THE POLLUTION HISTORY OF THE MINING REGION OF NW-ROMANIA, A MULTIDISCIPLINARY PROJECT.

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Abstract

During the last three millennia the mining regions of northwestern Romania (Maramureş, Apuseni) exposed the processes of cultural landscape from the first openings to the intensive mining exploitation and pollution during the last centuries. In a joint research project colleagues of the universities of Würzburg and Cluj (Romania) and the Federal Institute of Hydrology (BFG) of Koblenz evaluate the natural (river sediments, peat bogs) and historical archives in order to establish a history of cultural landscape and pollution. Geomedical aspects also take a great part of these investigations. The first results evidenced the good resolution and information content of the archives and a regional differentiated mosaic of heavy metal contanimation. This also reveals long distance effects of heavy metal pollution and the actual risks for the drinking water supply of the regional population, as well as for the whole Tisa river system. The present health situation of the Maramureş population underlines these risks by the elevated incidences of professional diseases.

Keywords: Carpathians, Romania, Hungary, Tisa River system, mining, pollution history, geomedicine, risk assessment.

Introduction

It was in January 2000 as the mining region of northwestern Romania got an enormous publicity by the nefarious cyanide spill of Baia Mare (Moran 2001). About 100000 m^2 of highly concentrated cyanide slurry was evacuated via the tributaries Săsar and Lăpuş into the rivers Someş and Tisa. This resulted into cyanide concentrations exceeding internationally accepted limits more than a thousand fold (VITUKI 2000).

About a month later an unsufficiently constructed dam of a tailing pond near Baia Borşa collapsed (Tittizer 2000). Consequently, the river Tisa was attacked twice. Once by the cyanide poisoning, which was diluted to less harmful values, only in the Danube river and parallely by the longtime pollution with heavy metals which could be stored in the rivers' sediments and finally may acummulate in the food chains. Especially the Upper Tisa was hit, since it was known before as a relatively less polluted river fulfilling the criteria of the Ramsar convention (Hamar and Sárkány-Kiss 1999).

In all there were three severe damages to the Tisa-Danube river systems in a short time, since in autumn 1999 the Pancevo bombings already caused severe poisonings downstreams, even if they were declared by NATO authorities as collateral damages.

Both accidents in 2000 could mobilize a great public. EU and UNDP deployed task forces to investigate and document the damages and to discuss and propose future prevention measurements (UNEP/OCHA 2000, Garvey 2000). EU represents as well as those from the national ministeries of environment announced a generous and longlasting aid and environment technique equipment of the regions concerned. At least these activities had the same fate as the cyanide flood. They got diluted, dissolved rapidly and afterwards they were hardy to detect anymore.

To get an idea about what planning measurements will be necessary in those regions in order to avoid further pollution and to get information on the ways of regeneration processes of the ecosystems it will be necessary to elucidate the historic evolution and the dimension of human impact.

Within a cooperation between the universities of Würzburg (Germany) and Cluj (Romania) and the Federal Institute of Hydrology (Koblenz, Germany) there is a common reserach project on the aspects of the longtime pollution of these mining regions and on the pollution development during the last millenia.

The area of investigation incorporates the most distal parts of the Pannonian (Someş-Lăpuş-) Plain and the mountain areas of Ţibles, Gutin, Maramureş (fig. 5) as well as the Apuseni-Mountains. The research is focussed on the present situation as well as it evaluates the natural (river sediments, peat bogs) and historical archives.

The following questions are the base of these investigation :

- which are the steps of the evolution of cultural landscape and of the intense exploitation of ressources?
- which are the consequences for the Tisa river system?
- which are the regeneration processes during periods of less intense exploitation?
- which are the consequences of the pollution on the health situation of the population?
- are there correlations between the mining history and the pollution levels in the sediments?
- which are the conclusions to be drawn from history for development possibilities and planning measurements to cope the negativ developments?

This article shall give the first results concerning the present situation and the background pollution.

The region and ist present situation

The Maramureş and the Baia Mare region itself take part of the historical mining areas of Europe. For long periods mining activities were concentrated on gold and silver and it had its first activities in the time of the Hungarian Kingdom whereas the Apuseni Mts. were exploited already by the Romans and Dacians. During medieval time the richness of the Hungarian Kingdom was founded on these mining activities (Fischer and Gündisch 1999, Maghiar and Olteanu 1970, Schröker 1994, Szellemy 1984, Wollmann 1999 a-d). Today the same orebearing lodes in the volcanic and cristalline massives of the Inner Carpathians are still exploited. Uplands and High Mountains of these regions are also characterized by a diversified cultural landscape based on a long tradition of agriculture and forestry (Geografia Romanei 1987, 1992, Moisei et al 2000, Posea et al. 1980).

This resulted into a twofold landscape. For the one it is characterized by traditional agriculture and settlement (Maramureş) and for the other the numerous active or abandoned mines and smelters are typical for the Baia Mare region itself together with their tailing ponds and an accelerated pollution. Moreover, the security state of the several decantation basins is very low, so even the scandalously conceived and constructed "Aurul" tailing pond was considered as an improvement of security (UNEP/OCHA 2000). The lead smelter of Baia Mare (the present "Romplumb") became important during the last centuries, and the metallurgical complex „Phoenix" processes ores from the whole region including the Apuseni Mts. This results into a high charge of lead, copper and zink as dust or solutes coming from exploitation and from smelting processes being reinforced by the lamentable situation of the metallurgical plants during the last decennia. Even it would be naive to wait a less polluted environment, it is necessary to decide which extremes are to reduce or to buffer in order to arrive to minimum health and environment standards. It also points to the necessity of Hungary and Romania, to aline their legislation (and its realisation) to those of the European Community. In all, the situation underlines the immanent thread for the river system of Tisa and Danube.

The local context- the town of Baia Mare

Urban planning of Baia Mare during the time of socialism was characterized by a forced industrialization and urbanisation, which was generally characteristic for the romanian society. That aggravated some negative evolution for the environment, such as the intense interfingering of industrial zones and residential areas, expecially the close neighbourhood of ore treatment plants and food processing factories. This is clearly shown in the town map of Baia Mare (fig. 1). Northeast of the town a steep valley harbours closely together the lead smelter „Romplumb“ and the residential årea "Ferneziu". The nearest houses already join the entrance of the factory. This neighbourhood naturally affected enormously the people´s health situation.

The mining and ore processing industry of the town is concentrated in the eastern part. The actual factory „Allied Deals Phoenix“ was founded in 1907 as a chemical and sulfuric acid plant and in 1925 it was transformed into a metallurgical complex. During the socialist period it was enlarged and at present it represents 40 % of the Romanian non-iron metal production. Today 3400 persons are working at the "Phoenix" complex, which also is the larges employer in Baia Mare. The intense growing of that factory and the extension of the town to the East caused the present interfingering of residential quarters with metallurgical, food processing and ceramic plants, a fact which was inforced during the socialist period. The situation is even aggravated by the presence of several retailing ponds in the town itself: „Tautii de Sus“ in the East, „Sasar“ and especially „Meda“ in the West. The already mentioned „Aurul“ plant was conceived to treat the retailing pond „Meda“ in the middle of residential areas. This pond had a load of about15 mio to material with an estimated content of 8 to gold and 50 to silver. Reclaiming should be combined with exploitation. A new pond for the remaining material was planned about 15 km west to the town.

Finally, in a „win-win“ situation three parties should find advantages:

a. the population by the creation of about 200 new jobs;
b. the „Aurul“ plant by the extraction of gold and silver;
c. the administration by the removal of an important source of pollution.

The plan failed out of insufficiant planning and a dangerous construction of the new pond resulting in the well-known cyanide spill (confer UNEP/OCHA 2000).

In all, the urban planning did not take into consideration the physical structure of the environment. This resulted into the classical basis for enormous pollutions:

- a relief of narrow side valleys leading to a large main valley with steep slopes facing to the West into the Pannonian plain. This relief provokes inversion situations since about 220-240 days per year there is calm. Frequent fog from the river and about 700 to 800 mm annual rainfall cause rapid precipitation of all pollutants and their incorporation into the soil;
- gases and dust from a rotten industry with no or insufficiant dustfilters are emitted into that depression. This incorporates about 4000 to SO_2, 650 to lead, 90 to zink and 80 to copper from the main sources „Phoenix“, „Săsar“, and „Romplumb“. In the early 90ies „Phoenix“ factory did erect a 340 m high chimney, which now distributes gases and dust over the town and the larger vicinity, depending on the winds direction. A comparable chimney was constructed recently for the „Romplumb“ plant.

In addition, about 24 tons of sterile are deposited within the town or in the near vicinity (1996). This endangers principally the water supply of Baia Mare and its surroundings. The water provision for Baia Mare itself is assured by the Firiza reservoir, the villages on the countryside however still depend on the shallow wells.

Consequently the health situation is endangered in two ways. On the one side there are the classical professional or work related diseases and on the other side the creeping and immanent risks by unsafe tailing ponds.

Professional diseases

Professional diseases are good indicators for the security of the production and for environmentally negative processes affecting the health situation of the population. Several problems arise by the evaluation of these diseases: access to data on the community level is difficult and the reliability of these data is uncertain.

However, the evolution of professional diseases during the last then years in Romania shows a rising morbidity. This depends more on accidents and registration mistakes, since after the political change the industrial capacity and production were largely diminished.

Tab. 1 Incidences of professional diseases in Romania between 1989 and 1998 after the verified diagnoses (source: DSP, Direcția de Sănătate Publică, Maramureș)

Diagnosis	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Incidences on o/oooo of the population	**134,4**	**142,1**	**140,4**	**139,1**	**162,9**	**201,5**	**215,2**	**213,4**	**218,2**	**191,0**
General cases:	1423	1470	1414	1506	1562	1875	2032	2038	2060	1828
Silicosis	413	502	405	611	586	795	782	605	581	735
-Silicosis	402	485	394	583	561	781	736	577	554	682
-Silico- Tuberkulosis	11	17	11	28	25	14	46	28	27	53
Work related poisonings:	536	400	425	405	419	362	362	355	392	336
-by lead	358	275	308	266	310	241	228	247	270	234
-by carbon monoxide	38	36	29	45	11	24	36	19	33	16
Skin diseases	200	208	293	74	78	143	174	156	90	65
Asthma	55	133	140	199	170	259	241	250	282	202
Infectious diseases	12	30	23	20	17	49	14	28	37	39
Ulceration of the nasal septum	26	16	17	19	11	8	40	13	1	13
Raynaud-Syndrom	21	27	14	11	21	16	57	121	121	100
Eye affections	28	37	13	11	6	4	6	9	2	5
Work-related cancers	4	0	0	1	6	5	0	5	3	3
Deafness	55	27	10	56	50	56	39	112	90	46
Other professional diseases	62	72	57	85	186	158	289	368	449	275

Tab. 1. reflects that silicoses, infectious diseases, eye affections and ulceration of the nasal septum generally increased. This was caused not only by the deterioration of working conditions but also by an ameliorated registration of diseases. Work-related deafness and affection of hearing, skin diseases and allergics were increasing too.

Tab.2 Incidence of work-related diseases in the counties of Transylvania in 1998 (source DSP, Direcţia de Sănătate Publică Maramureş)

Counties (judet)	AB	BH	BN	BV	CJ	CV	HR	*MM*	MS	SM	SJ	SB
Number of incidences	34	18	81	121	27	0	45	**465**	25	70	44	86
% of the general number	1,86	0,98	4,43	6,62	1,48	0	2,46	**25,4**	1,37	3,83	2,41	4,7
Number of employees exposed x10000	2,15	3,64	1,92	3,58	2,53	0,74	0,75	**1,17**	2,30	2,81	0,78	2,63
% of the genera number/RO	2,25	3,80	2,01	3,74	2,64	0,77	0,78	**1,22**	2,4	2,94	0,82	2,75
Incidences: o/oooo of people exposed	158	49	421	338	107	0	601	**3980**	109	249	564	327
Average of incidences/ RO	191	191	191	191	191	191	191	**191**	191	191	191	191
Differences o/oooo / RO	-33	-142	230	147	-84	-191	410	**3789**	-82	58	373	136
Number of dispenseries	7	10	2	8	13	2	3	**17**	7	6	3	7
% of the general number/RO	2,07	2,96	0,59	2,37	3,85	0,59	0,89	**5,03**	2,07	1,78	0,89	2,07

1 AB (Alba), 2 BH (Bihor), 3 BN (Bistriţa-Năsăud), 4 BV (Braşov), 5 CJ (Cluj), 6 CV (Covasna), 7 HR (Harghita), 8 MM (Maramureş), 9 MS (Mureş), 10 SM (Satu Mare), 11 SJ (Sălaj), 12 SB (Sibiu)

The numbers of incidences differ greatly between the departments of Transylvania. It is due to the different degree of urbanisation, the different branches of economy and industry, as well as the number of employees and the quality of medical treatment. It also shows the poor knowledge about risk and pollution, about the general obsolete state of production and technology, as well as about the unsufficient organization of technological processes.

The departments of Transylvania differ from the mean value of Romania. 50% of the departments show higher values including Maramureş with extreme ones. The Baia Mare region and its economic structure cause and direct the dimension of pollution. Even in this department the risk-exposed people are less numerous, it shows the highest number of incidences of all departments.

The pollution by SO_2 passes regularly the Romanian limits (CMA), also the concentrations of cadmium remain permanently on a high level. Acid rain is a well known phenomenon in the whole region. Also the technological improvement of the industry between 1992 and 1996 could not diminish the soil pollution by the numerous inherited environmental burdens.

The heavy metal pollution represents the main risk for the public health in Baia Mare, and lead stays for the most dangerous of these elements. It accumulates in the blood and bones and it has also negative consequences for the childrens cognitive development. There are some studies on the risks of lead pollution, however data prior to 1995 are not very convincing (internal information public health authority Cluj). Access to the results of studies, younger than 1995, is very difficult. This explains the poor transparency of public and private institutions and also it represents a serious problem for future studies. Useful investigations rely on the extrapolation of blood analyses of children. WHO conducted a study (cited after UNEP/OCHA 2000), which was focussed on the above-mentioned "Ferneziu" quarter in the vicinity of "Romplumb" factory. The transfer of these results to the whole town remains difficult. The charge of lead was measured to 0,532 mg/dl in adults and 0,633 mg/dl in children (the limit is 0.1 mg/dl for children and 0,2 mg/dl for adults). In 2000 the public health authority of Cluj made another investigation (Glasul Maramureşului,2000). This time it was carried out in the whole town and it was focussed on children of an age between 7 to 11, which allowed a spatial differentiation. The pollution rises from the western residential areas (0,15 mg/dl) to the historical center and the industrial quarters in the East (0,28 mg/dl) and further on to areas in the North- East (0,32 mg/dl). Again the "Ferneziu" quarter bears the greatest load with 0,77 mg/dl. The study underlines that 47,6 % of the children of Baia Mare of an age between 7 to 11 expose lead concentrations in their blood from 0,3 to 0,5 mg/dt and that 10% of the children have values of more than 0,7 mg/dl lead.

There is no comparative study on the air pollution by dust and carbon monoxide, even if they represent the main risk factors for the public health. It will be necessary to identify all the emission sources, to evaluate and finally to restore them. Only a technological reorganization of the industry or its general transformation and a new concept of the public health management will allow an amelioration of the health situation of the population of Baia Mare region.

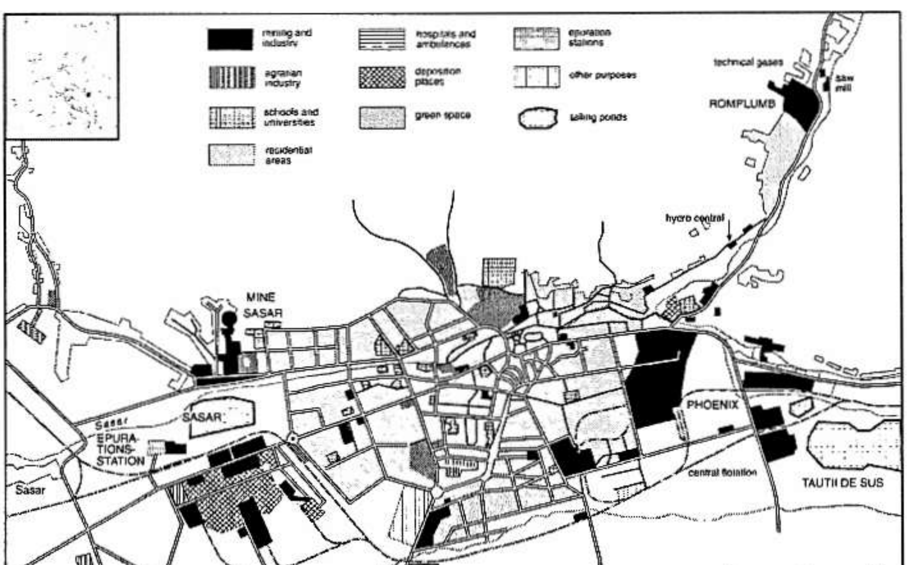


Fig. 1. Town- and land use map of Baia-Mare (Benedek and Molnar 2001, modified)

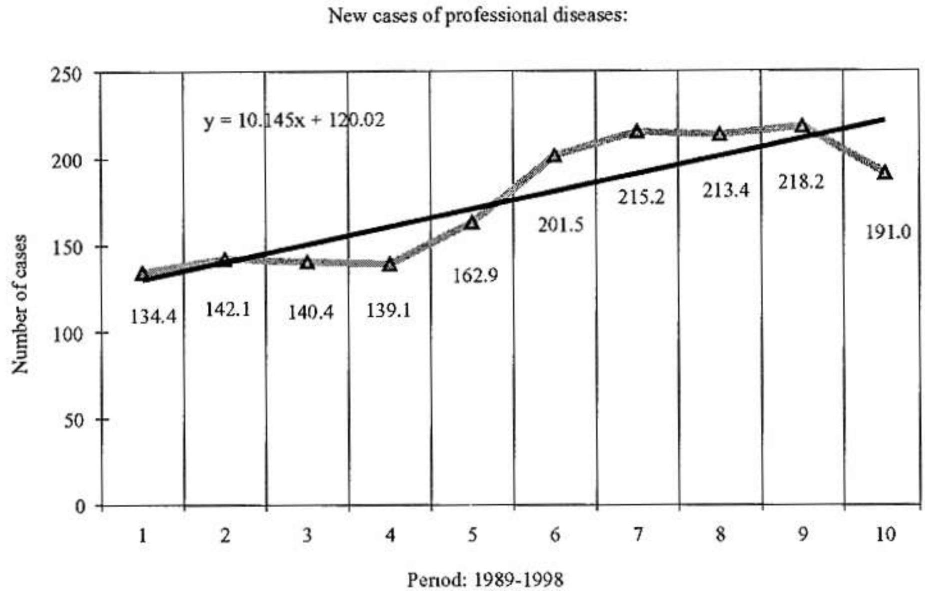


Fig. 2. Incidence of work related diseases between 1989 and 1998 (Benedek and Molnar 2001, modified).

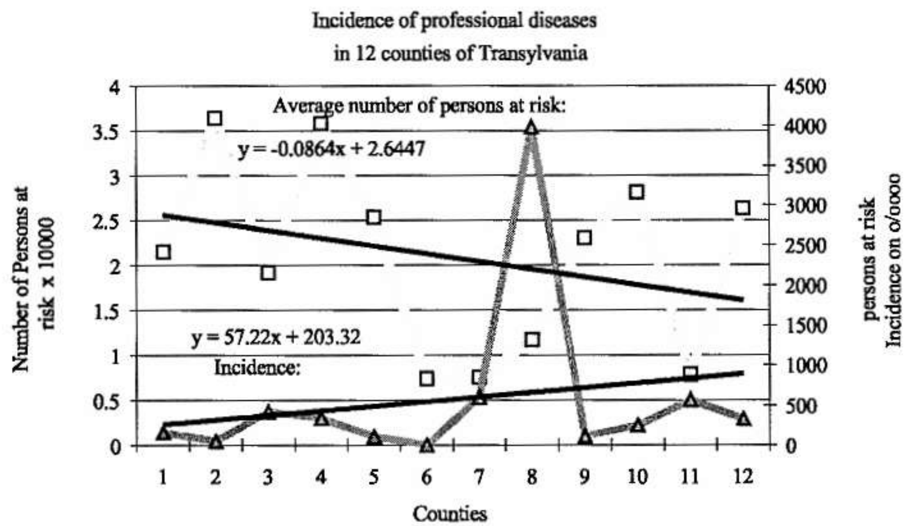


Fig. 3. Incidence of professional diseases in the 12 counties of Transylvania. 8: Maramureş (Benedek and Molnar 2001, modified)

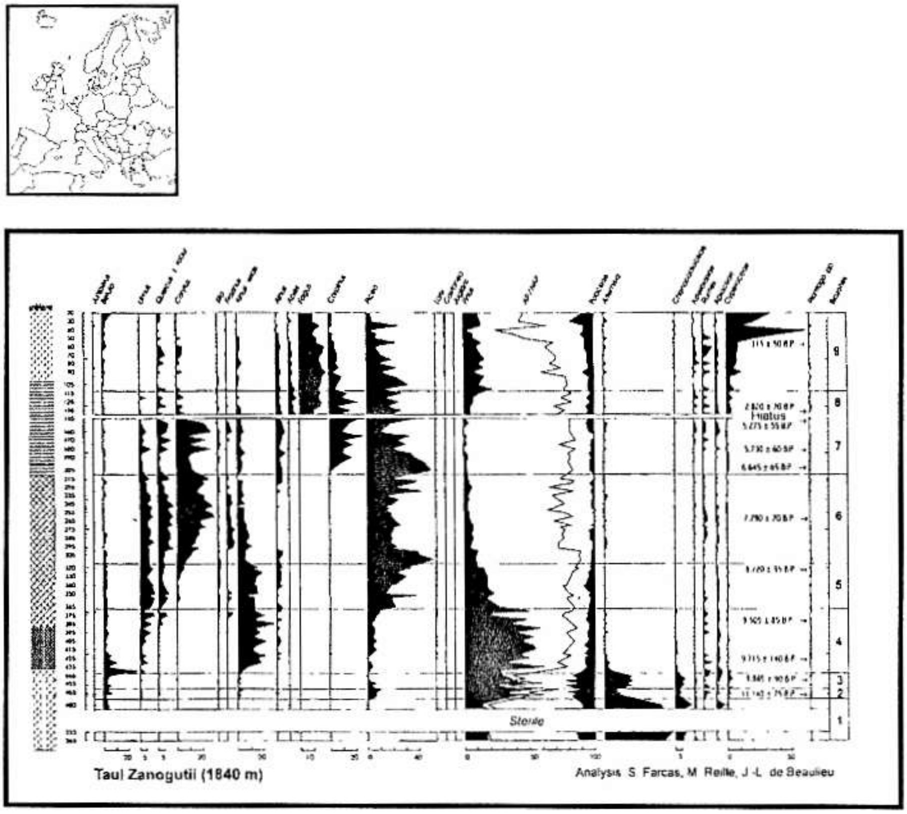


Fig. 4 Pollendiagram from Tau Zanogutii, Southern Carpathians showing indicators of human interfirence during the last three millennia (Farcas et al. 2001).

The dust pollution in the regional context

The above described health situation in Baia Mare and studies connected to the „Aurul" and Baia Borşa-accidents (Hamar 2001, UNEP/OCHA 2000) evidenced a general high charge of lead, copper and zink in the region. These elements are also known as classical indicators for industrial activities (Fauth 1985, Harres et al 1987, Radtke et al. 1997).

If one wants to follow the evolution of pollution through the centuries and to detect periods of extreme pollutions and of regeneration it will be necessary to find the apropriate archives. They must allow a precise registration of the environmental situation and they must preserve these signals. Normally one would seek for meromictic lakes and peat bogs, whereas fluvial sediments are only of second order, since resedimentation is always included (Berglund 1965). Anyway, finegrained deposits from backwaters in the mouth of a tributary (like Lapus in Someş) may be useful since they were deposited calmly. Moreover the situation will allow that they register the charges of the whole catchment area.

Historical archives depict the extremely complicated mining history of this region (Maghiar and Olteanu 1977, Schröcker 1994, Wollmann 1999a-d). It is also illucidated in palynological investigations from the Apuseni and Gultai Mts. (Björkman et al. 2002, Bodnariuc et al. 2002, Farcas et al. 2000, Feurdean et al. 2001, Mitroescu et al. 1989). A pollen diagram from the southern rim of the inner Carpathians may explain the different phases of human impact on the forest composition in the relation of *Fagus, Picea, Pinus* and gramineae during the last 3000 years (Farcas et al. 2000). Comparable investigations were done in the Banatian Mts (Rösch and Fischer 2000). In this context it will be nescessary to investigate a great number of sequences to depict the dimension of forest exploitation and changes. A longlasting mining and metallurgical history also incorporates an intensive forest exploitation or an organized forestry. Wood was necessary for the mine constructions but for the greater part for the metal smelting itself (Thomasius 1994).

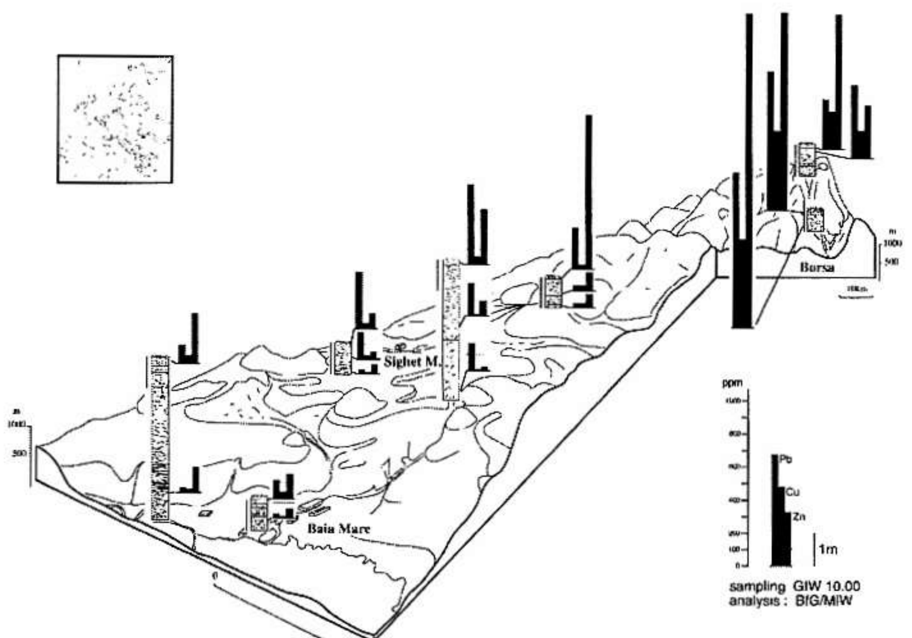


Fig. 5 Blockdiagram of the Baia Mare und Borşa region also showing the coring (draft Schulz, cartography Wepler)

Several peat bogs on the plateau between the Baia Mare and Maramureş depressions were cored in october 2000 as well as fluvial deposits in the direct vicinity of the „Aurul“ pond and in the terrasses around the mouth of Lăpuş into Someş (Fig.5). The peat bogs on the plateau may capt the dust transported from westerly winds, whereas the fluvial sediments may register the complete situation of the catchment area.

The sediments were taken by a modified Livingston piston corer, respectively a Russian corer for the peat bogs. The complete section of finegrained material of the Lăpuş terrace was taken as well as the peat bogs could be cored down to the the technical limits. To get a further information on the actual pollution we also sampled the Vişeu River terrace at Bistra containing the load of the 2000 Baia Borşa spill (s.a.) and fine accumulations near Borşa and Baia Borşa. These terrasses only allowed short cores. Samples from the top of the cores and from various depths were analysed for their heavy metal content in the laboratories of the Federal Institute of Hydrology/ Koblenz and of the Mineralogical Institute of Würzburg university using a wavelengthdispersive x-ray fluorescence-spectrometry (Phillips PW 1410 at Würzburg) with a 10% or more accuracy. Because of the limited quantity the whole material was treated. This was to test whether the information content of the sediments was clearly differenciated along the core or whether it only was a mixture. Remarkable regional differences are visible in comparing the surface samples (fig. 5) and the heavy metal contents clearly diminish with the depth of the sequences. Lead, copper and zink are mentioned as the most important indicators in order to allow a comparison the the samples taken along the rivers Vişeu and Upper Tisa at the same time by colleagues from Szolnok and Cluj (Hamar 2001).

The two sediment cores from the distal Pannonian (Someş-Lăpuş) Plain show relatively moderate values even the EU limits are largely passed: lead 143/146, copper 60/39 zink 193/207 each in ppm (fig. 6). The enormous consumption of zink dust by the gold extraction process explains the fact that zink values pass those of lead. The sediments on the plateau at about 1000 m elevation show remarkable differences to those of the plain. Lead concentrations rise with a factor of two to four (447 / 267) whereas zink has elevated values (333/119) only in one peat bog, copper behaves comparable to the sediments from the Someş plain. If one looks to the results from the deeper sediments, it becomes clear that they diminish in the river plain and on the plateau to about 30 ppm for lead with the exception of the peat bog near Creasta Cocosului. Copper remains comparable in its values. Zink retains a concentration between 65 and 157 ppm. Investigation of peat bogs in the Apuseni Mts. also reported an elevated heavy metal-pollution (Mitroescu et al. 1989).

This demonstrated a general concentration of pollutants on the plateau since during west wind situations the dusts from the foreland is transported over the plateau. The heavy metal contents of the fluvial terraces of Baia Borşa and Borşa however arrive to totally different dimensions. Lead rises to concentrations of 939 and 308 ppm, zink climbs up to 1890 ppm also copper shows concentrations up to 538 ppm. These values are comparable to those reported from river terraces in old mining areas in Central Europe (Fauth et al 1987). For the Baia Borşa area it is easy to explain since it is the region of ore extraction. However the situation near Borşa is problematic since the local population relies to shallow wells for the water supply as it is the case in the Someş plain. Even if the accumulation of heavy metals in the top soil of forests and peat bogs is different (cf. Schulte and Blum 1997), and if the mobilisation of heavy metal dust from sediments into the ground water is to verify (Symader 1984), the level of all possible tolerances is largely passed. This results into an general thread which also explains the public health situation (s.a.).

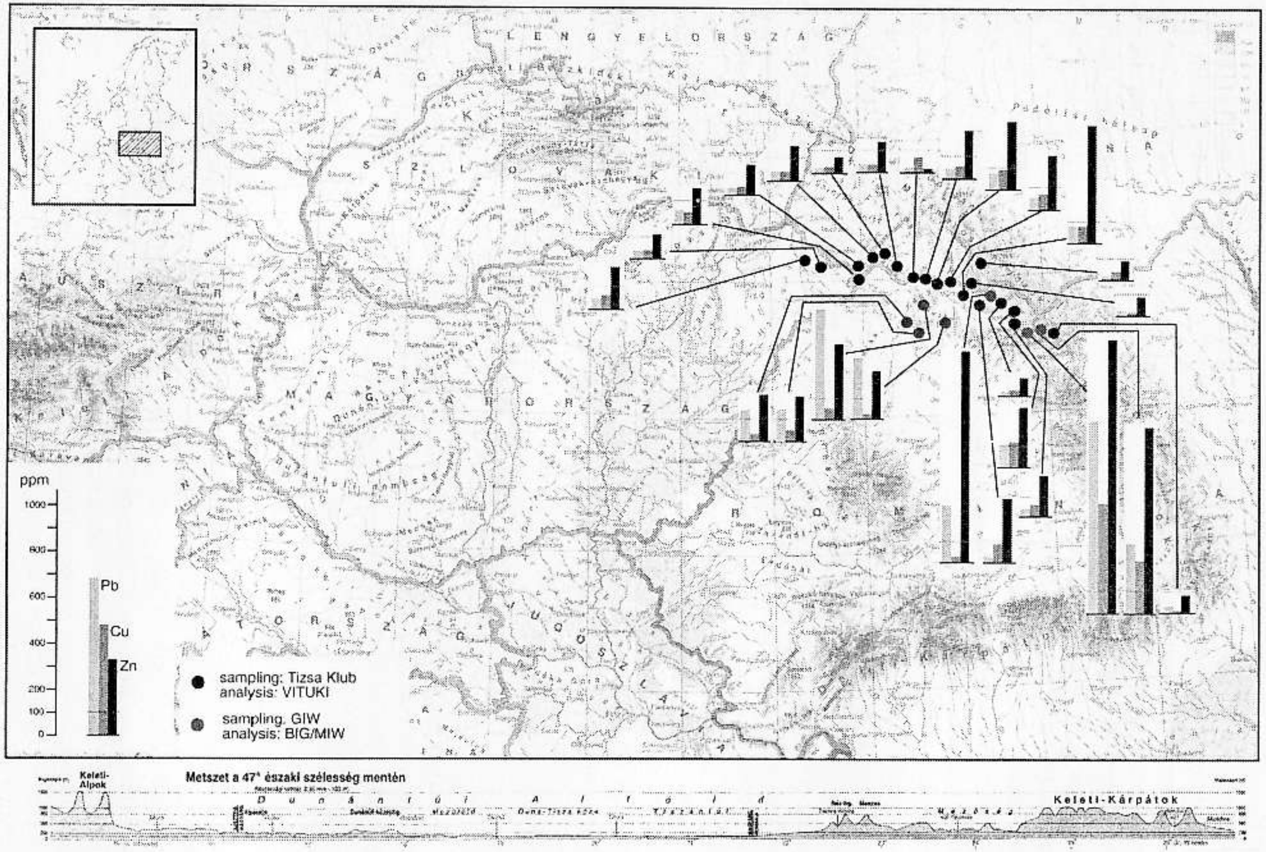
These heavy metal contents are generally higher than those reported in the geochemical atlas of Romania (IGR/BGR 2000, Sievers friendly communication) lead for example with a factor three. This may be due to he fact, that the surface sediments accumulated all dust deposits, whereas the river sediments themselves depict the respective actual condition of the transported material. There is also a large variety in space and in time. Copper and zink however show less pronounced differences.

A compilation of the results obtained on samples collected in october 2000 from the Würzburg group in the Pannonian Plain and on the plateau and from the Szolnok group along Vişeu and Upper Tisa (Hamar 2001) demonstrated the dillution effects along the Vişeu and Upper Tisa rivers, the differences between the plains and the plateaus, as well as the elevated values in the extraction zone of Borşa / Baia Borşa (fig. 6).

The pollution background

Parallel to the evaluation of the actual pollution the sediments cores already allow an estimation of the background pollution without a strong human influence. In this context one has to count with a lead concentration of 30 to 40 ppm, zink values between 60 and 170 ppm and those of copper af about 20 ppm. This stands for the Someş plain as well as for the plateau. The investigations on the Holocene sequence of Csaroda (NE-Hungary) also showed similar low concentrations of lead, copper and zink until the periods of intensive human impact (Sümegi 1999). The sediment core from the Viseau terrace behaves differently. Lead and copper have low concentrations only zink has values comparable to those of the Someş plain. There is no change with the depth. This may be caused by the sediment mixture during high floods in the steep valley different to the situation at the Lăpuş mouth in the Someş plain.

Fig. 6 Comparison of the actual heavy metal concentrations of surface sediments in the Baia Mara and Borşa regions and along the rivers Vişeu and Upper Tisa (after Hamar 2001 and own investigations, draft Schulz, cartography Wepler, topogr. Basis: Cartographia 1999)



Conclusions

The first results of investigations of the present and past heavy metall pollution, in the Baia Mare region show the general good quality of the natural archives and clear differences in the contenst of heavy metals of the different sediments depending on the exposition or on extraction and dust deposition. It becomes clear that the present heavy metal concentrations on the peat bogs at about 1000 m elevation are two to three times higher than those of the Someş plain. The extremely high concentration in the settlement area near Borşa may be explained by the near distance to the ore extraction area however it represents a direct thread to human health, since the local water supply depends on shallow wells as it is the case for the villages in the Someş plain around the „Aurul" pond too.

The present lead concentrations depass, with one exception, all the limits for soils, defined for Central Europe (cited from Harris et al. 1987). In the Borşa/ Baia Borşa region it also stands for copper and zink. The heavy metal concentrations decrease in the lower sediments in the plain as well as on the plateau beneath the above cited limits and so they may define the geological background pollution. Today the region has a generally elevated pollution background comparable to other mining areas (Faudt et al 1985, Harris et al 1987, IGR/BGR 2000). The threat for the public health however is inforced by the interfingering of metallurgical and food processing plants with residential areas. This is also explained by the comparison of the national and regional (Maramureş) health situation. In addition, there is the general thread of extreme damages caused by the insufficently protected inherited environmental burdens and by some scandalously conceived and constructed ore processing plants and their retailing ponds (cf. ICPDR 2000). This also represents an imminent danger for the whole Tisa River system.

Aknowledgements

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Zusammenfassung

Die Bergbaugebiete Nordwest-Rumäniens (Maramureş, Apuseni-Gebirge) zeigten über die letzten drei Jahrtausende exemplarisch die Prozesse der Kulturlandschaftsentwicklung von den ersten Öffnungen und Umstellungen der Landschaft zu intensiver Nutzung, den Regenerierungsphasen und der erneuten Nutzungsperioden seit der ungarischen Landnahme bis hin zu den intensiven Ausbeutungs- und Verschmutzungsphasen der letzten Jahrhunderte. Ein Kooperationsprojekt von Kollegen der Universitäten Würzburg, Klausenburg (Cluj, Romania) sowie der Bundesanstalt für Gewässerkunde Koblenz wertet die natürlichen

(Flusssedimente, Hochmoorablagerungen) und historischen Archive (Berichte, Karten) aus und bearbeitet dabei die Fragen nach den Etappen der Kulturlandschaftsentwicklung, nach den unterschiedlichen Dimensionen der Belastung innerhalb dieser Entwicklung, nach den Auswirkungen der Umweltverschmutzung auf die Gesundheit der Bevölkerung sowie nach möglichen raumplanerischen Maßnahmen zur Bewältigung dieser negativen Erbschaften.

Erste Ergebnisse zeigen einerseits die gute Auflösung und Reichhaltigkeit der Archive und andererseits das räumlich unterschiedliche Muster der Schwermetallbelastung. Insbesondere werden dabei neben den generell hohen Kontaminationen die starke Fernwirkung und die aktuelle Gefährdung der Trinkwasserversorgung der Bevölkerung in einigen Regionen sichtbar. Die aktuelle Gesundheitssituation des Kreises Maramureş belegt diese Gefährdung in der generell erhöhten Inzidenz von Berufserkrankungen.

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