Grygierczyk S., Pawełczyk W., Waga J.M., 1989: Antropogeniczne wartości przestrzeni geomorfologicznej Górnego Śląska - wysypiska i wyrobiska. Część II, skala 1:50 000, 1:100 000, 1:300 000, Wojewódzkie Biuro Projektów w Katowicach, Katowice.

Skarżyńska K. M., 1997: Odpady powęglowe i ich zastosowanie w inżynierii lądowej i wodnej, Akademia Rolnicza im. H. Kołłątaja w Krakowie, Kraków.

Szafer M., Kuczera A., Lubczyk M., Bluszcz A., Parusel J., 1997: Rekultywacja i zabezpieczenie przed paleniem skały płonnej w rejonie stożków przy szybie „Leon II" KWK „Rydułtowy", ocena oddziaływania na środowisko, Eureko, Katowice.

Anthropogenic aspects of landscape transformations	2	University of Silesia Faculty of Earth Sciences Sosnowiec 2002	36–42

Mieczysław LEŚNIOK
University of Silesia, Faculty of Earth Sciences, Sosnowiec, Poland

CHANGEABILITY OF PRECIPITATION POLLUTION AS A FACTOR OF THE NATURAL ENVIRONMENT DEGRADATION IN THE UPPER SILESIAN INDUSTRIAL REGION AND ADJACENT AREAS

Introduction

Air is one of the elements of the natural environment which are frequently influenced by human impact. Substances and compounds present in the air are absorbed and accumulated by other elements of the natural environment. Considerable part of them is transported in the soluble and solid form to the earth surface with precipitation (Wilson, Bell, 1996; Godzik et al., 1997).

Distinct increase of recent investigations on the quality of meteoric water shows how considerable role in the process of pollution transport from the atmosphere to other elements of the natural environment precipitation plays. Apparently, wet precipitation is not only a factor which can determine a degree and range of atmosphere pollution but also, due to the transport of the considerable amount of partly dissolved components, it is more dangerous for the environment than dry precipitation. Acid and much polluted meteoric water is a factor which causes corrosion of metals, dissolution and desintegration of rocks and buildings and also degradation of water (Seip, 1980; Nelson, Campbell, 1991; Veseley, 1994) and soil environments (Amacher et al., 1986; Alloway, 1995; Pacyna et al., 1997).

Method of sampling

Sedimentation funnels („British Standard") were used to collect meteoric water samples. They were made of polypropylene and their total area was 2500 cm^2. They were mounted 1,5 m above the ground surface in special racks.

Taking into account the fact that individual rainfalls show different chemical composition, the effort was made to collect each rainfall separately. Before the rainfall, the funnels were cleaned with distilled water and during the rainless days they were covered with lids to avoid dry precipitation. Under each funnel, polyethylene vessels were placed where meteoric water was collected. Then, the samples were poured into polyethylene bottles and taken to the laboratory. Directly after the samples were delivered, the measurement of pH and specific conductivity (C_{25}) were carried out. Apart from these measurements, the chemical analyses to determine the concentration of selected ions (SO_4^{2-}, NO_3^-, Cl^-, NH_4^+, Na^+, K^+, Ca^{2+}, Mg^+) were carried out.

Location and characteristic of the meteoric water sample sites

The sample sites were located in the south part of Poland in the following detailed locations (fig. 1): Sosnowiec (central-east part of the Upper Silesian Industrial Region), Ojców (in the area of the National Park in the south part of the Kraków-Częstochowa Upland), Wodzisław Śląski (south part of the Rybnik Coal Region and west part of the Morava Gate) and Cieszyn (Silesian Plateau and eastern part of the Morava Gate).

Fig. 1. Precipitation sampling sites: 1 – state boundary, 2 – boundary of U.S.I.R.

The measurement sites were distributed this way to represent average imission conditions typical for each area. Moreover, their location was associated with the main western direction of atmospheric circulation and additionally, in the Morava Gate, this circulation was modified by relief morphology (Hławiczka et al., 1994).

Air quality conditions

Air quality in the individual investigation sites is conditioned by local emission of gas and dust pollution which comes from the individual house holders, housing estate boiler rooms, local industrial boiler rooms, heating plants, factories and transport means. Additionally, if meteorological conditions are favourable, pollution is brought from the adjacent areas.

Recently, due to the recession in Polish economy, restructuring of the industry and pro-ecological activities, there has been a significant change in the proportion of the emitted pollution in the whole studied area. There was a considerable decrease of the emitted dust in the 90s as compared to the 80s. In the period 1990–1996, there has been further, systematic decrease of dustiness in Sosnowiec and Ojców, but, on the other hand, an increase of dustiness has been recorded in Wodzisław Śląski and Cieszyn (tab. 1). As far as gas compounds (SO_2, NO_x) are concerned, their concentrations in the period 1990–1996 have shown variable trends.

Differentiation in pH reaction of precipitation in the period 1990-1997

In this research, elementary precipitation has been the only base of all chemical analyses to evaluate the degree of precipitation pollution and to understand their reasons. It is associated with the fact, that an occurrence of rainfall and its chemical composition depends on physico-chemical processes which take place in the atmosphere. The results of the analyses allow to state that each separate precipitation has got different chemical composition and there are never two identical rainfalls. Therefore, collecting the meteoric water from several rainfalls causes that the concentrations of substances present in such water is averaged and usually increased. This leads to false evaluation of the quantity and quality of the compounds washed by precipitation in particular area.

The investigations which have been carried out for several years enabled to observe particular trends of time changeability of some pollution indices of precipitation. The most valuable are the results of pH reaction measurements (tab. 2).

In the period 1990–1992, acid precipitation (pH $< 5,0$) predominated in all the sites studied and it was the most frequent in Wodzisław Śląski (85%) and the less frequent in Sosnowiec (60%). The frequency of neutral precipitation (pH from 5,0 to 6,0) was the largest in Sosnowiec (32%) and the smallest in Wodzisław Śląski (13%). The alkaline precipitation was the most frequent in Ojców (12%) and Sosnowiec (8%) and the smallest in Wodzisław Śląski (2%). It should be emphasised also, that in the beginning of the 90s, the amount of „acid rain" in the whole studied area considerably increased as compared to the 80s. The amount of acid rain increased in the period 1990–1993 as compared to the period 1986–1989 from 30% to 70% in Sosnowiec and from 60% to 85% in Wodzisław Śląski (Leśniok, 1996).

The distribution of the pH reaction in the period 1993–1995 shows further changes as compared to the previous period (1990–1992). In the two sites studied, the precipitation acidity still increased. During this period, the amount of „acid rain" increased to 78% in Sosnowiec and to 80% in Ojców; in Cieszyn and Wodzisław Śląski it decreased to 70%. During the last two years (1996–1997), the participation of acid rain has still increased and reached 91% in Sosnowiec and 90% in Ojców. In Wodzisław Śląski, the amount of acid rain has increased again to 84% and in Cieszyn it has been similar to the previous period (1993–1995), i.e. 88%.

These trends are also confirmed by average values of pH reaction (tab. 3). A clear, regular decrease of pH reaction of precipitation since 1990 has been observed in Sosnowiec, Ojców and Cieszyn. In Wodzisław Śląski, on the other hand, an increase of pH has been observed since 1992. In 1995, pH reaction in this site was the largest among all the sites studied.

Table 1. Average annual concentrations of the concentrations of the selected air pollution indices at the individual sites in the period 1990-1996

Location	(μg/m³)	1990	1991	1992	1993	1994	1995	1996	standard
Sosnowiec	dust	128	140	131	126	118	103	98	50
	SO_2	56	53	55	52	48	41	39	32
	NO_x	73	55	53	54	67	60	56	50
Ojców	dust	94	91	89	93	85	82	75	40
	SO_2	39	32	33	38	32	32	35	11
	NO_x	52	41	40	43	40	42	40	30
Wodzisław Śląski	dust	94	122	148	131	109	105	126	50
	SO_2	41	45	42	44	48	43	37	32
	NO_x	55	43	45	47	36	32	33	50
Cieszyn	dust	-	53	51	49	42	41	44	50
	SO_2	-	41	36	39	35	30	31	32
	NO_x	-	35	33	40	29	24	22	50

Source: *Some data from the WSSE in Katowice and Bielsko Biała*

Table 2. Percentage participation of pH reaction of the precipitation in the individual pH ranges in the periods 1990-1992, 1993-1995 and 1996-1997

pH range	Sosnowiec			Ojców			Wodzisław Śląski			Cieszyn		
	1990 1992	1993 1995	1996 1997	1990 1992	1993 1995	1996 1997	1990 1992	1993 1995	1996 1997	1991 1992	1993 1995	1996 1997
< 5,0	60	78	91	72	80	90	85	70	84	71	87	88
5,0 - 6,0	32	19	9	16	17	9	13	28	16	25	11	12
> 6,0	8	3	0	12	3	1	2	2	0	4	2	0

Table 3. Average values of pH reaction of precipitation at the individual investigation sites in the period 1990-1997

Location	1990	1991	1992	1993	1994	1995	1996	1997
Sosnowiec	5,0	4,6	4,6	4,5	4,4	4,3	4,0	4,2
Ojców	4,8	5,0	4,5	4,6	4,7	3,7	3,9	4,0
Wodzisław Śląski	4,1	4,2	4,6	4,7	4,6	4,5	4,4	4,6
Cieszyn	-	4,7	4,5	4,3	4,5	4,2	4,3	4,0

This situation should be associated with the changes of the emission of some air pollution. As dust has got the abilities to neutralise part of the sulphur dioxide and nitric oxides, the decrease of its emission in the end of the 80s and beginning of the 90s was partially responsible for the increase of acid rain.

The decrease of dust emission has been associated with the recession of Polish economy, restructuring of the factories in the Upper Silesian Industrial Region (changes in the production profile, transfer of production to another places or its liquidation) and purposeful pro-ecological activities which have led, most of all, to reduction of industrial dust emission. Moreover, considerable part of the total pollution emission comes from the so-called „low-emission" from domestic sources. In the heating system of the urban part of Sosnowiec and Cieszyn where measurement sites are located, central sources of heating dominate (heating plants, housing estate boiler houses) which are partially provided with filters to reduce dust pollution. In Wodzisław Śląski, individual fire-places which have been coal- and coke-fired still dominate in the heating system of this town. These are not provided with filter and during winter the degree of dustiness in this area is very large. In case of Ojców, which is removed from the urban-industrial parts of the Upper Silesian Industrial Region and Kraków, the influence of dust pollution on the air quality is small and it is limited to local sources. Therefore rainout predominates here. It contains „vivacious" and mobile acid-creative compounds of sulphur which are transported from the adjacent areas (Różkowski et al., 1996).

Differentiation in the content of the selected pollution indices in the period 1986–1997

Changeability of the pH reaction is confirmed also by the selected, main indices of pollution precipitation from the period 1986–1997 (tab. 4).

Table 4. Average values of the individual indices of precipitation pollution at the individual investigation sites in the period 1986-1997

Location	Periods	pH	C_{25} (μS/cm)	Ca^{2+} (mg/dm^3)	SO_4^{2-} (mg/dm^3)
Sosnowiec	1986-89	5,9	142,0	9,8	43,7
	1990-92	4,7	93,0	6,9	24,3
	1996	4,0	81,0	3,7	13,1
	1997	4,2	72,0	1,3	8,4
Ojców	1990-92	4,8	52,0	2,5	7,4
	1996	3,9	40,0	1,9	5,1
	1997	4,0	35,0	1,1	5,6
Wodzisław Śląski	1986-89	4,9	103,0	5,1	39,1
	1990-92	4,3	72,0	4,2	17,3
	1996	4,4	55,0	2,2	9,8
	1997	4,6	40,0	1,1	7,5
Cieszyn	1990-92	4,6	63,0	2,6	9,8
	1996	4,3	58,0	2,1	7,6
	1997	4,0	52,0	1,4	6,2

In the all investigation sites, there has ben a decrease of specific conductivity (C_{25}) which is the most visible in the industrialised areas (Sosnowiec, Wodzisław Śląski).

Content of calcium which is emitted during coal ash burning shows also distinct decreasing trend and reaches the values similar to precipitation from the non-polluted areas of NE Poland (Leśniok, 1996).

In case of sulphur, especially in Sosnowiec and Wodzisław Śląski, a distinct decrease of its concentration is again noticeable. The recorded values are still several times larger than the precipitation with inconsiderable amount of pollution (2mg/dm^3). Sulphur is a predominating ion responsible for the acidity of the meteoric water in the samples studied.

Conclusions

- The results of the investigation show considerable time-spatial differentiation of the acidity and pollution in precipitation which result from quantity and quality changes in pollution emission to the atmosphere.
- In the time period studied, a regular increase of acid rain in the whole investigation area has been determined. Acid rain represents more than 85% of all the precipitation sampled. The participation of alkaline precipitation has still decreased and it is now not more than several percent.
- In the spatial distribution of precipitation acidity, distinct in the 80s differences between the areas of large emission and their out-skirts has obliterated. This is mainly caused by changes in emission structure of acid and alkaline compounds.
- The obtained results of the acid rain increase may be a signal of the initiation of acidification process in other elements of the natural environments (soil, water, flora, fauna).
- Precipitation is an important criterion to evaluate the degree of air pollution. Determination of the quality and quantity of the pollution loads transported in the precipitation may become a valuable information which could successfully allow to counteract acid rain. Therefore it is necessary to carried out monitoring of precipitation side by side with air monitoring.

References

Alloway B. J. (ed.), 1995: Heavy metals in soils. Blackie Academic & Professional.

Amacher M. C., Kotuby-Amacher J., Selimh H. M., Iskandar I. K., 1986: Retention and release of metals by soils – Evaulation of several models. Geoderma, 38: 131-154.

Godzik S. i in., 1997: Projekt badawczy polsko-norweski. Wpływ kwaśnej depozycji na uwalnianie metali ciężkich, Zadanie 6.1., maszynopis IETU, Katowice.

Hławiczka S., Sztyler A., Sandroni S., Cerutti C., Ośródka L., Jarzębski L., 1994: Transboundary transport of air pollutants from the Czech Republic to Poland through Brama Morawska, J. Ecol. Chemistry, 1, 13-21,

Leśniok M., 1996: Zanieczyszczenie wód opadowych w obrębie Wyżyny Śląsko-Krakowskiej, Wydawnictwa Uniw. Śląskiego, Katowice, ss. 124,

Leśniok M., 1997: „Kwaśne deszcze" na obszarze Wyżyny Śląsko-Krakowskiej. W: Zmeny geografického prostredí v pohranicních oblastech ostravského a hornoslezskhého regionu, Ostravská univerzita, Uniwersytet Śląski, Ostrava, s. 76–83.

Nelson W. O.,Campbell P. G. C., 1991: The effects of acidification on the geochemistry of Al., Cd, Pb and Hg in freshwater environments: A literature review. Environmental Pollution, 71; 91-130.

Pacyna J. M., Breivik K., & Pacyna E. G., 1997: The impact of acid rain on mobilization of heavy metals in soils in Poland. Norwegian Institute for Air Research. Kjeller, Norway.

Różkowski J., Leśniok M., Partyka J., 1996: Zanieczyszczenia opadów, wód powierzchniowych i podziemnych w wybranym rejonie krasowym Polski Południowej. W: Problemy Hydrogeologiczne Południowo-Zachodniej Polski, Wrocław, s. 97-105.

Seip H. M., 1980: Acidification of freshwater – sources and mechanisms. Proc. Int. Confr. Ecol. Impact acid precip., SNSF project.

Vesely J., 1994: Effects of Acidification on Trace Metal Transport in Fresh Waters. In: Steinberg C. E.W. & Wright R. F. (ed): Acidification of Fresh-water Ecosystems: Impications for the Future. John Wiley & Sons Ltd.

Wilson M. J., Bell N., 1996: Acid Deposition and Heavy Metal Mobilisation. Applied Geochemistry, 11: 133-137.

Anthropogenic aspects of landscape transformations	2	University of Silesia Faculty of Earth Sciences Sosnowiec 2002	43–52

József LÓKI

University of Debrecen, Department of Physical Geography, Debrecen, Hungary

THE SETTLEMENT OF HUMAN LIFE IN THE NORTH-EASTERN PART OF THE GREAT PLAIN

The natural development of the landscape in the Quaternary

As a consequence of the crust movements taking place at the end of the Tertiary and during the Quaternary periods, the area of the Great Hungarian Plain enclosed by the rising mountains sank into great depths. The inland sea filling the depression – which later became an inland lake – was the erosion base of the water courses running down from the mountains. The rivers transporting vast amounts of sediments gradually filled up the internal lake and built alluvial fans in the direction of the deepening areas.

The formation of the present drainage network lasted for a long time. The watercourses continually changed their flow of direction. The change in the direction of the rivers is the natural consequence of the rivers building alluvial fan. On this area, however, the several times repeated tectonic movements played a significant role. As a result of these, certain parts of the filling basin sank further down while other parts slightly lifted. On the edges of the Great Plain, the depressions formed along the tectonic lines naturally attracted the watercourses towards themselves. The waters which found runoff on the depressions linked together, transformed the former surface by erosion or accumulation – depending on their energy.

In the north eastern part of the Great Plain, the River Tisza and her tributaries arriving from the Carpathian Mountains built a large alluvial fan towards the central part of the Great Plain. The building and development of the alluvial fan was interrupted by the formation of the depressions on the edge (Bereg-Szatmár Plain, Bodrogköz, Rétköz) and the rising of the central part of the Nyírség region (fig. 1). The uplifted alluvial fan surface remained without living watercourse and thus in the dry periods the formation of the blown sand could start.

Collecting the watercourses running down from the moun-tains, the River Tisza was meandering on the depressed areas. In the slowly filling depressions of the Great Plain, the level differences were very small, therefore, the average stream gradient of the River Tisza was 4 cm/km, but at some places 2 cm/km reaches also occurred (Somogyi, 1967). The meandering watercourse built point bars and levées. During thousands of years,

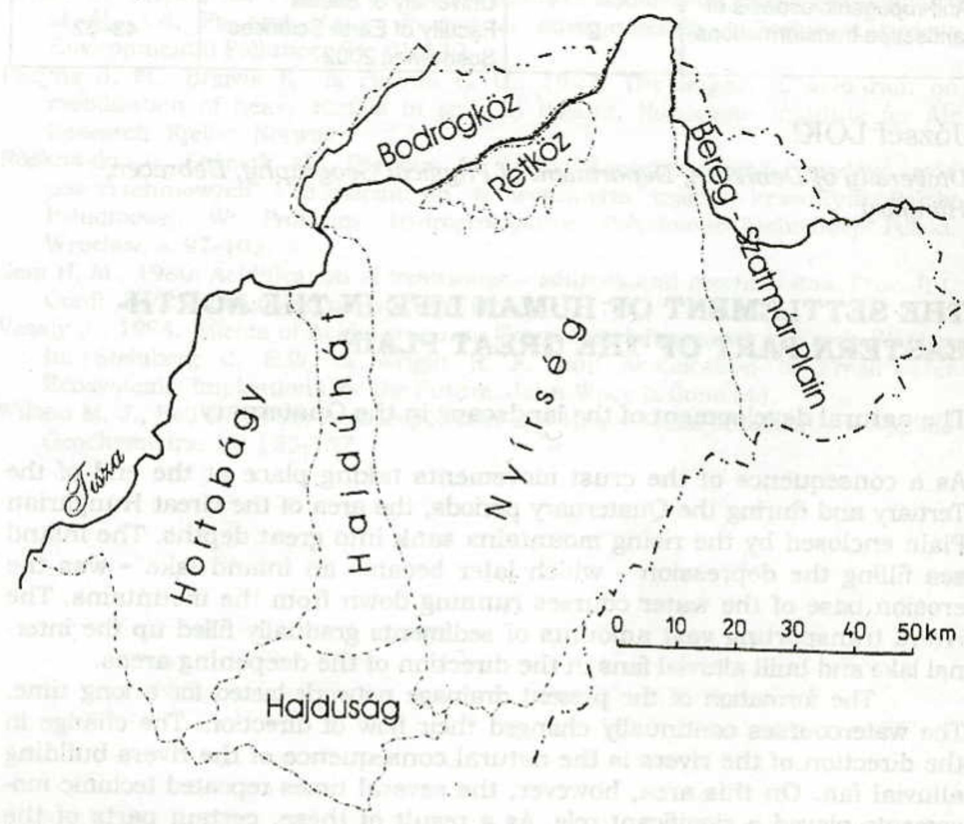


Fig. 1. The landscapes of the Northeastern Great Plain

a large number of ox-bows came into being by the natural cutting off the meanders.

The watercourses arriving from the mountain areas with heavier precipitation caused floods in the times of the spring snow melting and early summer. During these times, the huge mass of water covered the swampy, marshy flood plain regions, and often intruded even to the lower flat terrains enclosed by the higher lying terrains too. On the surface with small inclination, the uliginal woods and the reeds slowed down the regression of the flood. The flowing back of the water from the lowlying areas far from the river was further hindered by the levées and point bars. Thus, it often happened that the water has not regressed from the areas flooded at the end of the winter and early in spring when the early summer flood arrived. Due to the climate of the Carpathian Basin there are two floods annually. The passing of the floods usually lasted for several months. The deeper lying areas of the Great Plain were characterised by terrains covered by water permanently or temporarily.

On the studied area, in the north eastern part of the Great Plain, terrains of different heights were formed as a result of the landscape evolution.

The highest areas are made up of the remains of the elevated alluvial fan. The largest contiguous area like this is the Nyírség region whose surface is on average 40 m higher above its environs. This terrain category contains those parts of the depressions on the edge of the alluvial fan as well which were not destroyed as a consequence of the lateral erosion of the rivers.

The boundary regions of the depressions on the edge belong to the second level which constitute a transition between the lower lying terrains and the protruding parts of the alluvial fan. The transition area is in some places uniformly inclined while at other places escarpments can be found.

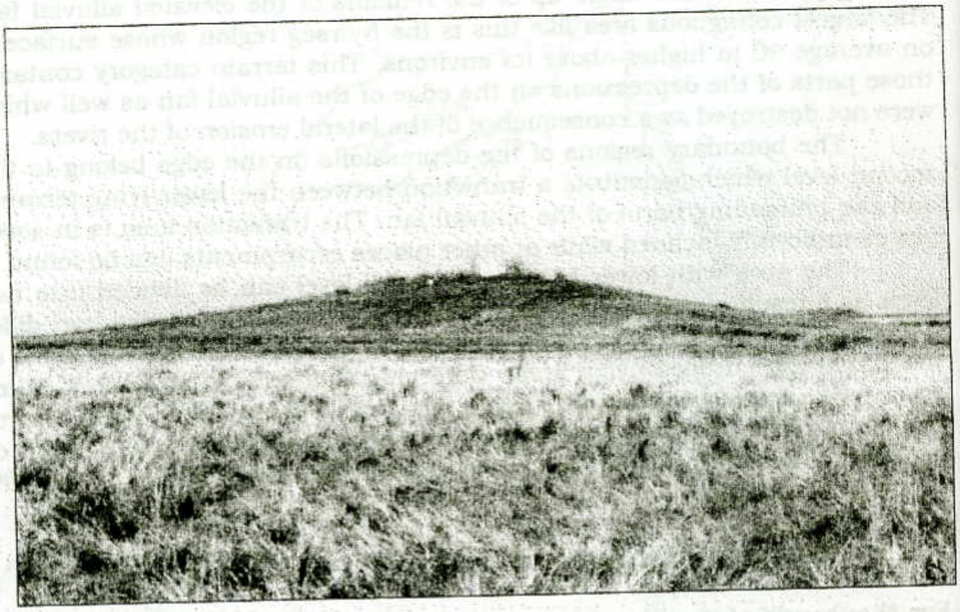
The area with lower height above sea level can be divided into two levels as a result of the geomorphic activity of the rivers. Though the level differences mean only a few meters but they are significant from the aspect of the floods. The deepest lying areas were characterised by permanent water cover, while the higher ones were either temporarily covered with water or protruded in a dry state from the huge water world depending on the extent of the flood. This state lasted as long as the anti-inundation works of the 19^{th} century were started.

The landscape and the man

For thousands of years, man accommodated himself to the landscape endowments. The lifestyle of the human communities depended a large scale on the climate and other natural factors.

The results of the archaeological researches up till now (Selmeczi, 2002) attested the fact that man settled down in the Carpathian Basin almost 400 thousand years ago. The researchers thought for a long time that there was no realistic chance for the discovering of the Palaeolithic findings on the Great Plain. In their opinion, the surface rearrangement taking place in the Upper Pleistocene and Holocene periods partly destroyed the glacial settlements and partly covered them with thick sediment layer. The excavations so far supported the assumptions of the researchers. The small number of Palaeolithic findings was excavated from several meters depth. The findings certify that the man of the Old Stone Age did not live on settlements but in casual hunters' camps.

The physical geographical changes resulting from the start of the Holocene period (warming, transformation of the flora and the fauna, etc.) created the objective basis for the food producing farming. As a result of this, during the New Stone Age, certain groups of people living on the Great Plain started to conquer the nature. Beside the gathering-hunting lifestyle, animal breeding and farming also appeared. The continuos production required to stay at one place for a longer period of time and to build more durable houses instead of the temporary shelters. These settlements were located on the higher lying terrains which were suitable for farming and were not endangered by floods. The long staying in one place is shown by the tell-like settlements containing more than one dwelling level on top of each other. The kurgans rising above their environs (phot. 1) and flat tells can be found in large numbers on the Great Plain (M. Nepper, Sőregi, Zoltai, 1980, 1981).



Phot. 1. Szabolcs mound (kurgan)

The kurgans (kunhalmok) are 3–6 m high conoidal buildings. Originally, the kurgans were long barrows from the Copper Age (table 1), while the tells were the settlement markers of the Bronze Age.

The flat tells came into being in a way that the centres of the settlements were renewed several times and a new building was raised over the ruined ones. Thus, the ruins of the buildings built on top of each other during the centuries formed a mound.

These have to be distinguished from the flat tells which rise only a few meters above their environment. The surface of the mounds was occupied by the later ethnic groups as well, for these non-flooded areas were excellent for settling down. The original height of the mounds considerably decreased as a result of the gradual washing-off of the soil. This is supported by those cemetery-excavations where the skeletons are often found directly below the surface level (at 10–20 cm depth).

During the Holocene, the wetter and drier periods followed each other. At the end of the New Stone Age, approximately 5000 years ago, as a consequence of the drier climate the agriculture was driven into the background and the life ceased to exist on the tell-settlements on the Great Plain. After this period only single-layer settlements were created. Animal breeding came to the fore in the place of the farming and accordingly settlements were formed along the rivers and streams, on the levées, in the environment of the back pastures and gallery forests.

As a result of the wetter period, farming appeared again beside the animal breeding and new settlements were formed on the cultivated areas. The technical development, the spread of the use of the bronze and iron

Table 1. The archaeological and geological chronology of the Holocene Period (After *Raczky P. (2000), **F.W.B. van Eysinga (1978), ***Huisink (1998))

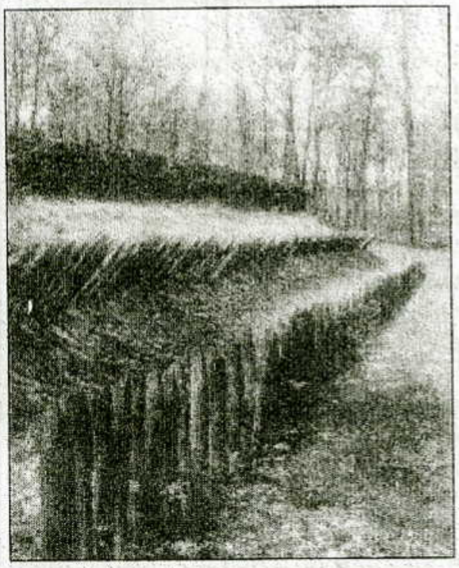
Archaeological timetable *		Geological timetable Old**		Geological timetable New***		
		Present	Sub-Atlantic Phase	Present	Sub-Atlantic Phase	Holocene
A.D. 1700	Modern Age					
A.D. 1000	Middle Ages					
A.D. 895	Hungarian Conquest					
A.D. 450	Migration Period					
A.D. 1	Roman Period					
				2500	Sub-Boreal Phase	
		2600	Sub-Boreal Phase			
B.C. 850	Iron Age					
B.C. 2800	Bronze Age					
		5600	Atlantic Phase			
				5700	Atlantikus fázis	
B.C. 4400	Copper Age					
		7300	Boreal Phase			
				8300	Boreal Phase	
B.C. 6000	New Stone Age					
		9600	Pre-Boreal	9600	Pre-Boreal	
B.C.10000	Transition Stone Age	10200		11500		

also helped farming. Consequently, the settlements survived for a long time on the areas which were suitable for farming.

In the Late Iron Age (3–2 centuries BC) our region was populated by the Celts. The Celts led food producing husbandry which they complemented with fishing and hunting. The remains of most of the Celtic settlements can be found on the higher lying and transition terrains of the alluvial fan. Farming was dominant on the higher lying areas. While on the lower lying transition and non-flooded areas those lived who took up animal breeding. However, there are Celtic settlement traces on the higher terrains along the rivers and backwaters as well. The Celts living there chose the sites of the former cultures and their buildings can be found on the levées and on the mounds. They took up fishing and hunting.

In the centuries of the Roman period, the Sarmatians used to live on our area. The archaeological excavations and the large numbers of findings show that they populated the entire area of the Great Plain except for the areas covered with water. Their settlement network was characterised by extensive villages and relatively densely situated farms.

For the protection of the settlements and the cultivated lands, ditches were deepened into which they led water and built earthworks. An example for this was the „Sarmatian big earthwork" built almost 2000 years ago (Csörsz-ditch). Its remains can be seen at many places even today (phot. 2).



Phot. 2. Detail of the „Sarmatian big earthwork"

During the period of the great migrations, the different ethnic groups (Huns, Gepids, Avars) followed each other on our area. From this period, only a few findings were excavated which referred to a new settlement as opposed to the earlier ones. The eastern border of the Gepid settlement area was the Csörsz-ditch which ran even in the Hajdúhát region as well. Their houses were dug 1–1.5 m deep into the ground. We may conclude from this that their settlements were situated on the higher terrains which were not endangered by floods.

The Avars, originally took up nomadic shepherding and did not have permanent settlements. In the spring and summer periods, they grazed on the inundated terrains and on the flatter pastures of the alluvial fan, while in the winter, they moved southward. They started to settle down from the beginning of the 7th century. The remains of the houses dug halfway into the ground and their pithouses occur on the areas which rise above the floodplain level. The ditch system surrounding the settlements signs the closeness of the water.

The Magyars settling down following the conquest changed over from nomadic shepherding to intensive animal breeding and farming (the cemeteries of the rural settlements can all be found on the eastern and south eastern parts of the protuberant sides) They occupied the tells and the kurgans at many places as well.

Somogyi (1994) demonstrated that during the times of the settlement of the Magyars, our area was characterised by the present main landscape types but with a different regional distribution (fig. 2). The low and high flood plains were unsuitable for the permanent settling down but their utilisation (fishing, hunting, reed cutting, etc.) was significant. Most settlements were formed on the areas with chernoziem soil. In the beginning, they were located on the edges of the inundated surface because the environs were suitable both for animal breeding and farming. The close water had a great importance in the water supply of the population and of the animal stock.

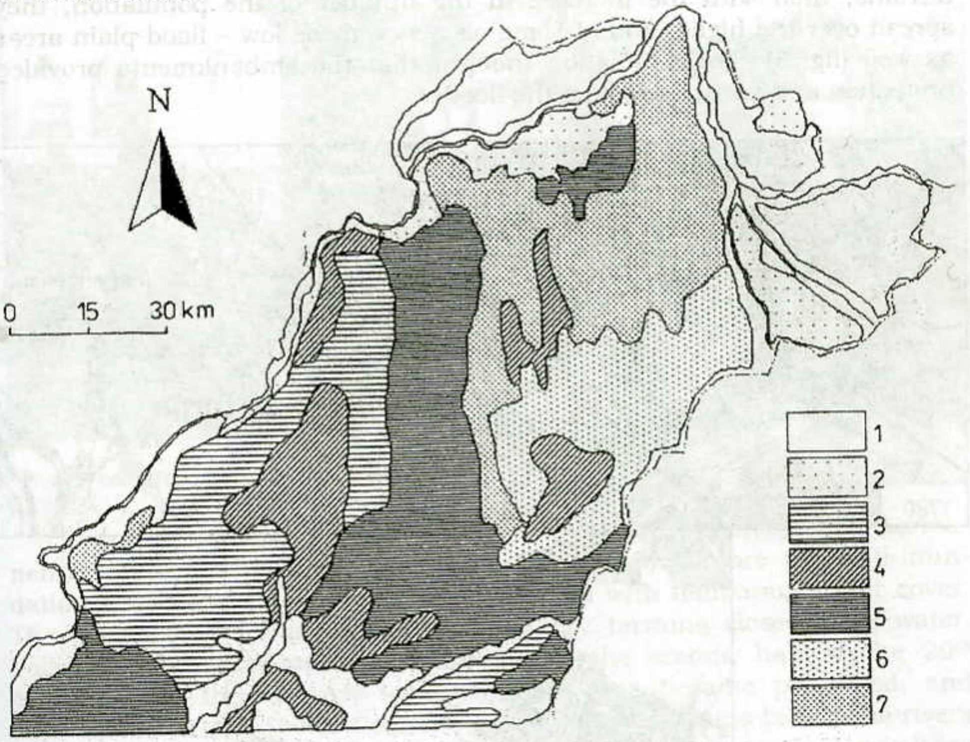


Fig. 2. The reconstructed landscape type map of the Northeastern Great Plain (after Somogyi, 1994): 1- Marshy, woody dead water; 2 - Swampy, peaty soiled, reedy, with free water surface in patches; 3 - Areas with meadow soil, hard wood, gallery forest; 4 - Small drainless basins; 5 - Loess pusztas with chernoziem soil; 6 - Areas wind sandhills and thin sand cover; 7 - Sand areas with chernoziem and brown soils

On the higher lying terrains of the alluvial fan, one has to differentiate between the areas with sandhills, thin sand cover, and the areas with chernoziem and brown soils. They took up shepherding on the areas with sandhills and thin sand cover, and farming on the areas with chernoziem and brown soils. The settlements of the alluvial fan were primarily formed on the cultivated lands. On the cultivated blown sand areas, wind erosion meant a danger in the dry periods. The archaeologists excavated findings from the Arpad era which were buried with thin sand cover.

Some of the settlements were ruined in the Turkish era. The inhabitants taking advantage of the natural endowments, lived on the high grounds between the swampy, marshy, or water covered areas. Following the Turkish conquest, the increase in the number of the population demanded the extension of the cultivable land. The extension of the agricultural lands could be solved only with anti-inundation works. As a consequence of the regulation of the rivers, building of embankments and inland water drainage canals, the natural landscape totally changed. The places of the areas covered with water permanently or temporarily was occupied by ploughlands, meadows and pastures. As a result of this, the flood plains started to become inhabited. The settlements first occupied the higher terrains, then with the increase in the number of the population, they spread over the high – and at some places even the low – flood plain areas as well (fig. 3). The population thought that the embankments provided protection and security against the floods.

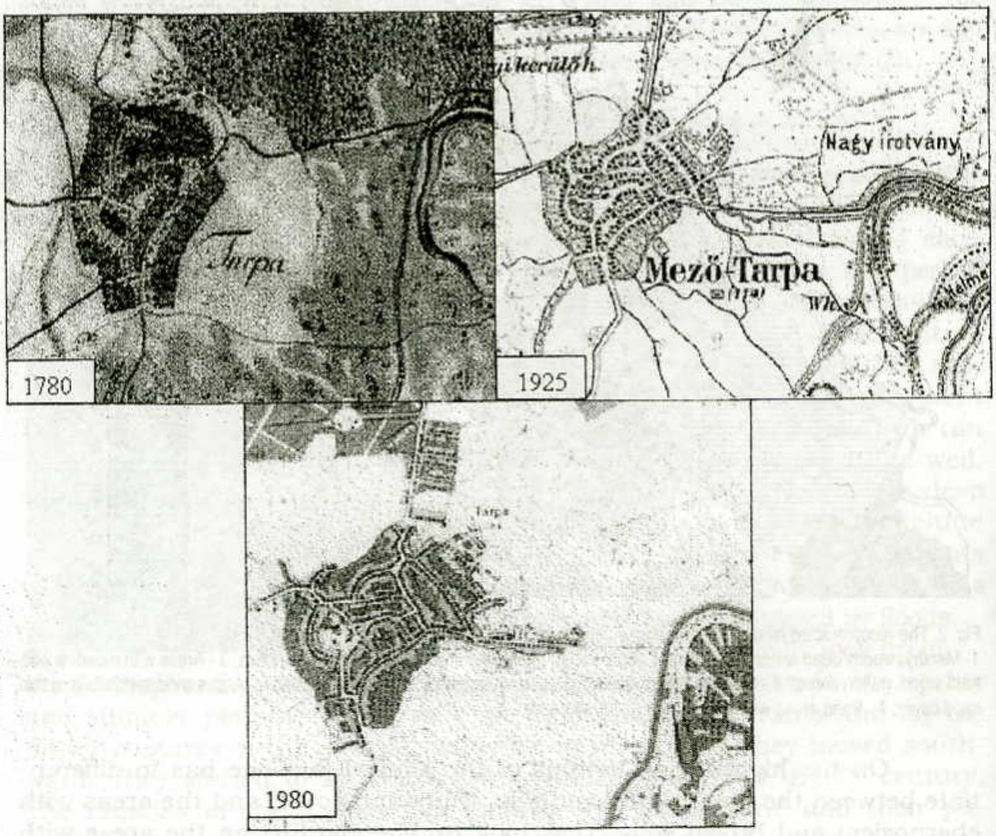
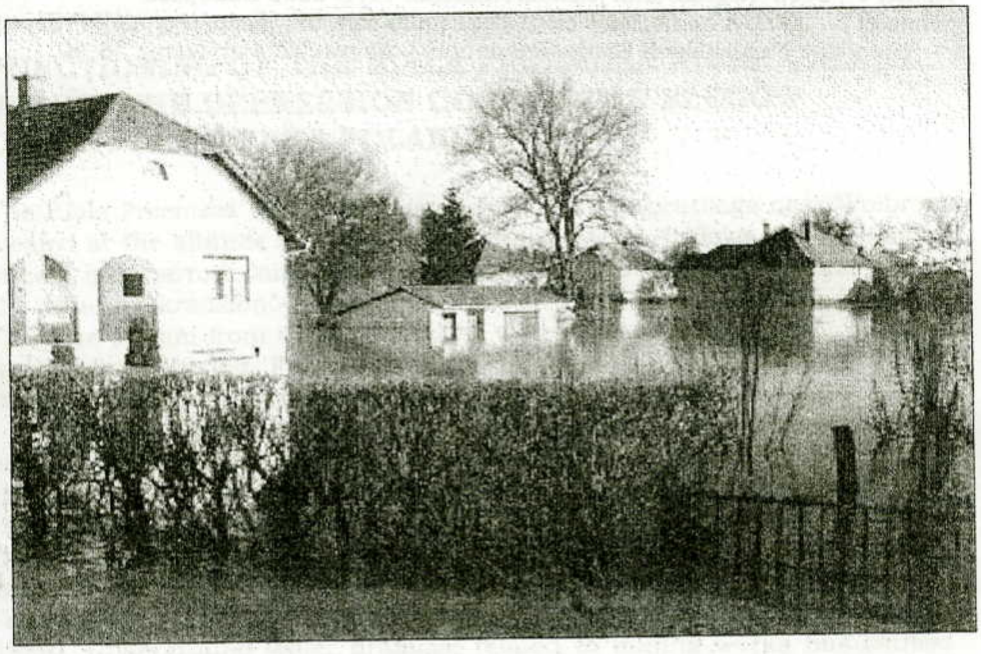


Fig. 3. The spread of the dwelling-house area (Tarpa) over the flood plain

The silting up of the flood plain of the rivers between the embankments, and the more rapid runoff due to the decrease of the forest areas on the area of the catchment area cause the heightening of the flood level. Thus, the danger of flood becomes more and more frequent. As a consequence of the bursting of dams in the past years the flood caused considerable damages on the settlements on the flood plain of the River Tisza (phot. 3).



Phot. 3. Flood in Tákos (Upper Tisza region) in 2001

In sum, it may be concluded that considerable areas were permanently covered with water in the Tiszántúl region before the anti-inundation works and there were also large areas with temporary water cover. The places of the human life were the dry terrains close to the water. Following the anti-inundation works, from the second half of the 20th century, first the formerly water-covered areas became populated, and then the borders of the settlements on the higher terrains beside the rivers spread over the flood plain areas. The population living on the lower lying areas of the Great Plain are endangered by the floods.

Bibliography

Geological timetable. Compiled by F.W.B. van Eysinga 1978. 3rd edition Elsevier, Amsterdam

Huisink M., 1998: Changing river styles in response to climate change (Examples the Maas and Vecht during the Weichselian Pleni- and Lateglacial). Vrije Universiteit, Amsterdam, 127.

M. Nepper I., Sőregi J., Zoltai L., 1980: Bihari halmok. Bihari dolgozatok. Berettyóújfalú: p. 31.
M. Nepper I., Sőregi J., Zoltai L., 1981: Hajdúsági Halmok Hajdúsági Közlemények 8. Hajdúböszörmény: p. 48.
Somogyi S., 1967: Az ármentesítés és folyószabályozás (vázlatos) földrajzi hatásai hazánkban Földrajzi Közlemények: 145-158.
Somogyi S., 1994: Az Alföld földrajzi képe a honfoglalás és a magyar középkor időszakában Észak- és Kelet-Magyarországi Földrajzi Évkönyv: 61-75.
Raczky P., 2000: Régészetünk jelentős feltárásai 1975–2000 Budapest.
Selmeczi L., 2002: A honfoglalás előtti élet az Alföldön. In.: „Szép vagy Alföld" Képes Krónika a Nagyalföldről Szerk.: Rakonczai J. Nagyalföld Alapítvány: 38–60.

Anthropogenic aspects of landscape transformations	2	University of Silesia Faculty of Earth Sciences Sosnowiec 2002	53–59

Oimahmad RAHMONOV, Jerzy WACH

University of Silesia, Faculty of Earth Sciences, Sosnowiec, Poland

FUNCTIONING OF THE BIAŁA PRZEMSZA RIVER VALLEY WITHIN THE DEPRESSION CONE IN THE BŁĘDÓW DESERT (SOUTHERN POLAND)

The Biała Przemsza takes its sources from minute peatbogs near Wolbrom located at the altitude of 377 m above the sea level. It flows out as a small stream in a narrow damp deep-cut valley, which is meridionally directed. In the Klucze-Okradzionów section, the river Biała Przemsza is fed by the Centuria stream from the right and by waters of the Biała (collecting mine waters) from the left. Flowing through the desert, the Biała Przemsza cuts it into two unequal parts: the northern one and the southern one.

In the Błędowska Desert area, the Biała Przemsza flows along a sand-eroded valley, 8–10 m deep and ca. 200–400 m wide, where it forms numerous meanders, side arms, floodings, swamps and bogs; these serve the functions of retaining areas. For the past thirty years, water conditions in the Błędowska Desert have undergone large transformations resulting from exploitation of Triassic deposits of zinc and lead ores in the surroundings of Olkusz (Wilk, Motyka, 1977; Różkowski, Wilk, 1980; Jankowski, Wach, 1984). Underground water drainage related to mining works has caused the ground water plane to drop to the depth of over 30 m (Kleczkowski, 1972). As the result of that process, Quaternary-Jurassic waters do not practically occur in low-thickness zones and are significantly reduced in the remaining area (Szczypek et al., 1994). The consequence of that condition is the decline of headstreams of the river Biała and strong infiltration of the Biała Przemsza waters near Klucze. Before the ore exploitation period, the ground water level in that area had been at the depth of up to 5 m (Kozioł, 1952).

Anthropogenization of water relations in the discussed area can be seen in pollution of surface, underground and precipitation waters (Jaguś, Rzętała 1997; Leśniok, 1996). An important part in the transformation of physical-chemical properties of waters was played by sulphite lyes, coming from Klucze Paper Mill, discharged to the river or onto the desert's sands in 1930–1980 (Niewdana, 1993). Those contaminants were so troublesome that they began to have an impact on changes in the settlement scheme – between 1940 and 1978 new houses were built far from the river and long-exploited fields in the valley were left because of their contamination.

Changes in the production profile of the Paper Mill as well as sewage treatment plants caused that the river is currently quite clean near Błędów and the valley has been overgrown with unusually abundant rushes and carrs. It should be emphasized that in the pre-war period the Biała Przemsza valley was a place for recreation and rest, especially near Okradzionów. Some of the Okradzionów people rendered services to holidaymakers who came to rest there.

In spite of the fact that the Błędowska Desert is situated within the depression cone, the river Biała Przemsza, which cuts it through, and its ecosystems function without any disturbances. The river valley has been completely clogged with sulphite lyes, which in turn resulted in hampering the river's outflow. Thus in the desert area the Biała Przemsza valley is overgrown with vegetation which is characteristic for damp areas. Major plant communities that grow in the Biała Przemsza valley include alder carrs as well as reed, cattail and sedge rushes. Birch and pine plantings can also be found in places on the edge of the valley (Rahmonow, 1999).

Characteristics of selected plant communities in the Biała Przemsza valley within the Błędowska Desert

Fraxino-Alnetum – riverside carr

Poland's most common lowland alder carr community includes forest formations with prevalence of black alder. In carr forests, these phytocenoses are a link to communities of *Alnetea glutinosae* class. Alder carrs are distinguished from other syntaxa of the *Alno-Padion* community with a constant – although varying in terms of composition and quantity – addition of alder and partly rush species (Matuszkiewicz, 2001). *Fraxino-Alnetum* occurs in swamping-tending habitats – like in valleys of slow-flow streams. Their soils are characterized by high fertility and humidity (Cabała, 1990).

In the research area (the Biała Przemsza valley), *Fraxino-Alnetum* is represented by the forest of medium-dense stand of alder trees. The addition includes *Betula pendula*; its height is usually similar to that of the alder or it creates the lower layer of the stand of trees. *Salix pentandra* can sometimes be found among the trees. In the analysed patches the denseness of the tree layer amounts to 70–90 % (Table. 1).

The growth of the shrub layer varies in different transects and takes up between 10 and 20 % of the patch area. Shrubs consist mainly of bird cherry *Padus avium*, with minor addition of willows: *Salix cinerea, S. caprea* and *S. purpurea*.

It can be observed, considering the floral abundance of the analysed phytocenosis, that species typical of that community and taxa characteristic for the *Querco-Fagetea* class are also accompanied by elements of other classes, e.g. *Alnetea glutinosae, Molinio- Arrhenetheretea, Phragmitetea* or *Artemisietea*.

In the research terrain, the *Fraxino-Alnetum* community shows a tendency of changes towards alder communities, which is clearly indicated by high share of species of the *Alnetea glutinosae* class. The described phytocenoses are poor in floristic terms.

Table 1. *Fraxino-Alnetum W.Mat.1952*

Succesive number of relevé	1	2	3	4	5	6	7	8	9	S
Number of relevé	1	3	2	22	12	1	10	13	4	T
Area of relevé [m²]	100	100	150	100	100	150	100	100	100	A
Date	12.06	27.07	12.08	12.09	03.07	27.08	12.06	28.07	29.06	Ł
Locality	Biała Przemsza river valley in Błędów Desert									O
Density of tree layer a [%]	80	80	90	70	80	90	80	90	90	Ś
Density of shrub layer b [%]	10	20	-	10	20	20	10	-	20	Ć
Cover of herb layer c [%]	100	90	100	100	80	80	100	80	80	
Cover of moss layer d [%]	-	4	-	-	5	10	-	-	-	
Number of species in the relevé	22	20	19	22	25	22	23	22	29	
D. *Fraxino-Alnetum*										
Alnus glutinosa a	3.3	4.4	4.4	4.4	4.4	5.5	5.5	5.5	4.4	V
Frangula alnus b	+	+	+	+	+	+	1.1	.	.	IV
Lycopus europaeus c	2.2	1.1	1.1	.	.	2.2	+	.	+	IV
Lysimachia vulgaris	1.1	1.1	+	1.1	+	.	.	+	1.1	IV
Solanum dulcamara	1.1	.	.	+	1.1	1.1	.	1.1	1.1	IV
Humulus lupulus	2.2	+	.	.	+	1.1	.	1.1	+	IV
Scutellaria galericulata	.	.		+		.		+	.	II
ChAll. *Alno-Padion* + **ChCl.** *Querco-Fagetea*										
Padus avium b	1.2	2.2	1.2	1.2	1.1	2.2	1.1	1.1	2.2	V
Aegopodium podagraria c	.	1.1	.	1.1	+	.	.	.	1.1	III
ChCl. *Alnetea glutinosae*										
Salix pentandra a	3.3	2.2		.	2.2	.		.	1.1	III
Salix pentandra b	.	.	1.3				1.2		.	
Salix cinerea c	1.1	.	.	+	1.2	.	.	.	1.1	III
Ribes nigrum	+	.	.	.	.	.	.	.	+	II
ChCl. *Phragmitetae*										
Peucedanum palustre c	.	1.1	2.2	.	1.1	+	.	+	+	IV
Carex acutiformis	2.2	1.1	.	2.2	1.1	.	.	.	1.1	III
Iris pseudacorus	+.2	.	.	.	.	.	1.2	+	+	III
Carex paniculata	+	.	.	+	.	.	+	.	.	II
Carex gracilis	.	1.1	.	.	1.2	.	+	.	.	II
Phalaris arundinacea	.	.	.	3.3	.	.	.	2.2	1.1	II
Phragmites australis	+	.	.	.	.	.	.	+	2.2	II
Ch *Molinio_Arrhenathretea*										
Caltha palustris c	1.1	.	.	.	+	+	1.1	.	.	III
Cirsium oleraceum	.	.	.	.	+	1.1	.	+	1.1	III
Crepis paludosa	+	1.1	.	.	+	.	+	.	.	III
Equisetum palustre	+	.	.	1.1	1.1	.	1.1	.	.	III
Scirpus sylvaticus	1.1	.	2.2	1.1	2.2	.	.	.	.	III
Angelica sylvestris	.	.	.	+	.	.	+	+	.	II
Cirsium palustre	.	.	.	1.1	.	+	.	+	.	II
Juncus effusus	.	+	.	.	1.2	.	1.1	.	.	II
Accompanying species										
Betula pendula a	.	.	1.1	1.1	.	+	+	.	.	III
Betula pendula b	+	1.2	.	.	.	.	.	+	1.1	
Humulus lupulus	2.2	+	.	.	+	1.1	.	1.1	+	IV
Galeopsis tetrahit c	1.1	2.2	4.4	2.2	+	1.1	.	.	.	IV
Galium aparine	.	.	+	1.1	.	.	1.1	.	+	III

Galeopsis pubescens	.	.	2.2	.	1.1	.	.	+	1.1	III
Eupatorium cannabinum	.	.	1.1	.	.	2.2	.	1.1	+	III
Urtica dioica	.	3.3	.	.	+	3.3	.	1.1	2.2	III
Plagiomnium ellipticum d	.	.	.	.	.	.	1.3	+.3	1.3	II
Brachythecium rutabulum	.	1.3	.	1.1	.	.	1.3	.	.	II

Sporadic species:
Bryum pseudotriquetrum 2d (1.3); *Carduus crispus* 2,5; Galium palustre 9; *Calliergonella cuspidata* d 9(1.3); *Carex canescens* 5; *Chaerophyllum aromaticum* 8; *Gallium mollugo* 5; *Geum urbanum* 9; *Glyceria fluitans* 3 (1.1); 7(2.2); *Fragaria vesca* 6 (1.1); *Mentha aquatica 1*; *Moehringia trinervia* 6,3 (1.1); *Mycelis muralis* 6 (1.1); *Menyanthes trifoliata* 7; *Plagiomnium cuspidatum* 4d (1.1); *Populus termula* a,b 6 (1.1); *Ranunculus repens 3* (1.1); *Rubus idaeus* 3 (1.1); *Rumex obtusifolius* 3 (1.1); *Salix caprea* 7 (1.2), 1 (1.1); *S. purpurea* 9; *Sambucus nigra* b 6; *Sorbus aucuparia* 6; *Tussilago farfara* 9 (1.1); *Viola palustris* 6 (1.1); *Valeriana sambusifolia 3,8,9*; *Dactylis glomerata* 7; *Deschampsia caespitosa* 8; *Geranium palustre* 4; *Lychnis flos-cuculi* 3,7; *Lotus uliginosus* 6; *Myosotis palustris*,7,9; *Climacium dendroides* d 4 (1.3); *Dryopteris filix-mas* 2; *Impatiens noli-tangere* 8; *Atrichum undulatum* d 5,6 (1.2);

In the communities under discussion, the mosaic-shaped system of small clumps and valleys – characteristic for alder carr – is poorly marked or does not occur at all. The terrain is swamped or sometimes even flooded when the water level is high. These are higrophilous and eutrophic phytocenoses, forming on highly wet soils of the silt-swamp or silt-peat type, whose humus-accumulation level is diverse and has a sharp border with the mineral substratum. The humus-accumulation layer has acid reaction (4.5 pH), which results from the acidifying effect of alder leaves on the ground (Olson, 1958). These habitats are characterized by rich organic matter. Another source was provided by sulphite lyes that had been supplied through pipelines from nearby Klucze Paper Mill to the slopes of the valley for a few dozen years. This is reflected in plant communities of this area, which are characterized by high viability, and occurrence of plants that suggest fertile habitats. Species belonging to the *Artemisietea* class are worth noticing. These are: *Eupatorium cannabinum, Urtica dioica, Malachium aquaticum* and ones of the *Phragmitetea* class. Their frequent occurrence suggests nitrogen-rich ground (Ellenberg, 1979; Rahmonow, 1999). The *Fraxino-Alnetum* community in the Biała Przemsza Valley is highly deformed as the result of the selection system of forest management.

Phragmitetum communis – reed rush

Reed rush usually occurs as a single-species community with *Phragmites australis* grass in prevalence. Areas of that community with addition of other swamp plants of similar demands towards the waterside habitat have also been found. The literature review – Haslam (1972), Matuszkiewicz (2001), among others – shows that this community is characterized by wide ecological amplitude and large expansiveness and that it covers large areas and produces large amounts of phytomass. Patches of that community are diverse in terms of flora and the dampness degree of the substratum they occur on. It occupies wet habitats or areas of partially stagnant waters. There also occur plants of other classes in the described community. The *Phragmitetae* class is represented by species like *Scutella-*

ria galericulata, Equisetum fluviatile, Phalaris arundinacea, Poa palustris and four sporadically occurring species. Plants of the *Molinio-Arrhennatheretea* class, in turn, which grow on wet and seasonally flooded habitats are characterized by high degree of stability. Of the *Artemisietea* class, there occur *Urtica dioica* and *Eupatorium cannabinum*. They have relatively high degree of stability. The stinging nettle *Urtica dioica* is a very common element that accompanies *Phragmites australis* in the Biała Przemsza valley (Rahmonow, 1999). Its occurrence is a good bioindicator that proves high concentration of nitrogen in the ground (Greig-Smith, 1948), which confirms Olsen's (1921) conclusion, based on the results of researches and observations, about nitrogen being a factor that controls occurrence of *Urtica dioica*. Increased contents of biogenic substances in the research area are confirmed by data obtained by means of interviews, according to which in 1970s the river Biała Przemsza was a stinking wastewater because of sulphite lyes that were discharged into it. Periodical rises of water increased matter supply to the flooded area, thus favouring growth of the above species. Thus fertility is caused by anthropogenically forced presence of organic compounds.

Caricetum gracilis – slender pointed sedge community

The community grows in the Biała Przemsza valley in heavily wet eutrophic habitats. Eutrophic damp sedge meadows occur on flood-lands and seasonally flooded areas. *Caricetum gracilis* is a substitute community of the most fertile forms of *Ribo-Alnetum* carrs and, according to Matuszkiewicz (2001), most of these phytocenoses are of anthropogenic nature. The prevailing and building species of this community is *Carex gracilis*, which grows over the whole area of the patch. There occur few species of the *Phragmitetea* class; of them, *Phalaris arundinacea* and *Peucedanum palustre* are of diversified coverage. The slender pointed sedge has an economic value in some parts of Poland and, depending on the swath time, it is used for hay or bedding material (Borysiak, 1994). As Zawadzka's (1953) studies show, the nutrition value of swamp sedge vegetation is higher than that of meadow vegetation in terms of vitamin contents. An exceptionally valuable information for this paper, obtained by means of interviews, is that people of Klucze borough had meadows in the research area, which they seasonally used for mowing and grazing until the valley was polluted with the sulphite sewage, which modified the process of overgrowing to a significant degree.

Typhetum latifoliae – cattail rush

The cattail rush community is frequently found in the Biała Przemsza valley. The dominating species – characteristic and giving a specific physiognomy to the patches of this community – is *Typha latifolia*. Besides cattails of the *Phragmitetaea* class, there also occur: *Alisma plantago-aqua-*

tica, Sagittaria sagitifolia, Acorus calamus, Lysimachia thyrsyjlora, Carex paniculata and other species.

Phalaridetum arundinaceae – canary grass rush

A dominating species in all studied patches is *Phalaris arundinacea* – a characteristic one for that community. It is accompanied by the only species of the *Phragmitetea* class – *Peucedanum palustre*. Equally often observed were species of the *Artemisietaea* class like *Eupatorium cannabinum* and *Urtica dioica*, which – as Motyka (1962) reports – indicate substratum's abundance in nitrogen. In the research area, this community forms mainly on flood terraces, which is indicated by high share of species of the *Molinio-Arrhenatheretea* class.

Final remarks

Plant communities that grow in the Biała Przemsza Valley do not differ very much, in terms of generic composition, from those growing in regions with natural low water surface. Shallow level of ground waters in the Biała Przemsza Valley is conditioned by proofing the bottom of the valley with sulphite lyes.

References

Atlas jakości powierzchniowych wód płynących na obszarze działania Regionalnego Zarządu Gospodarki Wodnej w Katowicach w 1994 roku. 1995. RZGW, Katowice: pp. 30.

Borysiak J., 1994: Struktura aluwialnej roślinności lądowej środkowego i dolnego biegu Warty. Wyd. Nauk. UAM, Poznań.

Cabała S., 1990: Zróżnicowanie i rozmieszczenie zbiorowisk leśnych na Wyżynie Śląskiej. UŚ, Katowice.

Ellenberg H., 1979: Zeigerwerte der Gefasspflanzen Mitteleuropas. Scripta Geobotanica, 9: 1-122.

Greig-Smith P., 1948: *Urtica dioica* L., J. Ecol., Vol. 36, 23: 343-351.

Haslam S. M., 1972: *Phragmites communis* Trin., J. Ecol., Vol. 60, 128, 585-610.

Jaguś A., Rzętała M., 1997. Przestrzenne zróżnicowanie wielkości jednostkowego spływu jonów Cl^-, SO_4^{2-}, NO_3^-, PO_4^{3-}, ze zlewni Przemszy w nawiązaniu do stopnia zagospodarowania jej powierzchni. Kształtowanie środ. geogr. i ochr. przyr. na obszar. uprzemys. i zurb., 24. WBiOŚ, WNoZ UŚ, Katowice-Sosnowiec.

Jankowski A. T., Wach J., 1984: Wpływ działalności górniczej na wody gruntowe w południowo-wschodniej części Wyżyny Śląskiej. Przewodnik Ogólnopolskiego Zjazdu PTG, Lublin.

Kleczkowski A., 1972: Wody powierzchniowe i podziemne Wyżyny Krakowsko-Wieluńskiej. Studia Ośrodka Dok. Fizjogr. 1.

Kozioł S., 1952: Budowa geologiczna Pustyni Błędowskiej. Z badań czwartorzędu w Polsce, 1. Biul. PIG, 65.

Leśniok M., 1996: Zanieczyszczenie wód opadowych w obrębie Wyżyny Śląsko-Krakowskiej. Wyd. UŚ, Katowice.

Matuszkiewicz W., 2001: Przewodnik do oznaczania zbiorowisk roślinnych Polski, Vademecum Geobotanicum. PWN, Warszawa.

tica, Sagittaria sagitifolia, Acorus calamus, Lysimachia thyrsyflora, Carex paniculata and other species.

Phalaridetum arundinaceae – canary grass rush

A dominating species in all studied patches is *Phalaris arundinacea* – a characteristic one for that community. It is accompanied by the only species of the *Phragmitetea* class – *Peucedanum palustre.* Equally often observed were species of the *Artemisietaea* class like *Eupatorium cannabinum* and *Urtica dioica,* which – as Motyka (1962) reports – indicate substratum's abundance in nitrogen. In the research area, this community forms mainly on flood terraces, which is indicated by high share of species of the *Molinio-Arrhenatheretea* class.

Final remarks

Plant communities that grow in the Biała Przemsza Valley do not differ very much, in terms of generic composition, from those growing in regions with natural low water surface. Shallow level of ground waters in the Biała Przemsza Valley is conditioned by proofing the bottom of the valley with sulphite lyes.

References

Atlas jakości powierzchniowych wód płynących na obszarze działania Regionalnego Zarządu Gospodarki Wodnej w Katowicach w 1994 roku. 1995. RZGW, Katowice: pp. 30.

Borysiak J., 1994: Struktura aluwialnej roślinności lądowej środkowego i dolnego biegu Warty. Wyd. Nauk. UAM, Poznań.

Cabała S., 1990: Zróżnicowanie i rozmieszczenie zbiorowisk leśnych na Wyżynie Śląskiej. UŚ, Katowice.

Ellenberg H., 1979: Zeigerwerte der Gefasspflanzen Mitteleuropas. Scripta Geobotanica, 9: 1-122.

Greig-Smith P., 1948: *Urtica dioica* L., J. Ecol., Vol. 36, 23: 343-351.

Haslam S. M., 1972: *Phragmites communis* Trin., J. Ecol., Vol. 60, 128, 585-610.

Jaguś A., Rzętała M., 1997. Przestrzenne zróżnicowanie wielkości jednostkowego spływu jonów Cl^-, SO_4^{2-}, NO_3^-, PO_4^{3-}, ze zlewni Przemszy w nawiązaniu do stopnia zagospodarowania jej powierzchni. Kształtowanie środ. geogr. i ochr. przyr. na obszar. uprzemys. i zurb., 24. WBiOŚ, WNoZ UŚ, Katowice-Sosnowiec.

Jankowski A. T., Wach J., 1984: Wpływ działalności górniczej na wody gruntowe w południowo-wschodniej części Wyżyny Śląskiej. Przewodnik Ogólnopolskiego Zjazdu PTG, Lublin.

Kleczkowski A., 1972: Wody powierzchniowe i podziemne Wyżyny Krakowsko-Wieluńskiej. Studia Ośrodka Dok. Fizjogr. 1.

Kozioł S., 1952: Budowa geologiczna Pustyni Błędowskiej. Z badań czwartorzędu w Polsce, 1. Biul. PIG, 65.

Leśniok M., 1996: Zanieczyszczenie wód opadowych w obrębie Wyżyny Śląsko-Krakowskiej. Wyd. UŚ, Katowice.

Matuszkiewicz W., 2001: Przewodnik do oznaczania zbiorowisk roślinnych Polski, Vademecum Geobotanicum. PWN, Warszawa.

Niewdana J., 1993: Zagrożenia jakości wód triasowych rejonu Olkusza w związku z przewidywanym zakończeniem eksploatacji kopalń rud. Kras i speleologia, 7. UŚ Katowice: 57-60.
Olsen C., 1921: Ecology of *Urtica dioica* L. J. Ecol. 9, 1.
Olson J. S., 1958: Rates of succession and soil changes on southern Like Michigan sand dunes. Botanical Gazette, 119: 125-170.
Rahmonow O.,1999: Procesy zarastania Pustyni Błędowskiej. UŚ WNoZ Sosnowiec.
Różkowski A., Wilk Z. (eds.), 1980: Warunki hydrogeologiczne złóż rud cynku i ołowiu regionu śląsko-krakowskiego. Prace IG, Warszawa.
Szczypek T., Wach J., Wika S. 1994: Zmiany krajobrazów Pustyni Błędowskiej. WNoZ UŚ Sosnowiec.
Wilk Z., Motyka J., 1977: Kontakty między poziomami wodonośnymi w olkuskim regionie kopalnictwa rud. Ann. de la Soc. Géol. de Pologne, 47, 1.
Zawadzka S., 1953: Wartości witaminowe sian z poszczególnych typów łąk białostockiego. Acta Soc. Bot. Pol., 22, 2. Warszawa.

Anthropogenic aspects of landscape transformations	2	University of Silesia Faculty of Earth Sciences Sosnowiec 2002	60–67

Martyna A. RZĘTAŁA, Tadeusz MOLENDA, Mariusz RZĘTAŁA

University of Silesia, Faculty of Earth Sciences, Sosnowiec, Poland

BOTTOM DEPOSITS AS AN INDICATOR OF ECOLOGICAL CHANGES (on the example of artificial water reservoirs in the Pogoria catchment – Silesian Upland)

The Pogoria stream, with its system of ditches and the Biała Ława tributary, discharges water to the Czarna Przemsza thus draining the area of 43 sq km, covering part of Dąbrowa Górnicza (including the Metallurgical Plant „Huta Katowice") and the north-eastern edges of Będzin. The catchment is characterized by the occurrence of artificial water reservoirs within its vicinity, the largest of them being: Pogoria I, Pogoria II and Pogoria III (Table 1). Their basins are hollows remaining of sand exploitation (Fig. 1).

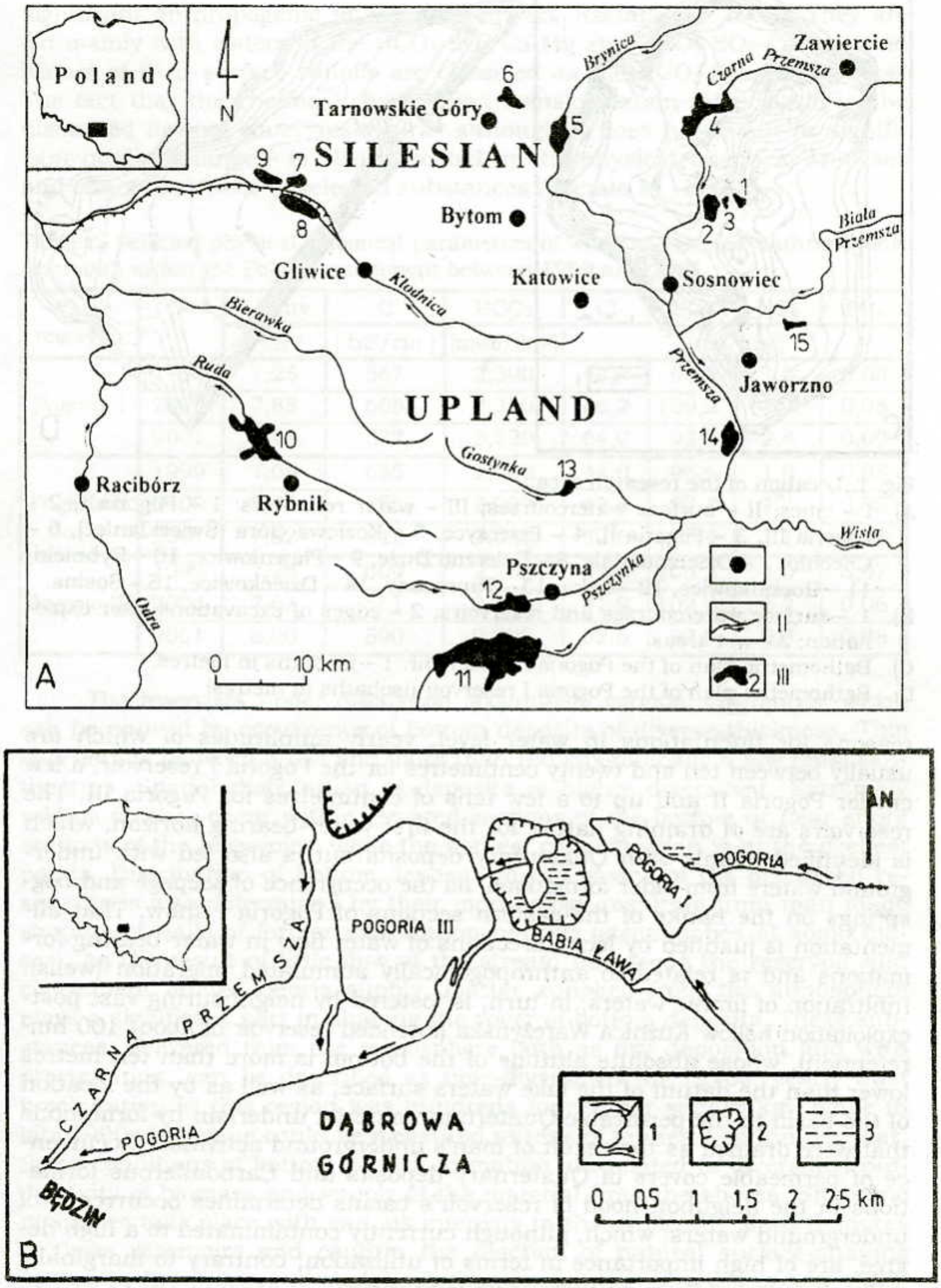
Except for the Pogoria I reservoir, the above objects are of poor technical infrastructure, however they serve (to various degrees) the recreation-sports-rest functions and Pogoria III is additionally an emergency source of water supply for the nearby metallurgy plant „Huta Katowice", allowing (through its pipeline system) for joint operation with other water bodies of the so-called Upper-Silesian Water-Economic System (e.g. Łosień, Dziećkowice).

Table 1. Post-exploitation water reservoirs in the catchment area of the Pogoria stream

Specification	Water reservoir		
	Pogoria I	Pogoria II	Pogoria III
Year of creation	1938	1955	1974
Catchment area	19,3 km^2	20,7 km^2	21,4 km^2
Reservoir area	0,75 km^2	0,26 km^2	2,10 km^2
Volume	3,6 hm^3	0,5 hm^3	12,0 hm^3
Mean depth	4,8 m	1,8 m	5,7 m
Theoretic time of total water exchange, in years	approx. 1,4	approx. 0,1	approx. 1,9
Use of the reservoir	S,R, W	U	S,R,W,ZP

Description:
R – recreation; S – sports; W – rest; ZP – industrial water supply; U – ecological grounds

The above reservoirs (Table 1), are fed mainly with waters of the Pogoria stream – the mean yearly flow in its upper course amounts to a few tens of $dm^3 \cdot s^{-1}$, while just below Pogoria III it is around 0,2 $m^3 \cdot s^{-1}$. Various feeding conditions, as well as the character of water management, are main



Poland
N
Zawiercie
Czarna Przemsza
Brynica
Tarnowskie Góry
SILESIAN
Bytom
Biała Przemsza
Gliwice
Kłodnica
Katowice
Sosnowiec
Bierawka
Jaworzno
Ruda
UPLAND
Przemsza
Gostynka
Racibórz
Rybnik
Wisła
Pszczyna
Pszczynka
Odra
0 10 km
A
I
II
III
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
N
POGORIA
POGORIA I
POGORIA III
BABIA ŁAWA
CZARNA PRZEMSZA
POGORIA
DĄBROWA GÓRNICZA
BĘDZIN
0 0,5 1 1,5 2 2,5 km
B

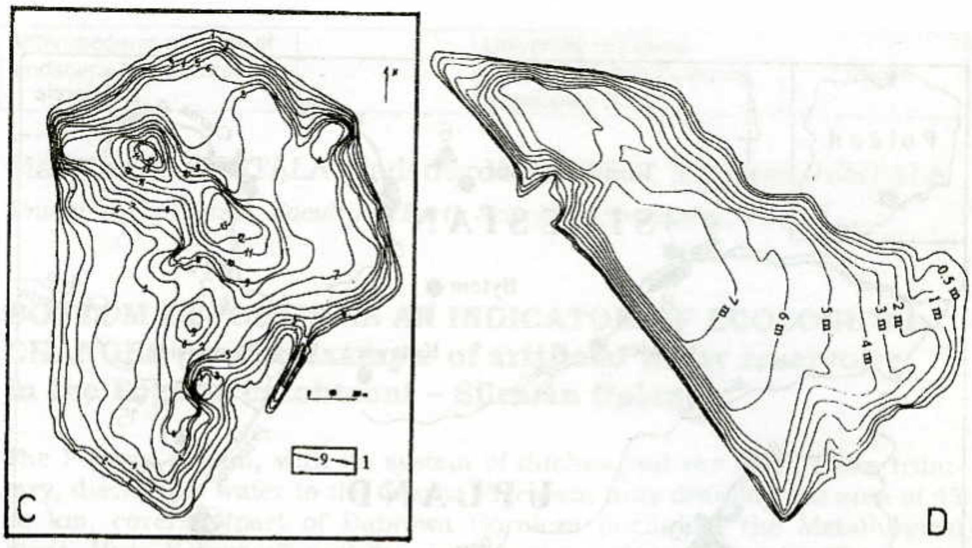


Fig. 1. Location of the research area:
A) I – cities; II – surface watercourses; III – water reservoirs: 1 – Pogoria I, 2 – Pogoria III, 3 – Pogoria II, 4 – Przeczyce, 5 – Kozłowa Góra (Świerklaniec), 6 – Chechło, 7 – Dzierżno Małe, 8 – Dzierżno Duże, 9 – Pławniowice, 10 – Rybnicki, 11 – Goczałkowice, 12 – Łąka, 13 – Paprocany, 14 – Dziećkowice, 15 – Sosina.
B) 1 – surface watercourses and reservoirs; 2 – edges of excavations after exploitation; 3 – wet areas.
C) Bathometric plan of the Pogoria III reservoir: 1 – isobaths in metres.
D) Bathometric plan of the Pogoria I reservoir (isobaths in metres).

reasons for fluctuations in water level, yearly amplitudes of which are usually between ten and twenty centimetres for the Pogoria I reservoir, a few cm for Pogoria II and up to a few tens of centimetres for Pogoria III. The reservoirs are of draining nature for the first water-bearing horizon, which is identified mainly with Quaternary deposits but is also fed with underground waters from older formations, as the occurrence of seepage and bog-springs on the banks of the eastern sections of Pogoria I show. That alimentation is justified by local directions of water flow in water-bearing formations and is related to anthropogenically stimulated migration (wells). Infiltration of limnic waters, in turn, is fostered by neighbouring vast post-exploitation hollow Kuźnica Warężyńska (intended reservoir of about 100 hm^3 retention), whose absolute altitude of the bottom is more than ten metres lower than the datum of the lake waters surface, as well as by the location of the basin in the permeable Quaternary material underlain by formations that were drained as the result of man's underground activities. Occurrence of permeable covers of Quaternary deposits and Carboniferous formations in the neighbourhood of reservoir's basins determines occurrence of underground waters, which, although currently contaminated to a high degree, are of high importance in terms of utilization, contrary to marginally utilized waters of Permian or Triassic formations.

In the light of quality assessment systems used in Poland, waters of reservoirs in the Pogoria catchment (Table 2) are considered among the objects of most favourable qualitative parameters in the region in spite of significant anthropogenic impact (Jankowski, Rzętała M., 2000). They are fed mainly with waters of the HCO_3-SO_4-Ca-Mg and HCO_3-SO_4-Ca type and waters of their surface runoffs are classified as the HCO_3-SO_4-Ca-Mg type. The fact that the chemical composition transformation takes place in the discussed flowing water reservoirs– although it does not result in significant quality change – is also indicated by the physical/chemical analyses and charge balances of selected substances (Rzętała M., 2000).

Table 2. Selected physical/chemical parameters of water of selected anthropogenic reservoirs within the Pogoria catchment between 1999 and 2001

Water reservoir	Years	Acidity	C	HCO_3	Cl	SO_4	NO_3	PO_4
		[pH]	[&S/cm]	[mval/dm³]	[mg/dm³]			
Pogoria I	1999	7,25	567	2,300	44,7	91,2	1,0	0,08
	2000	7,85	608	2,300	46,2	109,2	1,7	0,05
	2001	7,98	577	2,520	64,0	92,8	2,8	0,09
Pogoria II	1999	7,08	655	2,900	44,0	96,6	1,0	0,05
	2000	7,44	575	2,900	43,3	87,3	1,4	0,03
	2001	7,82	612	3,030	52,6	95,4	1,1	0,11
Pogoria III	1999	7,28	609	2,250	42,6	106,2	1,0	0,07
	2000	7,63	561	2,200	41,9	102,9	1,3	0,06
	2001	8,00	590	2,290	52,6	82,9	0,9	0,08

The reservoirs under discussion accumulate various substances, which can be noticed by occurrence of bottom deposits of diverse thickness. This is generally between a few and more than ten (sporadically a few tens) centimetres. Spatial distribution of deposits is highly diversified. Extremely seldom do they occur within elevated sections of the bottom or near-shore sections of the reservoirs, while the highest concentration is in the deepest points. Distribution of bottom deposits in the basins of the discussed reservoirs is also determined by their morphology resulting from man-made shaping of walls of former exploitation hollows (steep slopes at some places). As the result of little flow of the stream that feeds the reservoir and consequent limited debris supply, matter supplied from the atmosphere plays a significant part in shaping the cover of bottom deposits. These substances, delivered from the troposphere both as dry deposition and with precipitation, can be described as time-diversified. In 1970s, yearly dust precipitation in this region was hundreds tonnes per square km, while in late 1990s the value could be measured at tens of tonnes / sq km per year. Some conditions of bottom deposit formation are related to diversified productivity of biomass and supply of the material from the shores. Shoreline processes take place with various intensity in the artificially shaped shores of these reservoirs and confirm the reaction of natural surface-shaping factors to the process of surface anthropogenization (e.g. Szczypek, 1995; Molenda et al., 2001). Their occurrence is indicated by e.g. bars, sandy necks, spill banks, terraces, and active or inactive cliffs. Where the Pogoria flows into the Pogoria I reservoir, a delta was created which fills the post-exploitation subsidence of the triangle-shaped shoreline. The delta is built of sandy deposits fixed with plants and shrubs practically throughout its all area. The part of the delta adjacent to the reservoir is overgrown with abundant reed rushes, characteristic for many fragments of shoreline of water reservoirs in the Pogoria catchment. The vegetation is an example of fast regeneration of biocenotic systems after former damages caused by openpit sand mining.

Analyses of granulometric composition of bottom deposits that have been carried out suggest (after averaging the results) high diversification of the grain size. In case of the Pogoria I reservoir, the significant part is that of sandy fractions, amounting to 63%; dusty fractions reach 9% and clayey ones – 27%. Deposits of Pogoria III are characterized by sandy fraction contents at about 53%, dusty ones – at approx. 14%, and clayey ones – at approx. 33%. This is the straight consequence of environmental conditions in the catchment and its vicinity. It is clear especially when compared to different mechanical composition of deposits in other reservoirs of similar origin (e.g. Dzierżno Duże – vast majority of clayey particles amounting to approx. 65% grains of diameter below 0.02 mm). The Dzierżno Małe reservoir, in turn, which is similar to Pogoria I in terms of origin and age, is characterized by averaged granulometric composition: sands – 7%, dusts – 26%, clays – 67%.

Diversification of the reservoirs in terms of bottom deposits is indicated by basic analyses of physical/chemical properties (Table 3). Slight alkalinity of deposits and water is undoubtedly favourable for accumulation of many heavy metals in the reservoirs and hinders their migration. Concentration of organic carbon in bottom deposits of the Pogoria III reservoir is insignificant, not only in comparison to other objects in the Silesian Upland (e.g. Świerklaniec or Przeczyce – a few up to several percent; Dzierżno Duże – nearly as much as 50%), but also in comparison to the Pogoria I reservoir, which is located higher. Similar relations between reservoirs in the catchment can be seen in case of concentrations of calcium carbonate (Table 3) and vast majority of elements making up the basic composition (Table 4). What is especially noteworthy is high concentration of silica, reflected in minor roasting loss – contrary relations can typically be observed in case of reservoirs in the Silesian Upland because of occurrence of sewage matter and other pollutants in the deposits.

Table 3. Bottom deposits of selected water reservoirs in the Pogoria catchment – acidity (pH) and concentrations of organic carbon and calcium carbonate

Water reservoirs	Acidity	Organic carbon concentration	Calcium carbonate concentration
	[pH]	[%]	
Pogoria I	7,32 – 7,59	0,05 – 0,78	0,00 – 5,10
Pogoria III	7,55 – 7,82	0,08 – 0,44	1,70 – 3,10

Table 4. Concentrations of selected substances in bottom deposits of water reservoirs in the Pogoria catchment

Indicator	Pogoria I water reservoir	Pogoria III water reservoir
	[%]	
SiO_2	56,95 – 71,05	61,25 – 70,68
Al_2O_3	11,50 – 16,55	7,91 – 14,23
Fe_2O_2	6,96 – 10,09	2,83 – 5,64
MnO	0,06 – 0,192	0,068 – 0,094
MgO	1,09 – 1,84	1,59 – 1,85
CaO	0,59 – 2,24	2,74 – 4,43
Na_2O	0,54 – 0,86	0,41 – 0,75
K_2O	1,80 – 3,06	1,91 – 2,61
TiO_2	0,71 – 0,875	0,78 – 0,83
P_2O_2	0,19 – 0,28	0,09 – 0,13
Loss of calcination	0,12 – 13,57	7,78 – 10,78

Analyses of trace element concentrations in bottom deposits (Table 5) prove that the main problem is the accepted level of geochemical background being exceeded. This confirms the complex impact of anthropopressure on shaping the concentrations of trace elements in these deposits. Another issue is how far the geochemical background, taken from the paper by Kabata-Pendias and Pendias (1993), has been exceeded. This is characteristic for most water reservoirs of the Upper-Silesian region (Rzętała M.A., 2001). These concentrations are frequently much higher than the geochemical background for preindustrial alluvia of the Przemsza suggested by Klimek et al. (1995) and higher than levels considered as natural, given by Ciszewski (1992). In vast majority of cases, high concentration of microelements is the result of contamination of watercourses that feed the reservoirs. Analyses of concentrations of trace elements in bottom deposits also show the part flowing water reservoirs play in accumulation of pollutants. A spectacular example is data concerning the Pogoria I and Pogoria III reservoirs, i.e. the first and the last objects on the Pogoria stream (along its course). What is worth noticing is the fact that concentrations of heavy metals in bottom deposits of the first reservoir are frequently many times higher that those of the Pogoria III reservoir. The Pogoria I reservoir therefore serves the function of a peculiar „water treatment plant" for the flowing stream.

The subject matter of bottom deposits and morphology of the litoral of the discussed water reservoirs includes also the speed rate of silting and

Table 5. Mean concentration of selected elements in bottom deposits of selected water reservoirs of the Pogoria catchment

Element		Geochemical background (sedimentary rocks) *	Water reservoir	
Name	Symbol		Pogoria I	Pogoria III
		[ppm]		
Antimony	Sb	0,03 – 2,00	$\underline{3,53}$	1,30
Arsenic	As	1,0 – 13,0	$\underline{19,3}$	10,7
Barium	Ba	50 – 800	$\underline{678,7}$	432,7
Beryllium	Be	0,2 – 6,0	3,3	1,67
Bromine	Br	1 – 10	5,3	2,0
Cerium	Ce	7 – 90	$\underline{108,7}$	91,3
Cesium	Cs	0,5 – 10,0	10,0	8,6
Chromium	Cr	5 – 120	$\underline{132,3}$	104,7
Zinc	Zn	10 – 120	$\underline{1276,0}$	$\underline{185,7}$
Zirconium	Zr	20 – 220	$\underline{487,3}$	$\underline{484,7}$
Europium	Eu	0,2 – 2,0	$\underline{2,1}$	1,53
Yttrium	Y	4 – 50	$\underline{51,3}$	36,0
Cadmium	Cd	0,05 – 0,35	$\underline{15,27}$	$\underline{0,93}$
Cobalt	Co	0,1 – 20,0	$\underline{22,0}$	15,7
Lanthanum	La	4 – 90	56,1	42,8
Lutetium	Lu	0,2 – 1,2	0,8	0,70
Copper	Cu	2 – 60	44,0	20,0
Neodymium	Nd	4,7 – 41,0	$\underline{53,3}$	38,7
Nickel	Ni	5 – 90	50,0	33,7
Lead	Pb	3 – 40	$\underline{239}$	$\underline{51}$
Rubidium	Rb	5 – 200	123,0	112,3
Samarium	Sm	1,3 – 22,1	9,6	7,3
Scandium	Sc	0,5 – 15,0	13,9	11,6
Silver	Ag	0,050 – 0,250	$\underline{1,13}$	$\underline{1,00}$
Strontium	Sr	20 – 600	105,8	105,7
Terbium	Tb	0,2 – 2,0	1,3	0,9
Thorium	Th	1,7 – 12	$\underline{14,2}$	$\underline{13,37}$
Uranium	U	0,45 – 4,00	$\underline{4,20}$	3,97
Vanadium	V	10 – 130	110,3	86,7
Gold	Au	0,002 – 0,007	$\underline{0,025}$	$\underline{0,010}$

Explanation

a) symbol (*) at the „geochemical background" notion detonet values given for all kinds of sedimentary rocks listed by A. Kabata-Pendias and H. Pendias *(1993)*;

b) underlined values are values that exceed the geochemical background for sedimentary rocks.

so-called life-span of reservoirs. The latter depends on a number of factors – like the volume of the reservoir or alimentation volume, which determines the quantity of delivered debris. For these reasons the water reservoirs under discussion are characterized by diversified estimated time of functioning (Pogoria I – 1,6 thousand years; Pogoria III – 22,9 thousand years).

The studies show that bottom deposits are a good indicator of characteristics of the neighbouring environment. By giving evidence for the part natural and anthropogenic factors play in shaping their quantity, mechanical and chemical compositions and physical/chemical properties, they provide an excellent „record" of phenomena and processes that occur in the geographic environment of the catchment and the vicinity of the reservoirs. This also emphasizes their importance as an excellent indicator of ecological changes and interpretation of their morphologic record and the degree of contamination may bring much better economic results than expensive studies of water environment. shoreline processes, in turn, and the way they occur in artificial shores prove that money-consuming reclamation processes of water-filled exploitation hollows can be successfully replaced with revitalization processes of natural and spontaneous character.

References

Ciszewski D., 1992: Monitoring metali ciężkich w osadach rzecznych. Aura, 5. Wyd. Sigma-NOT, Kraków: 8-9.

Jankowski A.T., Rzętała M., 2000: Silesian Upland and its borders – condition and anthropogenic changes in the quality of surface waters. In: Burchard J. (ed.): State and anthropogenic changes of water quality in Poland. Wydawnictwo UŁ, Łódź: 143-154.

Kabata-Pendias A., Pendias H., 1993: Biogeochemia pierwiastków śladowych. Wydawnictwo PWN, Warszawa: 364 pp.

Klimek K., Niewdana J., Ciszewski D., Kocel K. 1995: Procesy i osady fluwialne we wschodniej części Górnego Śląska. In: III Zjazd Geomorfologów Polskich „Procesy geomorfologiczne. Zapis w rzeźbie i osadach.", 2. Przewodnik wycieczek. Wydział Nauk o Ziemi UŚ, Stowarzyszenie Geomorfologów Polskich, Sosnowiec: 47-72.

Kozyreva E. A., Rzętała M. A., 1999: Anthropogenic water reservoirs and development of natural relief transformation processes (a case study from the Silesian Upland and its borders). In: Snytko V. A., Szczypek T., (eds.): Modern nature use and anthropogenic processes. IG SB RAS, University of Silesia, Irkutsk-Sosnowiec: 56-60.

Molenda T., Rzętała M.A., Rzętała M., 2001: Anthropogenic changes in relief in the Silesian Upland – forms and processes. In: Současný stav geomorfologických výzkumů. Ostrava-Kružberk, 5.-7. dubna 2001. Ostravska univerzita, Česká Asociace Geomorfologů, Ostrava: 107-109.

Rzętała M., 2000: Bilans wodny oraz dynamika zmian wybranych zanieczyszczeń zbiornika Dzierżno Duże w warunkach silnej antropopresji. Prace Naukowe UŚ w Katowicach nr 1913. Wydawnictwo Uniwersytetu Śląskiego, Katowice: 176 pp.

Rzętała M.A., 2001: Procesy brzegowe i osady denne wybranych zbiorników wodnych w warunkach zróżnicowanej antropopresji – na przykładzie Wyżyny Śląskiej i jej obrzeży (maszynopis pracy doktorskiej). WNoZ UŚ, Sosnowiec. 141 pp.

Szczypek T., 1995: Anthropogenic relief in the eastern part of the Silesian Upland. In : Quaestiones Geographicae, SI, 4. UAM, Poznań: 265-270.

Anthropogenic aspects of landscape transformations	2	University of Silesia Faculty of Earth Sciences Sosnowiec 2002	68–76

József SZABÓ, László SÜTŐ
University of Debrecen, Department of Physical Geography, Debrecen, Hungary

CADASTERING LANDSCAPE VALUES IN EARTH SCIENCES - THEORETICAL QUESTIONS, PRACTICAL EXPERIENCES

Rising the problem

We can hardly find any natural landscape on the Earth today. This is because on the one hand effects of human activity can be traced in every corner of the world and on the other hand because alteration of the natural processes determining the characteristics of the landscape by human activity reaches beyond its immediate environment. As these processes act through landscape boundaries, traces of the society that continuously change material with nature are present even at those sites where it is not apparent at first glance.

We ought to accept as a fact that the effects of the society on nature are part of the natural operation of the system of the Earth, thus their termination is not possible. Transformation of natural landscapes will continue. *However, it is not of little importance as to how!* We must control our material exchange with nature not just for nature protection but also for protecting the future of the society. *This control should study the individual methods of human activity and their intensity in spatial context.* A successful control, apart from analysing the methods, volume and effects of social activity would bear in mind the present situation as well. *We need to be fully aware of the present rate of disturbance of our environment.* We have to know the natural objects or phenomena operating in our environment and furthermore, those objects, which were produced by human activity but became constant elements of the environment and their remain is maybe necessary for future development. Such elements, apart from objects established by material production, can be sites of cultural heritage as well, which play an important role in the self-knowledge of the society, which establish successful future development.

To obtain the above mentioned goals – nature and self protection – the society have to systematically survey its environment and the geographical landscapes in it, recording its present state and those natural and social objects (materials and processes) which can be regarded as (scientific) values either in studying the past or in developing the future successfully. This provides the base of the recently started (in Hungary as well) "single landscape value cadastering program". Such program financed by the Aggtelek National Park was carried out by the Department of Physical Geography co-ordinated by the authors. In the present papers we would like to outline some general experiences of this work.

Some questions in cadastering earth science landscape values

Although protecting different environmental values is of social interest, its effective implementation can not be done without appropriate legislation. Orders created by different authorities (ministry, local government) and controlled primarily by national parks can only be effective if we have an appropriate general view on the values to be protected. Thus the first step to establish effective protection is to cadaster these values. This work itself is complex. In theory (and in practice as well) its first step is to construct a scientific detailed landscape value system in which all objects, materials, etc. identified as values of the landscape can logically fit in. If we poses this, it is expedient to ordain as a authoritative standard to promote uniform cadastering. After detailed surveying, evaluation of the objects follows. In the course of this evaluation process it will turn out whether the objects fulfil the requirements of landscape values or not.

The system of cadastering

As a proper system for surveying earth science values have not been constructed yet, at the beginning of cadastering landscape values we faced the problem of creating a system. On the other hand the classification and qualification of biological values and the determination of their intangible values are well developed. Although there are classification systems and legislation considering values of cultural heritage (ethnographic, historical, architectural, etc.), determination their quality and intangible value is far from clear.

Surveying earth science landscape values was surpassed compared to other values until recently. The Nature Protection Act of 1982 provided the protection of geological and geomorphological values. The national cave cadaster was finished as well (Tardy, 1984), which is unique even in international context. However, surveying the rest of the earth science values was not following. The Nature Protection Act (1996/LIII.) provides the ex lege protection of 6 earth science values of high priority (caves, springs, barrows, marshes, alkali lakes, engulfments). The 6th paragraph of the Act regarding landscape protection gives the list of individual landscape values and orders their identification and recording. According to the Act, this work belongs to the scope of the national parks.

One reason for protracted surveying of earth science landscape values, lies in some their special character. While in the case of most of the biological values (flora, fauna, habitat) conservation means protection from human activity, considering social values survival often provided by utilisation. However, the case of earth science landscape values is more difficult:

- these values are usually less vulnerable than those mentioned above but their restoration is generally not possible (Kozák, Püspöki, 1995),
- slight alteration of the "more stable" geofactors results in changing of the biological values as well because of interdependence,
- some are the result of human activity, however, some are destroyed by human activity,
- certain processes belonging to the earth science landscape values may deteriorate or destroy artificial objects.

Regarding the above mentioned, the protection of earth science landscape values requires special measurements in which besides limitation the problem of recultivation also occurs.

The standard (MSZ 20381:1999 Hungarian Standard) promoting the surveying of individual landscape values was introduced in the 1990s on behalf of the Ministry of Environmental Protection and Regional Development. However, in our opinion there are shortcomings and unjustified parallelism (occurrence of special rocks – occurrence of rocks, etc.) and conceptual faults (surface occurrence, near-surface geological form, monoclinic forms, etc.) in its parts relating to abiotic natural values. We would like to highlight only a few problems:

- the standard should not categorise all earth science landscape values into the geographical landscape values,
- only moving sand forms are mentioned for forms having exogene origin,
- separating hilltops and ridges into different categories is not in agreement with the applied concept of the system,
- there are morphological values (point bars, canyons) among hydrological values
- the classification of lakes is improper, etc.

Therefore we did not use this standard, instead we constructed two newer and more applicable classification in two steps together with our geologist and national park colleagues. This classification is based on the formerly neglected nature protection system constructed in 1984 (Tardy, 1984). In this way we eliminated the incorrectness of the standard thus filling of the cadaster sheets was based on our classification. Although we experienced this classification as applicable, in our opinion it is important and necessary to implement landscape value surveys in a framework based on stricter principles.

When we study the abiotic natural constituents of the surface or near-surface strata, we can state that they can be classified into 3 main groups based on the definition of geology and the new system-like conception of geomorphology: materials, processes and forms. Therefore it is expedient to use these systemic categories in the protection of abiotic natural values as doing so we can clearly indicate which category the actual landscape value belongs to. Due to length limitation we are unable to show our system which is still under further development.

The qualification of values

Once we have a classification system we have to qualify the individual values, which in the case of earth science values is problematic. When qualifying the values of our surrounding environment in the first step we search for a characteristic indicating some kind of quality which could be the base of an economic, living standard, or scientific qualification system.

The relationship between the objectivity of the particular value and the subjectivity of the assessor presents the problem of creating such systems (Kozák et al., 1998). To filter out subjective aspects the approach have to be scientific. An objective qualification system can only be created on scientific bases. The more complex is the value to be assessed the harder it is to stay objective. An this is especially true for earth science values. In the creation of a qualification system those sciences will have the leading role, which concern the triple unity of material-process-form, as these can minimise subjectivity in assessing the significance of processes in the system of the Earth. The significance of the qualified values has to be given within a well defined region, as a nationally unique form will have different values regarding the Carpathian basin, Europe or the entire Earth. Scientists more or less agree on the attributes determining the earth science values:

- *Rareness:* If we were able to determine the spatial distribution of an earth science value based on its role in the system of the Earth (or in a defined smaller region) then, with this, we already pointed out those requiring primarily protection.
- *Size:* Because of the diversity of earth science values their different types cover a wide range of sizes, e.g.: volcano - mineral, etc. Size can be only aspect of comparison within a particular type.
- *Quantity:* This aspect contradict to rareness to some extent. The abundance of the particular object is measured in a certain area, therefore it is different from spatial distribution (Kozák et al. 1998).
- *Typicalness:* This is a characteristic which can be only determined in theory and the value is derived from its difference from the defined type description. Therefore we can not state that one of the features is the „most typical" (*Kiss 1999*) but *we need to indicate the basic characteristics upon which the classification can be based.* This is hardly definable in practice, bearing in mind the triple unity of material-process-form.

Endangeredness, vulnerability, demonstratibility, educational value, etc. determine the applied method of protection (jural, economic, nature protectional, etc.).

The more the scientific experiences dominate in the selection of the assessment aspects the more it is possible to decrease subjectivity. The process of evaluation following the creation of classification categories and the determination of qualifying characteristics, is an operation which can be „algorithmic", precisely for this reason the surveying should only be carried out by specialists (Kozák et al. 1998). The other opportunity is the multi-level evaluation (Kiss 1999) from which average values may be omitted because of its excluding system.

The score system of the evaluation gives only a relative number calculated by mathematic operations and the obtained order among values is only an order of priority. Nature protection needs help in finding the methods of interaction and conservation and in official proceedings, the calculated number based on the score system may contribute to this by determining priority of the objects considering certain protection tasks. However, this number itself can not be regarded as the base of scientific significance!

Experiences of landscape evaluation in the Cserehát

Cadastering individual landscape values is slow in Hungary due to the fact that the experts in the national parks are overwrought. Separated groups operate without co-ordination and even the professional composition of certain groups is not satisfactory. Therefore uniform surveying is hardly possible. Most of the national parks (*Bükk National Park, Aggtelek National Park*) realised their time limits and seeked co-operation with universities. To understand the evaluation of the survey carried out in the Cserehát under our leadership, it is important to know the most important characteristics of the area.

According to a preliminary agreement, the survey covered the southern 2/3 of the Cserehát and took place within the area of certain settlements. We registered a total of 463 values in 51 settlements and 15 settlement fragments (Fig. 1). The position of the landscape values was recorded on a map with a scale of 1:10000 and slides were attached to the filled data sheets.

The Cserehát both from natural and cultural point of view, is a less known and enclosed hilly region of the country. Its special characteristic is that it retained its enclosed state and agricultural nature in the immediate neighbourhood of one of the most transformed region by mining and heavy industry (Sajó valley, Miskolc) of the country.

The landscape values of the area are not spectacular and except for the canyon-like (therefore conspicuous) valleys of the Palaeozoic western margin, gently sloping forms dominate. The wide gently sloping valleys are unique in Hungarian hills, that is why those hilltops are act as landscape values from which this special character of the landscape can be perfectly viewed (Szabó, 1985, 1993).

The area is mostly unexposed from cultural historical point of view. Although art historical values of national significance are not abundant, numerous urban and economic historical values can be found, which are representing traditional architecture, economy or lifestyle. A total of 340 cultural historical, 83 earth science, 27 biological and 13 scenic values were recorded (table 1). The distribution of landscape values reflects the role of the society as social values are three times greater than the other values together even in this enclosed area. Thus it is essential to pay special attention to the protection of the existing values.

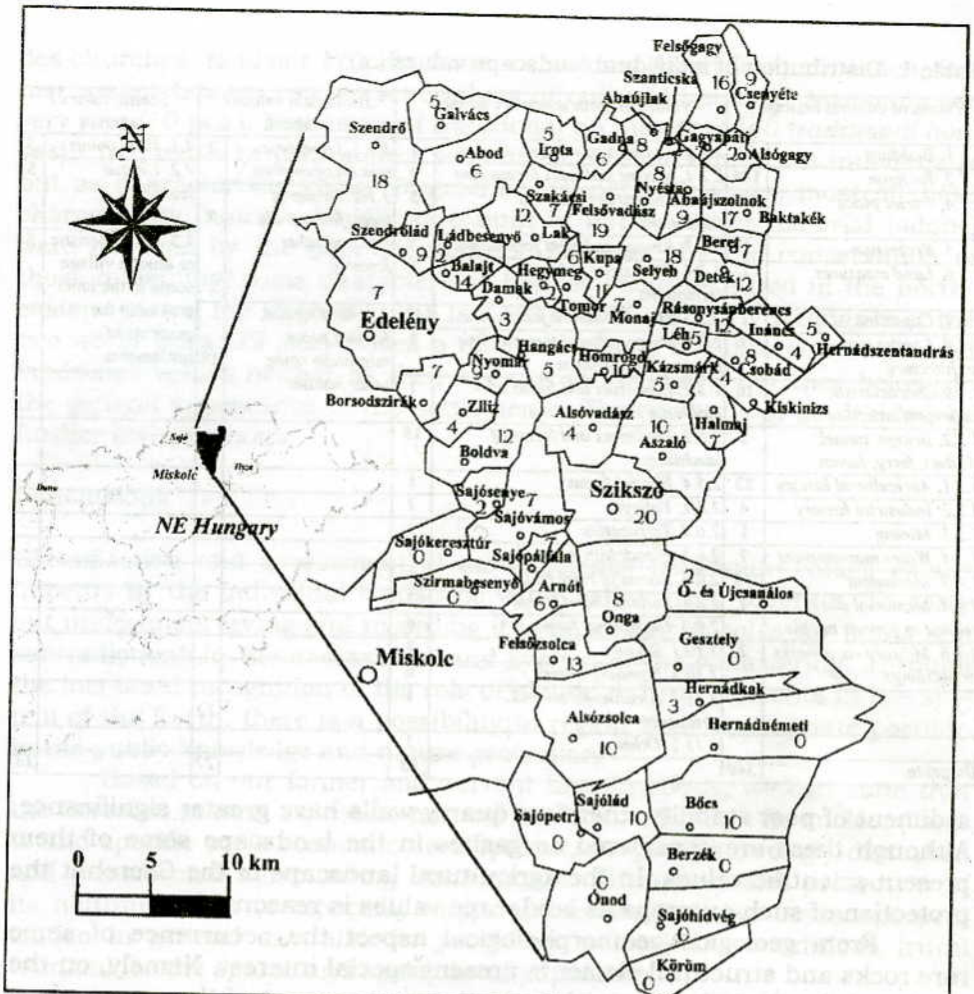


Fig. 1. Distribution of individual landscape values among settlements in the Cserehát

The majority of the natural processes (mass movements, gully systems) in the Cserehát are significant only when they endanger social objects. Despite this fact, they should be regarded as natural values! Most of the still developing spectacular forms of the surface were triggered by agriculture becoming more and more intense from the end of the 19th century onwards (transforming the steeper slopes into arable land, and overgrazing at places). Decreasing the extent of these land-use types would be beneficial from economic point of view and it would reduce the erosion and degradation of the soil. Some of the slopes of the loose Pannonian sediments characterised by mass movements and the gully systems are remnants of former land-use. With the abandonment of these land-use types these processes will not completely cease due to the geology of the area but will decrease significantly.

Only a limited number of geological outcrops exhibiting the geological development of the area was identified, however, they still give 3rd of the earth science values (31 pcs.). Natural outcrops are rare on the clayey

Table 1. Distribution of individual landscape values

Values of cultural heritage / amount		Values of earth sciences / amount		Biological values / amount		Scenic values / amount	
1.1.1. Building	82	2.1.3. Features of volcanic bodies	1	3.1.1. Lonesome tree on open area	2	4.1. View points	3
1.1.2. Religion	145	2.2.1. Marine sediment formations	9			4.2. Unique scenes	5
1.1.4. Burial place	21	2.2.2. Lacustrine sediment formations	3	3.1.2. Group of trees, famous old tree and other forestry	7		
1.1.5. Protection	3	2.2.3. Fluvial sediment formations	3			4.3. Characteristic or unique village scene in the inner area or in the outskirts of settlements	5
1.1.6. Land measures	2	2.2.4. Terrestrial sediment formations	1				
1.1.7. Captation	2	2.2.5. Mixed sediment formations	12	3.4. Nesting site, feeding place, migration route, other habitat	18		
1.1.8. Landscape architecture	10	2.3.1. Processes and forms of low grade metamorphism	1				
1.1.9. Characteristic settlement structure	16	2.3.2. Processes and forms of moderate metamorphism	1				
1.2.2. Bridge, tunnel, viaduct, ferry, haven	2	2.5.2. Processes and forms of landslides	18				
1.3.1. Agricultural history	23	2.5.4. Fluvial forms	1				
1.3.2. Industrial history	4	2.6.1. Valleys	7				
1.3.3. Mining	1	2.6.4. Terracettes	1				
1.3.4. Water management	7	2.6.5. Floodplain forms	2				
1.4.3. Monument	19	2.6.6. Forms of river beds	5				
1.4.4. Memorial site related to famous people	1	2.8.1. Solution karst forms	2				
		2.9.3. Derasional forms	6				
1.4.6. Military earthworks or buildings	2	2.10.1. Springs	2				
		2.10.3. Standing waters	6				
		2.11.1. Alcaline forms and processes	1				
		2.11.2. Other	1				
Összesen	*340*		*83*		*27*		*13*

sediment of poor stability, therefore quarry walls have greater significance. Although these are considered as gashes in the landscape some of them present scientific values. In the agricultural landscape of the Cserehát the protection of such outcrops as landscape values is reasonable.

From geological-geomorphological aspect the occurrence of some rare rocks and structural elements present special interest. Namely, on the one hand the Devonian formations in the western part of the area and on the other hand the canyon-like epigenetic valleys terminating in the valley of the Bódva river. Further rarity is the epigenesis currently taking place on Palaeozoic carbonate rocks through volcanic rhyolite tuffs where the rhyolite tuffs intercalating between the Devonian and Pannonian sediments in the south-western part of the region. These are significant valley sections both from scenic and scientific aspect (*Szabó 1985, 1993*).

The botanical and zoological values of the region are still poorly registered and this survey did not bring significant breakthrough in this context. The 27 recorded values only cover a few of the most significant types. Complete recording requires further systematic work in this case which should extend to the remnant forests of the area. These forests close to natural state hold significant botanical values.

People living in the area retained their religion, which is reflected by 145 religious values. Among them the rural churches are the most important ones (*63 pcs.*). Although most of them present no special architecture they are the most significant buildings in the villages and in places having inhabitants of several religion 2 or 3 churches can be found. Besides churches, roadside crucifixes are numerous. Apart from churches, former manor houses can present values of cultural heritage. Mansions are very rare (10 pcs.). Remnants of traditional architecture (*40 traditional houses*) - frequently in poor state - sometimes present values not individually but as characteristic village fragments (*16 pcs.*). However, most of these characteristic houses, which were built of not resistant material (adobe) were removed by the poor inhabitants. However, by the conservation of those remaining, some characteristic houses could be saved in the north-eastern part of the Cserehát. The fact that there are many remnants of the two world wars (*19 pcs.*) raised a dilemma. Some of these do not present landscape values neither by their age nor by their art, but they belong to the general appearance of the settlements. Their value will be decided by further investigations.

Conclusions

Classification and assessment of earth science landscape values gained impetus by the individual landscape value cadastering program. To carry out uniform surveying and recording it is important to solve the faults and contradictions in the assessment and system of the cadastering. Through the increased recognition of the role of abiotic natural elements in the system of the Earth, there is a possibility to regain their appropriate position in the public knowledge and nature protection.

Based on our former and current investigations, we can state that the Cserehát remain a close-to-natural landscape through its enclosed state and specific socio-economic development, despite its strongly disturbed and transformed surrounding environment. The reveal and protection of its natural values is especially important for nature and landscape protection in general and also for providing better living conditions (rural tourism) for the sparse and ageing local population.

References

Nature Protection Act of 1996 (1996/LIII)

Ahnert F., 1996: Einführung in die Geomorphologie. Verlag Eugen Ulmer, Stuttgart. 440 p.

Hevesi A., 1983: A természeti adottságok természetvédelmi szempontú értékrend szerinti minősítése. (*Qualification of natural conditions by nature protectional aspects.*) Manuscript, Budapest Hungarian Academy of Science Geographical Research Institute (MTA. FKI) p. 54

Hungarian Standard 20381:1999. Műszaki szabvány az egyedi tájértékek kataszterezéséhez. (*Technical Standard for cadastering individual landscape values.*) Hungarian Standardisation Board, 1999.

Kiss G., 1999: Talajok és morfológiai formák természetvédelmi szempontú értékelése. (*Evaluation of soils and morphological forms by nature protectional aspects. PhD dissertation.*) Debrecen, University of Debrecen. p. 150

Kozák M., Püspöki Z., Majoros Zs., 1998: Földtani értékek minősítése (*Qualification of geological values.*) Acta GGM Debrecina XXXIV. p. 327-339.

Kozák M., Püspöki Z., 1995: The place and role of environmental geology in the teaching of the subject: the study of nature. Acta GGM Debrecina XXXIII. p. 239-251.

Sütő L., Ráckevi J., 1998: Tájhasználati és értékvédelmi problémák az Aggteleki Nemzeti Park peremén, Szögliget példáján (*Problems in the land-use and protection of value at the edge of the Aggtelek National Park: Szögliget as a case of study*). Acta GGM Debrecina XXXIV. p. 367-387.

Szabó J., 1985: Landslide tpolog in hilly regions of Northern Hungary. In: Environmental and Dynamic Geomorphology / Pécsi M. Ed. Budapest Hungarian Academy of Science Geographical Research Institute (MTA FKI). p. 171-180.

Szabó J., 1993: Vergleichende Untersuchung der Rutschungsprozesse in Ungarn. Berliner Geohraphische Arbeiten Heft 79. o. 133-161.

Tardy J., 1984: A környezeti változások térképi modellezése a természetvédelemben In: A terméseti területi struktúraváltozások társadalmi, gazdasági és ökológiai értékelésének kartográfiai modellezése /Fodor I. Ed. Környezetvédelmi tanulmányok 4. kötet (*Modelling environmental changes by maps. In: Cartographical modelling of social, economic and ecological evaluation of natural spatial structure changes* /Fodor I. Ed. Environmental Protectional Studies volume 4.) p. 68-76.

Anthropogenic aspects of landscape transformations	2	University of Silesia Faculty of Earth Sciences Sosnowiec 2002	77–83

Katalin SZALAI, Zoltán UTASI, Gábor DEMETER, Zoltán PÜSPÖKI

University of Debrecen, Department of Physical Geography, Debrecen, Hungary

LITHOLOGICAL, STRUCTURAL AND GEOMORPHOLOGICAL ENDOWMENTS AS DETERMINATIVE FACTORS IN THE LANDUSE OF AN AREA

Raising a problem, borders of the research area

The geological endowments of an area determine its geomorphological characteristics and the way of land-use while human activity causes significant and often degrading changes in the state of the landscape elements (e.g. relief, soil and vegetation). Firstly, we analysed how much the geomorphological characters and the distribution of landscape elements of a territory are determined by the basic geological endowments. Secondly, we tried to specify how much these factors influence the way of land-use.

Our research area can be found in the hilly region of the intramountainous basins and the outcrops of the basement complex situated in the north Hungarian mountain-range among the Bükk, the Mátra and the Slovakian Ore Mountains (fig. 1). This territory represents a model for comparing the development of regions with different geological endowments.

Geological setting and structural conditions

The basement is mostly unidentified and these strongly cracked Palaeo-Mesozoic sequences only came to the surface in the eastern part of the research area during the Neogene structural movements (fig. 1). The imbricated nappe structure of the Uppony Mountains consists of Upper-ordovician–Silurian sandstone-clay shale-siliceous shale sequences (*Rágyincsvölgy* and *Csernelyvölgy Sandstone Formation, Tapolcsány Form.*), Devonian volcanics and limestones (*Strázsahegy Form., Uppony* and *Abod Limestone Form.*), Carbonic limestones (*Dedevár, Éleskő* and *Lázbérc Form.*) and Mesozois sediments (*Rudabánya Trias, Nekézseny Conglomerate Form.*). These Palaeo-Mesozoic sequences with NW vergence are dissected by steep reverse and transversal faults (Kovács, 1994).

Among the Tertiary basin-filling sediment sequences (fig. 1) the aleuritic, clayey, fine-sandy Upper-oligocene *Szécsényi Schlier* is characteristic. In the overlying bed of the schlier *Pétervására Sandstone Formation* is determinative. The sandstone that deposited in the late regressional phase of the transgression is coarser-grained, often strongly cemented and sporadically glauconitic. The late Oligocene regression was followed by a temporary terrestrial landscape evolution (*Zagyvapálfalva Clay Form.*) while the simultaneous tectonic movements were accompanied by acidic volcanic activity (*Gyulakeszi Rhyolite Tuff Form.*). During the early phase of the Lower-miocene transgression a sandy, clayey, aleuritic layer with coal seams deposited in the nearshore swampy environments. When the transgression became more intense fine-sandy, clayey-aleuritic, more open marine facies appeared (*Garáb Schlier*)(Budinszky-Szentpétery, et al 1999).

Palaeozoic imbricated nappe structure forms the surface on the eastern edge of the analysed area. West of this territory Miocene schlier-like sediments can be found striply alternating with the late Oligocene underlying sandstone westwards. In the west part of the region the members of the strongly cemented Oligo-Miocene Pétervására Sandstone Formation become dominant.

This spatial distribution is owing to the so-called Darnó fault system crossing the territory in the direction of NNE-SSW. Imbrication and basement nappe formation with distinct NW vergence are observable along this fault system in the East (Szalay et al., 1976). In the foreground of the imbrication nappe Miocene terrains appear at first then the tectonically connected strips of the Miocene and Oligocene sediments occur indicating the tectonic dissection that accompanied the thrusting up of the basement nappe. Going away from the fault zone purely Oligocene sandstone terrains appear.

The NNE-SSW oriented reverse faults and the transverse ones connected to them caused the Uppony Mountains to uplift and were inherited to the younger overlying sediments as well determining the main directions of the post-Miocene erosion. On the major part of the research area the faults preformed the current drainage pattern and the mass movements occurring on the valley slopes. Moving away from the Darnó fault system this tectonic preformation becomes less determinative.

Geomorphological endowments

We analysed the lithological bases of the geomorphological endowments with the help of the slope category maps. To compare the development of one drainage pattern to another we calculated valley densities and analysed the morphological characters for the territory of each rock formation appearing in the research area.

According to the evidence of the *slope category maps* (fig. 2) the steepest slopes can be found on the Palaeozoic terrain, especially on the surfaces built up of limestone with significant strength (>50% of the slopes is steeper than 40%). The same category dominates in the region of the strongly cemented Pétervására Sandstone Formation in the West. These facts prove the considerable dissection and the presence of consistent slopes there. On the territories mainly covered by fine-sandy-clayey-aleuritic

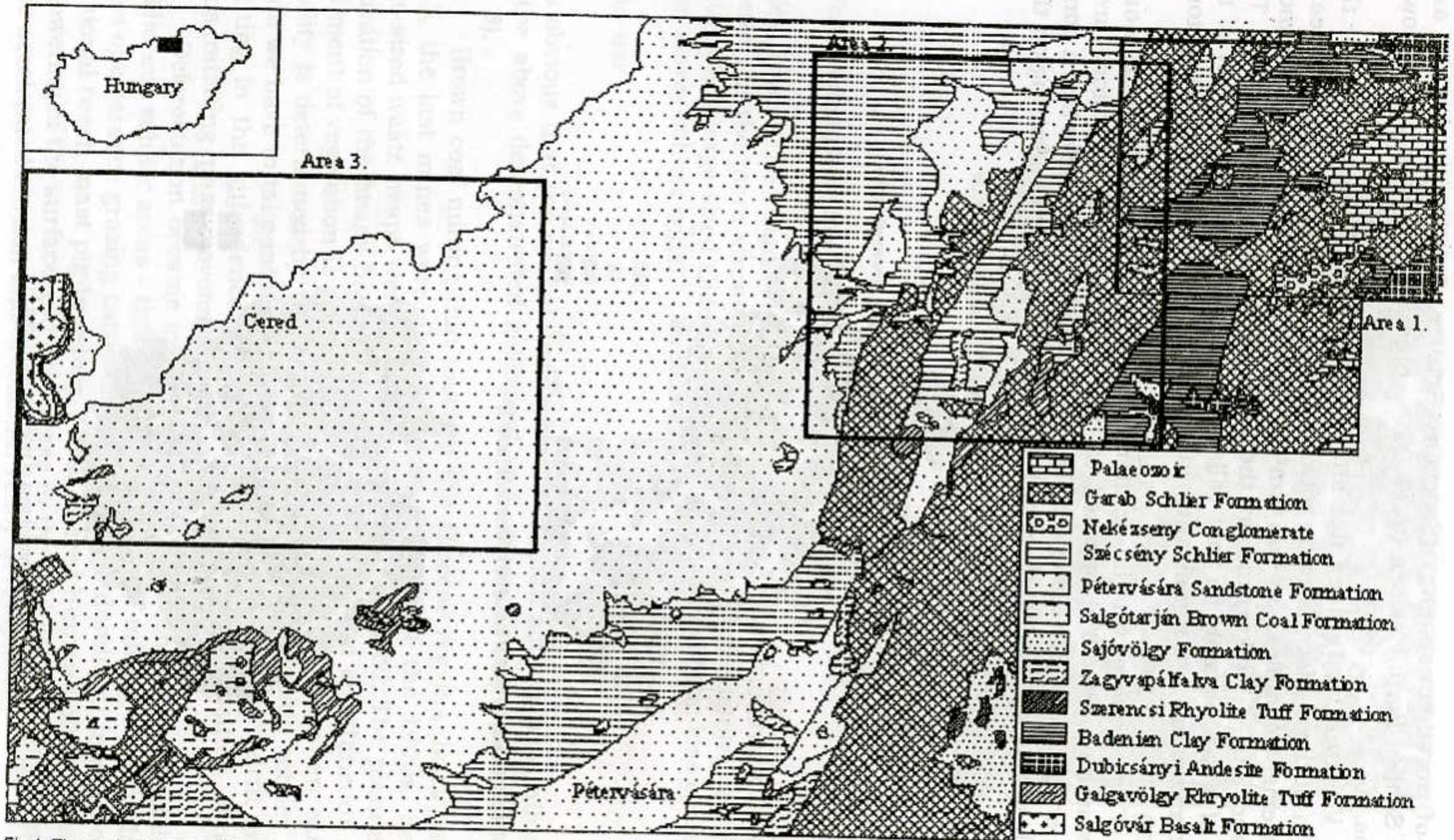


Fig 1: The geological map of the research area

rocks of worse consistency (Szécsény Schlier, Salgótarján Lignite and Garáb Schlier Form.) slopes of 17–25 % prevail, especially on the lower terrains.

Valley density does not show a consequent connection to the strength of the surface-forming rocks. It is 2,6–3,4 km/km^2 on the area of the basement complex, 3,4 km/km^2 in the case of the glauconitic sandstone and 3,07–4,89 km/km^2 in the regions covered by the schlier. The cause of it can possibly be that valley densities – beside the quality of the rock formations – are significantly influenced by the structure, the tectonic maturity of the region.

Furthermore, on the schlier areas the proportion of derasional valleys is high (30–40%) opposed to the Palaeozoic and sandstone areas where erosional valleys dominate. The consistency of the rocks has a considerable effect on the development o f mass movements appearing on the

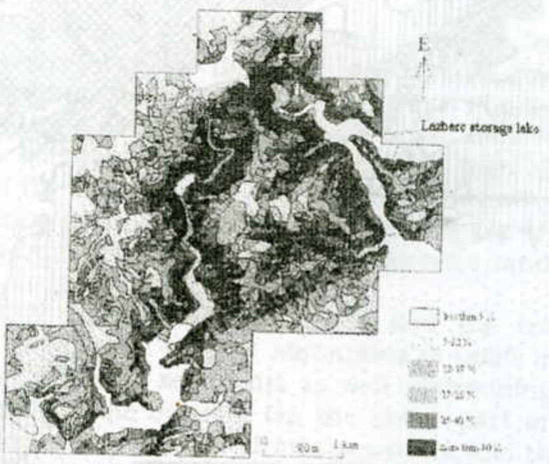


Fig 2/a: The slope category map of the Uppony Mountains (area 1)

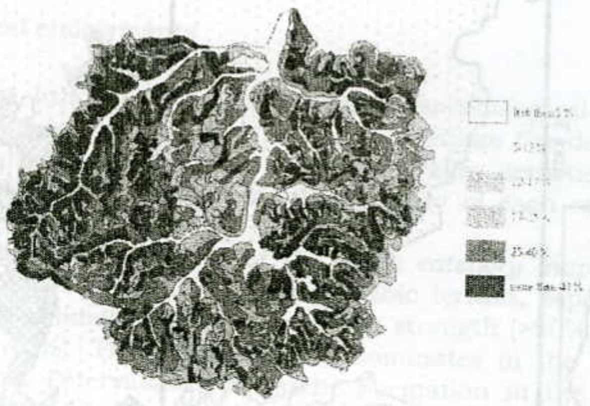


Fig 2/b: The slope category map of the catchment area of Hódos stream (area 2)

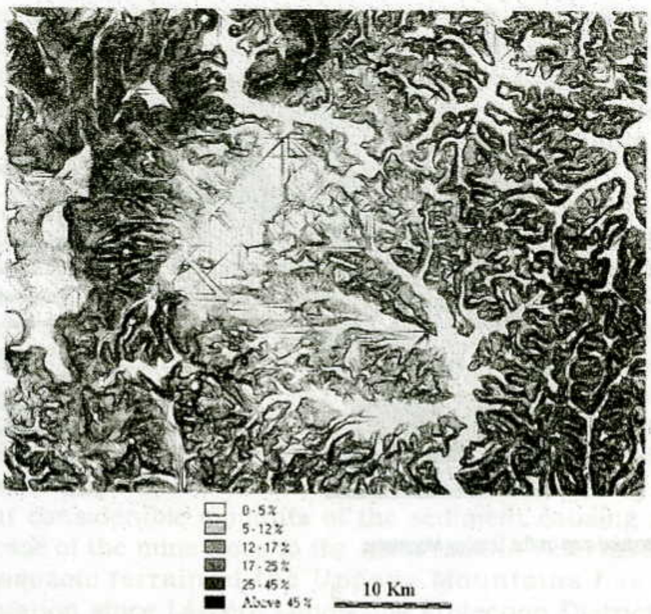


Fig 2/c: The slope category map of the Cered basin (area 3)

valley slopes. The Palaeo-Mesozoic terrains can be characterised by debris creeps. On the more strongly cemented, glauconitic sandstone soil creeps occur, while large-sized slides release along the faults of the less cemented, often clayey schlier beds.

Land-use

It is obvious that the spatial distribution of human activity was influenced by the above demonstrated geological and geomorphological endowments (fig. 3).

Brown coal mining that touched the *Miocene* regions dates back to 1845, the last mines were abandoned at the end of the 1990s. Several large-sized waste heaps were deposited during this period. The planned re-cultivation of the heaps has not been done yet and the spontaneous esta-blishment of vegetation is advanced on them. In the regions where surface stability is determined by the less cemented, clayey-aleuritic schlier sedi-ments we have to take into account the problems coming from drift driving resulting in the subsidence of the surface and the deposition of waste heaps initiating mass movements.

Deforestation became intensified in the 19th century – especially on the Miocene schlier areas - thanked to the growth of mining activity. In the places of clearance grazing cattle-breeding became dominant instead of the traditional beech-mast pig-breeding. These altered human activities caused the lowering of the surface and a decrease in the relative relief values owing to the accelerated erosion and derosional valley development.

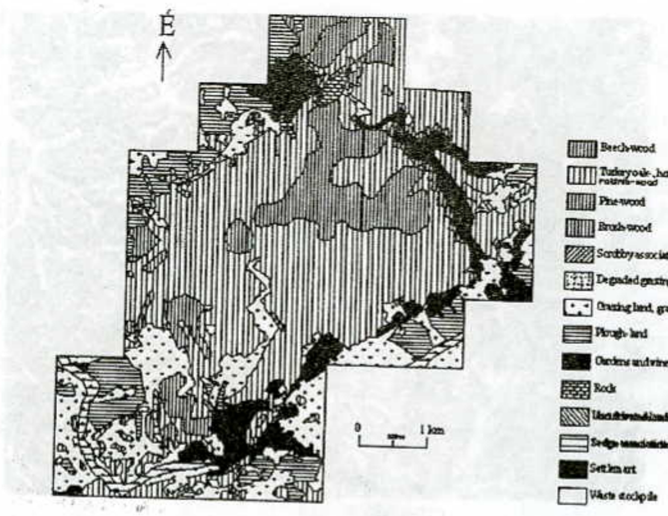


Fig 3/a: *The landuse map os the Uppony Mountains*

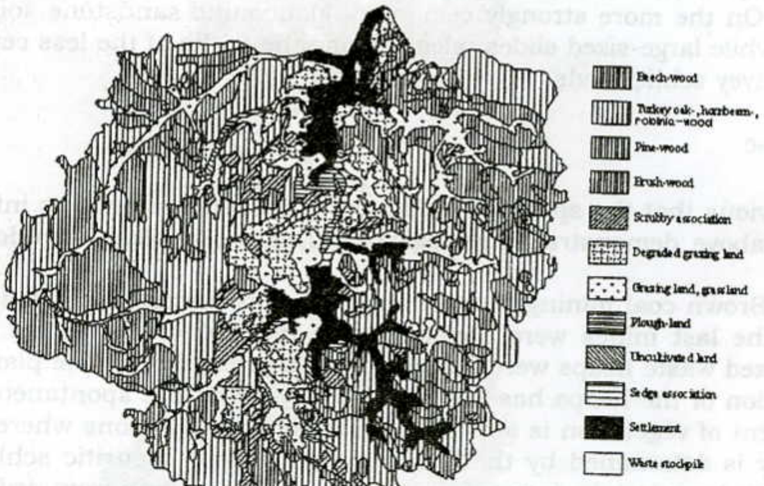


Fig 3/b: *The landuse map of the catchment area of Hódos stream*

The subsidiary agriculture of the land has been in a crisis since the change of regime (1990). Abandoned pastures started to become overgrown in weeds and degraded associations advanced. Reforestation also started (juniper, blackthorn). Grazing was forced back to the moist valley floors, some parts of the lower pediment (270–330 m above sea level) and near the meadow-lands, while plough-lands to the valley floors.

On the *Oligocene* terrain, which was not touched by mining activity, deforestation happened only on the higher pediment (380–440 m above sea level). The extension of secondary lines of cultivation was prevented by the morphological endowments which were less suitable for pastures and arable lands there (high relative relief values, erosional dissection). Continuous forests could remain in the region of the Tarnavidék Landscape Protection District.

By now the mainly opencast bentonite mining of the western region has been abandoned but significant hurts remained in the landscape. The unstable, former mining walls of several 10 meters are still falling and rain storms wash out considerable amounts of the sediment causing an acute problem in the case of the mine close to the main road in Pétervására.

The *Palaeozoic* terrain of the Uppony Mountains has been in a favourable situation since Lázbérc Landscape Protection District was established to protect the waters reaching the Lázbérc storage lake. The steep valley slopes are covered by forests there that means more than a half of the protected area. On the one hand, certain forest types (e.g. beech and scrub forests) refer to the geological, pedological and geomorphological situations of the Uppony Mountains but on the other, unfamiliar, introduced associations occur in some places (e.g. pine and robinia). Forests and grass lands are the most suitable ways of land-use to protect the waters of the area. Furthermore, the plough lands have to be cropped with plants that help in protecting against erosion (*Papilionaceae*).

We can conclude that the geological endowments of an area determine its geomorphological characteristics and the way of land-use to a high degree and human activity causes significant changes in the landscape as well. Fortunately, these often degrading effects are not so considerable in the protected areas since human activities are restricted there.

REFERENCES

Budinszky-Szentpétery I., Kozák M., Less Gy., Müller P., Pelikán P., Pentelényi L., Peregi Zs., Prakfalvi P., Püspöki Z., Radócz Gy., Tóth-Makk Á., Földessy J., Zelenka T., 1999: Geological map of the North Hungarian Mountains (without quaternary formations) scale 1: 100 000 - in the documentation of the Hungarian Geological Institute.

Kovács S. in Fülöp J., 1994: Geology of Hungary, Palaeozoic II. – Publishing House of the Hungarian Academy of Sciences, Budapest, p. 445.

Szalay I., Dudás K., Hegedűs E., Schönviszky L., Taba S.,1976: Geophysical structure investigation around the Darnó fault line - Annual Report of the Eötvös Lóránd Geophysical Institute of Hungary, for 1975, pp. 26- 30.

Anthropogenic aspects of landscape transformations	2	University of Silesia Faculty of Earth Sciences Sosnowiec 2002	84–87

[1]Tadeusz SZCZYPEK, [2]Valerian A. SNYTKO

[1]*University of Silesia, Faculty of Earth Sciences, Sosnowiec, Poland,*
[2]*Institute of Geography, Siberian Branch of Russian Academy of Sciences, Irkutsk, Russia*

MORPHOLOGICAL ANALOGUES OF DESERTS IN AREAS TRANSFORMED BY HUMAN IMPACT

Relief of real, climatic deserts is formed under specific conditions of large twenty-four hour's, thermal contrasts, at predominating high temperatures during day and notorious lack of humidity. The complex of proper morhogenetic processes function then with former intensive mechanical weathering.

During past decades two basic groups of opinions on the main role of proper relief-forming factors in desert areas have been formed: 1) flowing water is of essential importance, 2) wind activity is of essential importance (Klimaszewski, 1978). According to present points of view, taking into account moderately all desert and semi-desert conditions, the main relief-forming factor in desert areas in general seems to be the permanently (in the past) or periodically (today) flowing water, whereas the aeolian factor plays in principle the main role only within sandy deserts.

Proper lithological substratum decides of appearance of different morphological desert types.

The intentional and unintentional anthropogenic activity as well as stimulated by them natural geomorphological processes, called by Rozanov (1995) geotekhnomorphological, in some cases can cause the appearance of forms or even whole landscapes, which outwardly look like exotic areas in respect of climate and genesis – in relation to e.g. Central Europe. That is the thing that the occurring here natural geomorphological processes (geotekhnomorphological) have created here forms, which type, development mechanism, neighbourhood and distribution in space outwardly look like the relief occurring in climatologically desert areas. Therefore, the aim of this elaboration is the attempt to present morphological, only outward analogues of above-mentioned forms and landscapes with real desert ones (what can be of certain educational importance) and to take account into the stability of such landscapes. So we taking into account exclusively the landscape which is outwardly – morphologically similar to real desert ones, because the climatic conditions (especially precipitation) occurring here absolutely can not be accepted.

Morphological analogues of deserts can be created owing to human impact in different periods. We present two examples of them from the area of eastern part of Silesian Upland in southern Poland.

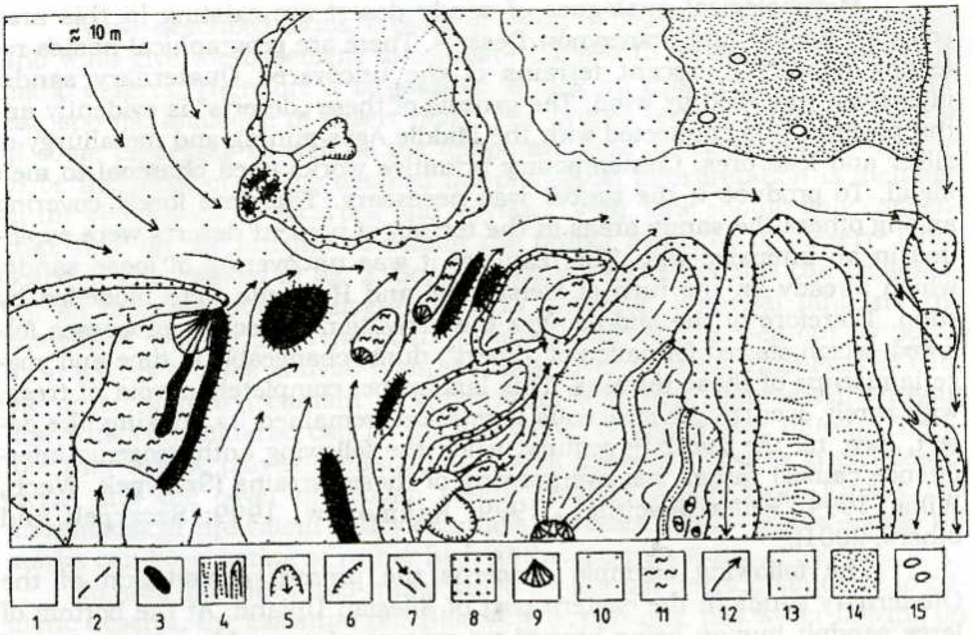


Fig. 1. Geomorphological sketch-map of area investigated:
1 – slopes, 2 – main crest lines, 3 – substratum outcrops, 4 – rain rills, 5 – landslides, 6 – erosion undercuts, 7 – big rain rills on erosion scarps, 8 – alluvial cones, 9 – deltas, 10 – alluvial plains, 11 – depressions without outflow, 12 – main direction of water flow, 13 – deflation surface with stone pavement, 14 – aeolian cover sands, 15 – sand shadows of „nebkha" type

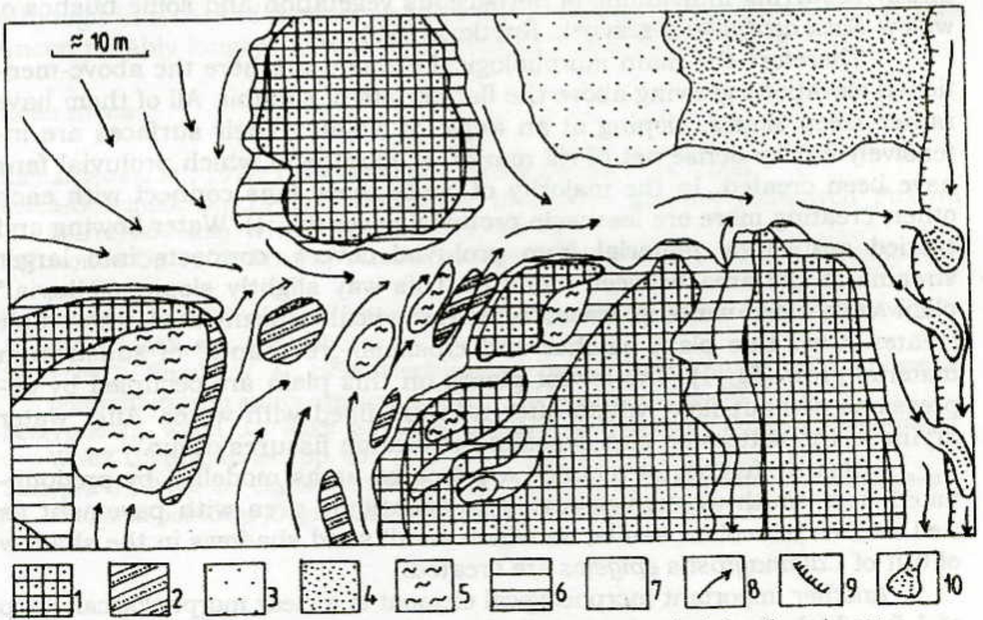


Fig. 2. Model of morphological types of „deserts" on investigated, anthropogenically transformed areas:
1 – hamada, 2 – debris desert, 3 – serir, 4 – erg, 5 – clay desert, 6 – proluvial plain, 7 – „alluvial" plain, 8 – dry river channels of braided type, 9 – wadi with torrential alluvial (proluvial) fans

Morphological analogues of sandy desert are existing in this area so-called Błędów and Starczynów Deserts. There are geographical names referring to wide in recent terrains of the uncovered Quaternary sands, intensively modelled by wind. The genesis of these „deserts" is evidently anthropogenic: it is connected with the Middle Ages mining and metallurgy of silver and lead ores. Contemporary primitive works used charcoal to melt metal. To produce it the timber was necessary. Therefore forest covering among others the sandy areas in the terrain of present deserts were exploited in an intensive way. The result of it was uncovering of loose sands, which already on the turn of Pleistocene and Holocene were modelled by wind. Therefore in the Middle Ages the activation of aeolian processes followed, which started formation of „desert", dune, changeable in time and space landscape of these terrains. This landscape, completely devoid of trees, with rarely occurring herbaceous vegetation, remained its, looking like desert, face, till the mid-20th century, when the following anthropogenic interference caused rather fast overgrowing of these terrains (Szczypek, Wach, Wika, 1994; Pełka-Gościniak, 1999; Rahmonow, 1999; Szczypek and others, 2001).

The following example concerns the present exploitation of the Quaternary sands in the eastern part of Silesian Upland. At the bottom of large sandpit human being heaped up masses of unusable – in respect of lithology (sand with admixture of silt and clays) – material. It was piled up in a form of more or less isolated mounds and differently orientated elevation rows of the height of 5–8 m. In the neighbourhood of these artificial elevations and on them there are almost any vegetation, except for sporadically occurring individuals of herbaceous vegetation and some bushes of willow *Salix acutifolia* (Szczypek, Snytko, 1998).

Therefore the main morphological element are here the above-mentioned elevations growing above the flat bottom of sandpit. All of them have rather steep slopes, sloping at an angle of 37–40°. Their surfaces are intensively cut by dense net of rill marks, at mouths of which proluvial fans have been created. In the majority of cases these fans connect with each other, creating more ore less wide proluvial cover (fig. 1). Water flowing and carried out sandy material from proluvial covers, connects into larger streams in the area between mounds. This way slightly sloping „alluvial" plain with clear winding traces after periodical concentrated water flow creates. Over this plain patches and erosional „remnants" of substratum material grow (fig. 1). The lowest places on this plain are occupied by depressions without flow, which after rain are filled with water. After water drying at the bottom on clay deposits desiccation fissures occur.

Slightly further of mounds are located areas modelled by predominated here south-western winds: it is deflational area with pavement as well as area of aeolian sands, on which small sand shadows in the shadow of tuft of *Calamagrostis epigeios* are created.

Another important morphological element is a clear morphological scarp of 1.5 m high. In many places it is cut by large and deep rain rills. At the mouth of them proluvial plain has been also created (fig. 1).

Above-described forms, created in result of flowing water activity (wash) and wind give the basement to compare them with forms occurring in climatic deserts. Therefore it is possible to look on this area as morphological, specific analogue of desert relief. The proper terrain relief, the course of some processes as well as the temporary lack of vegetation cover seem to be the proof of it. The detailed morphological interpretation is included in the elaboration of Szczypek and Snytko (1998). One should only concentrate here on the attempt to delimit the proper elements of „desert" landscape. It is presented in fig. 2. So, the mounds and elevations can be admitted as morphological analogue of rocky hamada. Proluvial fans are the equivalent of large proluvial plain (bajadas). Material carried out by periodical waters creates alluvial plain (bolson). Over its area fragments of rubble desert appear (remnant of substratum material). Depression without flow with clay material can be the equivalent of clay desert (takyr). Therefore they can be playas. Deflation area with pavement can be gravel desert (serir) and the cover of aeolian sands – sandy desert (erg). Finally the morphological equivalent of dry channels of desert rivers – wadis – large rill marks can be, creating at rather high anthropogenic scarp .

In area described and transformed by human impact, similarly to climatic deserts, the essential relief-forming importance has water flowing on slopes. The wind influence is appeared on outskirts, where areas are uncovered and exposed to its influence.

Both examples of morphological analogues of climatic deserts are anthropogenic creatures. Their stability should be low. In the second case it can be counted at the very most to some years (and it really exists), although in a case of Błędów and Starczynów Desert it appeared, that it was uncomparably longer – it was numbered by the hundred years.

References

Klimaszewski M., 1978: Geomorfologia. PWN Warszawa: pp. 1096.

Pełka-Gościniak J., 1999: Przestrzenna zmienność piasków eolicznych Pustyni Starczynowskiej. WNoZ UŚ Sosnowiec: pp. 75.

Rahmonow O., 1999: Procesy zarastania Pustyni Błędowskiej. WNoZ UŚ Sosnowiec: pp. 72

Rozanov L. L., 1995: Geomorfogenez i geotekhnomorphogenez: opyt sopostavlenia. Izv. AN RAS, ser. geografičeskaya, 6: 114–122.

Szczypek T., Snytko W. A., 1998: Morfologiczny model „rzeźby pustynnej" na obszarze przekształconym antropogenicznie. WNoZ UŚ Sosnowiec: pp. 48.

Szczypek T., Wach J., Wika S., 1994: Zmiany krajobrazów Pustyni Błędowskiej. WNoZ UŚ Sosnowiec: pp. 87.

Szczypek T., Wika S., Czylok A., Rahmonow O., Wach J., 2001: Pustynia Błędowska – fenomem polskiego krajobrazu. Wyd. Kubajak Krzeszowice: pp. 72.

Anthropogenic aspects of landscape transformations	2	University of Silesia Faculty of Earth Sciences Sosnowiec 2002	88–95

Csaba TÓTH, Gergely SZABÓ
University of Debrecen, Department of Physical Geography, Debrecen, Hungary

A SURVEY OF ANTHROPOGENIC MOUNDS (CUMANIAN MOUNDS) IN THE NAGYKUNSÁG, HORTOBÁGY AND THE HAJDÚSÁG

Introduction

The Carpathian-Basin and the Great Hungarian Plain, which is a homogenous region from the aspect of landscape geography is a keeper of many individual values. Among these values are the anthropogenic mounds of various kinds of functions, which are 3–4 m high and were built up of soil. They are called „kunhalom" in Hungarian, which means „Cumanian mounds" in English. This name seems to be inaccurate in the mirror of the archeological data. Most anthropogenic mounds were not erected by the Cumanians, who settled in the Carpathian-Basin in the 13th century, but by other people. On this base we should speak about Copper- and Bronze Age, Sarmatian, Germanic Scythian, etc. mounds. The conservation of the name „Cumanian mound" maybe fortunate, however, because on one hand it refers to the funeral habits of Cumanians and on the other hand it shows the anthropogenic origin of these mounds and mark the border clearly between them and other mounds (porongs, ridges and sand-hills) of natural origin (Kozma, 1910; Zoltai, 1938; Tóth, 1999).

The number of anthropogenic mounds in the Carpathian-Basin is approximately 1200 according to Béla Kozma (Kozma, 1910), according to later examinations there could be many more (around 40 000). According to the data of the survey, which is being carried out present days unfortunately only 1500–2000 pieces remained of them. Their number decreased dramatically in the 20th century. Farming on a large scale, the expansion of the settlements and the development of the transportation together contributed to their devastation (carry- or plough away, cripple). On the base of the numerous local initiatives the methods of their protection are now being worked out in order to save them and the 2nd paragraph of § 23 of the act LIII of 1996 „On the Protection of the Nature" claim them to be protected on national level. Their protection is justified, since these mounds have complex values of geomorphology, archeology, culture-history, ethnography, literature-history, landscape, botany and zoology.

In connection with the National Project for Cadastral Survey of Anthropogenic Mounds, which has been under way since 1999 our aim was to describe the status of the anthropogenic mounds in three regions (Nagykunság, Hortobágy, Hajdúság) which lies on the left bank of the River Tisza in the Great Hungarian Plain. It was a very urgent task from the aspect of nature conservation. This area is within the region bordered by Püspökladány-Balmazújváros-Tiszafüred-Fegyvernek, which is one of the Great Hungarian Plain's richest region in prehistoric anthropogenic mounds (Kozma, 1910). The three regions belong to two different types of landscapes. In the Nagykunság and Hajdúság on the chernozem soil plough lands can be found almost everywhere. The Hortobágy, which is famous for its sodic soil is utilized mostly as pasture land. The intact grasslands of the Hortobágy have been under protection as a part of the National Park since 1973. It was an important aspect in the examinations to compare the status of the mounds outside and inside the protected area of the Hortobágy National Park. The question is that at what degree these anthropogenic forms are altered and damaged due to the economic activities of the society.

Functional types of the mounds

Examining the mounds using methods of geomorphology, stratigraphy and archeology we can get answers for the questions when and why were these mounds built. In the followings we mention eight functions of the mounds. The importance of these functions have changed constantly during historic times (Buka, 1994; Csányi, 1999; Kozma, 1910; Tóth, A. 1996, 1999):

- a.) Residental-mounds (tell settlements): Waste mounds with an oval or irregular shaped base. Their relative height reaches 6–8 m. These mounds can usually be found on the levees of the rivers, which provide favorable conditions for human settlements (Sümeghy, Kozák, Tóth, 1998). The tells have reached their present size by the deposition of the material of residential levels of human cultures following each other in time. This form of settlement existed in the late Neolithic age (4000–3500 B.C.) and in the middle Bronze Age (2600–1500 B.C.). It shows an impact of South-Eastern Europe and of Asia Minor (tell is an Arabic word, it means hill).
- b.) Funeral mounds (kurgans): These mounds have various heights (3–10 m), a round base and a cone-like shape. They usually mark the place at least one tomb. They were mostly built in the Copper Age (3500–3000 B.C.) but various peoples of the Age of the Great Migrations erected such mounds as well like Scythians, Sarmatians, various Eastern-European and Asian nomadic peoples of the Steppe (Cumanians) (M. Nepper, 1976). Many kurgans can be found in the Great Hungarian Plain on the left bank of the river Tisza. Outside Hungary the Russian and Ukrainian steppe is rich in funeral mounds (Pálóczi, 1994; Selmeczi, 1992).
- c.) Watch-mounds (guard-mounds): There are many of these low (max. 2–3 m tall) mounds especially in the Great Hungarian Plain. The base of those mounds is not very large as well. They usually not contain archeological finds. They could play an important role

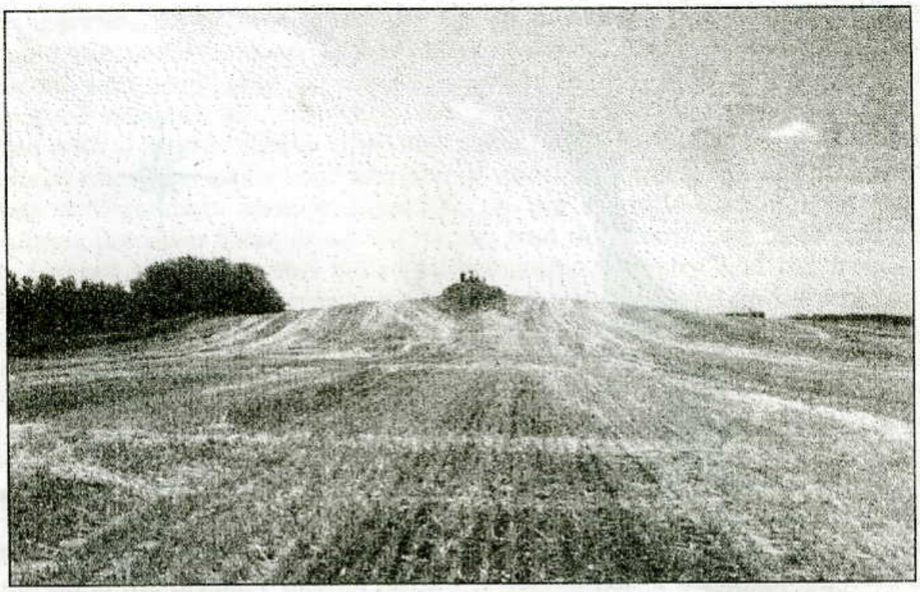
in forwarding of messages between the great tell settlements. Watchmen who were standing on them could pass the messages by light or sound signals.

Mounds originally had been built for these three purposes, so we should say that these are their *primary functions*. Later they have usually lost their primary function and got a *secondary function*. For this reason there are –or were– border mounds, execution mounds, cultic mounds, and mounds could mark the places of battles as monuments also (Budayné, 1998). In the 20th century mounds have lost all their before mentioned functions and got quite new, different ones. A significant part of them is used as plough land. Beside this almost all higher mounds can be used as a base for geodesic points (triangulation points, height marks; phot. 1), for example the „Bürök-halom" at Nagyiván (Tóth, 1999).

Methods

The survey of the mounds was carried out using a 24 point cadastral form compiled by us. We recorded in the form the name, the possible synonymous name, the GPS coordinates, the name of the settlement and the area in which the mound can be found, the length of the base of the mound, its absolute and relative height. Beside these facts the intactness (or being disrupted) of the body of the mound, objects can be found on the mound, plant types and the possible land use types were recorded as well. The cadastral form in the followings asks the land use types of the 500 meters neighborhood of the mound, the objects can be found there and their directions by the points of the compass. Finally the form details the literature- and culture-historic, botanical and zoological information in connection with the mound (Kozák, Tóth, 1998). To find the mounds and to determine their absolute height we used topographic maps of 1:10 000 and 1:25 000 scale. For the geomorphologic examinations we used a laser theodolite. It was used for the determination of the relative height, the steepness of the slopes, the circumference of the base circle and the volume of the mounds.

Certain characteristics of the mounds were represented in a point-map. For this reason the GPS coordinates of the mounds given in a WGS-84 reference system, which based on the orbits of satellites had to transform into a projection system, which is suitable for the comparison with the existing digital maps. The database was converted to a suitable format using Microsoft Excel then the coordinates were transformed to the Unified National Projection System. The next step was to import the data and the present it in ArcView GIS software. Via the combination of the points processed this way and the already existing maps we got the thematic maps presented. In the frame of this paper we present one, which shows the intactness of the bodies of the mounds.



Phot. 1. The top of the intact but ploughed "Tök-halom" inside the area of the Hortobágy National Park escaped from being ploughed away thanks to the height mark.

The most important results of the survey of the anthropogenic mounds

In the study area we have found 503 existing anthropogenic mounds and 26 places of former mounds. The point-map of the 503 mounds shows that they have a linear pattern (fig 1). Most of them can be found next to living water flows (Hortobágy, Sáros-ér, Árkus, Kösely Tócó), along the abandoned riverbeds and on the levees, which are free of floods. These areas were safe places for the people on one hand and provided living (fresh water sources, fishing and transportation facilities) on the other hand. The funeral mounds can usually be found along the river banks as well, which symbolized the journey of the dead's soul to the next world (to the other side of the river). The mounds in present days mostly lie far from waters on dried up agricultural lands, only a quarter of them can be found next to a water body (river, backwater, swamp, channel, fish pond, etc.), what is a consequence of the regulation of the riverways, which was started in the 19th century.

These several hundred or thousand years old, valuable anthropogenic features are objects of various kinds of human disturbing, for this reason a primary aspect was the *determination of the intactness of the body of the mounds* (fig. 1). It can be seen from the data that in the three region fortunately the intact mounds (56-68%) are dominant. Those mounds were considered to be intact where the shape of the body was symmetric and there are no cuts, pits or signs of material being carried away. If the degree of erosion due to the ploughing is not significant the ploughed mounds can

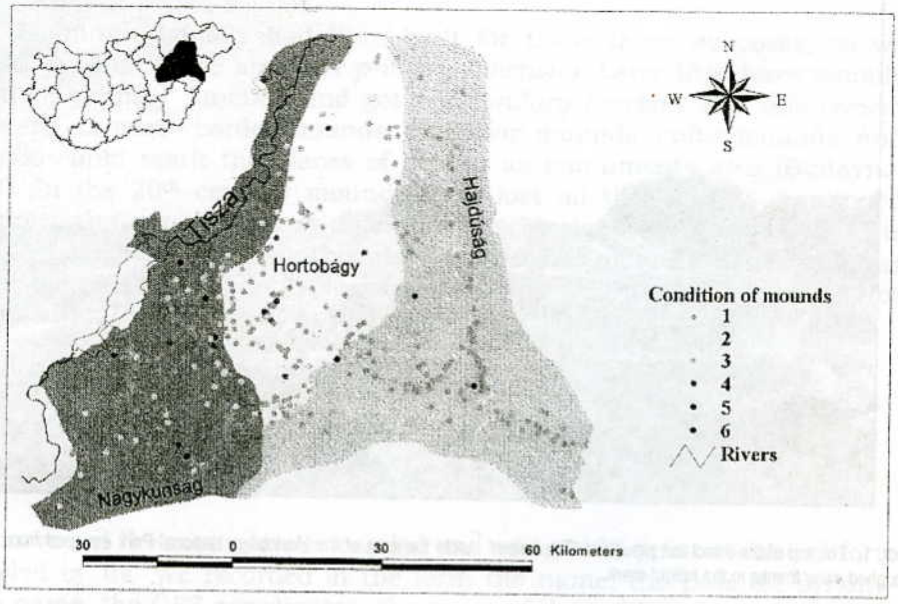


Fig. 1. The geographical positions of mounds of the studied area and clustering them by the intactness of the mound – bodies: 1 - intact mounds, 2 - distrupted mounds, 3 - damaged mounds, 4 - carried mounds, 5 - heightened mounds, 6 - the place of the former mounds

be judged to be intact ones too. The disrupted, damaged mounds and mounds partly or entirely carried away unfortunately occur in a large number in the study area. Analysis shows that the least intact and the most disrupted and carried away mounds can be found in the Hortobágy region, which has very unfavorable soil conditions. The number of damaged mounds and places of former mounds is significant in that region also. It is in connection with that the mounds contain valuable humus-rich soil (6–22 000 m^3/mound) (Tóth, 1999), what was a real treasure for the people of this area, more than that for the people of the Nagykunság or Hajdúság, where soils are much richer in humus. Studying the literature we found four mounds, which were not carried away but heightened. The causes were various: building of a trellis, a water tank, or an arbitrary ecclesiastic order (Tóth, 1988), which can be considered to be the most fortunate interventions from the aspect of the survival of the mounds.

In the followings another important aspect of the examinations was the *description of the surface of the mounds* and the determination of the *land use type* (tab. 1). It can be seen from the table that the ratio of the entirely ploughed mounds is outstanding (46%). In the second place there are the mounds with a disturbed grass cover, which represent 37% of the mounds. This plant cover developed due to the deterioration and weeding of the original loess-grass vegetation, or the abandonment of agricultural use. Farming on a large scale (the use of pesticides and fertilizers) accelerated the process of weeding. 44% of the mounds of the Hortobágy are covered with such type of vegetation, while in the other two regions the ploughed mounds are prevailing. 6.5% of the examined mounds are covered with a kind of forest. From the aspect of nature conservation forests (consist of neither native nor new arrival species of trees) are not preferable types of vegetation because originally on the mounds and in their environment the open loess-grass vegetation was dominant and trees had never covered them. For this reason afforestation, forestry and the frequent spontaneous growth of trees (acacia) should be considered as harmful processes. The original vegetation type in most part of the Great Hungarian Plain was the loess-grass (*Salvio-Festucetum rupicolae, Agropyro Kochietum prostrate*), which is very rich in species (Soó, 1931). Due to the expansion of agricultural lands this vegetation type can only be found in patches on the tops of the higher mounds, in boundaries between plough lands and in nature conservation areas. In the case of 18% of the examined mounds the original vegetation type can be found. In the case of 5.5% of the mounds (28 mounds) it is the dominant type of vegetation! The protection of these mounds is the primary task of nature conservation. 6 mounds are used as gardens. Only 8 (1.5%) mounds held their primary functions and are still being used as residential or funeral mounds.

In the protected area of the Hortobágy National Park there are 83 mounds. In the area protected for 30 years there are less ploughed (16.8%) and afforested (2.4%) mounds. The dominant is the disturbed grass cover (65%) and fortunately the ratio of mounds covered with the original loess-grass vegetation is higher (10%) than the average. These positive facts are only partly the results of the nature conservation efforts; on the other hand they are the consequences of the fact that the sodic soils of the Hortobágy region are not suitable for agricultural use.

Archeological excavations can determine the age of the mounds only. 6.3% (32) of the mounds in our study area have been examined by archeologists so far. On the base of the archeological finds found at the surface in the case of 23% (120) of the mounds we can state that those had been residential mounds (tell settlements). The existence of the archeological finds only in the case of the ploughed mound is obvious, the mounds covered with grass are not informative from this point of view.

We classified the mounds on the base of *their landscape values* too. We considered a mound to be of high landscape value when the shape of the mound is visible from a great distance (min. 1 km) markedly from each direction. Only 18% of the mounds belong to this group unfortunately. From the survey of the environment of the mounds it turned out that in 78% of the cases there are disturbing objects (channels, dikes, rows of trees, planted forests, transmission lines, roads, mobile-phone towers, garbage dumps, factories, sheep-folds, etc.). Most mounds (30%) fell into the category of mounds without landscape value since various objects like forests, rows of trees, weeding areas (abandoned plough lands), houses of the settlements, industrial areas or transmission lines hide them. In many cases the mound itself became so low (carrying- and ploughing away) that it is hardly recognizable and this way it has no landscape value any more.

Table 1. Dominate types of vegetation on the surface of the mounds

	Nagykunság		Hajdúság		Hortobágy		Hortobágy N.P.	
	Pieces	%	Pieces	%	Pieces	%	Pieces	%
Original grassland	4	2.7	9	4.7	15	7.9	9	10.8
Disturbed grassland	39	26.5	62	32	85	44.6	54	65.1
Tree shrub	0	0	3	1.5	1	0.5	1	1.4
Forest	9	6.1	17	8.9	9	5.9	2	2.4
Plough land	77	61.4	91	50.4	67	38.2	14	17.8
Garden	4	2.7	3	1.5	0	0	0	0
Cultural type	1	0.68	2	1.5	5	2.9	2	2.4
together	134	100	187	100	182	100	83	100

Conclusions

The map presentation of the examined half thousand anthropogenic mounds shows very clear that their appearance is not a random feature it follows certain rules. Most mounds can be found on flood free surfaces of the levees of the rivers and along the meanders of the rivers like a chain. Only a few mounds are placed far from the present or the former beds of the rivers. This proves that the establishment of the settlements near the rivers has been advantageous for the human society.

Summarizing the results of the survey we can state that the number of intact mounds covered with loess-grass vegetation is rather small (28). It proves that only a few mounds could survive the harmful effects of human economic activities. In each region most of the mounds are intact (65%), but there are many damaged, disrupted and entirely carried away mounds. In the Nagykunság and Hajdúság, where the soil is of good quality more than 50% of the mounds are used as plough lands. In the Hortobágy the ratio of ploughed and damaged mounds is lower due to the bad quality of soil and the protection of the National Park. A new problem is the 20th century loss of landscape value of the mounds, which can partly be explained by the appearance of the numerous new disturbing landscape objects and partly by the agricultural erosion and carrying away of the mounds. It is clear on the base of the survey that nature protection is not as advantageous for the mounds as it had been supposed. The reason for this is that by the time of the establishment of the Hortobágy National Park the mounds had been under agricultural use. The anthropogenic mounds became protected at a national level only in 1996 so the bad state of the majority of the mounds is partly a consequence of this situation.

References

Budayné K. I., 1998: Múltunk őrzői. A Nagy Sándor-halom és a Basa-halom ismertetője. Debrecen

Buka L., 1994: Az örökség megőrzése. In: A Tócó-völgy környezeti állapota (szerk.: Orosz G. Tamás)

Csányi M., 1999: A kunhalmok régészeti értékei (In: Kunhalmok, Szerk: Tóth A.) Kisújszállás, p 41.

Kozma B., 1910: A kunhalmok elhelyezkedése az Alföldön. Földrajzi Közlemények XXXVIII. pp. 437-443

M. Nepper I., 1976: Okkersíros temetkezés Püspökladány - Kincsesdombon. DMÉ. (Szerk. Dankó Imre, Debrecen, 1977) 49-65.

Novák T., 1998: A Hortobágy déli részén és a szomszédos területeken fellelhető medrek, medermaradványok és medernyomok, illetve a területen álló halmok térképe. Debrecen.

Pálóczi H. A., 1994: Hagyományok, kapcsolatok és hatások a kunok régészeti kultúrájában. Karcag, pp. 53-63.

Selmeczi L. (1992): Régészeti-néprajzi tanulmányok a jászokról és a kunokról. Folklór és etnográfia 64. Debrecen, pp. 25-31.

Soó R. (1931): A magyar puszta fejlődéstörténetének problémája. Földrajzi Közlemények LIX. 1-3. pp. 1-14.

Sümegi P., Kozák J., Tóth Cs., 1998: Tiszapolgár Csőszhalom régészeti lelőhely geoarcheológiai vizsgálatai. I. Részjelentés a Déry Múzeum számára, Debrecen, pp. 5-6.

Tóth A., 1996: A kunhalmokról mai szemmel. Természet Búvár 51. évf. 1. pp. 32-34.

Tóth A., 1998: A kunhalmok felmérése, geomorfológiai, geológiai és paleoökológiai vizsgálata. Zárójelentés (nyilvántartási szám: 278/F KTM)

Tóth A., 1988, 1989, 1990: Szolnok-megye kunhalmai I-II-III. Különlenyomat a Szolnok Megyei Levéltár Évkönyve, Szolnok.

Tóth A., 1999: Kunhalmok. Alföldkutatásért Alapítvány Kiadványa, Kisújszállás pp.13-45.

Tóth Cs., Kozák J., 1998: Országos kunhalom-felmérő adatlap. Alföldkutatásért Alapítvány, Kisújszállás.

Tóth Cs., 1999: A kunhalmok állapotfelmérése a Büte-halom példáján. A táj változásai a Kárpát-medencében c. konferencia kiadványa, Gödöllő, p 39.

Tóth Cs., 1999: Kunhalmok morfometriai vizsgálata a HNP déli pusztáin. A táj és az ember – geográfus szemmel. Geográfus Doktoranduszok IV. Országos Konferenciája, Szeged

Zoltai L., 1938: Debreceni halmok, hegyek. pp. 5-8.

Zoltai L., 1926: Eltűnt falvak és elfelejtett régi helynevek Hajdú vármegye mai területén. Debr. Képes Kal. Debrecen, 113.