Acta Universitatis Sapientiae

Agriculture and Environment

Volume 1, 2009

Sapientia Hungarian University of Transylvania
Scientia Publishing House

Contents

Acta Universitatis Sapientiae
Agriculture and Environment, 1 (2009) 5-10

Evaluation of Chinese broccoli under organic growing conditions

Tomas KOPTA[1], Robert POKLUDA[1]

[1]Department of Vegetable Science and Floriculture, Faculty of Horticulture in Lednice
Mendel University of Agriculture and Forestry Brno, Czech Republic
e-mail: tomas.kopta@mendelu.cz

Manuscript received 24.08. 2009; revised 20.09. 2009, accepted; 22.09.2009

Abstract: A marketable production characterized by stem weight, leaf area and leaf/stem ratio were measured in five cultivars of Chinese broccoli. From the results can be concluded the cultivar Hon Tsai Tai as significantly worst performing (stem weight 15,5 g, leaf/stem ratio 29 $cm^2.g^{1-}$) and cultivar Happy Rich as significantly best (stem weight 55 g, leaf/stem ratio 18,6 $cm^2.g^{1-}$). Other cultivars such as Summer Jean, Suiho and Green Lance were in between in this evaluation. Cultivar Happy Rich can be consequently recommended for summer production under organic growing conditions in the Czech Republic.

Keywords: Chinese broccoli, *Brassica alboglabra*, organic growing

1. Introduction

Chinese broccoli *Brassica oleracea* L. var. *alboglabra* is one of the main leafy vegetable crops grown in south-east Asian countries for its young flowering stem [1], [2]. Chinese broccoli, a perennial plant often grown commercially as an annual, is a cool-season crop and has some frost tolerance, preferring uniform conditions that are not too dry, wet or shady [3]. The optimum temperature for rapid growth is 18-28°C. Low temperatures promote early flowering. The crop is more heat tolerant than other broccoli [1]. Chinese broccoli should be grown the same way like traditional broccoli [4].

This vegetable consists of a tender green flower stem with buds that will become white or yellow flowers. The leaves and stems are covered with a white

haze due to cuticle and wax development [5]. The stalk, leaves and unopened flowerbuds are all eaten. Chinese broccoli has a slightly bitter taste and is used in soups and stir-fries or eaten as steamed vegetable [2]. Important quality characteristic are fresh leaves and stalks, with flower buds developed but not open. In the market the products are being sold usually bunched and trimmed to a length of 0,15 - 0,25 m [3]. In China there are numerous cultivars divided in according to their natural flowering season and their resistance to heat and cold. To date only a handful are listed in the Western countries [5]. Cultivars also differ in stem length and colour, from light to medium green [6]. Chinese broccoli is not well known in the mainstream market but is very common in Asia community markets [4].

Vegetables traditionally consumed in Asia are now also being sought out and consumed more frequently by people in Western countries [7]. Chinese broccoli is not really known in the Czech Republic and in according to commodity reports produced by the Czech Ministry of Agriculture, there is not any commercial production so far. However, this vegetable could have been one of the potential species for extension of vegetable production in the conditions of the Czech Republic.

The objective of this study was to evaluate growing characteristic (leaf area, stem weight and leaf/stem ratio) of five cultivars of Chinese broccoli cultivated under organic growing conditions. It can be expected some cultivars perform differently under climatic conditions of Czech Republic.

2. Materials and Methods

The experiment was carried out during the season 2008 at experimental field of Horticultural faculty in Lednice (Location: 48°47'36"N, 16°47'48"E, Czech Republic). In according to Larkcom 1991 [5] the heaviest yields are obtained from mid- to late summer sowing, maturing in late summer and autumn. In relation to our conditions July as sowing time was chosen.

All five cultivars (Hon Tsai Tai, Summer Jean, Suiho, Green Lance and Happy Rich) were sown at 22th of July directly in rows about 20 mm apart and thinned to approximately about 50 mm three weeks after sowing. Row spacing was 0,3 m. Experimental plot for one cultivar was 9 m long and contained approximately 90 plants with three replications. No fertiliser or pesticides were used during cultivation. The crop was covered with polypropylene non-woven textile to prevent pests damage from. The field was under sprinkler irrigation. It has to be mentioned that F1 Green Lance cultivar is classified as the standard cultivar [5].

20 young flowering stems with compact florets and leaves were harvested for evaluation. The whole plant was cut just above the second node from the

ground. Selection criteria were: stem length at least 0,15 m and stem diameter at the base of no less than 10 mm.

Marketable part of the Chinese broccoli is stem with flower buds and young leaves [5] so for comparison of all cultivars the stem weight and leaf area parameters were used. Immediately after harvest all leaves as well as 50 mm of lower part of the stem were removed and remaining stem was measured for weight. Removed leaves were used for measurement of leaf area by using of digital camera and Adobe Photoshop software. From that the leaf/stem ratio (further as LS ratio) were calculated. Such values expressed as cm^2 of leaf area per one gram of stem were used for relative comparison of all cultivars.

Data were analyzed by analysis of variance and the differences between the cultivars were evaluated by using the LSD test at a probability of $p = 0,05$ (Statistica 8.0, StafSoft Inc.1984-2007). Correlations between leaf area and stem weight were calculated by measure of Pearson's correlation (Unistat, USA).

3. Results and discussions

As was mentioned by Moore and Morgan [3] Chinese broccoli can be grown successfully all year, but different cultivars should be used in accordance with the season or climate. Matching the cultivars with different seasons or climates can be difficult. The poor quality came from using the not-adequate cultivar for that time of year. In our experiment some cultivars differs with stem weight, leaf area and LS ratio. Following table shows the average stem weight, leaf area and LS ratio for all cultivars with LSD test evaluation.

Table 1: Earliness, average weight, leaf area and LS ratio.

Cultivars	day to maturity in according to producer	average stem weight (g)	average leaf area (cm^2)	average LS ratio ($cm^2 . g^{1-}$)
Hoh Tsai Tai	37	15,5 a	441,6 a	29 a
Green lance	47	24,6 b	618,3 b	26,1 b
Suiho	44	26,7 b	584,7 b	22,4 c
Sumer Jean	35	28 b	596,3 b	22,2 c
Happy Rich	55	59,3 c	1061,4 c	18,6 d

Note: different letters represents significant differences among cultivars

In accordance to Table 1, stem weight and leaf area was found to be lowest in cultivar Hon Tsai Tai. Cultivars Summer Jean, Suiho and Green Lance were not statistically different in stem weight or leaf area between each other. This

group was statistically better performing than Hon Tsai Tai and worse performing than Happy Rich in both stem weight and leaf area. The highest leaf area and stem weight was recorded by cultivar Happy Rich which differ significantly. In case of this cultivar there was confirmed the statement reported by Morgan and Midmore [2] that later cultivars gave larger plants with higher yields.

In the Fig. 1 there is shown correlation between leaf area and stem weight for cultivar Suiho with regression formula.

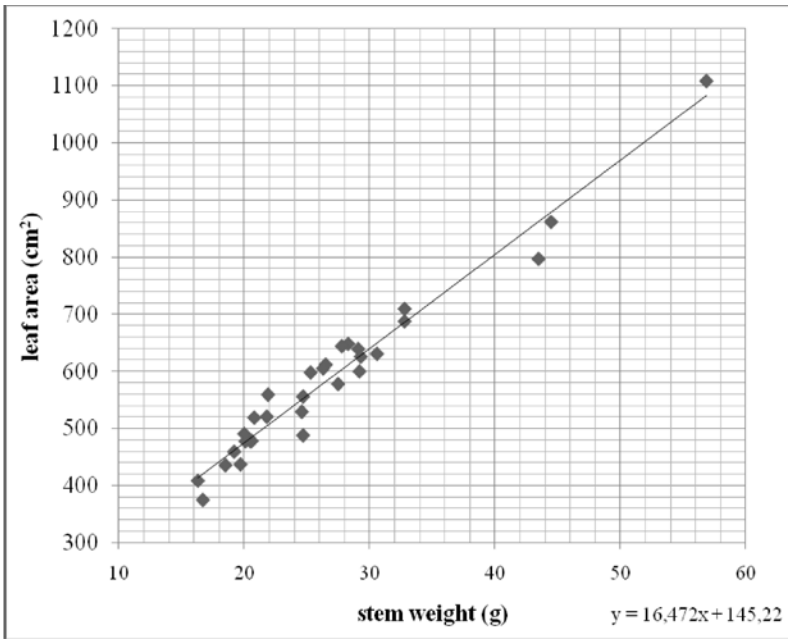

Figure 1: Correlation between leaf area and stem weight for cultivar Suiho.

Correlation between leaf area and stem weight was high in all cultivars: Hon Tsai Tai (r = 0,53), Summer Jean (r = 0,81), Suiho (r = 0,98), Green Lance (r = 0,53) and Happy Rich (r = 0,80). Due to this high correlation the evaluation of relative LS ratio was useful.

From Fig. 2 and Table 1 it can be resulted that LS ratio expressed in cm^2 of leaf area per one gram of stem was lowest for Happy Rich. Consequently, this cultivar can be evaluated as the best growing because it needs the smallest amount of leaf area to produce the stem. Opposite tendency was found in Hon Tsai Tai and Green Lance which needed statistically higher leaf area to produce the same amount of the stem.

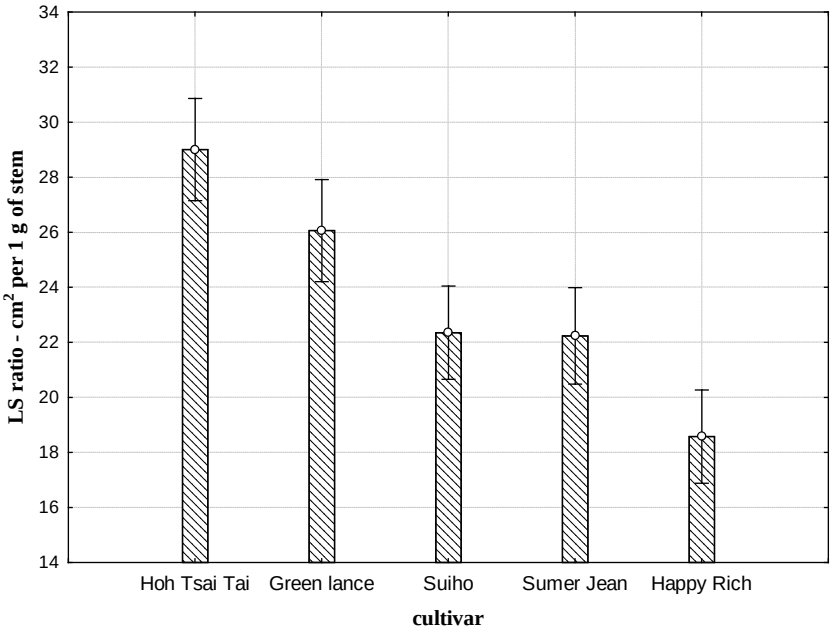

Figure 2: LS ratio for all cultivars.

Leaf area as determining factor of dry matter production is an important component of growth and yield of horticultural crops [8]. Relation between leaf structure and stem growth was mentioned by Yamamura [9]. He mentioned that herbaceous plant with more spread leaves may be forced to invest a larger portion of material into its stem tissue to maintain physiological and structural stability. The tendency (higher leaf area = bigger stem) was seen in the best performing cultivar Happy Rich and opposite relation for the worst performing cultivar Hon Tsai Tai. Other important factor mentioned by Liu and Stützel [10] is leaf thickness. He reported that thicker leaves usually have a higher density of chlorophyll and proteins per unit leaf area and, hence, have a greater photosynthetic capacity than thinner leaves.

4. Conclusion

Hon Tsai Tai was described as the earlier one and grows interestingly with its violet tone of leaves and stem. However, due to very low weight of the stem and low LS ratio it cannot be recommended as potential cultivar for production in given conditions. Cultivar Green Lance, classified as the standard cultivar [5], produced the second lowest value of stem weight and LS ratio value was close

to that calculated for Hon Tsai Tai. Therefore, it cannot be recommended as well. Cultivar Summer Jean and Suiho could be classified as relatively suitable for production in given conditions. Cultivar Happy Rich can be highly recommended for given conditions by means of summer production under organic growing conditions in the Czech Republic. In ongoing research, the differences in health promoting substances between all cultivars are evaluated as well.

Acknowledgements

This work was supported by Project GF 4195 of the Ministry of Agriculture, Czech Republic.

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Acta Universitatis Sapientiae
Agriculture and Environment, 1 (2009) 11-19

Characterization and classification of tea herbs based on their metal content

László KÉKEDY-NAGY [1], Artúr IONESCU [2]

[1]Babeş-Bolyai University, Faculty of Chemistry and Chemical Engineering, Chair of Analytical Chemistry
400028 Cluj-Napoca, Str. Arany J. nr.11, Romania, e-mail: lkekedy@chem.ubbcluj.ro

[2]Babeş-Bolyai University, Faculty of Environmental Sciences, 400294 Cluj-Napoca, Str. Fântânele nr.30, Romania, e-mail: arturkiralycj@yahoo.com

Manuscript received 29.07. 2009; revised 24.08. 2009, accepted; 13.09.2009

Abstract: 14 commercial tea herbs assortments Na, K, Li, Rb, Sr, Ba Fe, Cu, Mn, Pb, Zn, Mg, Ca, Ni, Cd and Co content has been quantified by flame atomic emission and absorption spectrometry. About 2 g of dried samples were digested using the standard wet-digestion (HNO_3 and $HClO_4$) method. The metal content of the herbs ranges in the mg/g levels, despite of their origin. The earth metals, K, Mn and Fe are present in the highest concentrations. The other essential microelements (Ni, Zn, Co and Cu) as well as the most toxic heavy metals (Cd, Pb) occur only in trace levels. The chemometric analysis of the data reveals the classification of the herbs in 3 main clusters based on the quantification of their Cd, Li, Pb, Cu and Sr content.

Keywords: tea herb, metal content, atomic spectrometry, cluster analysis, correlation analysis

1. Introduction

Plants absorb different chemical elements, including metals mostly in ionic form, with the help of their roots. Based on the importance in the plant's metabolism the metal could be essential or non-essential element and by their quantity in the plant there are classified as macro- ($10 - 10^{-2}$ %) or micro-element ($10^{-3} - 10^{-12}$ %) [1].

The genus of the plant, the environmental conditions and the nature of the metal play a major role concerning the metal intake. The absorbed metal is incorporated and accumulated in different parts of the plant (root, leave, fruit, seed etc.), the human or of the animal consumption any part of it represent the

introduction of the plant, including the metals, into the food chain at a given level. The most dangerous metals for human health are the heavy metals Hg, Pb and Cd, considered as the “most toxic” ones [2, 3, 4].

The humanity uses the tea herbs infusions from ancient times as delectable item or as a natural medicine [5, 6]. The hot water extracts a part of the metals incorporated and by drinking the tea infusion they are introduced in human organism, including the most toxic ones. The main goal of the present work was to assess the quantity of metal ions intake for humans by tea drinking, to check the heavy metal accumulation in the herbs tissues, especially Pb, Cd and Cu, as consequence of the environmental pollution [7]. For this reason 16 metals (Na, K, Mg, Ca, Fe, Cu, Mn, Zn, Co, Ni, Li, Rb, Sr, Ba, Cd and Pb) have been quantified in 14 different tea herb blends and fruits stocks, the analytical data were processed by using chemometric methods [8, 9].

2. Materials and Methods

The metal content of 14 commercial tea herbs and fruits stock samples was determined by the flame atomic emission spectrometry (FAES) and atomic absorption spectrometry (FAAS). For quantification the standard calibration curve method have been used [10, 11]. About 2 grams of dried sample were taken for analysis. This quantity is usually used (even packed form in paper bags) for the preparation of a cup of tea infusion. The reagents were of p.a. purity, for the preparation of the solutions distilled water was used in all cases.

The tea samples where the followings [name (code)]: anti-diarrhea tea (AD), mint tea (CM), black tea (CN), green tea (CV), blackberry leave tea (FM), forest fruits tea (FP), raspberry leave tea (FZ), thyme tea (IC), chamomile tea (KT), blend fruit tea (MF), buckthorn bark tea (SC), nettle tea (UV), heath speedwell tea (VO) and Yellow Label tea (YL).

The organic matter was dried first in an electric oven at 105 °C and grounded to fine powder. ~2 grams of each of the prepared sample were taken for the analysis, weight on analytical balance. The samples were digested using the standard method of wet acid digestion for plant samples (conc. HNO_3 and conc.$HClO_4$) [12]. A reference sample for the background correction was prepared too, by using the same acids in the same quantities.

The determinations were carried out by using a HEATH-701 (Heath Co., Benton Harbor, MI, USA) single channel modular spectrometer, a HEATH EU-700 grating and a HEATH EU-700-30 photo detector unit. As detectors photomultiplier tubes were used, the 1P28A (Hamamatsu, Japan) in the UV-VIS spectral range and the M12FC51 (NARVA, Germany) in the VIS-IR range, respectively. The detector signal was introduced through an amplifier and data acquisition card (National Instruments) into an IBM PC and processed with a

home made software program, written in Quick Basic language. As fuel the 98-99 % purity of methane gas was used from the pipe. The oxidant was compressed air, used at constant pressure and yield of 500 L/h.

3. Results and discussion

The Na-, K-, Li-, Rb-, Sr- and Ba-content were determined by FAES method, while the Fe-, Cu-, Mn-, Pb-, Zn-, Mg-, Ca-, Ni-, Cd- and Co content by the FAAS one. The flame atomic spectrometric measurements were performed using the optimal instrumental parameters for each element.

The calibration curve has been established individually for each element, selecting the linear domain of analytical signal – concentration relation (Table 1.).

Table 1: The experimental conditions and the calibration data.

Element	λ (nm)	The equation of the calibration curve	
Li	670.8	I = 106.9*C + 0.12	R = 0.9995
Na	598.5	I = 6.196*C + 0.078	R = 0.9995
K	766.49	I = 3.800*C – 0.030	R = 0.9995
Rb	780.0	I = 12.59*C + 0.135	R = 0.9990
Sr	460.7	I = 0.681*C + 0.035	R = 0.9995
Ba	553.8	I = 0.302*C – 0.141	R = 0.9995
Mg	285.3	A = 0.177*C	R = 1
Ca	422.7	A = 0.003*C	R = 0.9995
Mn	279.5	A = 0.034*C	R = 1
Fe	248.3	A = 0.013*C	R = 1
Co	240.7	A = 0.002*C + 0.001	R = 0.9915
Ni	232	A = 0.003*C + 0.001	R = 0.9990
Cu	342.8	A = 0.022*C	R = 1
Zn	213.9	A = 0.104*C + 0.008	R = 0.9905
Pb	217.7	A = 0.008*C	R = 1
Cd	228.8	A = 0.052*C	R = 1

The metal concentrations were calculated from the calibration curve, taking account the degree of the dilution of the samples prior the determination. The data representing the metal quantity of ~2 g of dry solid sample are presented in the Tables 2 and 3.

Table 2: The alkaline and earth-metal content of the tea herbs.

Sample	Metal concentration (mg / 2 g sample)							
	Li	**Na**	**K**	**Rb**	**Sr**	**Ba**	**Mg**	**Ca**
AD	0.0029	0.53	21.2	0.0242	0.031	4.44	8.96	15.0
CM	0.001	1.59	30.6	0.0121	0.005	7.14	10.40	10.8
CN	0.0002	0.45	26.7	0.2138	0.045	1.70	4.72	0.0
CV	0.0003	0.35	27.5	0.0360	0.008	0.29	2.22	0.0
FM	0.0007	0.04	22.0	0.0215	0.018	4.74	12.68	14.3
FP	0.0008	1.21	15.9	0.0272	0.025	3.13	3.66	0.0
FZ	0.0004	0.19	25.0	0.0419	0.004	7.60	9.95	13.4
IC	0.0011	0.13	24.0	0.0305	0.050	7.41	7.50	11.1
KT	0.0006	0.76	27.2	0.0311	0.045	7.43	7.94	20.3
MF	0.0008	0.32	18.3	0.0297	0.023	3.53	4.82	3.0
SC	0.0003	0.16	3.9	0.0201	0.064	10.79	6.72	18.3
UV	0.0007	0.51	49.4	0.0279	0.101	30.23	19.12	54.5
VO	0.0005	0.26	29.5	0.0273	0.027	2.35	3.36	0.0
YL	0.0002	0.27	30.5	0.2887	0.026	0.57	2.21	0.0

Table 3: The heavy metal content of the tea herbs.

Sample	Metal concentration (mg / 2 g sample)							
	Mn	**Fe**	**Co**	**Ni**	**Cu**	**Zn**	**Pb**	**Cd**
AD	0.174	0.96	0.025	0.0167	0.0386	0.056	0.0188	0.0029
CM	0.153	0.24	0.000	0.0654	0.0089	0.021	0.0061	0.0009
CN	0.693	0.54	0.000	0.1664	0.0454	0.023	0.0125	0.0000
CV	1.054	0.40	0.000	0.0167	0.0864	0.058	0.0250	0.0000
FM	0.547	0.19	0.075	0.0833	0.0341	0.042	0.0437	0.0029
FP	0.064	0.59	0.074	0.1982	0.0023	0.007	0.0062	0.0000
FZ	1.312	0.17	0.049	0.0164	0.0201	0.068	0.0246	0.0028
IC	0.179	0.45	0.000	0.0929	0.0042	0.028	0.0174	0.0009
KT	0.130	0.78	0.000	0.0830	0.0204	0.078	0.0062	0.0010
MF	0.335	0.56	0.124	0.0000	0.0045	0.009	0.0186	0.0000
SC	0.757	0.16	0.100	0.0665	0.0159	0.000	0.0187	0.0010
UV	0.149	0.18	0.000	0.0000	0.0470	0.041	0.0185	0.0019
VO	0.211	0.26	0.000	0.1824	0.0226	0.069	0.0124	0.0029
YL	1.180	0.55	0.000	0.0662	0.0135	0.265	0.0124	0.0000

The results show, that the vegetal stock samples contain the metals in trace levels. The highest quantities were found for K and for the earth metals (Ca, Sr, Ba, Mg). The K content varies within narrow limits; the plants contain it almost in the same concentration. The uniform distribution of this element in the samples of different origin is the consequence of role of K^+ played in the plant metabolism, as cell osmotic pressure regulator. As macro-element Ca exhibits the highest concentration, Na occurs in the lowest one. Among of the essential micronutrients Fe and Mn were found in the highest concentrations, in average of 0.496 mg and of 0.43 mg, respectively. Their concentrations vary between large limits, depending on the sample origin. The other essential microelements determined (Ni, Zn, Co, Cu) exist in much lower concentrations; only few samples contain these elements in measurable levels.

In the case of non-essential microelements Ba is present in the highest concentrations, in all of the samples, despite of their origin. The high Ba concentration could be attributed to high pH value of the soils. The Rb, Ba, Ca, Co and Zn concentrations vary between the largest limits among the elements determined. The most toxic heavy metal loadings (Pb and Cd) of the samples are very low, which suggest the absence of these pollutants in the vegetation zone. Only one sample (FM) contains lead in considerable amounts, probably due to the vehicular traffic pollution.

In order to reveal the hidden relationships between the data (and samples) we performed the chemometric analysis (cluster- and factor-analysis) of them. The cluster-analysis was performed in order to create the classification of the samples and of the elements. The tree diagram was constructed using the following options: complete linkage and Euclidean distance between the elements (considered as variables). Taking account of the linkage distances between the elements, they were stepwise eliminated in descending order of the distance between them. In the first step K, Ca, Mg and Ba were eliminated (see Figure 1), than Mn, Fe, Na, Ni, Zn and Rb.

From the tree diagram results that the elements are grouped in three groups based on their concentration in the plant tissue. The biggest linkage distances are between K > Ca > Mg > Ba (in descending order); the smallest ones are in the case of Pb > Cd > Li > Sr > Cu > Co (each present in low trace). The K, Ca, Mg and Ba content allow only the large-scale classification; their elimination does not modify either the position of the remaining elements in the cluster tree nor the linkage distances. It was calculated the average concentration, the standard deviation and the relative standard deviation (% RSD) for all elements too (Table 4).

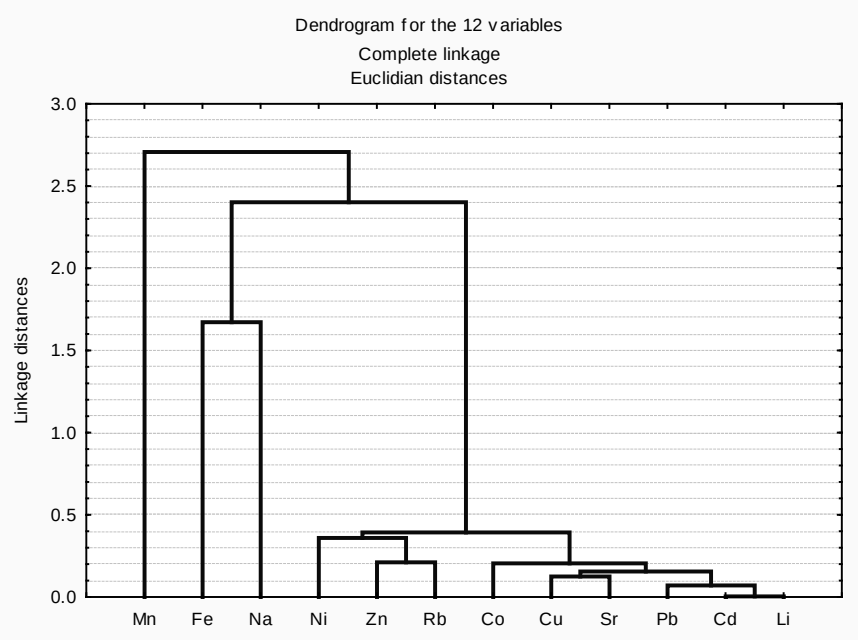

Figure 1: The dendrogram for the 12 variables (elements).

Table 4: The statistical values of the parameters.

Element	**Average concentration (mg / 2 g sample)**	**Std. Dev.**	**RSD**	**RSD (%)**
Li	0.00074	0.00067	0.901	90.1
Na	0.48	0.44	0.91	90.7
K	25.1	10.0	0.4	39.7
Rb	0.059	0.0829	1.39	139.4
Sr	0.034	0.026	0.77	77.3
Ba	6.52	7.47	1.15	114.5
Mg	7.45	4.66	0.63	62.5
Ca	11.5	14.5	1.3	126.3
Mn	0.49	0.432	0.871	87.1
Fe	0.43	0.25	0.58	57.7
Co	0.032	0.044	1.380	137.9
Ni	0.0752	0.066	0.881	88.1
Cu	0.0260	0.022	0.881	88.1
Zn	0.055	0.065	1.198	119.8
Pb	0.0172	0.00984	0.571	57.1
Cd	0.0012	0.00121	0.9906	99.1

The results show the followings: (i) the metallic elements are present in the dry vegetal samples in trace levels; (ii) the earth metals are present in the highest concentrations while the alkaline- and the heavy metals in the smallest amounts; (iii) the small average concentrations result from the fact that the given element is present in low quantities in the plant tissue, on the other hand only few sample contains it over the determination limit (exceptions are K and Na); (iv) the small amounts of lead and cadmium in the samples show the environment is pollution free, from this point of view the tea consumption is not dangerous for human health; (v) as it was expected, K exhibits uniform distribution among the samples, the Rb, Ba, Ca, Co and Zn content varies best, their concentration in plant tissue depend in the highest degree of the nature of the sample.

The cluster analysis was carried out for the cases (the samples) too, in order to classify them. The classification was performed by keeping all the elements (variables) for calculus, with the conditions of the complete linkage and the Euclidian distances (Figure 2.).

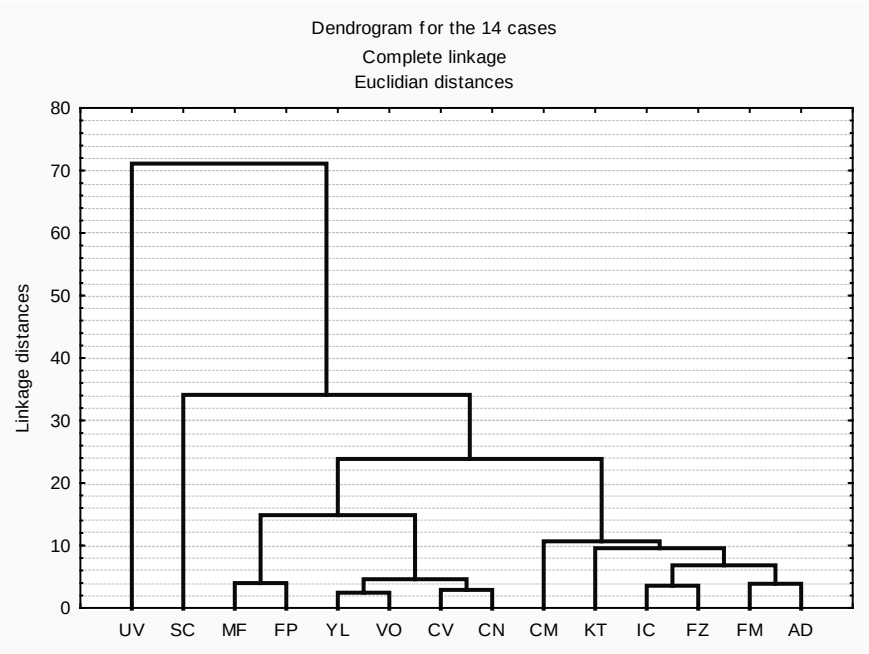

Figure 2: The dendrogram for the 14 cases (tea herbs)

The samples are grouped into two main clusters (exceptions are the samples encoded UV and SC, being well distinguished from the others). The first cluster contains the samples CM, KT, IC, FZ, FM and AD; the second one

the samples MF, FP, YL, VO, CV and CN. The tea weeds (*Camillia sinensis*) resemble best (CV, CN and YL), sample VO belongs to this group too. The composition of the blended fruit tea stocks (MF and FP) is almost the same, probably under the different commercial name the blend are made from the same components mixed almost in same ratio. The one component medical herbs (CM, KT, IC, FZ, FM and AD) make up one group, having similar chemical composition.

Similar results have been obtained carrying out the factor analysis. Using Varimax normalization and taking account of the loadings higher than 0.7, only two factors are sufficed in order to perform the classification of the samples. The first factor includes the samples coded with CM, CN, CV, FP, IC, MF, VO and YL; the other is composed with the remaining ones (exceptions are the samples SC and UV which differ significantly from the other groups). The factor analysis performed for the elements shows that they are grouped in three factors: the first group includes the elements Mg, Ba, Ca and Sr; the second group contains Co, Cu, Zn, Na, Rb, Fe, Mn and Ni; and the third one contains Cd, Pb and Li. K belongs to none of the mentioned groups. It can be seen that the applied chemometric analyses lead closely to almost the same results regarding the groups of the samples and that of the elements.

The correlation measurements between elements were performed too. The earth metals exhibit the highest correlation (above + 0.7). For the Ca and Ba pair the coefficient of correlation has highest value of all, being of +0.961. Moderate negative correlations have been found for K with Co (- 0.700) and with Pb (- 0.655), respectively.

4. Conclusion

The samples contain the metals in trace levels, the mass of them vary from sample to sample; the most dangerous metal for human health (lead and cadmium) are present in low concentrations, and only in few samples. The determination of the metal content of tea herbs and fruit tea stocks allows the assessment of environmental pollution and the quality and quantity of metal ions intake by human organisms. Based on the chemometric analysis the samples could be classified unambiguously in two clusters, their origin could be estimated too. The tea herbs samples are classified in three main clusters, based on the quantification of their Cd, Li, Pb, Cu and Sr content.

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Acta Universitatis Sapientiae
Agriculture and Environment, 1 (2009) 20-30

Cadmium biosorption on native *Saccharomyces cerevisiae* cells in aqueous suspension

Katalin TÁLOS[1], Csilla PÁGER[1], Szende TONK[2], Cornelia MAJDIK[2], Béla KOCSIS[3], Ferenc KILÁR[1], Tímea PERNYESZI[1]

[1]Department of Analytical and Environmetal Chemistry, Faculty of Science, University of Pécs, 6 Ifjúság, H-7624 Pécs, Hungary, e-mail: ptimea@ttk.pte.hu
[2]University Babeş-Bolyai; Faculty of Chemistry and Chemical Engineering**,** 11 Arany J., RO-400293 Cluj-Napoca, Romania
[3]Department of Medical Microbiology and Immunology, Faculty of Medicine, University of Pécs, 12 Szigeti, H-7624 Pécs, Hungary

Manuscript received 24.08. 2009; revised 20.09. 2009, accepted; 22.09.2009

Abstract: In the present study, sorption of cadmium (II) ions from aqueous suspension on to native *Saccharomyces cerevisiae* cells of different origin was studied. Baker's yeast, waste yeast from brewery and cultivated yeast cells were used as biosorbents for cadmium removal in solution.

The kinetics of cadmium biosorption by native Baker's yeast was investigated at different initial concentrations of the metal ion (5, 12.5, 25, 50 mg/L) at a pH 6. The adsorption equilibrium was reached within sixty minutes. The biosorption experiments were carried out at the natural state of pH 6 in the biomass suspensions using batch technique. Cadmium adsorption isotherms were determined on Baker's yeast at different sorbent dosages and yeast biomasses of different origin in the initial concentration range of 10 - 250 mg/L. The adsorption equilibrium of cadmium from aqueous solutions by yeast biomasses can be well described by Freundlich equation. The amount sorbed at equilibrium was found to be directly proportional to the initial metal ion concentration divided by the sorbent mass.

Keywords: heavy metal**,** adsorption, Baker's yeast, cultivated yeast, waste yeast from brewery, isotherm, kinetics

1. Introduction

Water pollution due to heavy metals is an issue of great environmental concern. Cadmium is one of the most toxic metals affecting the environment, which poses serious health hazards through entry into the food chain by anthropogenic pathways.

In the past few decades, biosorption using microbial biomass as an adsorbent, has emerged as a potential technique for metal removal, compared to other processes such as chemical precipitation, evaporation, ion exchange, adsorption, membrane processing and solvent extraction. Using microorganisms as biosorbents for heavy metals offers a potential alternative to existing methods for detoxification and recovery of these components from industrial waste waters. The special surface properties of microorganisms enable them to adsorb different kinds of pollutants from solutions [1 - 8].

Cadmium removal by biosorption has been extensively investigated during the last several decades [1 - 9]. In biosorption process cadmium can be removed by microorganisms like fungi, algae or bacteria [1 - 5]. Our biosorbent is Saccharomyces cerevisiae, which is a fungi, model organism in microbiology, used in several industries (Baker's yeast, brewery's yeast) and easy to cultivate. Much waste yeast is being produced and these forms could be used as biosorbent for removal of pollutants.

Our aims of this biosorption study were the followings:

- to test the cadmium removal in the biosorption process using various *Saccharomyces cerevisiae* yeast biomasses as a biosorbents,
- to evaluate the influences of different experimental parameters on biosorption, such as sorption time, sorbent dosages and initial cadmium concentration using batch technique,
- to determine adsorption isotherms using batch technique and analyze the adsorption equilibrium using Freundlich equation,
- to investigate the effect of biomass concentration on biosorption process using Baker's yeast.

2. Materials and Methods

Fungal biomasses

The biosorbents were Saccharomyces cerevisiae of different origin, as Baker's yeast (commercial yeast, Budafok, Hungary), yeast waste from brewery (Pécs, Hungary; Cluj Napoca, Romania) and cultivated Saccharomyces cerevisiae.

The waste yeast from brewery was washed thoroughly with distilled water and then it was liofilized. The Baker's yeast was used as sorbent material in natural commercial form. Its water content was 32 %. The strain used was Saccharomyces cerevisiae DSM 1333 which was kindly supplied by Department of Medical Microbiology and Immunology, University of Pécs. It was cultivated on Müller-Hinton culture medium, with 5 % glucose, at 37 °C during 48 hours. After cultivation it was liofilized.

Chemicals

The cadmium form Cd(II) (Cd(NO3)2.4H2O) (> 99 % purity) was purchased from Fluka Ltd (Hungary) and was used without further purification. The stock solution were prepared by dissolving 0,6525 g Cd(NO3)2.4H2O in 1.0 L of distilled water. The test solutions were prepared by diluting 500 mg/L of stock solution of cadmium to the desired concentrations.

The cadmium concentrations of prepared solutions varied between 5 – 250 mg/L in the sorption experiments.

Kinetics study of biosorption

In the cadmium kinetics study by Baker's yeast the concentration of cadmium ion was 5, 10, 25 and 50 mg/L at a suspension concentration of 1 g/L. The experimental time was 350 minutes. During agitation at 250 rpm in the first 30 minutes the samples were taken in all 5 minutes, after next during 30 minutes in all 10 minutes, in the following 2 hours in all 15 minutes and last sample was taken in the 350 minutes. The supernatant was spin-dried at 5500 rpm and diluted for analysis by atomabsorption spectrophotometry.

Batch experiments

Biosorption experiments were carried out in batch mode for determination of adsorption isotherm. The adsorption capacities of various biomasses at the same suspension concentration (1 g/L) were compared. In the case of Baker's yeast the suspension concentrations were 1.0, 2.0, 5.0, 10.0 and 20.0 g/L. The initial concentration of cadmium ion varied between 0 - 250 mg/L. Biosorbent and cadmium solution were placed in a test-tube. Tubes were agitated on a shaker at 150 rpm at constant temperature (22.5 ± 2 °C). Samples were taken at given time intervals (24 h), and then spin-dried at 5500 rpm for 10 min. The supernatant was used for analysis of the residual cadmium ions. The amount of cadmium adsorbed at equilibrium, q (mg/g), was obtained as follows [9]:

$$q = \frac{(c_0 - c_e)V}{m} \quad (1)$$

where,

c_0 and c_e are the initial and equilibrium liquid phase concentrations (mg/L)
V is the volume of the solution (L) and
m is the weight of the dry biomass used (g).

Analysis

The concentration of cadmium ion was determined by atomabsorption spectrophotometry (Perkin – Elmer 2380) at 228.8 nm. The calibration of cadmium was made with standard cadmium solution (Scharlau) in the concentration range of 0 – 2.5 mg/L.

3. Results and discussions

Adsorption kinetics of cadmium on Baker's yeast in aqueous suspension

The cadmium adsorption kinetics was investigated on Baker's yeast at a suspension concentration of 1 g/L at a pH 6.5. The initial cadmium concentrations were 5; 12.5; 25 and 50 mg/L. Figure 1a shows the change of cadmium concentrations versus adsorption time. In the Figure 1b the adsorbed cadmium amounts are presented against the adsorption time. The biosorption process of heavy metal by Saccharomyces cerevisiae usually completes rapidly [1, 6, 7]. Both figures represents that the adsorption equilibrium was reached within 60 minutes as the cadmium concentration did not decrease after 60 minutes.

In the case of 5 mg/L cadmium concentration the adsorption equilibrium was reached within 5 minutes, in the case of 10 and 25 mg/L initial concentration the equilibrium was reached within 60 minutes.

In the adsorption equilibrium at initial cadmium concentration of 5 mg/L the maximal adsorbed cadmium amount is q_{max} = 4.73 mg/g, at initial cadmium concentration of 12.5 mg/L the maximal adsorbed cadmium amount is q_{max} = 7.92 mg/g, at initial cadmium concentration of 25 mg/L the maximal adsorbed cadmium amount is q_{max} = 13.89 mg/g and at initial cadmium concentration of 50 mg/L the maximal adsorbed cadmium amount is q_{max} = 48.01 mg/g.

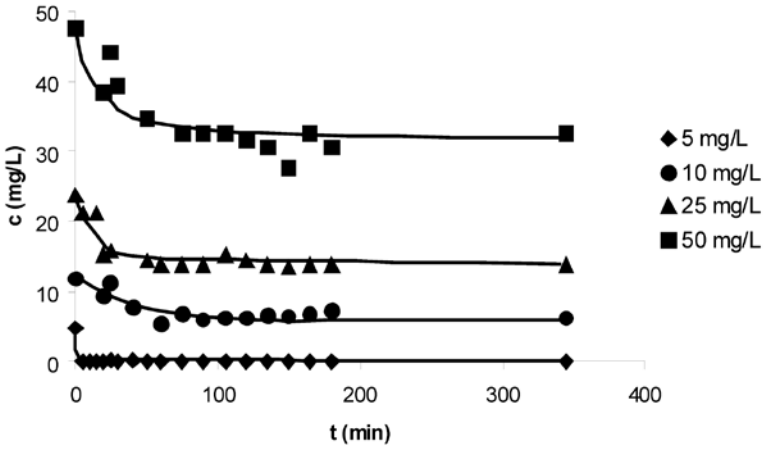

Figure 1a: Change of initial cadmium concentrations during the sorption kinetics of cadmium by Baker's yeast versus adsorption time, initial concentrations: 5; 12.5; 25; 50 mg/L, temperature: 22 ºC, biomass concentration 1 g/L

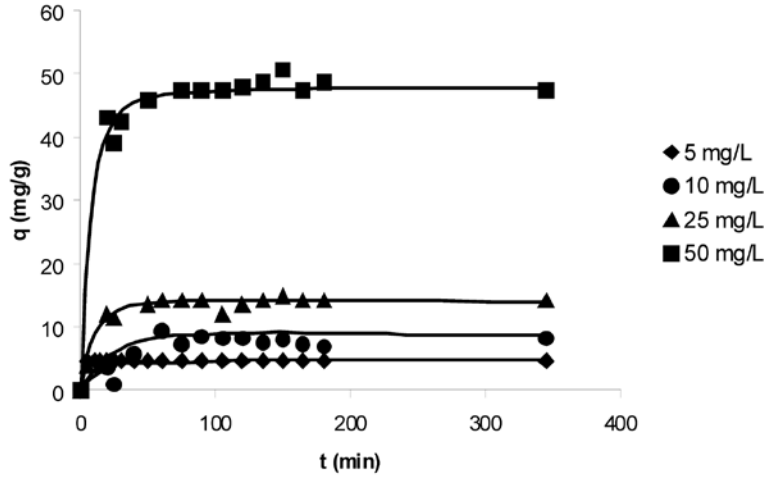

Figure 1b: The effect of initial concentration on the sorption kinetics of cadmium by Baker's yeast, initial concentration: 5; 12.5; 25; 50 mg/L, temperature: 22 ºC, biomass concentration 1 g/L

The adsorption rate was higher in the first thirty minutes, but decreased until the equilibrium was reached. Similar trends were found by other workers [6, 7]. It should be noticed that the adsorption of cadmium increased with an increase of the sorption time.

Adsorption isotherms of cadmium by *Saccharomyces cerevisiae* biomass from different origin in aqueous suspension

The adsorption isotherms of cadmium by Baker's yeast were determined in the initial concentration range of 5 - 250 mg/L by varying biomass dosage. The biomass concentrations were 1; 2; 5; 10; 20 g/L. On Figure 2 the adsorbed cadmium amounts are presented against equilibrated concentration. The cadmium adsorption by Baker's yeast increases with the decrease of the biosorbent dosage. At a suspension concentration of 1 g/L the maximal adsorbed cadmium was 109.8 mg/g, at a concentration of 2 g/L the maximal adsorbed cadmium was 32.2 mg/g, at a concentration of 5 g/L the maximal adsorbed cadmium was 16.5 mg/g, at a concentration of 10 g/L the maximal adsorbed cadmium was 7.4 mg/g and at a concentration of 20 g/L the maximal adsorbed cadmium was 1.48 g/mg.

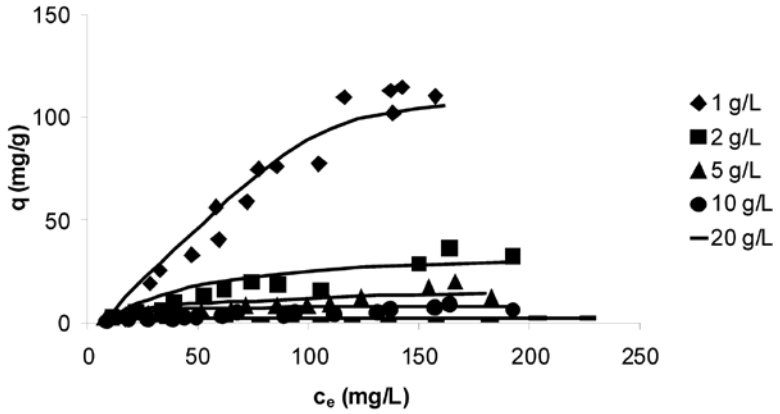

Figure 2: Cadmium adsorption isotherms by Baker's yeast from aqueous solutions at the biomass concentration of 1 g/L in the initial concentration range of 5-500 mg/L.

The analysis of equilibrium is important for developing a model that can be used for the design of biosorption systems. For adsorption analysis Langmuir and Freundlich equations were employed. Using Langmuir equation the results could not be evaluated.

Freundlich isotherm

The Freundlich equation based on sorption on a heterogeneous surface is given below as equation [9]:

$$q_{eq} = K_F C_{eq}^{1/n} \tag{2}$$

where,

KF and n are the Freundlich constants, which are indicators of adsorption capacity and adsorption intensity of the sorbents (2). Equation (3) can be linearized in logarithmic form as follows:

$$\log q_{eq} = \log K_F + \frac{1}{n} \log C_{eq} \tag{3}$$

The values of KF and n can be estimated respectively from the intercept and slope of a linear plot of experimental data of log qeq versus log Ceq.

The linearized Freundlich adsorption isotherms of cadmium (II) ions using various suspension concentrations are shown in Figure 3 a – e. The values of KF and n calculated from the plot are given in Table 1. along with the regression correlation coefficients. The parameters KF related to the sorption

capacity increased with decreasing biomass concentrations and thus increasing maximal adsorbed amount of cadmium ions. The Freundlich exponent n increased with increasing biomass concentrations as well.

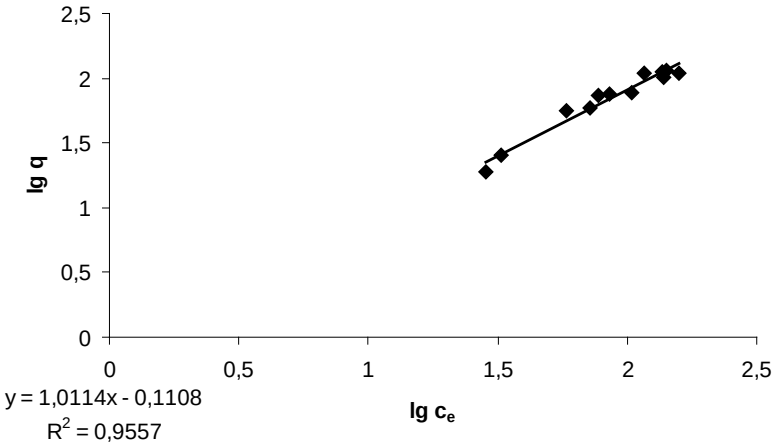

Figure 3a: The linearized Freundlich adsorption isotherm of cadmium(II) ions obtained at a biomass concentration of 1 g/L.

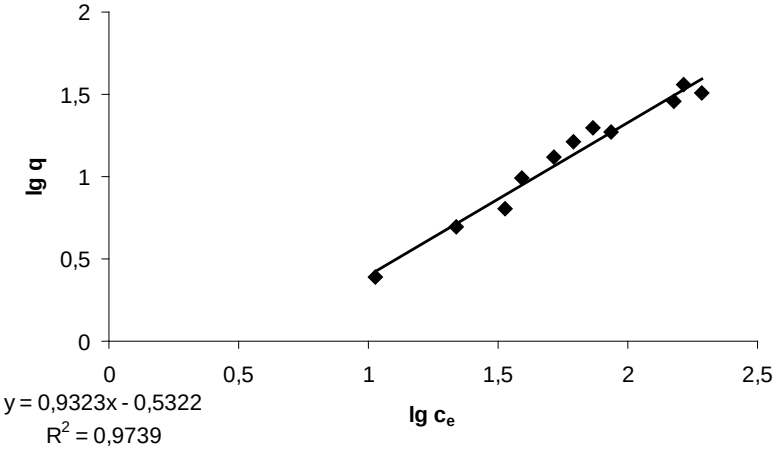

Figure 3b: The linearized Freundlich adsorption isotherm of cadmium(II) ions obtained at a biomass concentration of 2 g/L.

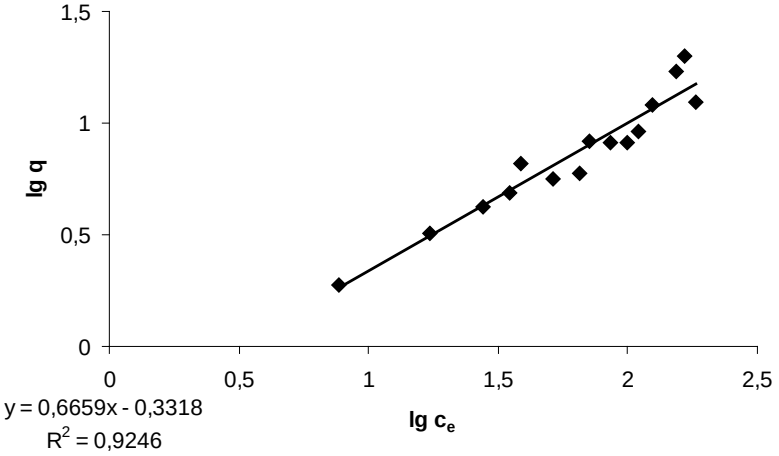

Figure 3c: The linearized Freundlich adsorption isotherm of cadmium(II) ions obtained at a biomass concentration of 5 g/L.

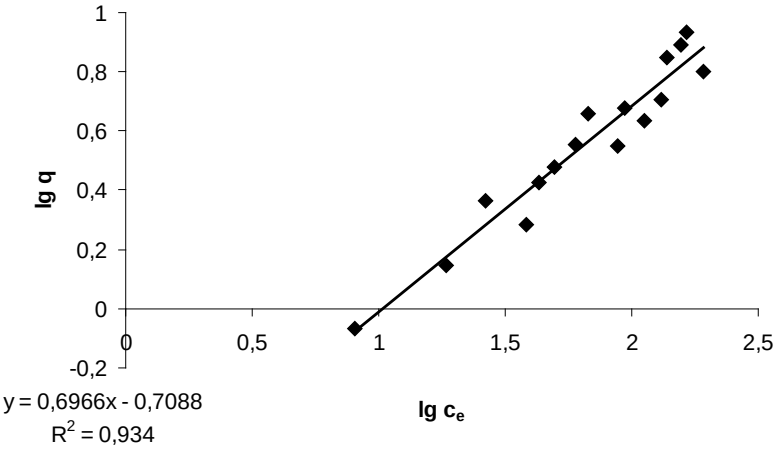

Figure 3d: The linearized Freundlich adsorption isotherm of cadmium(II) ions obtained at a biomass concentration of 10 g/L.

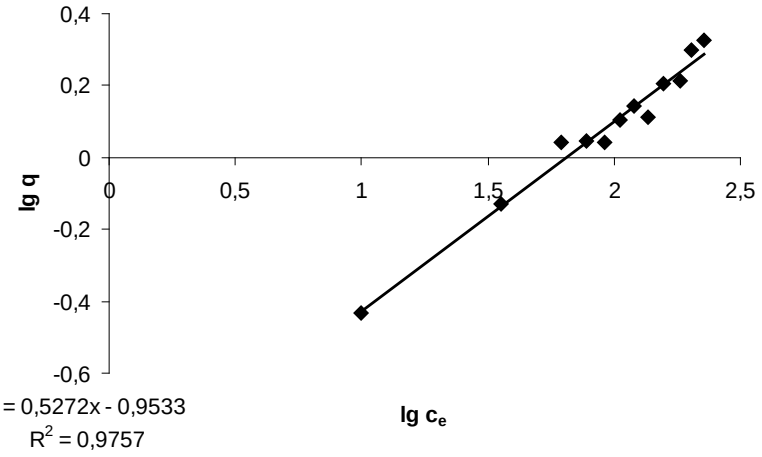

Figure 3e: The linearized Freundlich adsorption isotherm of cadmium(II) ions obtained at a biomass concentration of 20 g/L.

Table 1: The Freundlich isotherms constans of cadmium(II) ions by Baker's yeast at different biomass concentrations in the initial concentration range of 5-250 mg/L.

	Freundlich		
suspension concentration (g/L)	n	K_F $_{(mg/g)(mg/L)^n}$	R^2
1	0.99	0.77	0.9557
2	1.08	0.29	0.9739
5	1.49	0.47	0.9246
10	1.43	0.20	0.9340
20	1.89	0.11	0.9757

The Figure 4. represents the adsorption isotherms of cadmium (II) ions by Saccharomyces cerevisiae of different origin in aqueous suspension at the same biomass dosages (1 g/L) in the initial concentration range of 0 – 250 mg/L. The various Saccharomyces cerevisiae biomasses were the followings: commercial Baker's yeast from Hungary, waste yeasts from brewery (Cluj, Romania and Pécs, Hungary) and cultivated Saccharomyces cerevisiae fungal cells. The waste yeast from brewery of Cluj – Napoca had the worst adsorption capacity (q = 66.4 mg/g) and adsorbed linearly the cadmium (II) ions. In the low concentration range of metal ion the brewery waste from Pécs can adsorb more

ions than the Baker's yeast, but in higher concentration range it was reverse. The adsorbed amount of cadmium was the highest in the case of cultivated biomass (q = 140 mg/g). In the low concentration range preferential cadmium adsorption occurred on the surface of cultivated biomass in comparison with commercial and waste yeast cells from brewery.

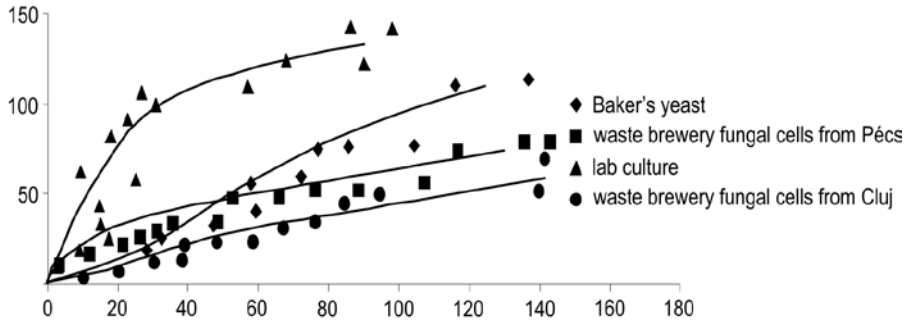

Figure 4. Adsorption isotherms of cadmium(II) ions on *Saccharomyces cerevisiae* biomass of different origin in aqueous suspension (1 g/L).

4. Conclusion

The cadmium(II) ion adsorption on native Saccharomyces cerevisiae biomass of different origin in aqueous suspension was investigated in this study. The various Saccharomyces cerevisiae biomasses were the followings: commercial Baker's yeast from Hungary, waste yeasts from brewery (Cluj, Romania and Pécs, Hungary) and cultivated Saccharomyces cerevisiae fungal cells. Experiments of adsorption kinetics proved that the adsorption equilibrium was reached within 60 minutes as the cadmium concentration did not decrease after 60 minutes. The adsorption isotherms of cadmium ions by Baker's yeast were evaluated in the initial concentration range of 5 - 250 mg/L by varying biomass dosage. The sorption capacity increased with an increase in initial cadmium concentration and decreased with increasing biomass concentration. The Freundlich model exhibited a good fit to the adsorption data of cadmium. The adsorption isotherms of cadmium(II) ions by Saccharomyces cerevisiae of different origin in aqueous suspension at the same biomass dosages (1 g/L) was analyzed as well. The cultivated yeast proved to be the best sorbent for

cadmium removal. In the low concentration range of metal ion the brewery waste from Pécs can adsorb more ions than the Baker's yeast, but in higher concentration range it was reverse. The least cadmium amount was adsorbed by waste yeast from brewery of Cluj – Napoca.

Acknowledgements

The authors wish to thank the Hungarian Science and Technology Foundation, the Division of Hungarian – Romanian Bilateral Affaires (grant no: OMFB-00789/2008).

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Acta Universitatis Sapientiae
Agriculture and Environment, 1 (2009) 31-37

Potential phytoremediation function of energy plants (*Tamarix tetranda* pall. and *Salix viminalis* l.) in effluent treatment of an intensive fish farming system using geothermal water

Réka HEGEDŰS[1, 2], Tünde KOSÁROS[1,2], Dénes GÁL[1], Ferenc PEKÁR[1], Mária BÍRÓNÉ ONCSIK[1], Gyula LAKATOS[2]

[1]Research Institute for Fisheries, Aquaculture and Irrigation, Szarvas, Hungary, e-mail: hegedusr@haki.hu, kosarost@haki.hu, gald@haki.hu, pekarf@haki.hu, oncsikm@haki.hu
[2]University of Debrecen, Department of Applied Ecology, Debrecen, e-mail: lakgyu@delfin.klte.hu

Manuscript received 05. 15. 2009; revised 06. 15. 2009; accepted 06. 20. 2009

Abstract: Sodium and other elements of salts are persistent in recycled water and are among the most difficult components to remove from water. In our study, the salinity (822±148 mg L^{-1}) of the effluent water of an intensive African catfish farm was reduced by irrigating halophyte tamarisk (*Tamarix tetranda* Pall.*)* and "energy willow" *(Salix viminalis* L.*).* In the first year experiments showed that the rate of Na and Mg uptake by tamarisk was higher, but willow resulted in higher removal efficiency per unit area, if the subsequent sodification effect on the soil and the risk of exceeding the salt-tolerance of the plants are neglected.

Keywords: geothermal water, energy plants, salt removal, phytoremediation

1. Introduction

In most cases the effluent water of intensive fish farming is discharged untreated into the adjacent surface waters and the environment is loaded by it. Low cost and effective methods are needed to treat aquaculture effluent in order to ensure the long-term sustainability [1]. Effluents are reused for irrigation purposes in many countries around the world [2]. Wastewaters can often contain significant concentrations of organic and inorganic nutrients. There is a potential for these nutrients to be used as fertilizer source when the water is recycled for irrigation in agriculture. Soil microorganisms also have been observed to increase metabolic activity when sewage effluent is used for irrigation [3], [4]. Irrigating halophytes with saline effluent from aquaculture

facilities might be a useful strategy to prevent eutrophication of surface waters caused by the direct discharge of aquaculture effluent [1]. Scientists from Israel and Italy had shown it was possible to produce an excellent yield of biomass for fuel by growing saltcedar (*Tamarix sp.)* on arid lands. They established experimental plantations of these plants, irrigated either with salty effluent from a desalination plant, or with recycled sewage from a local township. In the first two years, the plants grew 70 to 100 tonnes of biomass per hectare with underground roots and above ground parts; for biofuel, they expected a yield of 40 tonnes per hectare per year [5].

Our main goal was to obtain data about additional alternative methods to decrease the discharge of environmental pollutants and furthermore to bring promise of biomass production for energy purposes. In our study we also examined the potential phytoremediation ability of a halophyte energy plant, tamarisk/saltcedar *(Tamarix tetranda* Pall.*)* and an energy plant, a willow (*Salix viminalis* L.) in the irrigation reuse of the aquaculture effluent water.

2. Materials and Methods

The experiments were conducted at the Research Institute for Fisheries, Aquaculture and Irrigation, Szarvas, located at 46 º51´28´´ N and 20 º30´59´´ E. The local climate is continental with an average rainfall of 500 mm. The amount of precipitation in 2008 is shown in *Table 1*.

Table 1: The amount of precipitation in 2008 in mm (Szarvas, Hungary)

Jan.	Feb.	March	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.
28.0	3.1	42.8	37.9	32.8	133.8	45.2	49.2	39.0	17.6	3.6

The effluent water of the intensive fish farm was treated in a stabilization pond and after that in a fishpond [6]. The treated effluent water was dosed relatively in low amount, because the depth of rainfall was high this year. The total precipitation was 398 mm in the vegetative season. The water demand was complemented with 80 mm by micro-irrigation. The irrigation water from fishpond was portioned by micro sprinkler system (with 2 m distance among the spray heads). The main irrigation time was in July and August. This study was carried out in two ponds with concrete bank, 19:5x35 m sizes at each of them. We propagated by 20 cm cuttings of willow and set 1 year sapling of tamarisk. The row distance was 100 cm and the plant spacing was 80 cm at tamarisk and the spacing was 70x40 cm at the willow.

Sampling of water was performed once every month and 6 times. The elements (Ca, K, Mg, Na, P) of water samples were determined by ICP technology (Application note by Thermo Scientific: 40756, 40755). The

nitrogen content was measured by Kjeldahl method (MSZ EN ISO 5983-1:2005). The chemical properties of the applied effluent for the irrigation are shown in *Table 2.*

Table 2: Chemical properties of the applied effluent for the irrigation

Parameters	Unit	Average±SD (n=6)
Total salt	mg L^{-1}	822±148
Conductivity (20°C)	μS cm^{-1}	980±161
Total nitrogen	mg L^{-1}	10.8±4
Total phosphorus	mg L^{-1}	1.3±0.3
K	mg L^{-1}	6.3±0.7
Ca	mg L^{-1}	23.9±3.5
Cu	mg L^{-1}	0.028±0.014
Fe	mg L^{-1}	0.18±0.097
Mg	mg L^{-1}	11.4±1.7
Mn	mg L^{-1}	0.057±0.047
Na	mg L^{-1}	229.8±45.2
Zn	mg L^{-1}	0.011±0.008
Cl^-	mg L^{-1}	30.5±3.2
SO_4^{2-}	mg L^{-1}	11.7±3.9
HCO_3^-	mg L^{-1}	685.3±107.4
SAR*		9.7±1.76
Na	%	81.1±9.7

*sodium adsorption ratio calculated with the Gapon equation, expressed in mE

The soil samples were collected by Eijkelkamp type manual auger in spring and autumn season at 5 points from the 20cm upper layer of the soil. The experimental area was used as fishpond system previously. The sediment was approximately 20 cm deep, under it there was an impermeable loamy layer. The analysis of pH, total salt, $CaCO_3$ were measured by the Hungarian standard of MSZ-08-0206-2:1978; the K_A (clay content) were determined by the method of MSZ-08-0205:1978 standard, the organic matter (OM) by MSZ-08-0210-2:1977, the nitrate-N according to MSZ-20135:1999 standard. The P_2O_5, K_2O content and Cu, Zn, Mn, Na elements of soils samples were analysed with atomic absorption and by the method of MSZ 20135 (Hungarian standard).

Plant samples were collected from 10 points in the autumn season and were mixed and composed to 4 average samples. The fresh weight of vegetative parts (biomass) was recorded, then oven-dried at 105ºC, for dry weight determination. Plant samples then were ground into a fine powder using a

laboratory mill. Plant samples were analysed for total nitrogen by Kjeldahl apparatus, total P, Na, K, Mg, Ca were measured using ICP-OES after a microwave digestion.

The data of experiments were compared statistically by LSD test, using SPSS software.

3. Results and discussions

Before the plantation the pH value was slightly alkaline, according to the measured salt% the type of the soil was solonchak. It was classified to the compacted meadow soils with slight organic content. The values of the calcium carbonate% of the two areas were different, in the case of the willow plantation was slight and in the case of the saltcedar was medium. Both of the fields were well provided by phosphorus and potassium. The elements soluble in EDTA (Cu, Zn, Mn) were also present in sufficient concentration. The sodium content was very high in the case of both areas. Some properties of the soil at the experimental site are given in the *Table 3*.

Table 3: Soil chemical properties before the plantation (1) and at the end of the vegetation period (2)

Parameters	Unit	I/1	I/2	II/1	II/2
pH		7.3	7.3	7.1	7.1
K_A		65	60	59	64
Total salt	%	0.12	0.09	0.14	0.16
Organic matter		1.77	1.46	1.94	1.68
$CaCO_3$		8.51	9.3	4.07	4.3
AL- P_2O_5	(mg kg^{-1})	601	491	557	567
AL- K_2O		300	318	352	393
AL-Na		275	242	313	367
EDTA-Cu		7.89	6.04	8.31	7.91
EDTA-Zn		5.05	3.23	5.56	5.72
EDTA-Mn		63.5	73.8	123	119
$NO_3^-+NO_2$		14	7.1	5.76	6.02

I: *Tamarix t.*, II: *Salix v.*; AL: ammonium-lactate, EDTA: ethylene diamine-tetraacetic acid

High sodium ion in water affects the permeability of soil and causes infiltration problems. When sodium is present in the soil in exchangeable form, replaces Ca and Mg adsorbed on the soil clays and causes dispersion of soil particles (i.e. if calcium and magnesium are the predominant cations adsorbed on the soil exchange complex, the soil tends to be easily cultivated and has a

permeable and granular structure). Recycled effluent water can be a source of excess Na in the soil compared to other cations (Ca, K, Mg) and therefore it should be appropriately controlled.

At the end of the vegetation period the total salt content in the soil of tamarisk plantation was lower than that of the willow plantation, the value decreased to 0.09% from 0.12% .The amount of the available sodium reduced in the soil of tamarisk and increased in the soil of the willow. The total sodium content increased in both of them. The sodium adsorption ratio (SAR) did not vary significantly from the initial value, in the case of tamarisk it was lower and more favourable and in the case of the willow the SAR increased so the sodium ratio became higher (*Table 4*). When the SAR rises above 12 to 15, serious physical soil problems arise and plants have difficulty in absorbing water [7].

Table 4: The adsorbed alkali metals and the sodium adsorption ratio in the soil before the plantation (1) and at the end of the vegetation period (2)

Samplings	Ca	Mg	Na	SAR
	(mg kg^{-1})			me
I/1	15143	7695	309	0.5
I/2	36600	9860	576	0.5
II/1	32339	11390	508	0.6
II/2	23100	7560	668	0.97

I: *Tamarix t.,* II: *Salix v.*

The element contents of the plants are shown in *Table 5*. The salt content of the geothermal water mainly consists of Na-, Ca-, and Mg-bicarbonate (60-80%), so the removal capacity of Na, Ca, Mg and the N, P, K uptake of the irrigated plants were examined. The accumulated Na and Mg amounts in the leaves of tamarisk were significantly higher ($p<0.05$) than in the leaves of willow. The Na and Mg were stored preferably in the stem of the willow however the tamarisk accumulated them in their leaves. The Ca concentration of tamarisk leaves was higher ($p<0.05$) than in the willow leaves, but the concentration of this element of the willow stem was higher. In the case of P there was not significant deviation among the species. The uptake of the K was similar, it was higher in the leaves but there were not any significant differences. The N content of the willow was found in higher amount than in the tamarisk, both in the leaves and the stem.

Table 5: The element contents of the examined plant parts (in dry matter)

Plant parts	(n=4)	Salix v. (leaf)	Salix v. (stem)	Tamarix (leaf)	Tamarix (stem)
Dry matter	%±SD	33.7±1.9	32.1±2.5	32.4±0.9	57.7±2.6
N		3.19±0.35	1.11±0.21	2.51±0.2	1.59±0.32
K		1.79±0.32	1.36±0.39	1.99±0.19	0.82±0.02
P		0.37±0.05	0.18±0.02	0.47±0.14	0.19±0.02
Ca	mg kg^{-1}±SD	11325±121	5380±1250	21925±699	4243±553
Mg		3175±359	1445±197	7718±810	1888±204
Na		437±158	958±839	5525±946	1050±232

The traceable differences per unit area were calculated by the produced biomass data, which is enclosed in *Table 6*. Total Na accumulation in tree biomass after 1 year of treatment was relatively low. The Na concentration in the leaves in the high-salt treatment of the tamarisk was more than twice than the levels of the willow.

Table 6: The nutrient uptake by investigated plants (kg ha^{-1})

Plants	N	K	P	Ca	Mg	Na
Salix v. (leaf)	114.13	64.08	13.47	13.65	3.83	0.53
Salix v. (stem)	81.21	99.45	13.23	12.62	3.39	2.25
Salix v. (total)	**195.34**	**163.53**	**26.70**	**26.28**	**7.22**	**2.77**
Tamarix t.(leaf)	15.52	12.33	2.89	4.40	1.55	1.11
Tamarix t. (stem)	28.46	14.60	3.49	4.37	1.95	1.08
Tamarix t. (total)	**43.98**	**26.93**	**6.38**	**8.77**	**3.49**	**2.19**

The results of the first year experiments showed that the sodium and magnesium uptake by tamarisk was higher. However, the high biomass producing capacity of willow resulted in higher removal efficiency per unit area, neglecting the subsequent sodification effect for the soil and the risk of the salt-tolerance of the plants.

4. Conclusion

According to our experiments the irrigation may be considered as a good alternative for pre-treated salinity catfish farm effluent use, but requires regular monitoring of soil salinity to prevent soil salinization. In the vegetation period the sodification effect was negligible according to the soil parameters. The results of the first year experiments showed that the Na and Mg uptake by

tamarisk was higher, but the high biomass producing capacity of willow resulted in higher removal efficiency per unit area. We conclude that using salinity aquaculture effluent to irrigate halophytes can be a viable strategy for disposal of effluent. Salt-tolerant and halophyte species may provide effective phytoremediation since they grow to large sizes, allowing the larger amount of biomass to accumulate more salts. Other benefits of effluent reuse are: protection of water resources, prevention of river pollution, recovery of water and nutrients for agriculture, savings in clear water use and effluent treatment cost and producing biomass for renewable energy generation simultaneously. The results of our research may contribute to elaborate an environmental-friendly, locally applicable wastewater treatment technology.

Acknowledgements

Financial support for the research work was provided by the Sustainaqua EC-project (COLL-CT-2006-030384).

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Acta Universitatis Sapientiae
Agriculture and Environment, 1 (2009) 38-45

Adaptating dynamic simulation to a wastewater treatment plant reconstruction

Endre DOMOKOS[1], Viola SOMOGYI[1], Ákos RÉDEY[1], T. YUZHAKOVA[1]

[1]Institute of Environmental Engineering, University of Pannonia, Hungary
e-mail: domokose@uni-pannon.hu
e-mail: somogyiv@uni-pannon.hu
e-mail: redeya@almos.uni-pannon.hu
e-mail: yuzhakova@uni-pannon.hu

Manuscript received 30.07. 2009; revised 20.08. 2009, accepted; 25.08.2009

Abstract: The examined municipal wastewater plant was designed for 100,000 population equivalent (PE) and which was previously operating as a total oxidation system. The management wanted the plant to perform denitrification and excess phosphorus removal out of economical and environmental reasons. In this study the reconstruction plan created by the company was examined with the help of modeling software. On behalf of this the plant would function well during the summer, but at low water temperature (15°C) the expected results would not be met. Therefore the authors, after further calculations, suggested a new scheme.

Keywords: nutrient deficiency, phosphorous removal, modeling

1. Introduction

The wastewater treatment plant was working in the same structure since 1994. It was designed for a daily load of 48,000 m^3. The plant consists of three primary settlers with a total volume of 2270 m^3, four aerated reactors 3000 m^3 each and four secondary settlers (2750 m^3 each) operating in parallel mode.

The annual rate of flow of 2003 (Figure 1.) shows that in most of the year the input of the plant was around 21,000 m^3/day and even in the processing period of the preserving factory it did not go over 23,000 m^3/day. The daily fluctuation was of greater influence. This derived partly from the cyclic changes in processing and in the rate of the municipal flow, partly from the function of the feed pumps. The changes of a typical summer day are shown on Figure 2.

1.1. The characteristics of the wastewater

The hydraulic load of the plant was registered from the beginning. The volume and the dissolved oxygen concentration of the aeration tanks were recorded every 30 seconds by a computer. The control of certain elements in the technologic system was taken less care of because on previous supervisions and experiences the efficiency of treatment had seemed to be stable. Though the abrupt overloads of the processing wastewater had caused problems previously in the summer period but this was not revealing to 2004 summer. The oxygen supply of the system was between 1.5-5.0 mg/l according to the sensors which proved to be ample. Because of the great water temperature and sludge concentration denitrification took place only to a small degree beside total nitrification during the experimental measurements. Practically biological excess phosphorus removal could not be performed. It must be noted that the load was below the average.

Relying on the measured data one presumes a daily pattern of nutrient concentrations similar to the discharge curve (Figure 3). The peak in COD noticed at 08:00 a.m. was the result of the change of shift in the preserving factory when the boiling and wash-water was let out after the previous shift.

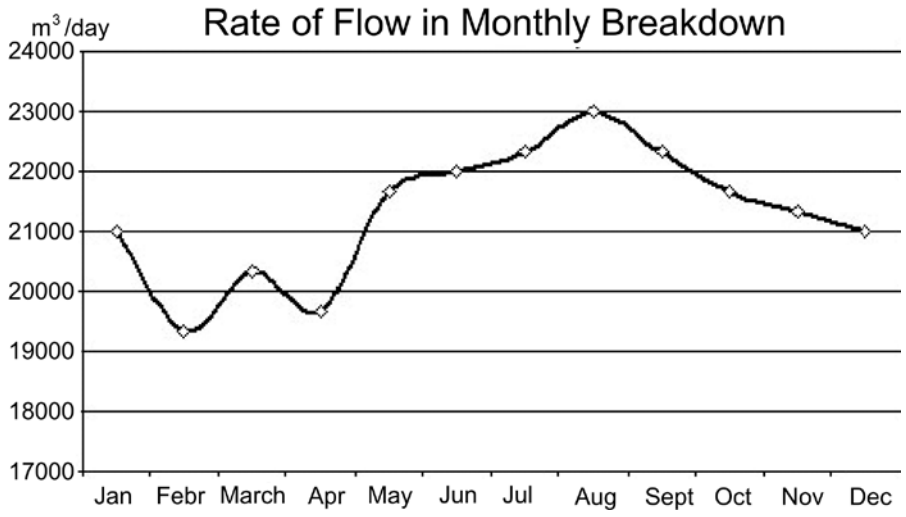

Figure 1: The rate of flow in 2003.

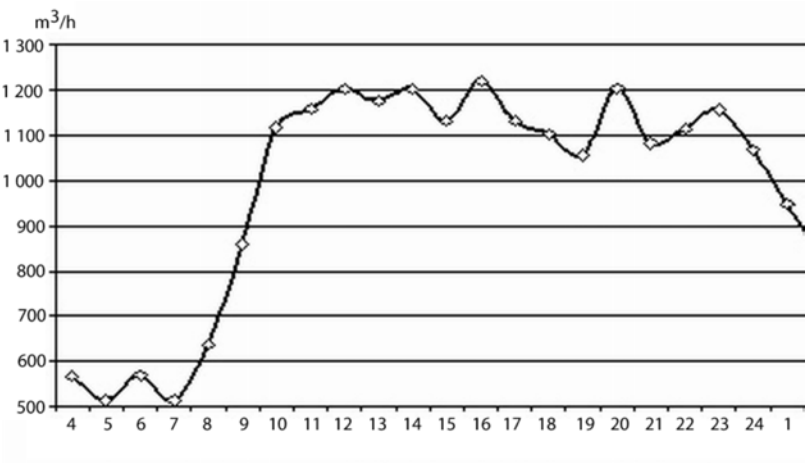

Figure 2: The fluctuation of wastewater flow on 14-15.08.2004 represents a typical summer day.

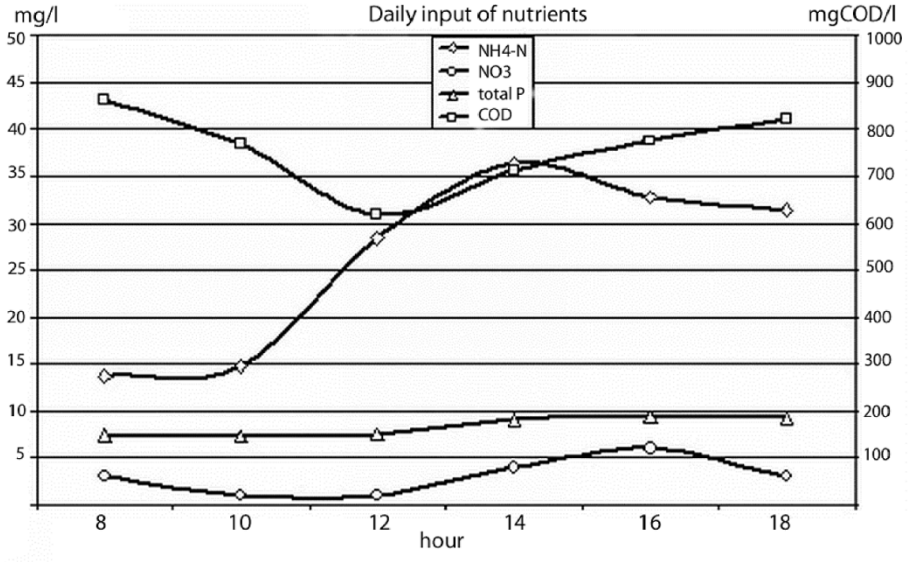

Figure 3: The nutrient concentrations correlate with the rate of inflow.

2. The planned changes

The management had realized that the plant had to be reconstructed before the introduction of stricter limiting values. On behalf of this the specialists of the company had created a draft on altering the plant (Figure 4.). As it will

become clear later on that was not the best version, but the company asked the authors to examine that one. The aim was to solve the three-step treatment without building a new object. In the next few lines this notion is described.

The wastewater proceeds from the detritor to the quaternary shaft from where it is led to the three primary settlers. The volumes of the settlers are 2*800 and 670 m^3, to which 2*490 and 380 m^2 surfaces belong. That adds up to a total surface of 1360 m^2 which means 0.36 m/h overflow rate at a minimum load of 500 m^3/h and 1.04 m/h at a maximum load of 1300 m^3/h. The sludge from the primary settlers is lead to the biological digestion tank mixed with the excess sludge from the thickener. From the gas obtained from the digestion tank electric current is induced which is used for aeration. The surplus energy is fed to the city mains.

The preliminary settled wastewater gets into the 2750 m^3 anaerobic tank or to the equalizing basin with the same size where the processes of hydrolysis start. The next stage is the 3000 m^3 anoxic tank where the wastewater rich in nitrate is recirculated, too. After that the cess-water arrives to a cascade, first to the 3000 m^3 big, high-rate aeration tank (No.1). From there it is led to the 2nd and 3rd low-rate aeration tanks. The last step in the treatment is the two shunt-connected secondary settlers (volume: 2750 m^3, surface: 1017 m^2 each). Finally the treated water is let to the Brook Csukás.

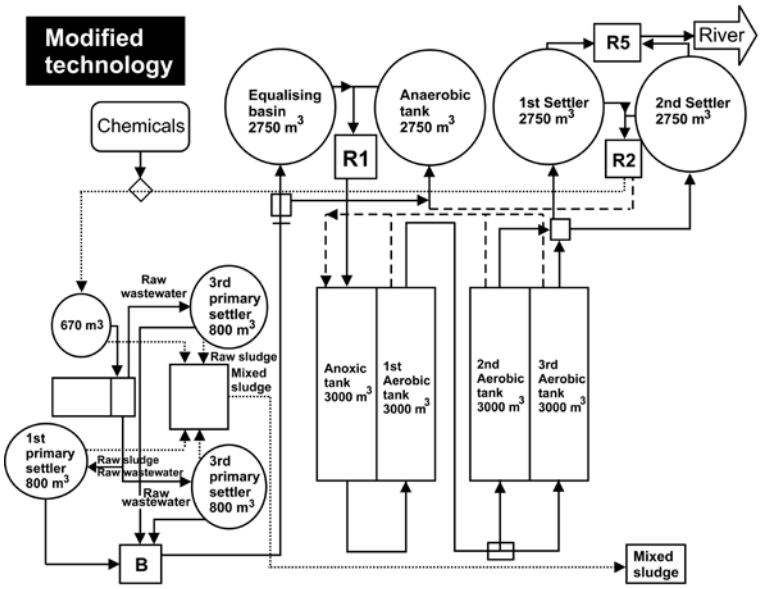

Figure 4: The plan of the reconstruction has alterations only in the way of the wastewater.

3. Evaluating the results of the simulation

In case of the changes the ammonium-nitrogen concentration would become lower than 1 mgN/l while the nitrate concentration would stay between 3-6 $mgNO^3/l$. The system is not able to remove excess phosphorus even in the new structure mainly because of the low sludge retention time (8.5 days) but this can be solved by chemical means.

Unfortunately these suitable values are only true in summer. At 15°C water temperature the ammonium-ion and nitrate concentration of the effluent will be at the limiting values and if temperature falls, which happens quite often in Hungary in wintertime, the system will operate under the expected values. The situation will get worse as the temperature goes down. At 10°C the nitrification will practically stop.

On the results of modelling the plan discussed above may be carried out. Analysing the data it may be stated that the system is verging on nutrient deficiency. This is because of the great amount of nutrient removed by the primary settlers. On the other hand the greater the removed nutrient amount is the more biogas (and so electric current) can be produced which is a considerable source of income. In summer this causes slight problems only during the peaks but in winter the whole operation becomes unstable.

4. Recommendations

During the simulation additional examinations were carried out. The quality of the treated water was studied in cases of different cascade-line structures. The results of the simulation showed that the rate of nitrification would fall back if the 2^{nd} and 3^{rd} tanks were added up instead of connecting in parallel. In addition the possibility of totally leveled system was also examined but it turned out that the efficiency of nitrification fell back significantly in this case, too.

From the steady-state calculations it becomes clear that the sludge retention time is very low in the system which makes nitrification unstable. It is advisable to increase the sludge concentration to at least 5000 mg/l. With this the overall retention time would become 11.1 days resulting 5.7 days in the aerobic tanks.

The equalizing tank indicated in the original plan has no real significance because the system can handle the regularly changing load; in fact fluctuation is advantageous in terms of the biology.

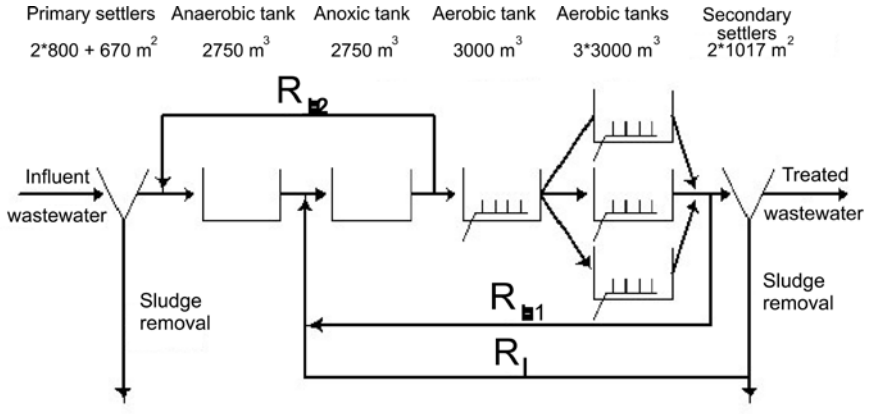

Figure 5: Another version of reconstruction is advised by the authors.

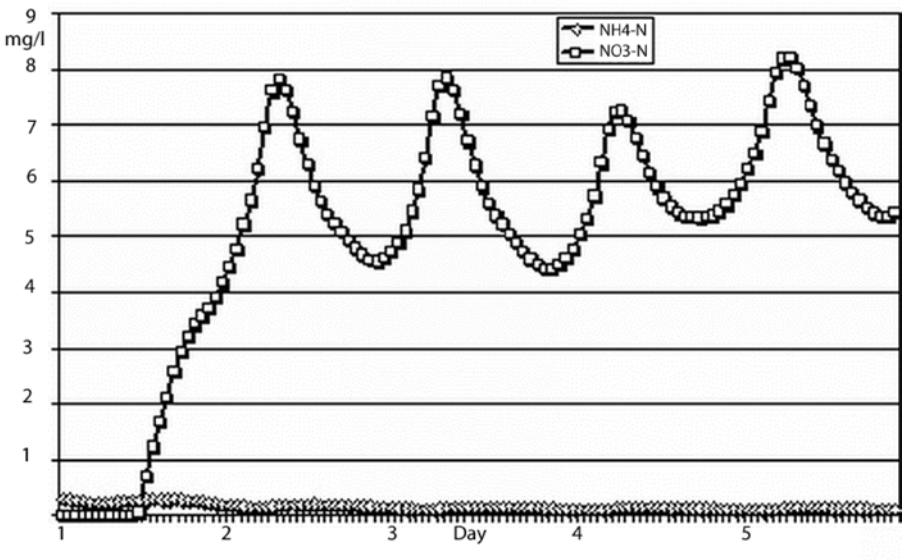

Figure 6: The concentrations in the effluent change according to the new proposal at 20°C.

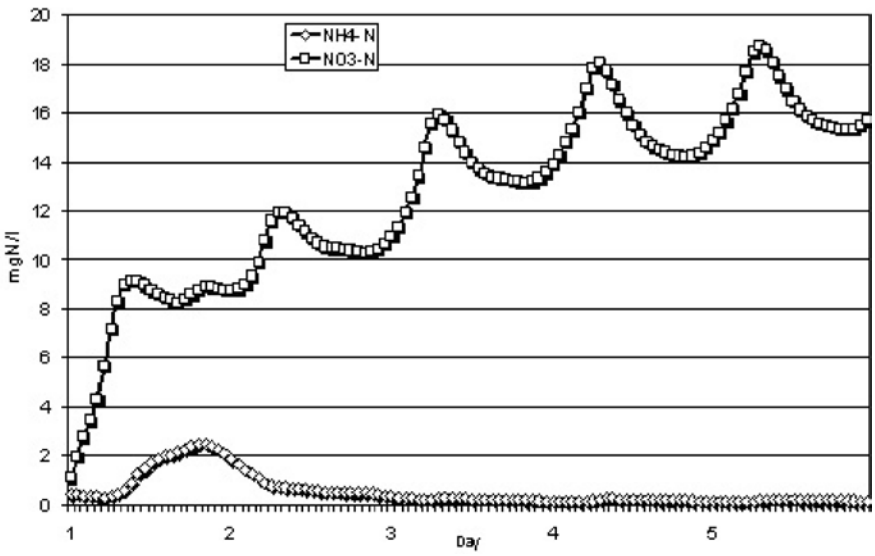

Figure 7: The effluent concentrations change according to the new proposal at 10°C.

A new plan is suggested by the authors which is a time-honoured method (UCT, a system developed by University of Cape Town) adapted to the plant. A new aerobic tank needs to be built shunt-connected to the 2nd and 3rd aerated basins (Figure 5.). In this version the overall sludge retention time would not change but in the aerobic sector it would become 7.6 days which would result a more secure operation.

In case of this structure of the wastewater plant the ammonium and nitrate concentrations would both change as seen in Figure 6. (at 20°C) and in Figure 7. (at 10°C).

5. Summary

In this paper the reconstruction plan of a wastewater treatment plant was reviewed. The scheme was examined with the help of computer-aided simulation.

It became clear that the changes planned by the management of the plant will fulfil the expectations only above 15°C water temperature while the biological excess phosphorus removal will not be possible because of the great amount of nutrient taken away in the primary settlers.

Another proposal was introduced by the authors. In the new version the ammonium-nitrogen concentration would meet the limit values even at lower water temperature (i.e. under 15°C) but the nitrate concentration would not be sufficient. It is necessary to build a new object and/or to reduce the quantity of

removed nutrients in the primary settlers in order to have the plant function properly in wintertime, too.

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Acta Universitatis Sapientiae
Agriculture and Environment, 1 (2009) 46-56

Examination on buffering ability of heavy metals in fresh-water sediments

Veronika SALACZ[1], Péter KERESZTÚRI[1]

[1]Department of Applied Ecology, Faculty of Science, University of Debrecen
H-4032, Debrecen, Egyetem tér 1., Hungary
e-mail: stuszivadasz@gmail.com

Manuscript received 05. 15. 2009; revised 06. 05. 2009; accepted 06. 06. 2009

Abstract: Due to development of technology and urbanization environmental pollution has become an increasingly severe problem. Heavy metal pollution is one of the best known environmental problems

In our experiments the examined heavy metals were the cadmium and the lead. The seed germination test was the *Sinapis alba* ecotoxicological test. Results were evaluated statistically.

It can be established that the more the quantity of the sediments are and the longer period they are shaken, the better the ability of the sediments is to buffer the polluting heavy metal.

Keywords: sediment, heavy metal, ecotoxicological testing, buffering ability

1. Introduction

Heavy metal pollution, which becomes an increasingly severe problem for humanity, is one of the best known environmental problems [1]. Plants easily take up heavy metal ions which accumulate in them and become nutrient source for animals [2].

There are several factors, which influence the toxic ability of heavy metals such as the amount of the given heavy metal, the quality and the quantity of the given sediment, the age and size of the given plant and so on [3]. In the course of our experiments the importance of the quality and quantity of sediments and the shaking period were principally examined.

Heavy metals can damage plants in different ways. They can alter permeability of cell membranes since they are able to react with essential metabolites [4]. They can damage photosynthetic pigments if the expositional time is long, chlorophyll synthesis can clog, which has negative effects on the photosynthesis itself as well [5]. Some of these changes are macroscopic for

instance chlorosis and necrosis. Roots can be damaged and shortened, the plant itself can become infertile as well [6].

The examined samples are derived from the southern shore of Lake Balaton, Balatonaliga and Balatonlelle. Samplings were taken from such areas, which are covered by water in rainy periods but in dry periods when the water level decreases terrestrial plants can appear periodically [7] thus through these plants heavy metals are able to infiltrate into the terrestrial ecosystems and develop their toxic effects [8]. The aim of our experiments was to assess the effects of the cadmium and the lead to the sediments depending on the shaking period, the concentration of heavy metals and the amount of the sediment suspension.

2. Materials and Methods

Ecotoxicological seed germination tests study how the phototoxic heavy metals affect germination. In our experiments 10, 20 and 30 mass percent of sediment suspensions were shaken on a bolting machine for one, two and three hours using 50, 100, 250 and 500 ppm concentrations of heavy metal ions. Shaking period illustrates the period of interaction of sediment and water phases. The experiments were carried out with *Sinapis alba* seed germination test [9]. The used statistic program was the Past 3.0 .

3. Results and discussions

Non-treated sediments

10, 20 and 30 mass percent of sediment suspension were prepared from samples derived from Balatonaliga („A") and Balatonlelle („L"). They were shaken for one, two and three hours on a bolting machine. On the y-axis average lengths of seedlings in the different samples can be observed correlating to the average length of seedlings grown in distilled water (*Figure 1*.).

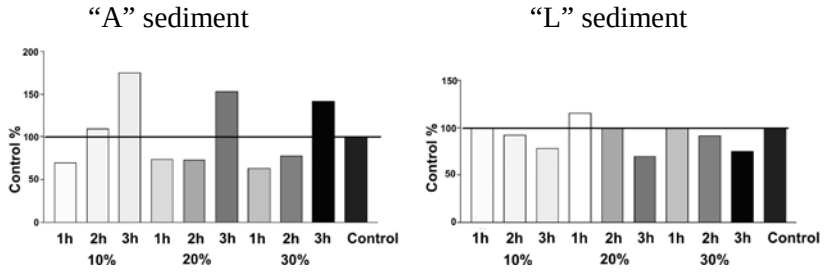


Figure 1: Length of seedlings grown in untreated "A" and "L" sediments

In the case of the “A” sample the three-hour-shaking proved to increase the root length. In other cases mild toxic effect could be observed.

In the case of the “L” sample an opposite effect can be seen. We measured significantly smaller values when the suspensions were shaken for three hours. In this way we can observe that the three-hour-shaking proved to retard the root growth. In other cases no significant changes were found.

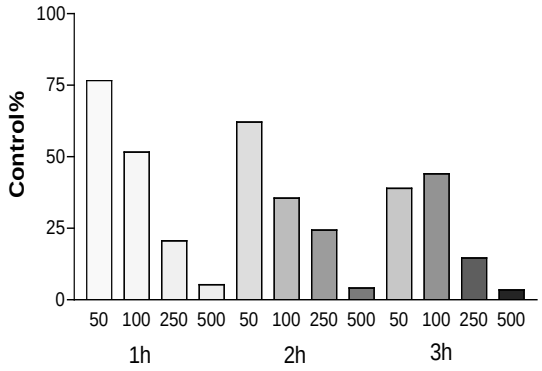
The possible cause of the results can be that the “A” sample might contain nutrients which were dissolved in the solution due to shaking and became easily available for seeds. Presumably in sample “L” some kinds of toxic matter were at present, which was also dissolved due to shaking and blocked the growth of seedlings. For more information further studies are needed.

Seed germination tests under laboratory circumstances with treated sediments

Cadmium and lead ions were added to the sediment suspensions (10 mass%, 20 mass%, 30 mass%), which were shaken for 1, 2, 3 hours on a bolting machine in laboratory circumstances. Different heavy-metal concentrations were prepared: 50 ppm, 100 ppm, 250 ppm and 500 ppm.

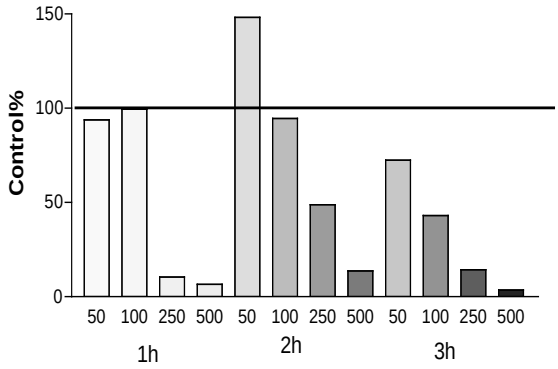
Cadmium treated sediments

Sediment “A”



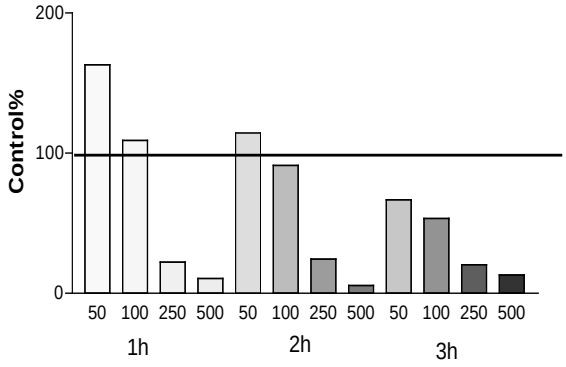
10%

Figure 2: Comparing the sediment (10 mass%) and cadmium (50 ppm, 100 ppm, 250 ppm, 500 ppm) concentration in cadmium treated sediment “A”



20%

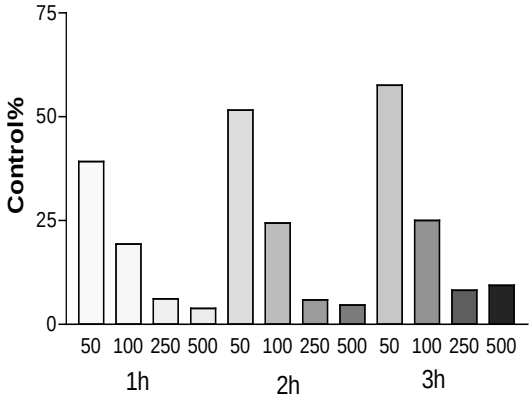
Figure 3: Comparing the sediment (20 mass%) and cadmium (50 ppm, 100 ppm, 250 ppm, 500 ppm) concentration in cadmium treated sediment "A"



30%

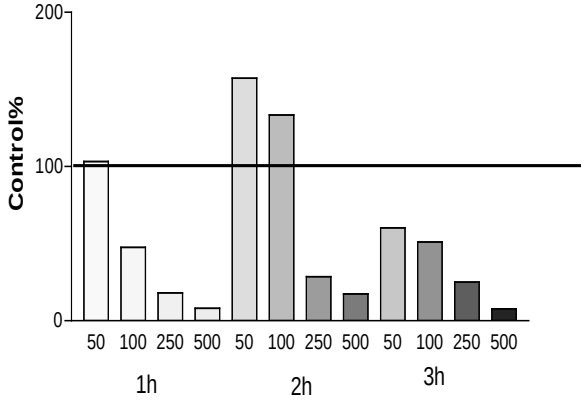
Figure 4: Comparing the sediment (30 mass%) and cadmium (50 ppm, 100 ppm, 250 ppm, 500 ppm) concentration in cadmium treated sediment "A"

Sediment "L"



10%

Figure 5: Comparing the sediment (10 mass%) and cadmium (50 ppm, 100 ppm, 250 ppm, 500 ppm) concentration in cadmium treated sediment "L"



20%

Figure 6: Comparing the sediment (20 mass %) and cadmium (50 ppm, 100 ppm, 250 ppm, 500 ppm) concentration in cadmium treated sediment "L"

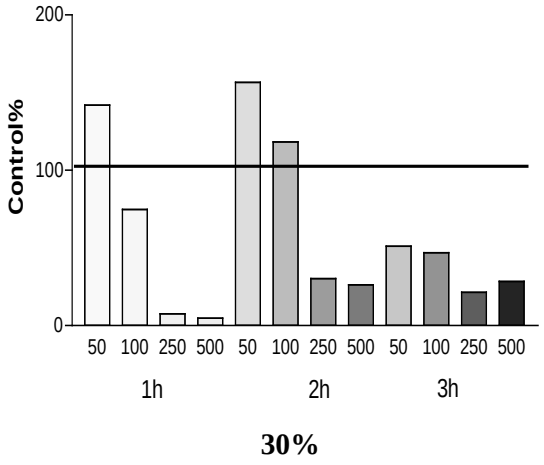


Figure 7: Comparing the sediment (30 mass%) and cadmium (50 ppm, 100 ppm, 250 ppm, 500 ppm) concentration in cadmium treated sediment "L"

The tendency, when sediments were treated with cadmium, is obvious. The bigger concentration of heavy metal was at present in the sediment suspension, the smaller the seedlings were. In most cases 250 ppm and 500 ppm proved to be so toxic that much of the seeds did not even sprout. When 50 ppm and 100 ppm concentrations were used the germination was detained. When the shaking time lasted only one hour or the sediment content of the suspensions were only 10 %, the average length of the seedlings were significantly smaller even at 100 ppm. Presumably the longer shaking period and the higher sediment content help on adsorbing polluters. It is also true that the average root length is smaller when 10% sediment content was used at 50 ppm and 100 ppm than 20% or 30 % sediment content at 50 ppm and 100 ppm. There is no significant difference between 20% and 30%. So it can be said that bigger amount of sediments has favorable effects on the growth of seedlings when mild cadmium pollution is observed (*Figure 2-7.*).

Lead treated sediments

Sediment "A"

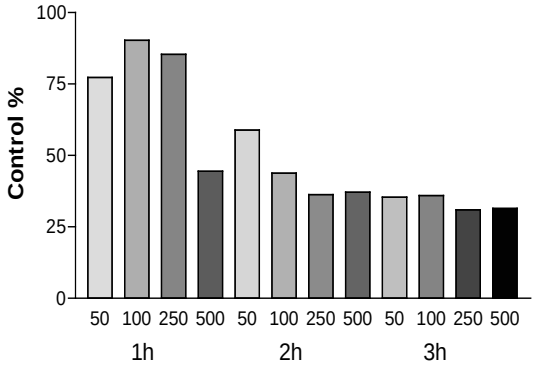


Figure 8: Comparing the sediment (10 mass%) and lead (50 ppm, 100 ppm, 250 ppm, 500 ppm) concentration in cadmium treated sediment "A"

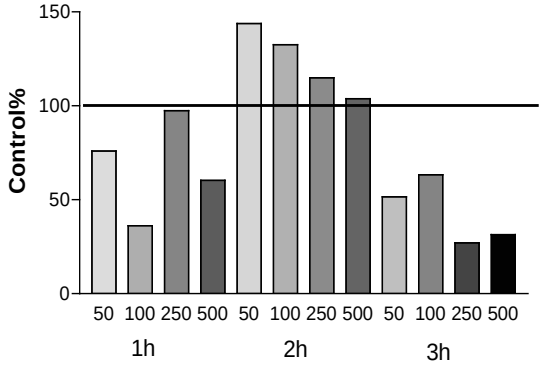
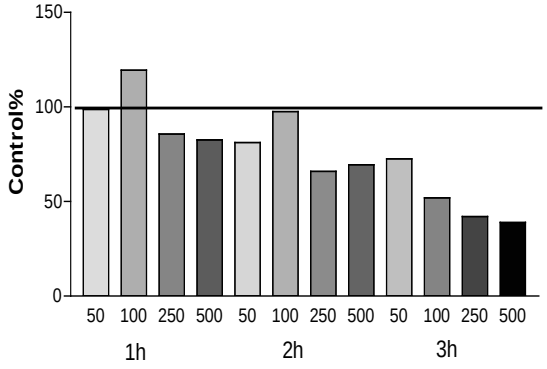


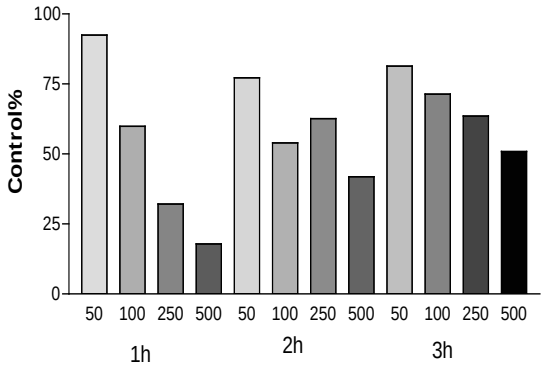
Figure 9: Comparing the sediment (20 mass%) and lead (50 ppm, 100 ppm, 250 ppm, 500 ppm) concentration in cadmium treated sediment "A"



30%

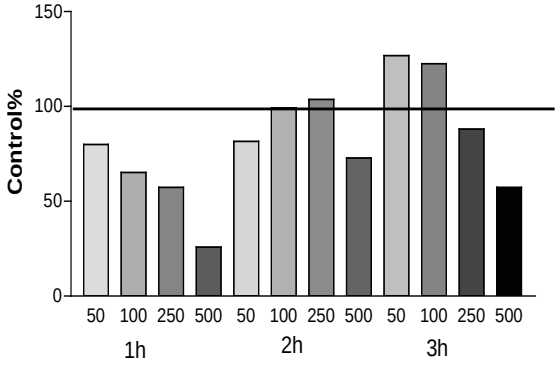
Figure 10: Comparing the sediment (30 mass%) and lead (50 ppm, 100 ppm, 250 ppm, 500 ppm) concentration in cadmium treated sediment “A”

Sediment “L”



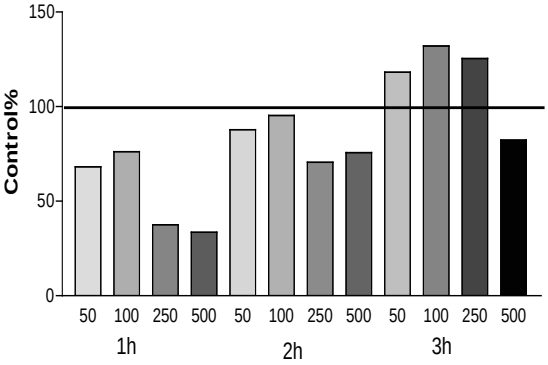
10%

Figure 11: Comparing the sediment (10 mass%) and lead (50 ppm, 100 ppm, 250 ppm, 500 ppm) concentration in cadmium treated sediment “L”



20%

Figure 12: Comparing the sediment (20 mass%) and lead (50 ppm, 100 ppm, 250 ppm, 500 ppm) concentration in cadmium treated sediment "L"



30%

Figure 13: Comparing the sediment (30 mass%) and lead (50 ppm, 100 ppm, 250 ppm, 500 ppm) concentration in cadmium treated sediment "L"

When lead was added to sediments under laboratory circumstances the tendency was not obvious. Seedlings in treated sediments were smaller than seedlings in untreated sediments, but as the lead contents were increased the root lengths did not show unambiguous fluctuation (*Figure 8-13.*). The reason for this is unknown, further experiments are needed.

Comparing the effects of lead and cadmium

The samples were treated with cadmium and lead in laboratory circumstances. Different heavy-metal concentrations were prepared: 50 ppm, 100 ppm, 250 ppm and 500 ppm. On the whole it can be established that both the heavy metals blocked the growth of seedlings but the cadmium proved to be more toxic than the lead.

Comparing samples "A" and "L"

It is unambiguously seen that the average root length of seedlings which were grown in sediment "L" are significantly smaller than those which were grown in sediment "A" *(Figure 5.)*. Consequently the buffer capacity of sediment "L" is notably smaller than the buffer capacity of sediment "A". This establishment is also underpinned by results with the experiments with non-treated sediments but further studies are needed.

4. Conclusion

Heavy metals can infiltrate in terrestrial and aquatic ecosystems through human activities. Since they can bioaccumulate, they have enormous effects on plants, animals as well as humans [10]. Non-essential heavy metals can be toxic in low concentrations as well and they can not be degraded in a biological way.

Samplings were taken from such areas, which are covered by water in rainy periods but in dry periods when the water level was decreased terrestrial plants have the possibility to appear periodically.

Ecotoxicological seed germination tests study how the phototoxic heavy metals affect germination. In our experiments 10, 20 and 30 mass percent of sediment suspensions were shaken for one, two and three hours using 50 ppm, 100 ppm, 250 ppm and 500 ppm concentrations of heavy metal ions. Shaking period illustrated the period of interaction of sediment and water phases. The experiments were carried out with *Sinapis alba* seed germination test

Both the heavy metals blocked the growth of seedlings but the cadmium proved to be more toxic than the lead. Due to our results it can be established that the more the quantity of the sediments are and the longer period they are shaken, the better the ability of the sediments is to buffer the polluting heavy metal.

Acknowledgements

Publishing of this journal is supported by the Institute for Research Programmes of the Sapientia University.

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Acta Universitatis Sapientiae
Agriculture and Environment, 1 (2009) 57-64

On-site wastewater treatment systems and legal regulations in the European Union and Hungary

Viola SOMOGYI[1], Viktória PITÁS[2], Endre DOMOKOS[3], Bence FAZEKAS[4]

[1]University of Pannonia, Institute of Environmental Engineering, Veszprém, Hungary, e-mail: somogyiv@uni-pannon.hu
[2]UP, Institute of Environmental Engineering, Veszprém, Hungary, pitasv@almos.vein.hu
[3]UP, Institute of Environmental Engineering, Veszprém, Hungary, domokose@ uni-pannon.hu
[4]UP, Institute of Environmental Engineering, Veszprém, Hungary, e-mail: fazekasb@almos.uni-pannon.hu

Manuscript received 28.07. 2009; revised 15.09. 2009, accepted; 20.09.2009

Abstract: The on-site wastewater treatment systems (WWTS) provide an alternative to regional wastewater treatment plants. Their application can be limited by the options for the disposal of treated water.

The Hungarian settlement structure underpins the importance of on-site WWTSs. It would be essential to apply wastewater treatment methods that are economical and environmentally reliable contributing to meet the requirements raised by the EU.

The aim of the research was to examine the regulations and practice of different European countries and to develop recommendations for further use of treated water originating from on-site WWTSs considering the Hungarian circumstances illustrated with an example.

Key-words: decentralised systems, legislation, water reuse, sewage disposal

1. Introduction

An alternative to the centralized way of wastewater treatment has begun to evolve nowadays: the application of on-site WWTSs as a decentralized way of sewage treatment.

These small-scale units have high priority in low population density areas, where the discharge of sewage to a central WWTP through a drainage system is not profitable. Constructing too long drainage conduits is not rational for two reasons: high costs and stagnant wastewater. The latter can cause rotting and/or

cooling down of the sewage in cold weather depending on the hydraulic residence time [1]. These make wastewater treatment much more difficult.

The Council Directive 91/271/EEC concerning urban wastewater treatment states that where wastewater collection systems are not justified either by economic or environmental aspects individual systems should be used. In case of Hungary this task is rendered more difficult by the numerous sensitive areas where further inspections on realisation have to be done. The reuse of treated water is not regulated either.

2. The European context

Of the total number of settlements in member countries of Central and Eastern Europe Global Water Partnership program[1] 91.4 % have less than 2000 inhabitants [2]. This concerns around 20% of the CEE population which is around 4% of Europe's population. The perspective until 2015 is that 75-90% of the total CEE population will become connected to the centralized systems of sewerage and wastewater treatment. This leaves a gap of 10-15%, corresponding to about 20 million rural inhabitants [2]. Since there is no obligation for the wastewater treatment for those settlements there is a risk of neglecting the problem.

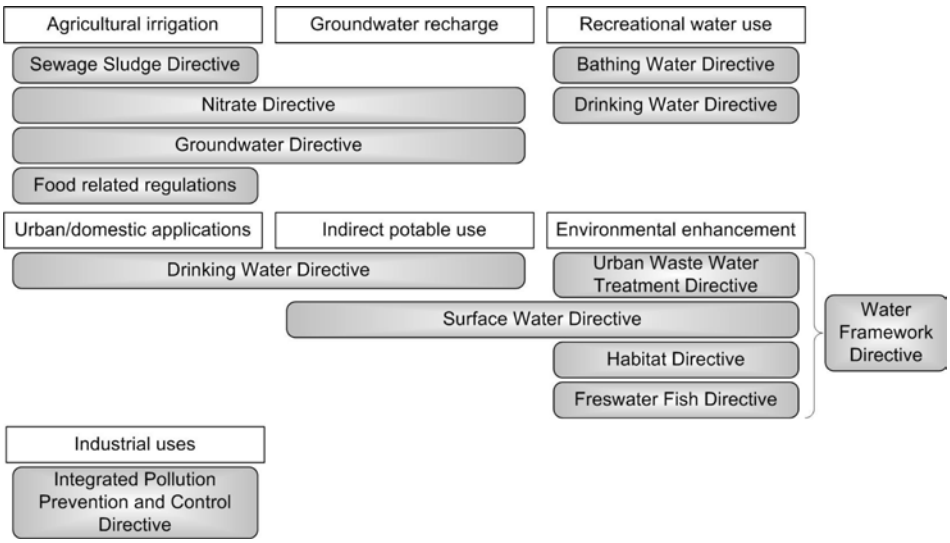

Figure 1: Reuse types and corresponding European Directives [4]

[1] Bulgaria, Czech Rep., Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, Slovenia and Ukraine, from now: CEE countries. Moldavia was not included at the time of the survey.

The European Council Directive 91/271/EEC concerning urban wastewater treatment states that "Treated wastewater shall be reused whenever appropriate" [3]. The problem is that the term 'appropriateness' remains legally undefined. One possibility to decide whether a reuse application is appropriate is to consider the costs and benefits.

Though there is no uniform regulation on water reuse in the EU, some of the concerns relevant to water reuse applications have already been addressed by separate directives. Figure 1 gives an overview of the different reuse purposes and relevant directives. It has to be mentioned that there are certain domestic applications that do not need potable water quality (i.e. toilet flushing). There is still a gap even in the European legislation concerning the quality criteria of greywater for non-potable use.

The Swedish framework for regulation of on-site treatment systems was updated in 2006 and 2008 [5]. One specification is that on-site systems need to reduce BOD_7 and phosphorus by 90% and nitrogen by 50% in sensitive areas, whereas systems in other areas must reduce BOD_7 and phosphorus by 90% and 70% respectively [5, 6]. Despite the strict limits, many conventional on-site wastewater treatment systems in Sweden do not meet these requirements [5]. Hence, many private households will need to improve their treatment systems.

In Finland, approximately one million residents (around 19% [7]) and over one million vacationers are located outwith the municipal sewer network [8]. It has been estimated that in rural areas the discharge of phosphorus to water is 50 % higher than in urban areas [9]. For this reason, rural wastewater treatment is tightly connected to eutrophication and needs to be considered in planning water management and restoration processes. One interesting point of the Finnish regulation is that the corresponding decree encourages the use of dry toilets [8].

A study was carried out by the University of Brighton investigating the extent of rural sewage treatment in the UK [9]. Approximately 98% of UK households are connected to the sewerage network [10], therefore the majority of municipal wastewater from both urban and rural areas is treated in wastewater treatment plants. In the United Kingdom water supply and wastewater industries are privately owned since 1989 therefore profit is an important aspect in the UK.

The distribution of the unconnected 2% of households is currently unknown [9], but it is probable that many of these properties are situated in rural areas. Of the non-mains systems 77% treats wastewater in septic tanks, 14% has package plants and 9% is unknown, which is not very promising. Still, in the UK the greatest problem in wastewater treatment seems to be the state of private sewers, i.e. those structures that are not owned by the one of the nine major sewerage companies. 45% of private sewers are in a condition susceptible to

deterioration and 17% are at significant risk of failure [9]. The problem will be solved only in 2011 when the ownership will be transferred to the sewerage companies [11].

3. Hungarian specialities

96% of Hungary's surface water comes from the neighbouring countries. Due to this fact, the quality and quantity of the Hungarian water bodies depend greatly on the interventions of these countries. However, Hungarian industrial and agricultural pollution contributes to the contamination of those as well and un- or not well-treated sewage plays a great role in the pollution load of the water supply. Since more than 90% of drinking water comes from groundwater, its protection is a strategic task in Hungary [12].

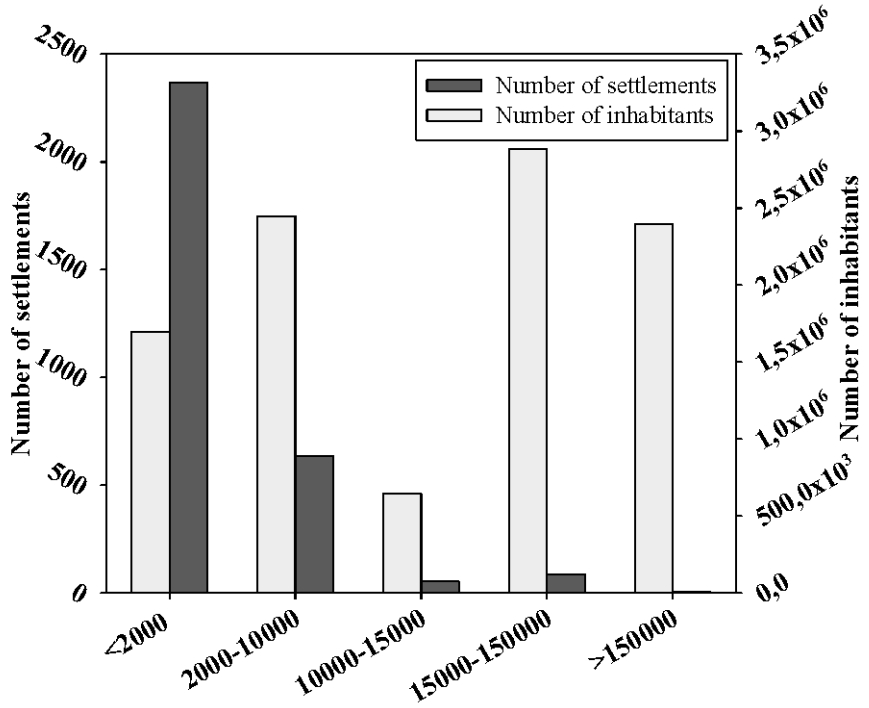

Figure 2: Settlement structure of Hungary (according to data of 2006.12.31.) [12]

About the settlement structure of Hungary it can be stated that the proportion of settlements with less than 2000 inhabitants is high (75.3%) but only 16.9% of the population lives in there (Figure 2) [12]. Therefore the

proportion of the amount of Hungary's whole wastewater flow coming from these settlements is only 4.7%. Despite of this fact, these are the places where the installation of small WWTUs should be taken into consideration regarding that their uniting into a wastewater treatment agglomeration group[2] is not feasible in many cases (mostly when these small settlements are far from each other in addition)[9].

The proportion of households in areas with no available sewerage system is 24.7 % (according to data of 2006.12.31.) [12].This data underpins the need for packaged WWTUs in Hungary.

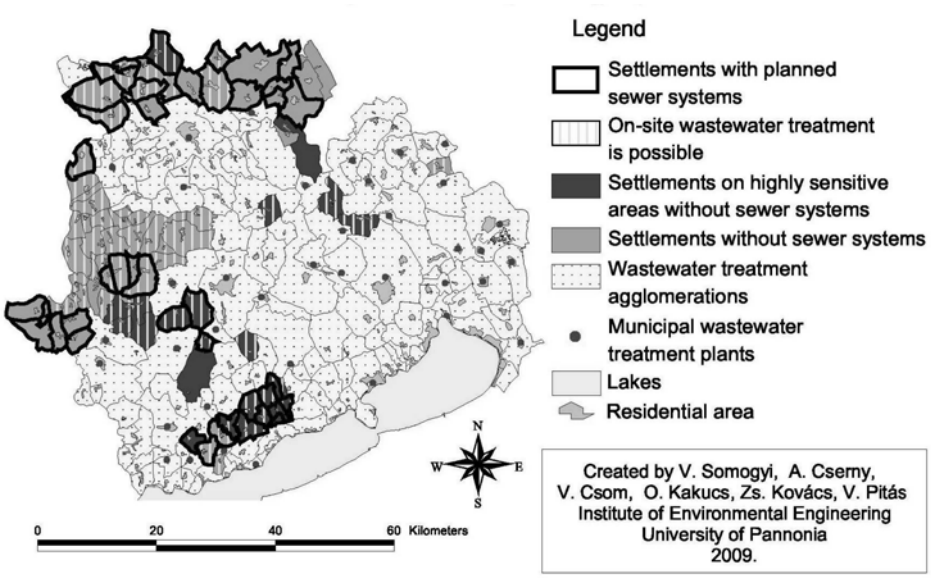

Figure 3: The status of wastewater treatment in Veszprém County, Hungary

Veszprém County is taken as an example for the Hungarian situation. In 2007 79.4% of households were connected to sewage systems which is higher than the nationwide average (69.8%) [13]. This is mainly because Veszprém County has great territories of highly sensitive areas concerning groundwater [219/2004] therefore to solve the question of wastewater treatment was of high priority. Nonetheless at present there are 85 settlements (39.2%) that are unconnected whereof at 41+1 settlements (19.3 %) centralised wastewater treatment will be applied in the near future (Figure 3) [14, 15, 16, 17]. The addition of plus one refers to a settlement that was not included in the list of agglomerations [14] but decided to invest in a local wastewater treatment plant

[2] e.g. the agglomeration group in the area of Veszprém with a central WWTP in Veszprém

in order to allow new investments at the village [18]. That concerns about 5.9% of the population and 6.4% of the households of the county. At almost all of the remaining settlements on-site wastewater treatment systems are applicable [15]. There are only 9 settlements that are on highly sensitive areas but at 7 of these decentralised means of wastewater treatment are allowed since their residential areas do not concur with vulnerable territories therefore discharge is possible. The other two must join a wastewater treatment agglomeration. Fortunately in both cases this can be carried out: both villages are in the neighbourhood of a regional wastewater treatment plant.

It has to be stated that according to the corresponding legislation [15] only the disposal of treated wastewater originating from on-site WWTUs established in vulnerable areas is prohibited, treatment is not. Taking the costs of this solution into consideration if treated wastewater has to be delivered to a municipal WWTP the implementation of a package plant becomes uneconomical. The only alternative in this case would be the total recycling and reuse.

One of the biggest problems connected to the introduction of small WWTUs in Hungary is that regulation concerning their establishment, maintenance and the disposal of treated water is scattered in parts of more than ten laws, and the disposal of treated water is not regulated properly. Regarding the problem, in case of less than 500 m^3/year water output the town-clerk has the competence of licencing. The Hungarian National Public Health and Medical Officer Service (ÁNTSZ) contributes as specialised authority. In special cases when the construction of the facility requires a building permit the Regional Inspectorate for Environment, Nature and Water is of competence [18]. Unfortunately the only way of disposal that can be permitted following the required examinations is the discharge of water into land drains according to Government Decree 50/2001. (3. IV.) [19], in spite of the fact that these WWTUs can produce high standard effluents assuming proper maintenance. This way the treated water could be laid back to the house for non-potable reuse purposes.

In advance, it is important to create an organization dealing with the authorization and regular control of decentralized WWTUs, and even to put an emphasis on the producers' and users' responsibility. Figure 4 shows the suggested decision-making model concerning the disposal of the effluent of small WWTUs. While making the model reasons that preclude on-site WWTUs were not taken into consideration. The coloured cell contains the solution for which there is no legislation in Hungary yet. This paper wanted to put an emphasis on this imperfection which greatly puts the spreading of decentralized WWTUs back in Hungary.

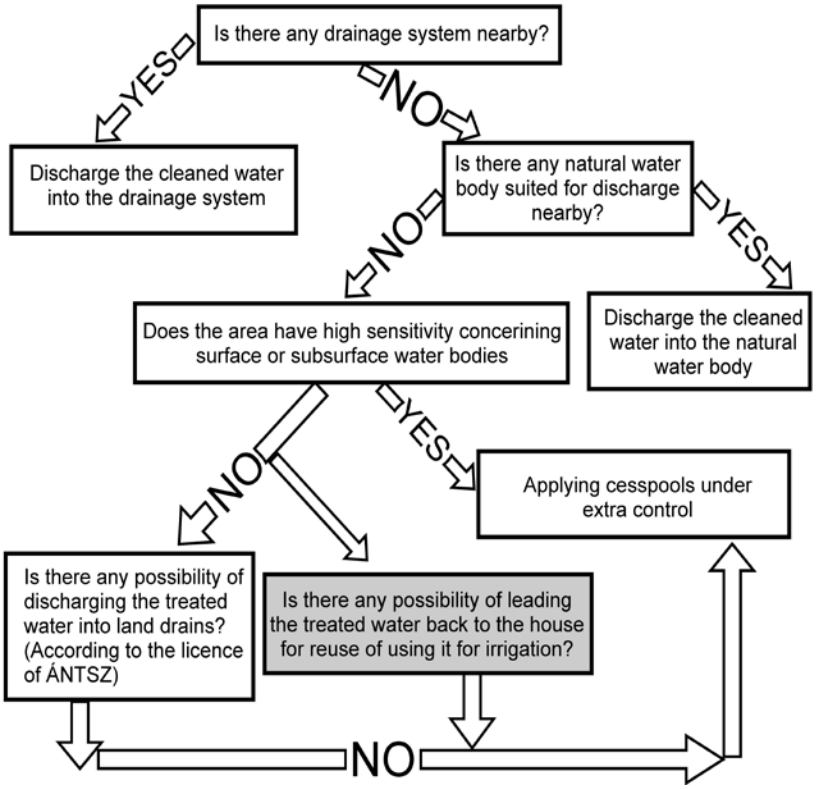

Figure 4: Steps of deciding on the disposal of small WWTUs' clarified water

4. Conclusions

Wastewater treatment in rural areas is the next problem that has to be faced in Europe. There are countries that have taken steps in order to preserve their 'good state' of their water bodies from that point of view and others have to deal with the question in order to provide their citizens with proper sanitation systems. In the case of Hungary the problem concerns one quarter of the population but the numerous regulations concerning on-site WWTSs and the legislation gap of water reuse hinder the spreading of environmentally feasible solutions. The latter applies to most of the European countries as well.

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Acta Universitatis Sapientiae
Agriculture and Environment, 1 (2009) 65-73

Estimation of sediment accumulation rate with gamma-spectrometry

Tamás GYŐRFI[1], Péter RAICS[2]

[1]Eötvös József College, Baja, Hungary, e-mail: gyorfi.tamas@ejf.hu
[2]Institute of Experimental Physics, University of Debrecen, Hungary,
e-mail: raics@tigris.unideb.hu

Manuscript received 09. 30. 2009; revised 10. 04. 2009; accepted 15. 04. 2009

Abstract: Our aim is to determine the age of the deposited sediment from which it is possible to estimate the rate of accumulation. We used the easily detectable Cs-137 isotope (half life $T_{1/2}$=30,07 year) for our investigation.

The results of the measurements show that the Cs-137 is present at a depth of about 54,8 cm. The nuclide Cs-137 which can be detected in the sample got into the environment in 1986 after the Chernobyl accident. The sample taking was performed in 2005. Supposing a linear model during 19 years the sedimentary rate determined by gamma-spectrometry is 2,9 cm/year.

Keywords: sedimentation, radioactivity, activity concentration, soil composition

1. Introduction

The filling up of the Nyéki-Holt-Duna watercourse (situated in the south of Hungary, next to Pörböly) has been determined by Ildikó Mátrai (EJF, Baja) with geodesic method [1], see *Fig.1*. To be able to compare and specify the measurement results, there was a need to determine the rate of silting up with another method, too.

Our aim is to determine the age of the deposited sediment with gamma-spectroscopy from which it is possible to calculate the rate of accumulation.

Gamma-spectrometry has become a very widely applied analytical method [2,3,4], due to the fact, that the gamma-photons are easy to detect providing the possibility of non-destructive analysis even bulk samples. The easily detectable

^{137}Cs isotope (half life $T_{1/2}$=30,07 year, gamma-energy 661 keV) was utilized for our measurement. This isotope was released into the atmosphere during the 1950s and the 1960s as a result of atmospheric atomic blasts as well as by the Chernobyl reactor accident in 1986. From the atmosphere it has fallen into the soil.

The ^{137}Cs isotope is suitable for determining the chronology of the sediment deposited during the last 40-50 years. The presence of the isotope and the function of the activity concentration as a function of soil depth refer to the age of accumulation. It was also possible to measure the ^{232}Th, ^{238}U and ^{40}K activity.

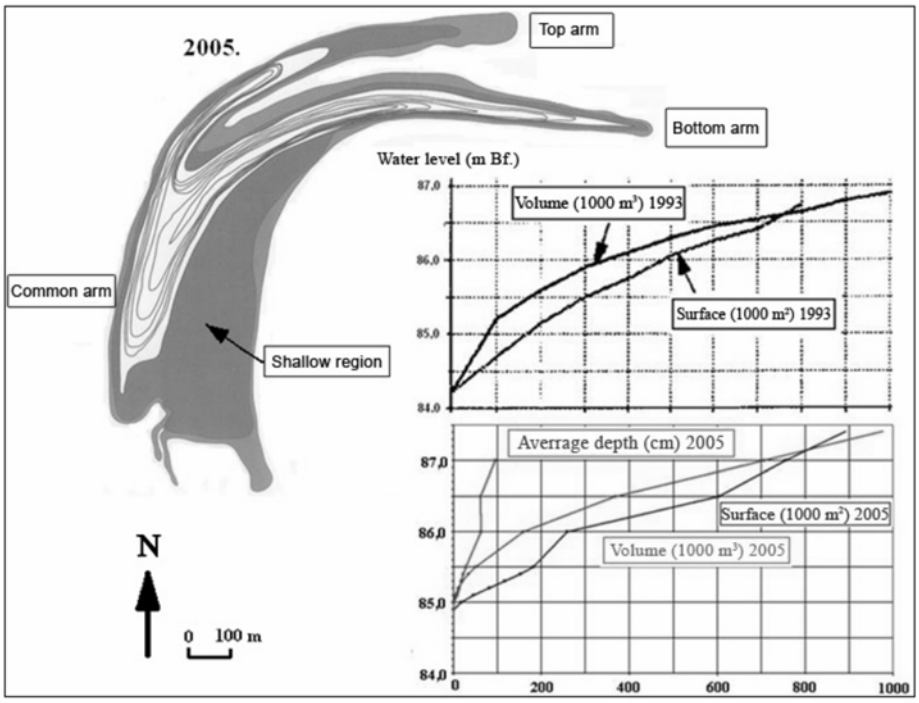

Figure 1: The isograms situation plan and surface-volume graph of the Nyéki-Holt-Duna.

In the course of the Chernobyl accident 19,5 kg ^{137}Cs were released from the reactor to the atmosphere. Cesium is a very volatile metal, being able to generate independent aerosols. Supposing an average aerosol size of 0,5 μm, then, in the case of uniform distribution, that amount of ^{137}Cs resulted in 6,4 kBq activity on every square meter of Europe as far as the Ural [5].

2. Experimental

We have performed the measurements with a CANBERRA GC2018 type, portable, extra-pure germanium detector, the sensitive volume of which is 100 cm^3. [6] The spectra were accumulated, displayed and processed by means of a PC and the GENIE2K software [7]. The scheme of the experimental setup and the photo of the detector may be seen in *Figs. 2* and *3*, respectively.

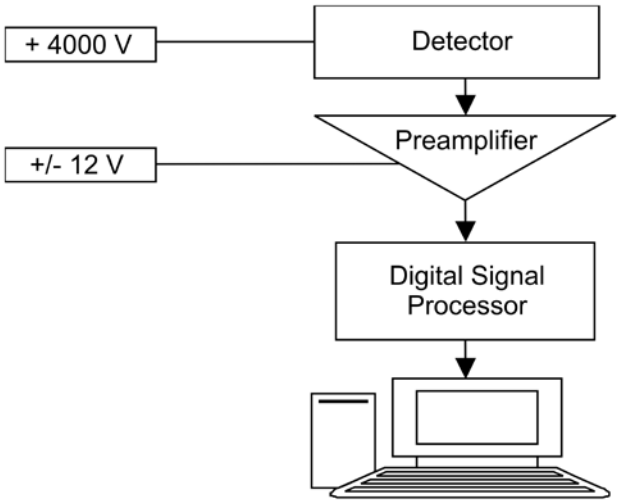

Figure 2: Scheme of the gamma-spectrometer

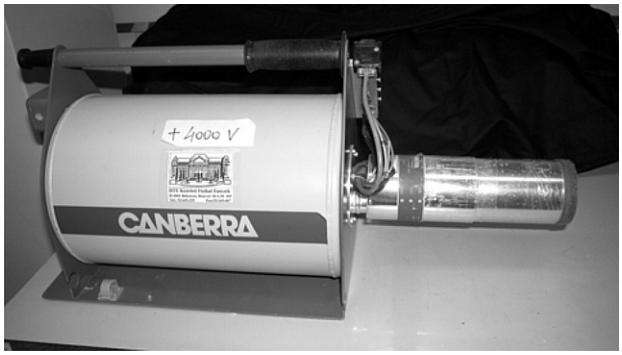

Figure 3: GC2018 type HpGe detector.

3. Material and methodology

A. Samples

The sample was taken in October 2005 by drilling. A 113 cm long segment was brought to the surface from the watercourse of the Nyéki-Holt-Duna. The length of the dry sample was 68 cm, consequently the packing factor is 0,6. A photo of the sample is shown in *Fig. 4.*

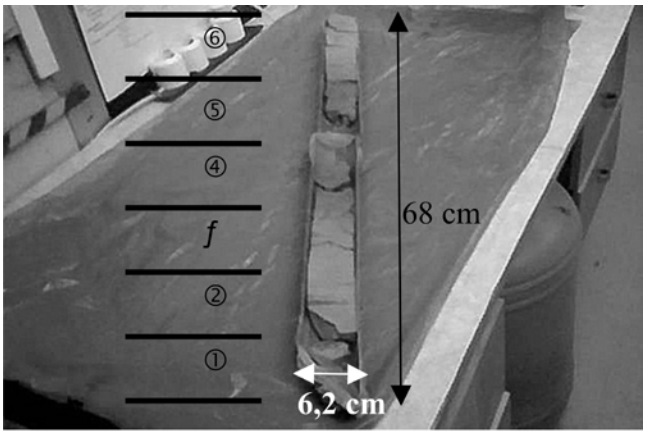

Figure 4: „Dry" environmental sample for investigation.

For the purpose of the measurement we have divided the sample into six pieces, reduced it to powder, sieved through a sieve of 630 μm and placed them packed into plastic jars of equal geometry. (The height and diameter of the cylindrical sample holder jars are: h_t~35 mm, d_t~67 mm, respectively.) Net mass, density, volume and the specific thickness of the samples can be obtained from the parameters of the jars by calculation.

The ^{137}C activity of the sample was determined by gamma-spectrometry. The activities with reference to mass were expressed in terms of activity concentration (Bq/kg).

B. Determination of the activity concentration

The samples were placed in the immediate vicinity of the window of the detector cryostat so that the bottom of the jars touched the window. The detector and the sample were shielded by a closed lead container. The detector bias was 4000 V. The maximum channel number selected was 8192 for the multichannel analyzer. This satisfactorily covers the entire measuring range up to 2,7 MeV

energy. The spectrum acquisition and analysis were performed by means of software GENIE2K of Canberra.

The samples were measured twice with a time difference of 20 days.

Having converted into Excel, we have derived the background corrected impulse values of the individual peaks. (The spectrum of the background radiation was also analyzed with closed lead shield).

Based on the literature gamma-energy values, the actual isotopes were identified from our measured peaks. Besides ^{137}Cs, the activity concentrations of the normally occurring nuclides as ^{238}U, ^{235}U, ^{232}Th with their daughter products as well as for ^{40}K were determined [8]. The peaks having the appropriate statistics were selected for the calculations. Nuclear data for these isotopes and their utilized gamma-lines are summarized in *Table 1*.

Table 1: Nuclear data for the measured gamma-peaks

Decay series	Nuclide	Branching ratio	Energy (keV)
^{232}Th	^{228}Ac	0,0438	209,23
^{232}Th	^{212}Pb	0,4740	238,63
^{232}Th	^{228}Ac	0,1260	338,31
^{232}Th	^{208}Tl	0,3036	583,14
^{232}Th	^{228}Ac	0,2840	911,14
^{232}Th	^{228}Ac	0,1617	968,91
^{232}Th	^{208}Tl	0,3564	2614,71
^{238}U	^{226}Ra+^{235}U	0,0400	186,14
^{238}U	^{214}Pb ^{226}Ra	0,2020	295,20
^{238}U	^{214}Pb ^{226}Ra	0,4010	351,92
^{238}U	^{214}Bi ^{226}Ra	0,4840	609,27
^{238}U	^{214}Bi ^{226}Ra	0,1600	1120,28
^{238}U	^{214}Bi ^{226}Ra	0,0418	1377,64
^{238}U	^{214}Bi ^{226}Ra	0,1660	1764,49
^{238}U	^{214}Bi ^{226}Ra	0,0530	2204,14
	^{40}K	0,1067	1460,86
	^{137}Cs	**0,851**	**661,65**

In order to be able to determine the activities belonging to the gamma-transitions of the individual isotopes (*Table 1*) we need:

- the intensities of the individual gamma-lines
- the branching ratios of the transitions
- the efficiency of the detector, and
- the compensation of the counting losses.

Intensities were calculated from the peak areas and measurement live time. Branching ratios are known from the literature and are listed in *Table 1*.

With the complex efficiency [9] of the detector available, the activity can be calculated with formula (1) and (2):

$$\eta_{komplex} = \frac{\int_0^{2\pi}\int_0^{R}\int_0^{H} \eta(Eg,z)\cdot\eta(E\gamma,\Theta)\cdot e^{-\mu\cdot z}\ \mathrm{r}\cdot \mathrm{d}\Theta\cdot dr\cdot \mathrm{dz}}{\mathrm{V}} \tag{1}$$

$$A = \frac{I}{\gamma\cdot\eta_{komplex}} \tag{2}$$

Here γ is the branching ratio, I is the intensity measured by the detector and $\eta_{komplex}$ is the complex efficiency.

By dividing the results with the mass of the given sample m_s, we get the activity of the individual isotopes relating to a unit mass, i.e. the activity concentration, the symbol of which is *AK* (Bq/kq). The isotope mass in the activity formulae (3) and (4) below is denoted by m_i, L is the Avogadro-number, M is the molar weight and λ is the decay constant of the nuclide.

$$A = N\cdot\lambda = \frac{m_i}{M}\cdot L\cdot\lambda \tag{3}$$

$$AK = \frac{A}{m_s} = \frac{m_i}{m_s}\cdot\frac{L}{M}\cdot\lambda \tag{4}$$

It was found, that whilst the activity of the decay products of ^{238}U changed during the time, the activity of ^{232}Th remained unchanged. The same is true for ^{40}K. The reason for the previous effect is the emanation of the radon from the sample after its processing. Corrections for this loss were applied.

The uranium, thorium and potassium content of the soil samples was determined by means of activity concentrations. The final results for ^{238}U and ^{232}Th are average values from the activity concentrations of their daughter nuclei belonging to the given decay series. In the case of ^{235}U this value was determined by the ratio of the specific activity of ^{238}U and ^{235}U. [7]

C. Activity concentrations of ^{238}U, ^{232}Th and ^{40}K of the sample

The activity concentrations of ^{238}U, ^{235}U, ^{232}Th and ^{40}K content of the soil samples were calculated by the expressions (3) and (4).

The ^{238}U, ^{232}Th and ^{40}K content and the activity concentrations of the Nyéki Holt-Duna watercourse samples are shown in *Table 2*.

Table 2 : The ^{238}U, ^{232}Th és ^{40}K activity concentration AK and content of the samples taken from the Nyéki-Holt-Duna watercourse.

Depth:	**6,5 cm**			**19 cm**			**28 cm**		
Jar:		t 04			t 06			t 07	
	AK	**Content**	**Error**	**AK**	**Content**	**Error**	**AK**	**Content**	**Error**
Z	**Bq/kg**	**g/ton**	%+/-	**Bq/kg**	**g/ton**	%+/-	**Bq/kg**	**g/ton**	%+/-
92:U	24,415	1,98	11,77	16,04	1,30	44,12	16,82	1,36	15,88
90:Th	26,939	6,64	4,82	21,10	5,20	5,00	17,37	4,28	7,76
19:K	506,493	16700	1,98	408,20	13500	8,20	338,538	11200	1,18
Depth:	**41 cm**			**54,5 cm**			**64 cm**		
Jar:		t 03			t 02			t 01	
	AK	**Content**	**Error**	**AK**	**Content**	**Error**	**AK**	**Content**	**Error**
Z	**Bq/kg**	**g/ton**	%+/-	**Bq/kg**	**g/ton**	%+/-	**Bq/kg**	**g/ton**	%+/-
92:U	23,82	1,93	18,24	21,60	1,75	28,72	23,74	1,92	7,72
90:Th	20,85	5,14	2,74	26,16	6,45	7,65	26,51	6,53	3,28
19:K	379,41	12500	3,15	480,15	15900	1,75	456,02	15100	1,22

We have compared our soil composition results with details of measurements taken in other areas and it was found that the *AK* values listed in *Table 2* are in good agreement with results obtained in other countries of the World.

Table 3: ^{137}Cs activity concentration of the samples taken from the Nyéki Holt-Duna watercourse.

Sample	Depth (cm)	Average	Net CPS	A (Bq)	AK (Bq/kg)	+/-%	Mass (g)
4	0-13	6,5	0				
6	13-23	19	0				
7	23-33	**28**	2,47E-02	1,661	**14,97**	54,07	110,945
3	33-49	**41**	2,20E-02	1,413	**16,65**	50,85	84,89
2	49-60	54,5	0				
1	60-68	64	0				

C. ^{137}Cs activity concentration of the sample

^{137}Cs was traceable in samples number 7 and 3. Their results are summarized in *Table 3*. The activity distribution in depth is shown in *Fig.5*. The ^{137}Cs contamination originating from experimental atomic blasts was not only confined to samples from the Chernobyl accident.

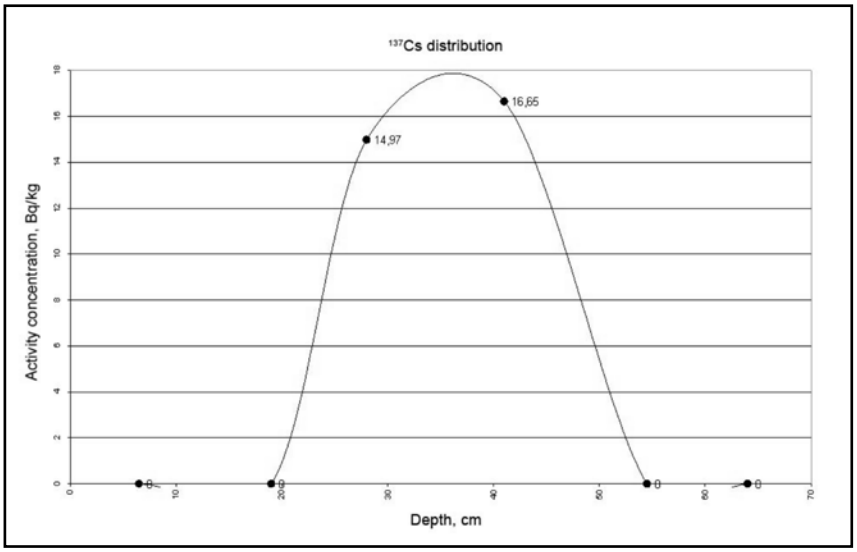

Figure 5: ^{137}Cs distribution in depth.

4. Summary

The results of the measurements show that the ^{137}Cs is present in the "dry" sample at a depth of about 33 cm, which corresponds to the sampling depth of 54,8 cm. The nuclide ^{137}Cs which can be detected in the sample was released into the environment in 1986 after the Chernobyl accident, the sampling took place in 2005. Supposing a linear model, during 19 years the average speed of the sedimentary process determined by gamma-spectrometry is 3,2 cm/year. Cs-depth from our measurement is not in contradiction with results of other investigations [10] which resulted in a chronology shown in *Fig.6.* Depth of 54,8 cm lies below the correlation line while that of [10] for the Tisza river region does above giving a good average around the fitted curve.

Considering the size of the sample, the *^{137}Cs* released in the 1950s and 1960s from the atmospheric atomic blasts could not be detected. The most probable depth of these could be 130 cm [10]. By determining the Cs

originating from atmospheric atomic blasts, the accuracy of the measurement can be further improved.

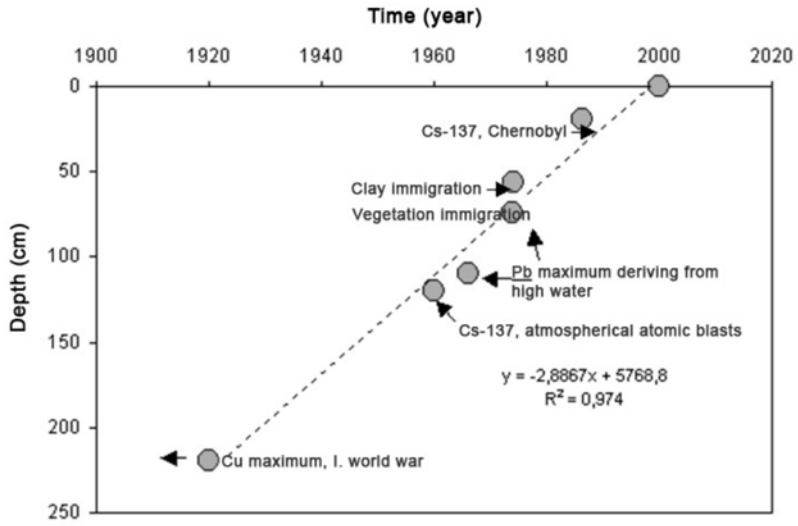

Figure 6: Events useful to establish sedimentary chronology [10].

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Acta Universitatis Sapientiae
Agriculture and Environment, 1 (2009) 74-82

Slope danger on the territory of Cluj-Napoca resulting from the structure and morphology of the hills between the river Someşul Mic and the valley of Nadăş (between Tăietura Turcului and Cheile Baciului)

Ferenc WANEK[1], Szilárd POSZET[1]

[1]Department of Environmental Sciences, Sapientia – Hungarian University of Transylvania, Cluj-Napoca, Romania
e-mail: wanek.ferenc@gmail.com, poszet@yahoo.com

Manuscript received 15.09. 2009; revised 20.09. 2009, accepted; 22.09.2009

Abstract: In this study we continue the survey of the slope danger on the territory of Cluj-Napoca resulting from its geological and morphological structure. The examined section is the hills lying in the western part of the Tăietura Turcului, which separate the rivers Someşul-Mic and Nadăs. The geological construction of this territory is more complex than the one lying on the eastern part of the Tăietura Turcului, but here too the layers, rich in clay minerals have a decisive role concerning the quality and the number of the slope processes. On this territory too, morphological characteristics are largely influenced by the differences between the dip angles of the northern and southern slopes. On the other hand, here, the presence of the structural steps makes the surface formations more varied. It is very important to examine the extent of slope danger, because those slopes are considered potential future building areas.

Keywords: Cluj-Napoca, geology, geomorphology, endangerment

1. Introduction

We began our geological and geomorphological research concerning the endangerment of the hillside territories of Cluj-Napoca [1] in the last year, and now we continue it on the drainage division territory Someşul Mic–Nadăs, on the western part of the Tăietura Turcului until the line marked by the Hajtás Valley and the Cheile Baciului. The southern bottom of the slope and the lower terraces have belonged to the inner part of Cluj-Napoca for a long time, (e.g. the Grigorescu quarter that is to be found on the City terrace of the Someşul Mic), but the city keeps growing and like this streets and houses creep up on the abrupt southern slopes too. The less abrupt northern slopes facing the Nadăs are

presently free from buildings, but the construction of a huge industrial area has already been begun at the foot of the Hoia hill, although it would be desirable to keep this territory, together with the Village Museum and the Hoia Forest (a popular recreation area) safe from the inconsiderate, greedy intentions.

2. Geological and geomorphological characteristics

2.1. The geological structure of the territory

The studied area is constituted exclusively from Paleogene and Neogene, i.e. a Late Eocene–Oligocene (Priabonian–Kiscellian) and Middle Miocene (Badenian) deposits, with a little angular discordance between them (fig. 2.)

In this case the Paleogene (Eocene–Oligocene) deposits also contain earlier elements than the ones to be found on the territory between the Cetățuia and the Tăietura Turcului. This is because towards West, at the bottom of the hills, one after the other, appear the older strata, as the general dip of the Paleogene layers has a WSW–ENE direction. Like this between the Donat quarter and the Hajtás valley, at the southern bottom of the range of hills, in western direction keep appearing on the surface the clay-and-sand sediments, rich in smectite of the Nadăş Valley Formation which undeniably are supposed to slide.

In the cover is to be found the not too thick sequence of the Jebucu Formation (~ 20 m [2]), containing terrestrial clays and freshwater or brackish water oolitic limestone intercalations; the Cluj Limestone Formation overlying, in the base with bankig, massive limestone, rich in fossils, with marlstone on the upper part, characterised by foraminifera-lumachella of *Nummulites fabiani* (it is about as thick as the former one). Cartographically it is difficult to separate these two formations, because the uppermost carbonate layer of Jebucu Formation many times can not be separated from a lithological point of view from the lower part of the Cluj Limestone Formation. Therefore we presented them together on the geological map. The similarity of the surface appearance of the limestone and also their much bigger slope stability than that of the floor and cover strata, makes this linking possible. Formerly they have often been discussed together too [3], [4].

Beginning from the Brebi Marl Formation, having sea characteristics, although slight differences are to be found, we meet the formations about which we already spoke in our former study [1]. However here the Brebi Marl Formation covers a much larger surface area, as it is represented in its complete (more than 50 m) thickness.

In the cover of the former one, under the sand-and-clay Mera Formation with limestone layers in it (30-35 m), appears, in a lenticular-like form, the thin (not thicker than 2 m) Hoia Limestone Formation too. We mapped these two

formations together too, as the thickness of the lower stratum would not make it possible to distinguish them graphically. Thanks to the limestone layers, these two together show up with a well distinguished morphology (cuesta) on the abrupt sides, unlike the Brebi Marl Formation under them and the Moigrad Formation above them, this one containing clay and its layers being inclined to slide.

The Moigrad Formation appears on a wide stretch on the examined territory too, this being ensured by its significant, (100-130 m), thickness. In this case too, cartographically – in case of slight exposured territory (as a lithological resemblance too) – it is hard to distinguish from the Dâncu Formation, therefore here we have presented the two formations together on the geological map.

The last representative of the Paleogene sequences on our territory, the Cetățuia Sandstone Formation, is to be found only in a small, unimportant spot. However it can be well identified on the basis of former mappings and the surface debris around the last but one elevation of the Hoia crest facing the Tăietura Turcului. Here its surface shaping role is less important than at the Cetățuia, because, besides being thinner and spot-like. The Badenian Dej Tuff Formation, having a transgressive superposition, characterises the morphology of the whole crest with its cuesta-structure anyway.

Former researchers made a clear-cut distinction among the three strata of the Middle Miocene (Early Badenian) of the Dej Tuff Formation (on the bottom marlstone, in the middle tuff, on the top marlstone), but we must say that in our present examination we could not really follow this. However, on the whole, thanks to the resistance of the tuff layers, it can be followed even morphologically in this territory. The significant morphological appearance of the Dej Tuff Formation was already noticed by Anton Koch [5]. It can be proved cartographically too, that this overlying strata the Paleogene – with a slight discordance of angle (fig. 1) –, showing the significant (Upper Oligocene, Lower Miocene) lacuna.

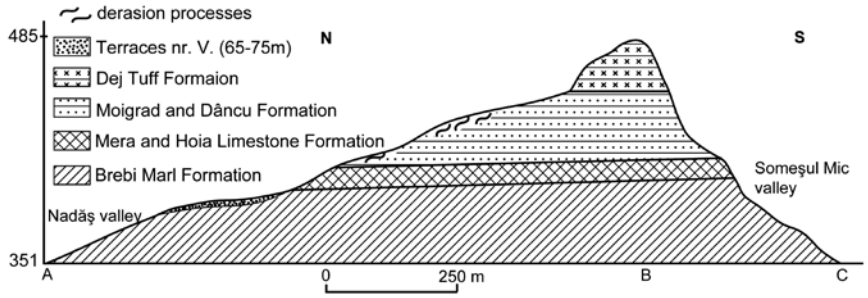

Figure 1: Profile N – S direction (exageration 3X).

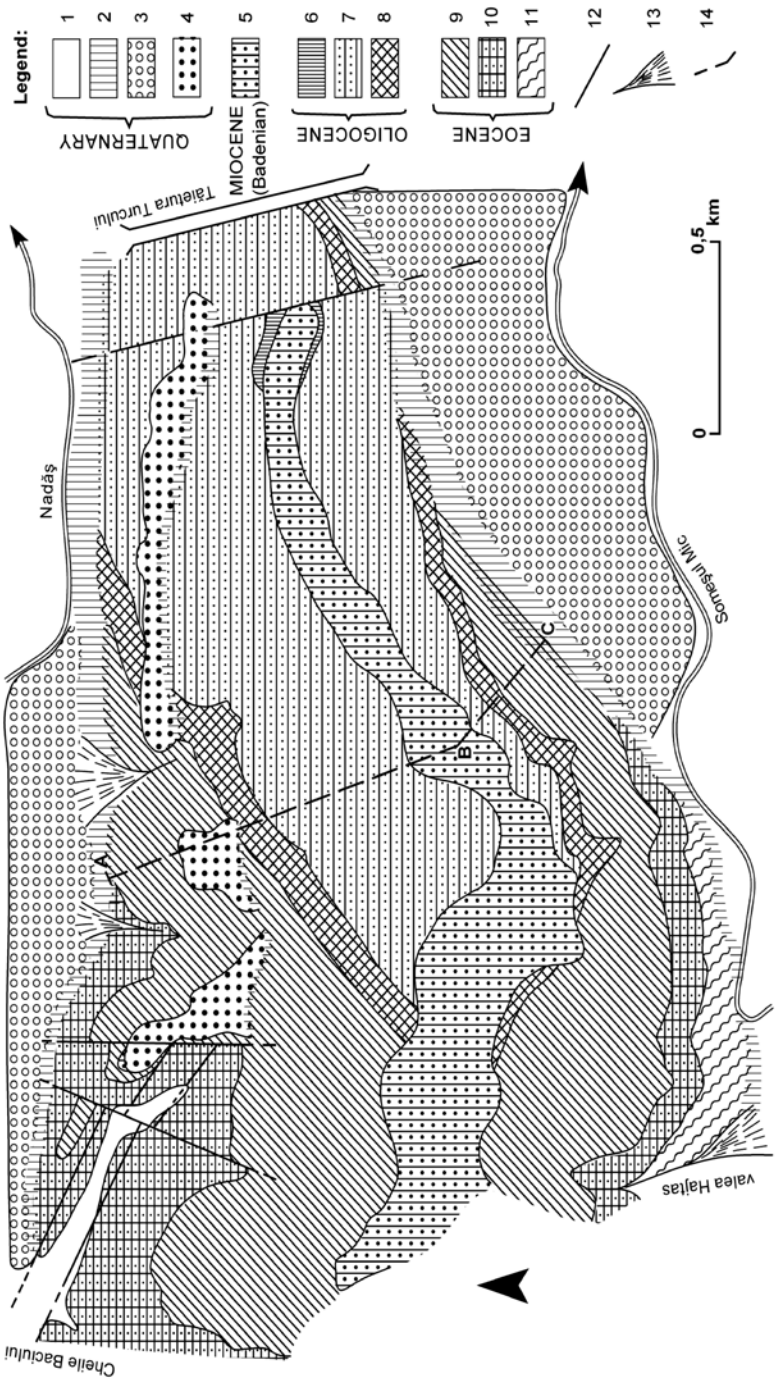

Figure 2: Geological map 1 = alluvium; 2 = glacis; 3 = Terraces nr. I. (5–6 m); 4 = Terraces nr. V. (65–75 m); 5 = Dej Tuff Formation; 6 = Cetățuia Formation; 7 = Moigrad and Dâncu Formation; 8 = Hoia Limestone and Mera Formation; 9 = Brebi Marl Formation; 10 = Jebucu and Cluj Formation; 11 = Nadăș valley Formation;

The formations of the Quaternary here too are made up of river sediments, debris cones and slope debris. River formations are only subordinately represented by present-day alluvia, but the City terrace (T. I.) layer is quite large, on it was built the Grigorescu quarter. This terrace layer can be found along the Nadăş too. Besides this only one other terrace layer can be identified on our territory, that of the Cetățuia (T. V). This is almost continuous on the northern slope of the range of hills and it was cut up only by the linear erosion of the recent times.

The slope debris was created mostly by Pleistocene gelisolifluction movements (both on the northern and on the southern sides), but the products of Holocene and present day slide mass movements (mostly on the Southern slopes) are also to be found.

From the point of view of their structure, the formations of the territory form a slightly 5-8º falling monoclinic, that is risen at the eastern part only by two faults, one at the Tăietura Turcului, and another, parallel one under the statue of Donath. Further more, at the NW corner of the territory, in front of the Cheile Baciului two parallel faults raise the Jebucu Formation. Its weaker resistance against erosion resulted in a negative surface. At the eastern part these two faults are crossed by two other faults of S – N orientation. The height of the faults is 10-20 m.

2.2. Geomorphological characteristics of the territory

The elements having a decisive role in shaping the geomorphological aspects of the examined (~ 7 km) territory: the geological construction; the climatic characteristics of the Quaternary and the following era; the presence of coverage with plants and the anthropic effects that have become more and more intensive (fig. 3).

The present-day descending of the crest of hill dividing the valley of the Someşul Mic from the valley of the Nadăs, its asymmetry is due to the dip of the stratum of the territory (see above), to the dislocation of the Someşul Mic towards North, followed by a strong lateral erosion [6], [7], and to the mass movement processes taking place in the Pleistocene era.

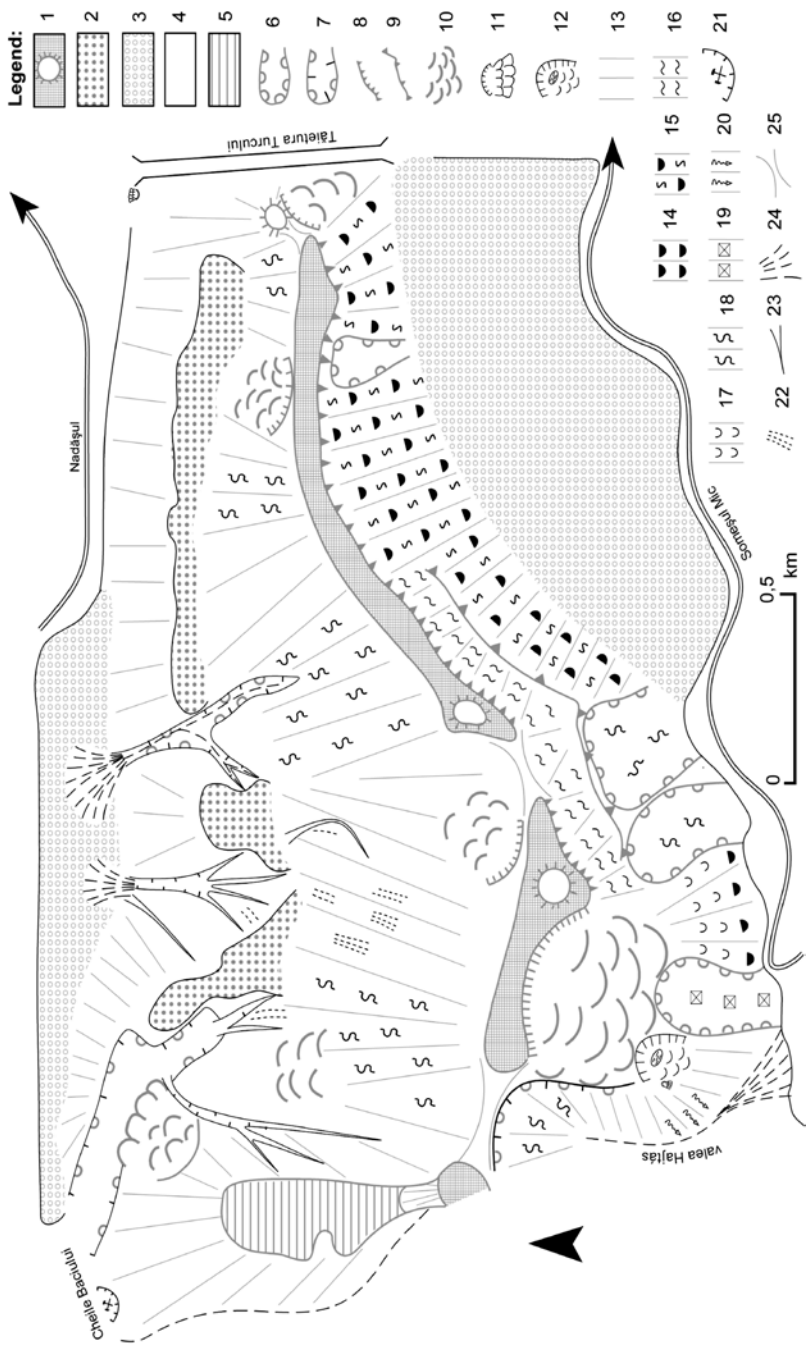

Figure 3: Geomorphological map 1 = hill crest with residual; 2 = Terraces nr. V. (65–75 m); 3 = Terraces nr. I. (5–6 m); 4 = alluvium; 5 = hill ridge; 6 = derasional valley; 7 = erosion-derasion valley; 8 = upper cuesta escarpment; 9 = lower cuesta

The limestone and tuff layers that divide the strata containing more clay minerals give a strong cuesta characteristic to the abrupt Southern slopes (fig. 3, 4).

We can notice important differences between the Northern and Southern slopes (fig. 5) concerning the division of the categories of slopes on the territory (fig. 4). The slight (0-2,5º) and stronger (2,5-5º) dip of the terraces and of the flood-lands characterise 30 % of the territory. The dip of the Northern slopes is slighter (5-15º) than that of the Southern ones (15-35º) but they cover a larger percentage of the territory (~50 %).

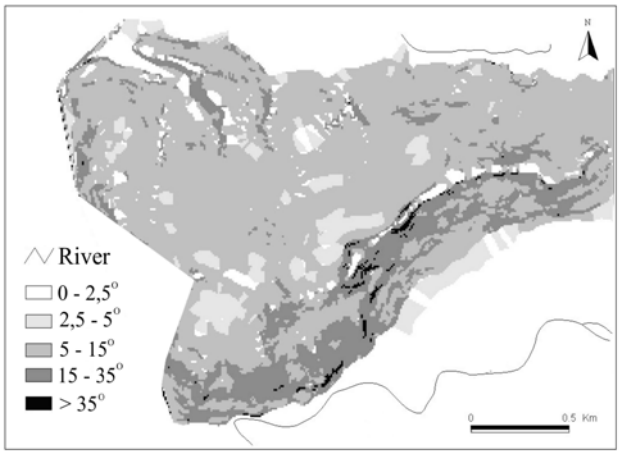

Figure 4: Slope categories map.

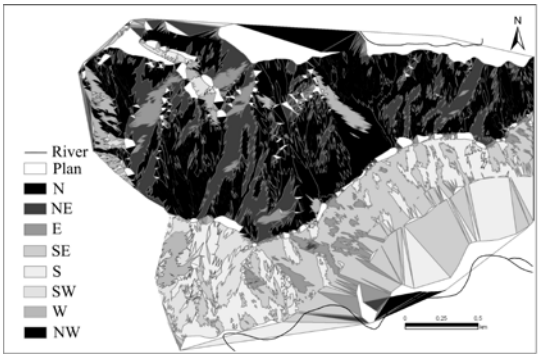

Figure 5: Slope exposure map.

The formation of the southern, more abrupt slopes, besides the above mentioned stratigraphyc characteristics, was largely determined by the erosion

of the river Someşul Mic in the Quaternary era. The shrinking of the basis of erosion resulted in a strong cut.

The subsequent valley of the river kept deepening and enlarging and it became asymmetric because of the lateral erosion having a northern direction. The harder layers (limestone and tuff) of the strata with a varied lithology belonging to the Tertiary period kept the abrupt slopes and made possible the formation of cuesta escarpments. The existence of the upper cuesta front (fig. 3) was described by Gr. Posea [8] in the middle of the previous century. The formation of the lower cuesta front was caused by the coming to the surface of the more resistant layers of the Hoja Limestone (and Mera) Formations (fig. 1.).

The sides of the valleys were shaped first of all by the slope processes. The formations shaped by the mass movements in the Pleistocene era, slide boulders, derasion valleys, strongly defined the face of the slopes formed on the top of the stratum, influencing in the same time the characteristics of the present-day slope processes too (fig. 3).

That is the abrupt slopes are covered by a deluvial blanket of sediment of a varied thickness which form a very unstable surface. Slope danger becomes even greater because of the burden of buildings, of a rainy period or of the more accentuated trepidation.

The northern slopes are more or less terrains formed on the bedding surface. Their surface has become rugged because of derasion movements taking place in the Quaternary and in our days too. Their bottom part has fallen to pieces because of the erosion. This was made stronger by the stronger erosion caused by deforestation. Moving backwards the torrens become step by step longer, helping along the formation of the unstable slopes.

We find it important to notice that at the NW corner of the territory there is a derasion valley formed on the incoherent sediments thrown up between the two faults. This valley is situated vertically on the valley of the Cheile Baciului.

3. Conclusions

The geological structure of the examined territory (tectonics and lithology) has a great importance in the formation of the morphology of the terrain and in the development of the surface formations.

In the geological structure of the territory take part mostly layers containing clay and sand (much smectite), built up of sediments and cut by limestone and tuff layers. As a result of Quaternary events (strong cut, lateral erosion, derision processes) on this structure was carved its present day morphology where the Holocene mass movement processes take place. This inherited, continuous development of the surface was further shaped by human activity during the historical times. As a result of this, in the case of the abrupt sides of the valley

on the left bank of the river Someşul Mic, slope danger became more imminent, while in the case of the slopes on the right bank of the river Nadăs this danger, at least in their present state, is slighter.

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Acta Universitatis Sapientiae
Agriculture and Environment, 1 (2009) 83-92

The environmental conditions in Carpathian basin and the environmental policy of European Union

László MIKLÓS[1], Anna ŠPINEROVÁ[1]

[1]Faculty of Ecology and Environmental Sciences of the Technical University of Zvolen, Zvolen, Slovak Republic, e-mail: laszlo.miklos@nrsr.sk; spinerova@pobox.sk

Manuscript received 19.09.2009; revised 22.09.2009; accepted 24.09.2009

Abstract: The EU plays a leading role in the global environmental policy. This policy resulted to a considerable environmental improvements, supports and increases respect to the environment protection, as well as strengthens authority of civil organization. In the same time, it increases the bureaucracy and tends to homogenize the protection policy in member states. On other side, it is obvious, that within the EU member states an enormous diversity of physical conditions exists. Each region considers its own environmental problems as most important. This diversity should be respected, not respecting it causes tension between individual countries or regions.

Keywords: diversity of conditions, homogenization of policies

1. Introduction

The EU plays a leading role in the global environmental policy. This policy results in considerable environmental improvements and, simultaneously, significantly supports the environment protection and increases respect to its tasks, as well as it strengthens the authority of civil organization dealing with environment protection. But at the same time, it increases the bureaucracy in some organs of EU. Different boards and directions tends to a kind of over-regulation, presumably with the best intention. According to these centralized guidelines, directives and regulations, the environment protection in individual member countries tends to homogenization, too. On other hand, it is obvious

that from the viewpoint of environmental protection, as well as from the social, economical and even awareness aspects, the EU member states, including the Carpathian Basin countries, too, exhibit an enormous environmental, natural and physical diversity. Based on this reason, the most important environmental problem for each region is that of its own area. The homogenized administrative rules might cause tensions in individual regions or countries. The presented paper analyses some of these questions.

2. How can we assume the environmental policy of EU

The substantial question can be formulated also provocatively as follows: **does it help or burden**? Let us try to answer this agitating question from various aspects. From viewpoint of different interest group, the strong EU environmental policy can be characterized in the following way:

a) it is unambiguously helpful for **physical environment**: it caused an evident and comparable improvement in many fields, especially in pollution control, waste management and in nature protection.

b) it helps to the environment **administration bodies**. The often underestimated or even negatively perceived roles of environment departments in different countries have been significantly strenghtened.

c) it supplies environment protection with considerable financial means: a great portion of EU-funds is determined just for environment protection

d) helps to the "**alternative economy**", hence those, who wish to develop environmental technologies – treatment of wastes, recycling, landscape planning, alternative production and consumption of energy, as well wish to transform the environment protection into a normal part of general production process.

e) help for the **public -** helps the non-governmental organizations to access the information about environment protection, in participation in decision making processes. EU also supports the right on the law exacting (implementation of the Aarhus Treaty|.

On other side, the negatives should be also mentioned, especially the „over-regulation" tendency of EU is also subjected to a strong criticism. From this aspect, the EU environmental policy can characterized as follows:

a) introduction of any new regulation brings for the **officers** new learnings, reorientation and uncertainty, hence it **burden** them.

b) it is burden also for the (traditional) **production branches**: the EU regulations toughen the existing practice in most member states, increase the sanction extent, reduce chance to ignore the existing regulations and introduce new or original rules (e.g. IPPC, E.I.A, EMAS).

c) in general for **government** is this policy a burden: meeting the environmental regulations means special measures – particularly at the entry the EU it was so. The EU rules continuously enforce the governments to make intern compromises, while they are mainly interested to achieve economical results during their functional – most often the four year - periods.
d) to **politicians** in member states this policy might mean labor, satisfaction, but also disillusions burden and criticism, depending also on the affiliation of the politicians to the governing or to the opposition party. The process and logic of preparation of regulations in the commission is not always clear, often chaotic, the strong member states and strong lobbies often take initiative or extort modifications of new regulations, what might cause a felling of disappointment.

Beside it, it is also necessary to mention the **wide public,** which observes the things from outside and is not specially concerned in environment protection. Its opinions change from case to case, from affair to affair. Sometimes they fear from environment pollution, other time they damn the "orthodox" greens, since according to this opinion they inhibit entering the nature conservation areas by his or her car. They often react emotionally, many times not willing to hear the facts. This mass of people can be easily influenced, especially by environmental orientation of popular politicians.

3. Substantial conditions of environment protection

In the above chapter we discussed just the **political** aspects of the EU environmental policy. However, for the environment protection at least three other groups of conditions are substantial. These conditions are actually compactable with principles of sustainable development. They are:

a) The **physical** conditions of environment protection

They represented actually the intrinsic physical properties of environment - the **environment itself**, whose physical substance is given by nature (the terms we use to call them – e.g. geosystem, ecosystem, landscape, environment, region – is irrelevant).

What is the situation of the Carpathian Basin from this point of view? The basic concise answer: the physical conditions ***differ and change*** from state to state, from region to region.

b) The **economical** conditions of environment protection

The economic sphere is permanently in general in an antagonistic relationships (probably a little generalizing) – with developing, and - according to them increasing - demands of the environment protection. The economic sphere disposes in most cases with distinct stronger lobbies that the environment protection – if we consider only the formal system of institutions, e.g. the environment ministries in each country is confronted with several

economical ministries and its success depends more or less on their benevolence or individual sensitivity to the environmental issues (do not over-estimate the pronouncement of almost all politicians, how they love the nature and environment). The substantial influencing conditions are the type of the economical system, the level of economic development and productivity, the priorities of economical policy – or the economic priorities) of the policy of concrete government (?). Of course, it is a complex system! From the viewpoint of the economic conditions of the environmental protection the Carpathian Basin countries – with acceptable generalization – are ***similar, but regionally different!***

c) The **societal-cultural** conditions of environment protection

Out of that, what we have already stated about the political macro-environment, the most important group of conditions within this field are the **legislative** conditions, the society's cultural level and the **environmental awareness**. We can say, again with acceptable generalization, that the Carpathian Basin countries from this point of view are ***similar,*** mutually ***comparable*** and ***corresponding!*** In addition, just these conditions became still more homogeneous after the entry in EU.

Thus, we can conclude that the Carpathian Basin countries have very similar conditions for environment protection, **except for the physical and natural conditions**, which are

- locally specific
- regionally variable
- stable to a high degree, persistent or much slower changing than other groups of conditions
- the natural rules, which can not be changed by human activity, correspondingly react on the anthropogenic interventions.

Does the European Union, regional groups of countries or environment protection policy of individual states properly adapt to it?

4. The main features of physical environment of the Carpathian Basin

It is obvious, that locally or regionally changing conditions, which are on other hand constantly bound to a given place, functioning according to immutable natural rules, when disturbed by human activities – again only according to natural rules and autoregulation – developing sometimes in a dangerous direction – e.g. the **physical** environmental conditions are that, what **needs the protection**. However, the decision makers – first of all from subjective reasons, mostly influenced by their professional education, of course – do understand this problem least. At the same time, specialists in environment protection are not sufficiently able to gap and resolve the problems effectively

from bird's eye view, especially with regard to their ability to use political, economic and social arguments to explain physical rules of environment protection and practical measures resulting from them. We are much more speaking about related- not physical - phenomena, for example, about the potential or real impacts of the environment protection on economy and social sphere.

How to proceed to improve this situation? According to my experience, many times the examples and metaphors taken from other spheres can bridge the gap and influence the politicians and public. They can be successfully used in the environment protection policy, too.

Some known metaphors – even commonplaces – used by "greens", focused on environment awareness of politicians:

- the common Europe **as a house** and its **"green" bricks** (Green Bricks of Europe). A nice effort, but the problem is that the green bricks mean the protected areas only, stressing their protection, but what shall we do with other parts of the landscape – the "mortar"? The politicians may understand the cliché that it is far enough to deal with green bricks, you greens be satisfied, the other part of the country is free of protection.
- Europe as a **living being** and its **"green" organs**. In this metaphor we used to speak about the living being's green vertebra, green lungs, stomach, arteries end their significance. This concept is also used in not-fully-professional circles. According to international conventions, a considerable protection is given to green vertebra or green lungs, for instance the Convention of Biodiversity, the Ramsar Convention, the UNESCO Man and Biosphere program, the Paneuropean Ecological Network and its national implementations (ECONET, NECONET), and of course, the legally binding NATURA 2000.

In this case, the environmentalists, the nature conservators have done some mistake. They focused too much on individual organs, but they did not ask, what happened with the body as a whole? Now we can realize that we have cared much less about the body!

The role of the Carpathian Basin in this common "house" or "living being" should be relatively unambiguously defined. Using the metaphors, the Carpathian Basin is a central courtyards of European House, here are located central organs of the living being, it is surrounded by walls (external skeleton?), and here are also crossing corridors, the main arteries.

Of course, we can deal with these metaphors and commonplaces also absolutelly seriously. Some maps from the Landscape Atlas of the Slovak Republic can be given as examples (Miklós, Hrnčiarová (Eds.) 2002).

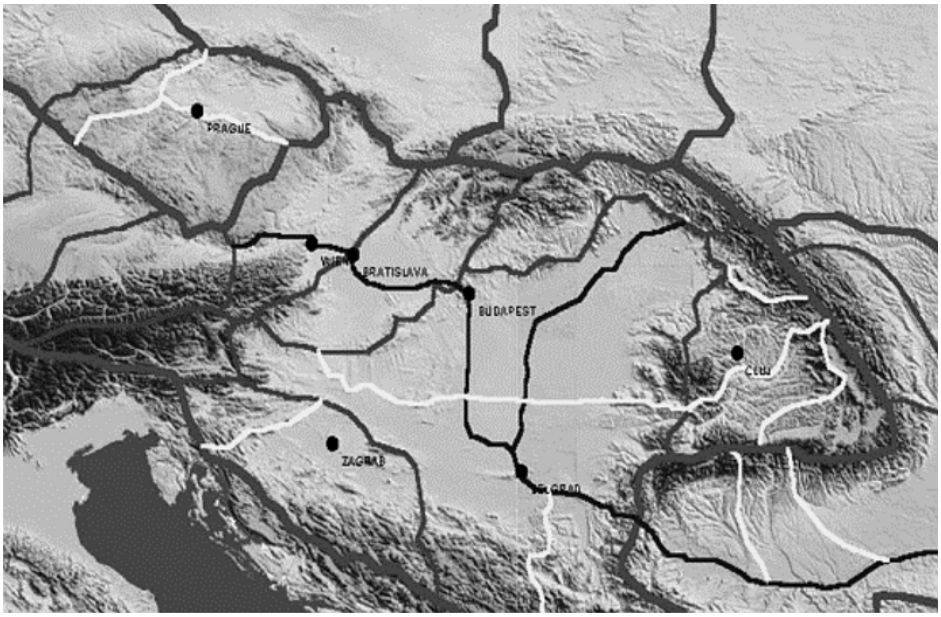

Figure 1: The walls, rooms, corridors, courtyards of our common house

Several other inalterable factors of physical environment are of substantial importance for sustainable development of Central Europe,e.g.as follows:

- Near Kremnica there is the geometrical center of Europe, as well as the entire Carpathian Basin is in center of Europe. This means realy that it functions as a courtyard, communication house, crossing and meeting place; however many negative and positive environmental issues are connected with those facts, as:
- There is a great contact zone of clima-geographical and **biogeographical regions** (Hercynicum, Carpathicum, Beschidicum, Balticum, Noricum, Illyricum, Pannonicum and Ponticum)
- It resulted in a high climatic, ecological and **biological diversity**!

A special attention should be paid to the **Carpathian** mountains, as:

- The Carpathians are a roof of Europe and its main **watershed.**
- The Carpathians are a vertebra and wall: the Europe's green vertebra and, at the same time, a barrier in both directions, inwards and outwards they protect and regulate flow of energy and information.
- The Carpathian mountain ranges – hence the natural walls of the common house – played and play a special role from viewpoint of the administrative borders.
- The barriers cut the corridors, many times they represent difficult obstacles - difficult passes, narrow valleys, canyons.

- A characteristic feature of the Carpathians is a series of mutually isolated intramontanous basins, interconnected with the main rivers (Váh, Hron, Ipeľ, Sajó, Tisza, Szamos, Körös) flowing through the hollows.

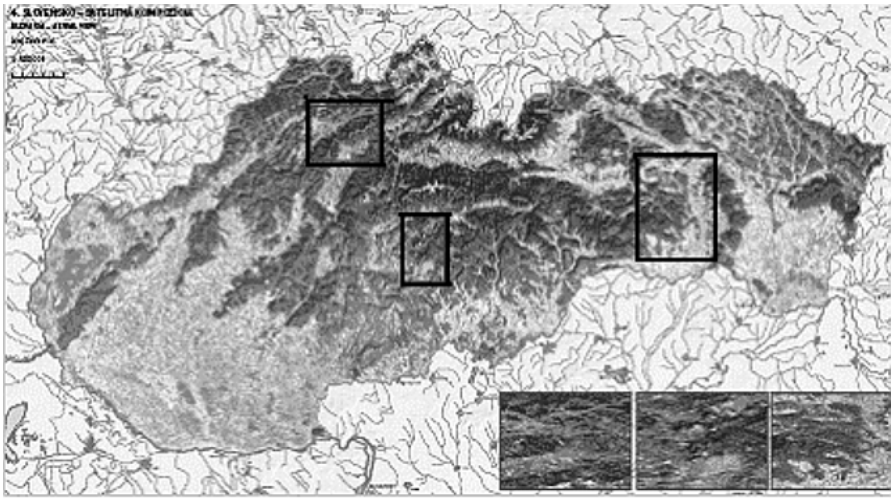

Figure 2: An example from the Landscape Atlas of the Slovak Republic: natural barriers and corridors, intramontanous basins (satellite image).

What does all this mean from the viewpoint of environment and sustainable development? Just briefly and with acceptable generalization: the material, energy and information predominantly "flows" from the **mountains** downward, in the **basins** and central **lowlands:** water, biomass, geothermal energy, but also the pollution and energy resource for the human king, thus:

- in the lowlands
  - there is a more advanced development, but at the same time also
  - more intensive environmental deterioration
- in the highlands
  - there is more healthy live conditions, but
  - there are worse socio-economic conditions, in new era a new potential
  - excellent physical conditions for relaxation, recreation, turism.

5. Some substantial consequences

The great natural and physical diversity in the EU member states, especially in the Central European states, results in a logical conclusion that the environment protection policy must be bound first of all to the **changing and**

region-specific physical conditions. Is it so in the unified Europe and in Central Europe: not at all! The EU policy leads to unification.

Of course, it is to be defined here, what part of the environment protection need more country- and region-specific approaches and what not. The protection rules oriented on environment-friendly technologies and environment protecting technologies - generally characterized as protection of individual elements of environment, as the prevention of air and water pollutions of all kind, waste management, recycling – can be unified without serious ostacles. These issues are treated on global level, as the matter of fact, the zero-pollution technologies, wasteless technologies, closed circle technologies and clear production systems are quite frequent. Where and to what degree they can be applied, is a question of political decisions, money and economy level.

An original, concrete region-specific application of environmental policy is needed especially nature conservation, landscape management, watershed management and theirs new integrated modifications. In this domain an exaggerated unified approach can be harmful.

One example:

The **NATURA 2000** is a good example for an unified system of EU regulations in nature protection, wich considerably helped to nature conservators to enforce their interests in member states. The NATURA 2000 defines theoretically which habitats and species are from the point of view of the whole territory of Europe endangered, near to extinction, or important from different point of view – so defines the habitats of **European importance,** and, prescribes their protection. At the same time, in the non-expert circles, in the wide public or in the economical circles – which do not sympathize with nature protection – this concept can be understood also in such a way that other habitats, the habitats not defined within NATURA 200 sites, **are not important** and that in many "NATURA-siteless" regions important habitats do not exist at all, and any nature or other protection is needed here. In opposite, for nature friends, localpatriots, this fact could cause frustrations – is my country less valuable than others? Other extreme is that an absolutely consequent application of regulations of NATURA 2000 could lead to protection of nearly a half of the country, what could lead to fully unqualified negotiations and tug-of-wars.

All these facts can cause tensions on local, regional or national level. It is to be stressed that from the viewpoint of the ecological functioning of a region the most important is the local habitat, local ecosystem!!! But the globalized theoretical and administrative concepts result in the fact that:

- too much protected areas are situated in mountains, wetlands, karsts, halophilous habitats and deserts. They represent the "aristocratic" ecosystems.

- much less protected areas are in lowlands, on loess plateaus or in "common" highlands. They represent the "commons". However, it is to be noted, that in Central Europe the area of "commons" predominates and is more productive from the economical viewpoint. But we protect them much less. It also can cause the regional tensions.

6. Integrated approaches in environment protection in EU

The integrated approach to the care on environment is a program of the future. This approach is different as the unification, homogenization or globalization, of course. Its aim is to preserve natural functional conditions of integrated physical units - irrespectively if we call them landscapes, geosystems, regions, ecosystems - **as a whole and entire complexes,** not to protect separately individual elements of environment. It can be achieved only by whole territory-covering concepts including spatial management and planning instruments.

The integrated approach shows a strong support on theoretical level of environmental policy. It started in 1992, at the Rio-de-Janeiro conference, where the 10th chapter (*Integrated approach to the management of land resources*) of the AGENDA 21 unambiguously formulated inevitability of integration. The World Summit on Sustainable Development in Johannesburg in 2002 considered the integrated approach to management of natural resources as a task of highest importance. The EU and its member states try to realize these political declarations in practice, but the realization of integration ideas delays from different reasons.

Just a note: the branches of science of integrated (or complex) character, e.g. ecology, landscape ecology, physical and economic geography, can play an enormous role in this field, as well as environmental sciences oriented not only on technical protection of individual elements.

In EU the integrated environmental policy is unambiguously regulated by the following legislative norms:

- Integrated prevention and pollution control – IPPC – the EU directive.
- Integrated watershed management – EU water frame directive
- NATURA 2000 directives.

These regulations work within the European framework and cause satisfaction, conflicts and problems.

The integrated environment protection also include some other regulations, which are specific for the member states and have not yet been unified, as:

- Territorial/ physical /spatial planning
- Landscape planning – a regulation existing in more EU states, but not unified

- Integrated landscape management – exists on theoretical level, only.

In spite of difficulties and unsatisfying current stage, we can conclud that in the field of the integrated environmental policy the EU is strong and plays a leading role in comparison with other world.

Acknowledgements

The paper presents the results form the scientific project APW0240-7 Model of representative geoecosystems on the regional level.

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Acta Universitatis Sapientiae
Agriculture and Environment, 1 (2009) 93-103

Review of the effects of point sources in Jászberény by applying the Gauss model and the methods of mathematical statistics

János SZŰCS[1]

[1]Department of Science and Physical Education, Szent István University, Jászberény, Hungary,
e-mail: szucsi.janos@gmail.com

Manuscript received 27.07. 2009; revised 26.08. 2009, accepted; 27.08.2009

Abstract: Since 1990 remarkable changes and structural transformations have taken place in the field of industry, services and agriculture in Jászberény, which is known as the "capital" of Jászság. These processes effect also the environment in indirect way. The operators of companies have to report about the point sources in their territory to the environmental protection authority, and the data of local immission measuring net are also available. On the ground of the mentioned data it is possible to model the transmission of polluting material and to analyse the emission and immission data with the methods of geographic information system and mathematical statistics.

Keywords: emission, immission, spread, variance analysis, t-probe

1. Introduction

After the democratic change the environmental protection, within it the protection of atmosphere, got a role of high priority in the countries in Central Europe. In Hungary among others the following regulations rule the protection of atmosphere:
21/2001. (II. 14.) governmental regulation about the rules related to protection of the atmosphere, 14/2001. (V. 9.) KöM-EüM-FVM common regulation about the limit values in the field of air pollution, about the emission limit values of fixed air polluting point sources;

17/2001. (VIII. 3.) KöM regulation about the rules related to checking, controlling and valuation of the air pollution and the emission of fixed point sources;
4/2002. (X. 7.) KvVM regulation about the designation of air polluting conurbations and zones.

In Jászberény three immission measuring stations were located (Fig. 1). The checked deteriorative material is NO_2, SO_2 and settling dust. The scanning of measured data is daily by NO_2 and SO_2 and monthly by settling dust.

The measuring point of Szivárvány nursery (Measuring point 3) stands near a middle sized road in the outskirts of the town. In its surroundings private houses and four-storey blocks of flats can be found. The role of industry is not important here but the one of agriculture is all the more as ploughlands can be found in some hundred meters from the measuring point.

The measuring point situated in the area of Szent István Egyetem Alkalmazott Bölcsészeti Kar (Measuring point 2) stands near a middle sized road in the garden suburb as well. This measuring point is the nearest to the biggest industrial companies of the town, which deal with production of household machines and industrial components. Significant part of small and medium sized plants (suppliers of the mentioned multinational companies) is concentrated in this area. The distance of agricultural areas is no more than some hundred meters. The main direction of wind in the town is north-western, so the wind delivers the polluting material from the industrial area to the town centre.

The measuring point in the town centre (Measuring point 1) can be found near one of the busiest main road (road no. 31) of the town. This road has a common segment with the main road no. 32 for some hundred meters, which is the other busiest road in the town. As the building of ring road is not finished yet, big part of the transit traffic passes through the town centre. This measuring point can be found in the centre of the town, so the industrial and agricultural areas are outermost from this place, but it is the nearest to the bus station, which is a significant pollutant. Immission data are available from 1990 by measuring point 3 to 2004, by measuring point 2 to 2006, by measuring point 1 to 2007. It is to stress that there are rather few forests near the town, but so much the more grazing-lands and plough-lands. Furthermore only one big factory can be found in the eastern part of the town, which primarily deals with plastic-processing.

Objects of the survey:

- preparation of coordinate spatial substance of report obligated point sources
- preparaion of SO_2, NO_2 and solid material emission cadaster of registered point sources
- cartographing of spatial effects of point sources in the area of Jászberény
- analysing the connections between the effects of point sources and the air quality of the town
- valuation of the air pollution os the town

2. Material and Methods

According to the above mentioned regulations there are nearly four hundred report obligated point sources in Jászberény. Overwhelming majority of the point sources is flue and chimney. Quarterly report about the emission of sources is prepared, which the operators usually determine by means of material-balance. Data are available from 2002 to 2007. I determined the exact location of about three hundred point sources as primer data collection by GPS, the coordinates of the remaining about one hundred locations were determined by approaching values as secondary data collection. I linked individual identifier to the points, which created connection between the locations and the data, so it is possible to visualise the emission data geographical. The reports include the name, temperature and volume of the issued material, the identifiers and the height of the sources, the surface of the emission points and the number of working hours. I approached the distribution of pollutants with Gauss model, to determine the concentration below the axis of smoke torch I used the

$$C_{GL} = \frac{E_G}{2\Pi\delta_y\delta_z u_m} e^{-\frac{1}{2}\left(\frac{y}{\delta y}\right)^2} \left\{ e^{-\frac{1}{2}\left(\frac{z-H}{\delta z}\right)^2} + e^{-\frac{1}{2}\left(\frac{z+H}{\delta z}\right)^2} \right\} \quad (1)$$

relationship for rainless period neglecting the dry and humid settling. E_G (mg/s) is the gaseous pollutant emission related to short average period of the continuous operating point source, H(m) is the effective height of point source chimney, u_m (m/s) is the average of wind speed characteristic to the fume torch, δ_y and δ_z are turbulent diffusion factors normal horizontal and vertical to the side of the fume torch. I calculated the collateral chimney height of sources (m) with the

$$\Delta h = \frac{k}{u}(1{,}5vd + 0{,}0096Q_h) \quad (2)$$

relationship if the temperature difference between the issuing agent and the environment is more than 50˚C and the issued heat output is less than 10000 kW.
In every other case with the

$$\Delta h = \frac{2{,}7 Q_h^{1/2}}{u^{3/4}} \tag{3}$$

relationship. The effective chimney height is the summation of the corrected actual and the collateral chimney height,

$$H = h_k + \Delta h \tag{4}$$

The correction of effective chimney height considered the downflow if the output speed of the issued agent is v(m/s) < 1,5u

$$h_k = h + 2\left(\frac{v}{u} - 1{,}5\right)d \tag{5}$$

in every other case h_k=h. To approach the heat output I used the

$$Q_h = 271\frac{T_s - T_h}{T_s} \cdot d^2 v \tag{6}$$

simplified relationship, where d (m) is the inner diameter of the output cross-section of the source or the diameter calculated from the emission surface. T_s (K) is the temperature of the issued agent, T_h (K) is the air temperature in effective chimney height. As by all sources the collateral chimney height did not reach 50% of the effective chimney height I considered the wind speed in the emission points characteristic to the fume torch. The

$$u(h) = u_0\left(\frac{h}{m_0}\right)^p \tag{7}$$

relationship gives the wind speed in the emission points (m/s), where m_0 is the height of wind measure place, u_0 is the wind speed in z_0 height and p is the index of wind profile equation. To define the horizontal δ_y (m) and the vertical δ_z (m) turbulent diffusion factors I used the

$$\delta_y = 0{,}08\left(6p^{-0{,}3} + 1 - \ln\frac{H}{z_0}\right)x^{0{,}367(2{,}5-p)} \text{ and the} \tag{8}$$

$$\delta_z = 0{,}38\,p^{1{,}3}\left(8{,}7 - \ln\frac{H}{z_0}\right)x^{1{,}55e^{-2{,}35p}} \tag{9}$$

formulae, where z_0 is the raggedness parameter. In the calculations I considered the average meteorological characteristic values: 2,5 m/s wind speed and 6 stability parameter. As value of raggedness parameter I chose 1,5. The continuous sources cause the maximum surface-close concentration in $x_{\max}$ wind-along distance where δ_z=0,707H. During the calculations I linked the $x_{\max}$

value to all sources and represented the results on a map so I could impound the areas of the town, where the point sources have the most significant effect. I executed the examinations by nitrogen-dioxide and sulphur-dioxide partly because they are very important pollutants partly because beside the emission data the data of immission measuring places in Jászberény are also available. I compared the data of immisson measuring places with t-probe and divided them into seven disjoint aggregations according to the days of the week. Applying variance analysis I examined if there are any deviations among the prospective values. Furthermore I examined the solid material emission in the town. The settling speed of solid material significantly depends on the grain dimension which is not included in the reports, so I used descriptive statistical methods to analyse the emission values. In addition I compared the values of settling dust also with t-probe.

3. Result and discussions

The spatial location of the sources partly reflects the extension of industrial areas, besides it can be observed, that along the main roads many emission points are located first of all because of the extractors of drying cabins of car traders. The sources in the town centre can be attributed to the report obligated boilers. The height of emission points fundamentally affects the pollutant concentration in their surroundings. Examining the frequency distribution of height by point sources in Jászberény it can be observed, that the high chimneys and stacks are not typical in the town, great majority of the material gets into the atmosphere in about 3-15 m distance from the ground.

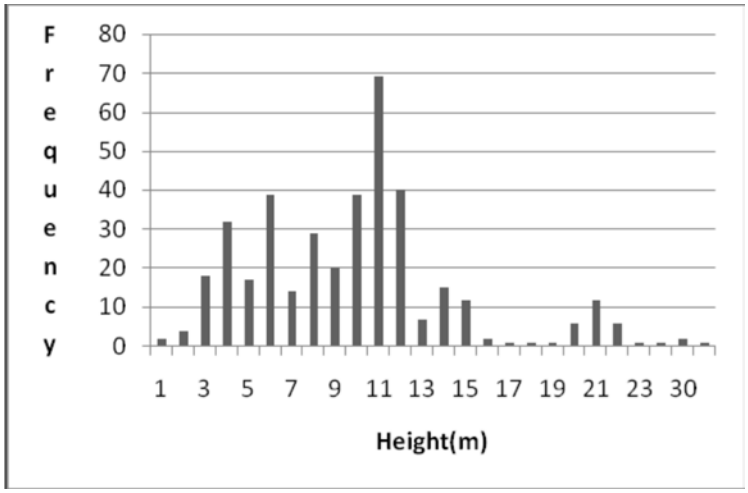

Figure 1: Height of report obligated point sources in Jászberény.

Nearly 80% of nitrogen-oxide emission originates from traffic, in addition during the heating season the quantity coming from heating (first of all from gas heating) increases the emission. Among the industry originating pollutants the only one to mention is the processes in connection with metal machining. Representing the x_{max} distances as puffer zones around the reported sources the dominant role of industrial areas can be observed, additionally during the heating season the emission grows in the town centre as well (Fig. 3 and 4).

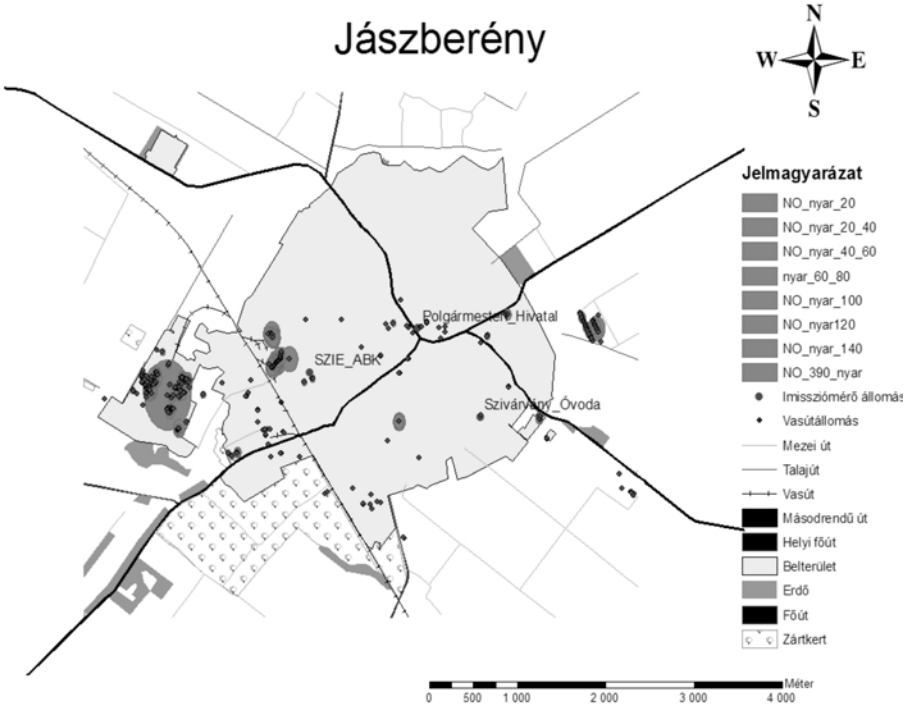

Figure 2: NO_x emitting point sources and puffer zones during not-heating period.

The emission data show relative homogeneity in time with the dominance of the western part of the town. It could be concluded, that the highest immission values can be measured in the western part of the town. On the other hand the highest concentration is measured in the town centre during both the heating and not-heating period, it is followed by the average of measuring place no. 3. The immission values are the lowest in the measuring place no. 2, which is the closest to the biggest reported emitting places. From this the dominance of traffic can be concluded. Checking the immission data on 95% reliablity level

with t-probe the average of the measurment points shows significant deviations. The correlation coefficients show weak connection among the measuring places both in heating and non-heating seasons. As the values measured in the town centre are the highest and most of the human activities show periodicity related to the days of the week the measured values can be classed into groups according to tha days of the week, and can be examined if there rae significant deviations among the groups. Checking the results on 95% reliablity level with the help of diffusion analyse, we can appoint, that there is no significant deviation among the values. From the empirical distribution function plotted by the nitrogen-dioxide immission values in the town centre it can be determined that the possibility of keeping the limit value of 85 $\mu g/m^3$ in 24 hours is 1 (Fig. 4).

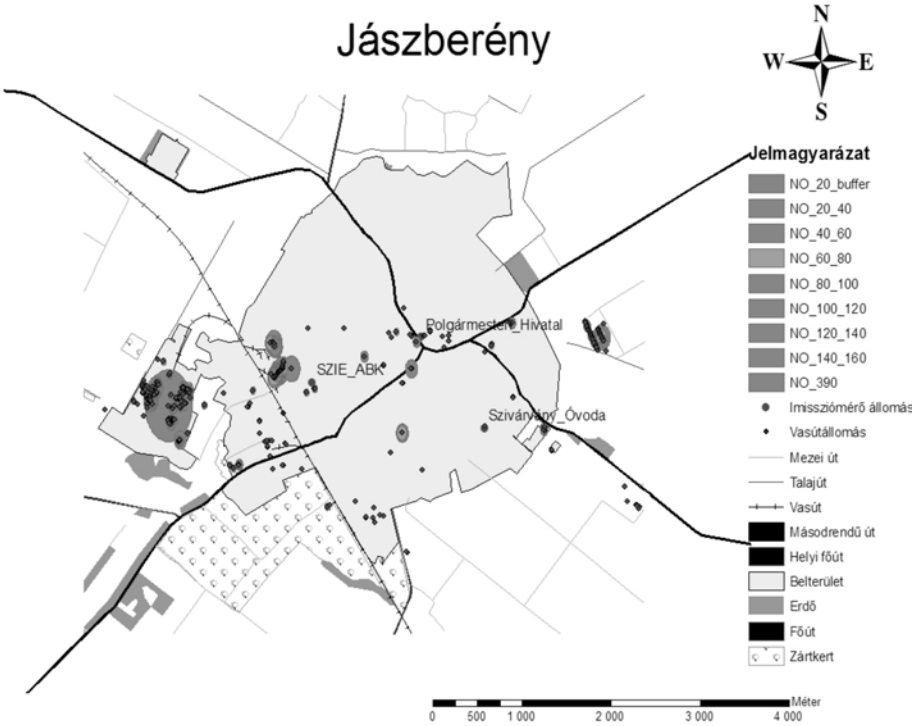

Figure 3: NO_x emitting point sources and puffer zones during heating seasons.

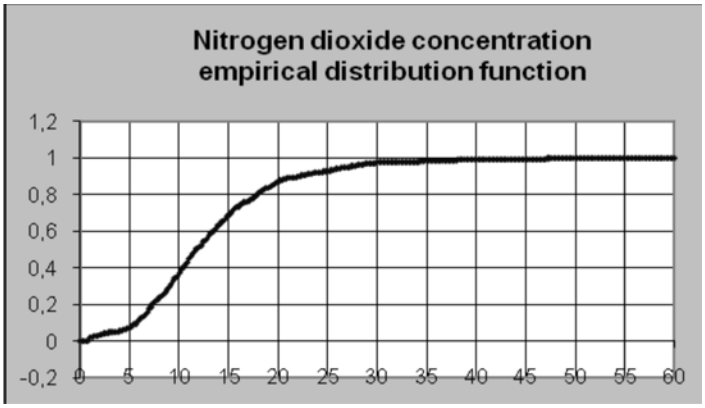

Figure 4: Nitrogen dioxide concentration empirical distribution function.

The most favourable changes both national and local happened in the field of sulphur-dioxide, which is mostly considered to be blamed for the development of acid rain. In the Mátrai power plant in Visonta not far from Jászberény a new waste-gas-eliminator was put in operation, which probably favourably influences the air quality of the town. Checking the emission of reported point sources we can observe, that irrelevant quality of sulphur-dioxide can be measured and only in the western part of the town (Fig. 6), the other sources do not emit this pollutant at all. Checking the immission data on 95% reliablity level with t-probe the average of the measurment point in the town center is the highest both in heating and non-heating seasons. In heating seson the data of the other two measuring points can be considered equal while in non-heating period the data of measuring place no. 2 is higher than the ones of no. 3. Among the values of the measuring places the correlation coefficients show the tightest connection in the case of sulphur-dioxide, in heating period a moderately strong, in non-heating period a very strong connection, there is nearly a function-like connection between the datalines. In Jászberény the modernization of heating technology program took place between 1984 and 1995, in consequence of it 90% of the flats changed on gas heating. Comparing the number of flats with gas heating and the average winter SO_2 values the correlation coefficients is -0,56, which shows a medium strong connection. As result of the favourable effects the immission values in case of all measuring places decreased and nowadys the measuring of SO_2 concentration is stopped.

The limit value of sulphur-dioxide concentration is 125 $\mu g/m^3$ in 24 hours, which is kept for certain (Fig. 5). If we compare the data ranged into disjoint sets according to the days of the week on 95% level with the help of diffusion analyse, we can appoint, that there is no deviation among the values. From this

and from the emission data it is to concluded, that by now the anthropogenic activity does not significantly influence the SO_2 concentration in the town.

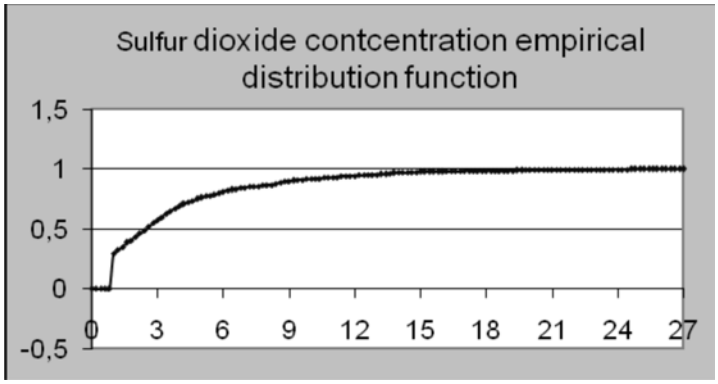

Figure 5: Sulfur dioxide concentration empirical distribution function.

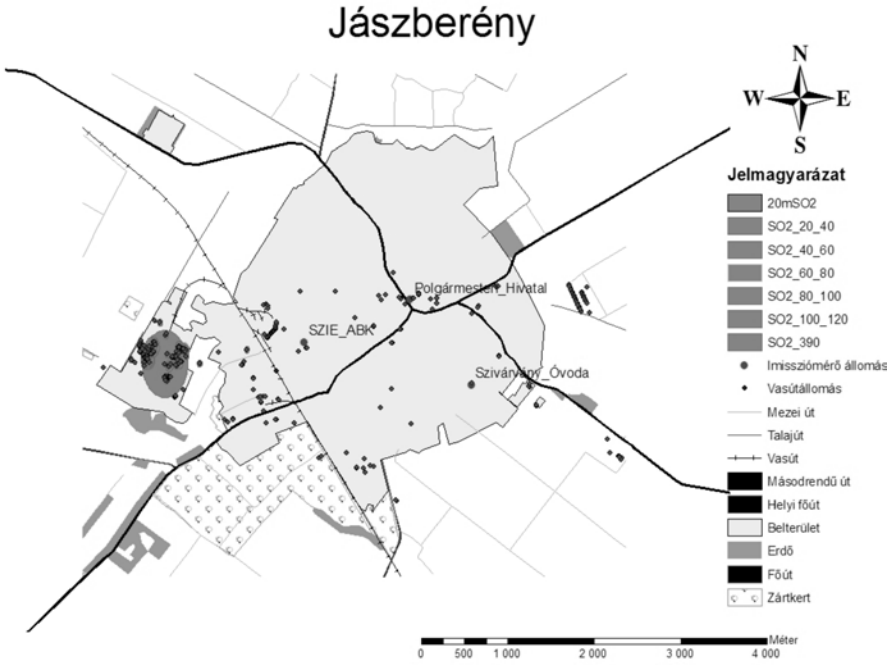

Figure 6: SO_x emitting point sources and puffer zones.

By examining the solid material emission in the town no reliable diffuse model can be defined on the grounds of the available data, still with simple methods of geographic information system and statistics several deviations can

be determined compared to the previous material. The most striking difference is, that there is no spatial and temporal homogeneity, the dominant role of the industrial area, apart from the area along the line, decreases. But some new areas come into the limelight primarily in the south-eastern and south-western part of the town, while the emission in the eastern part is unimportant. In the inner district of the town there is practically no emission (Fig. 7). Nevertheless significant quantitative alteration and shifting of the relations can be noticed in the consecutive periods, which can be explained by the irregular orders of the companies and the seasonal jobs. Examining the immission values of settling dust time related, we can notice yearly periodicity alike by sulphur-dioxide and nitrogen-dioxide, but in contrast to the other pollutants with summer maximums and winter minimums. Performing the t-probes on 95% reliablity level the prospective values of measuring points can be regarded equal, it follows from this that the town is exposed to relatively equable dust settling. Among the values of the measuring places the correlation coefficients show weak connection. The immission measuring stations in the town have registered limit-out values solely by settling dust in the previous years, which develops in summer period mainly in the town centre supposedly because of the traffic. The probability of keeping the 16g/(m^2*30 days) limit value in the town centre is 0,85.

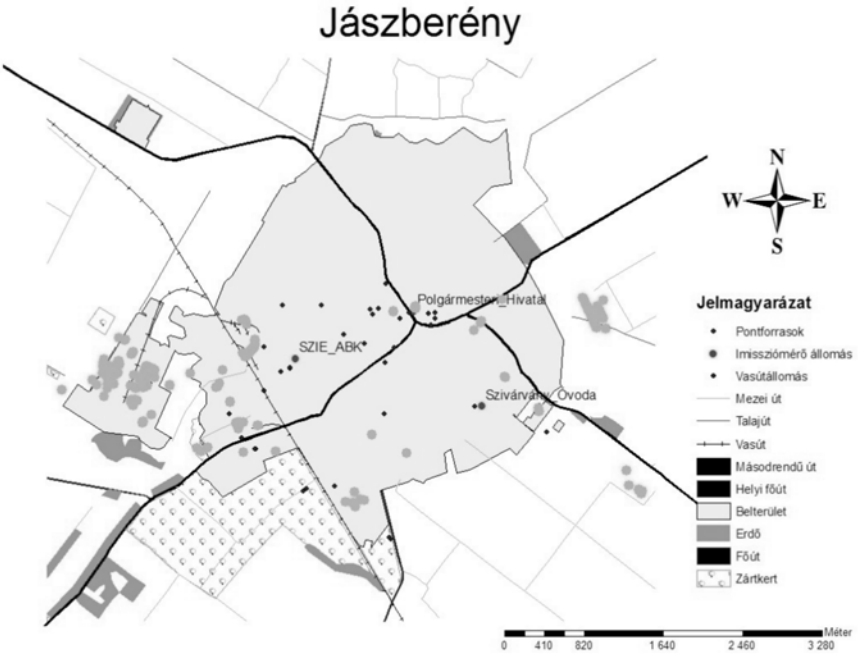

Figure 7: Point sources emitting solid material in Jászberény.

4. Conclusions

By applying diffuse model I defined the areas of Jászberény which are most effected by the point sources by means of the available data. According to the processed immission data we can appoint that over the last years the immission limit values, expect by the settling dust, were kept in the town, and the air quality can be regarded good. The effect of point sources on the air environment is not remarkable. The examination of town traffic and heating emission are a question of further examinations.

Acknowledgements

I express my thanks to Dr. Bíró Tibor, Dr. Nagyváradi László, Dr. Nagy Tibor, Dr. Pirkhoffer Ervin and Dr. Wirth Lajos for their help during my work.

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Acta Universitatis Sapientiae
Agriculture and Environment, 1 (2009) 104-115

Utilization potential of solid biomass for energy production in the Ajka Subregion

Orsolya KAKUCS[1], Tibor KUN-SZABÓ[1]

[1]Institute of Environmental Engineering, Faculty of Engineering, University of Pannonia, Veszprem, e-mail: kakucso@yahoo.co.uk

Manuscript received 20.08. 2009; revised 21.09. 2009, accepted; 24.09.2009

Abstract: This work assesses the utilization potential of solid biomass for combustion purposes in a Hungarian subregion through determinig the potentially available solid biomass and the energy production and consumption structure. The results report an unexploited minimum potential of 454 TJ/a of agricultural biomass, which is suffice to replace natural gas for heat production in the communal-residential sector. The maximum potential of 1018 TJ/a could moreover be used to reduce fossil fuel consumption in the industrial and agricultural sector and to mitigate the firewood demand of the Ajka Power Plant. Forest biomass potential was found to be exploited fully in the subregion.

Keywords: bioenergy, potential assessment**,** regional energy balance

1. Introduction

The use of biomass is considered an important solution for the depletion of fossil fuel resources and the greenhouse gas problem [1]. Present experiences, however, reveal that the application of biomass for energy production is environmentally sound and contributes to rural development if it happens locally or regionally. Accordingly, the application possibilities and their impacts have to be assessed at local or regional level as well.

This work aims to determine the utilization possibilities of solid biomass for combustion in the Ajka Subregion (AS), Hungary. For this purpose, the relevant energetic, agricultural and rural development strategies and programs were

studied, and the potentially available energetic solid biomass, as well as the energy production and consumption structure in the reference area was determined.

The AS is located in the western part of county Veszprém in the Middle-Transdanubian Region and incorporates 39 settlements. There are only two towns in the subregion where more than the half of the inhabitants is concentrated, and 22 of the settlements are small villages with less than 500 residents. The natural conditions of the AS benefit the sylviculture, grass farming and viniculture, but don't benefit the intensive arable farming. The arable land which makes 40% of the total area is mostly of low-quality. Regarding the socio-economic conditions the subregion can be characterized by heterogeneous problems. The centre town, Ajka and its outskirts are battling with the industrial structural reconstruction brought by the political system change, whilst the small settlements are facing the problems of anachronistic agricultural production and marketing [2].

The local exploitation of the unutilized natural resources could be a great opportunity for the AS to strengthen local economy and increase the living standard of its inhabitants.

2. Materials and methods

The flowchart of the assessment is shown in *Fig. 1*, and each step is commented in the following.

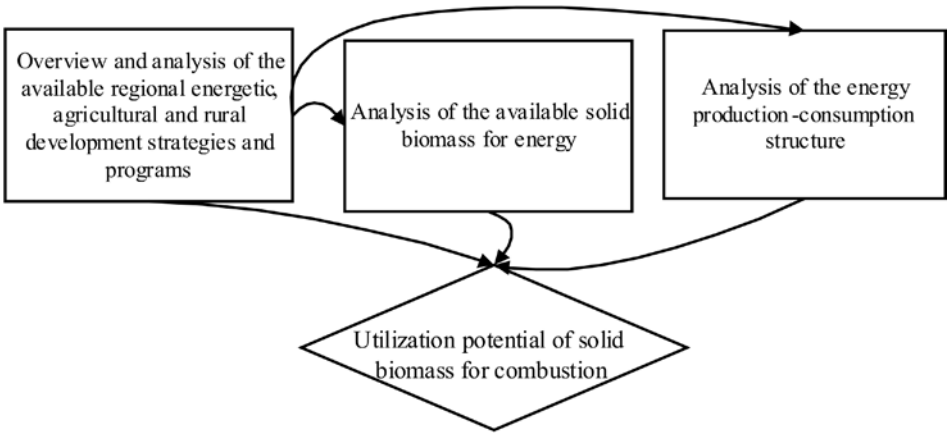

Figure 1. Flowchart to analyse the utilization potential of solid biomass for combustion purposes in the AS

2.1. Overview and analysis of the relevant energetic, agricultural and rural development strategies and programs

As the first step of the assessment, the energetic, agricultural and rural development objectives and plans were identified which are relevant for the AS.

There was no energetic assessment or strategy prepared for the AS until now, so the energetic concept of the Middle-Transdanubian Region from the year 2006 [3] was analysed, which includes biomass application recommendations also at subregional level.

Information about the agricultural production structure and rural development objectives of the AS were taken from the Agricultural and Rural Development Program of the AS 2004 [2].

The content of these documents will be specified in Chapter 3.1.

2.2. Analysis of the solid biomass potential for energy production

There are several solid biomass types suitable for energetic use, however not every types have a great significance in the subregion. Selection of the relevant crops, thus, happened based on the natural conditions of the area, the structure of the agricultural production, the proposals of the above mentioned documents and relevant Hungarian scientific literature [4-7].

For performing the calculations, the methods of Unk [3, 8] and Szarka [9] were studied. The details of the analysis are introduced by the selected biomass types in the following.

2.2.1. Agricultural crop residues

The studied crop residues were corn-ears straw, corn-stalk, sunflower stalk and plate, rape straw, lopping from orchards and vine from vineyards.

The total annual residue amounts were calculated based on the cultivated areas and the average residue yields. The energy value of these residues gives the theoretical potential. Residues collectable for energy purposes were considered the technical potential.

As it was not possible to get the actual and accurate figures of the production areas by the arable crops in the subregion, two cases were analysed. The minimum case is based on the data of the Agricultural Census 2000 [10-11] given for the AS. In the maximum case the areas registered as arable land were taken and the distribution by crop types was estimated [12-13]. The data and factors used for the calculation are summarized in *Table 1*.

Crop production figures were gathered from county statistics [14], whilst residue yields and heating values were derived from literature [3, 6].

Table 1. Basic data for the calculation of the agricultural crop residue potential for energy production

Denomination	Unit	Corn-ears	Corn	Sun-flower	Rape	Or-chard	Vine-yard
Crop production area							
minimum	ha	9393	4263	1180	1181	57	244
maximum	ha	12320	5591	1550	1550	57	700
Average crop yield	kg/ha/a	3181	3630	1650	2290		
Residue-to-product ratio	%	96%	180%	210%	140%		
Average residue yield	kg/ha/a	3054	6534	3465	3206	2500	1800
Rate of residues available for energy	%	70	70	70	70	100	100
Rate of collectable residues for energy	%	50	50	50	50	50	50
Heat value of residues	MJ/kg	15	15,5	14,5	14	11	11

2.2.2. Energy crops

Energy crop plantations are established on arable land and can be classified into two groups: the one is constituted by herbaceous plants and the other by arboreal plants [6]. For this study the Szarvasi-1 energy grass was chosen as herbaceous plant, and robinia and poplar as arboreal plants.

In order to get the annual energy crop potential in the subregion the size of the potential cultivation areas were multiplied by the crop yields and the heating values. To identify the available land for energy plantations the proposals of Unk [3, 8] were considered. In the minimum case energy crop plantations were assumed to be established on 80% of the set-aside land (app. 1000 ha), whilst the maximum case moreover includes the conversion of about one third of the low-quality arable land (3500 ha) where corn-ears and maize are produced. The maximum case so calculates on 15% of the total arable area in the AS.

Accordingly, if we assess the potential of crop residues together with the maximum case of energy plantations establishment, the available residue amounts will decrease.

Agricultural statistics [10-11] and literature [4] were used to obtain these data.

2.2.3. Forest biomass

Following the proposal of the staff of the Forest Planning Office in Veszprem [15], the yearly gross increment was considered as the upper limit of the yearly logging, which is in accordance with the sustainable management principle of Hungarian forests.

Theoretically the total yearly gross increment of forests could be used for energetic purpose, but the actual use is determined by various technical, economic and environmental factors, as well as the attitude of the forest managers, which are all hard to quantify. Thus, the amount of the forest biomass available for energy production is given by a maximal technical potential, where industrial wood use and residue formation during the logging process were taken into account.

To perform the calculations national and subregional forest statistics served as data source [16-17].

2.3. Analysis of the energy production and consumption structure (energy balance)

The energy balance calculation method of the OECD/IEA [18] was studied to determine the energy balance of the AS. This method serves as base also for the national energy balances. In this study, the production of primary energy carriers, energy conversion in heat and power plants, as well as the final energy consumption by sectors were calculated, and the energy dependency of the subregion was judged. The energy consumption of the transport sector was not included in this study, as it is hard to interpret at subregional level.

The production of fossil fuels and the heat and power generation figures were derived from relevant publications and data provided by the Bakonyi Power Plant Plc. [3, 19]. Final energy consumption was determined by sectors and settlements using statistical data and performing estimations [11, 20-21] (see Table 2). In some cases, consumption of certain energy sources was neglected based on the national energy balances and statistics as well as information on local circumstances [3, 21-23].

Table 2. Determination method of the final energy consumption figures by sectors

<table>
<tr><th rowspan="2">Sector</th><th colspan="8">Energy carrier</th></tr>
<tr><th>Solid fuels</th><th>Oil products</th><th>Electri-city*</th><th>District heat</th><th>Piped gas*</th><th>PB-gas</th><th>Fire-wood</th><th>Other (agri residues)</th></tr>
<tr><td>Residential</td><td>E</td><td>n</td><td>√</td><td>√</td><td>√</td><td>na</td><td>E</td><td>E</td></tr>
<tr><td>Communal</td><td>n</td><td>n</td><td rowspan="4">√</td><td rowspan="4">√</td><td>√</td><td>n</td><td>n</td><td>n</td></tr>
<tr><td>Agriculture</td><td>n</td><td>E</td><td rowspan="3">√</td><td>n</td><td>n</td><td>n</td></tr>
<tr><td>Industry</td><td>n</td><td>na</td><td>n</td><td>n</td><td>n</td></tr>
<tr><td>Services</td><td>n</td><td>n</td><td>n</td><td>n</td><td>n</td></tr>
<tr><td colspan="9">*Comment:* data available: √, data not available: na, own estimation: E, neglected: n
*includes consumption of consumers supplied by the energy supplier companies</td></tr>
</table>

2.4. Utilization potential of solid biomass for energy production

Based on the results of the previous assessments it can be determined how much solid biomass potential can be exploited for combustion purposes in the AS and in which sector and for what purpose should it be utilized.

3. Results and discussions

Results are introduced and discussed in the following according to the grouping of the methodological description.

3.1. Overview and analysis of the relevant energetic, agricultural and rural development strategies and programs

The energetic concept and strategy of the Middle-Transdanubian Region outlines a long-term energy management and supply concept for the region. It proposes to develop a new energy carrier structure with the significant share of renewable energy resources, especially primary biomass. In order to strengthen local economy primary biomass is suggested to be processed, converted and utilize locally.The energetic concept includes the next proposals regarding solid biomass for firing purposes:

- support of small- and medium-scale innovative technologies instead of the reconstruction of centralized and outdated power and heat production plants,
- progressive increase of the renewable-based power and heat supply in the residential, communal and agricultural sectors
- establishment of biomass-based small- and medium-sized power plants in the centre town of every subregion and in industrial parks,
- establishment of 25700 hectares of wood plantations and 10000 hectares of herbaceous plantations on low-quality and unutilized arable land for the production of solid energy carriers for firing purpose,
- establishment of technologies for the processing of primary biomass (pelleting, briquetting) in 3-5 settlements of every subregion.

The Agricultural and Rural Development Program of the AS considers the underdevelopment of rural areas and the continuous impoverishment as the biggest problem of the subregion, whilst the touristic, economic and natural capability of the area is found to be unexploited. The program identifies the efficient use of natural resources, cultural specialities and values as an option for rural development. A special objective of the program is to develop a competitive product structure including energy crop production, but potential production areas are not assigned. A substantive target, however, is to identify alternative options for the utilization of low-quality soils.

3.2. Analysis of the solid biomass potential for energy production

3.2.1. Agricultural crop residues

Applying the method introduced in Chapter 2.2.2, the annual theoretical energetic potential of the studied agricultural crop residues fell into the range of 981 and 1293 TJ, according to the minimum and maximum assumptions. The results for the technical availability range from 344 to a maximum of 455 TJ/a, and they are demonstrated in *Fig. 2* by crop types. As it can be observed, straw of corn-ears and corn-stalk arise in the greatest amount within the subregion.

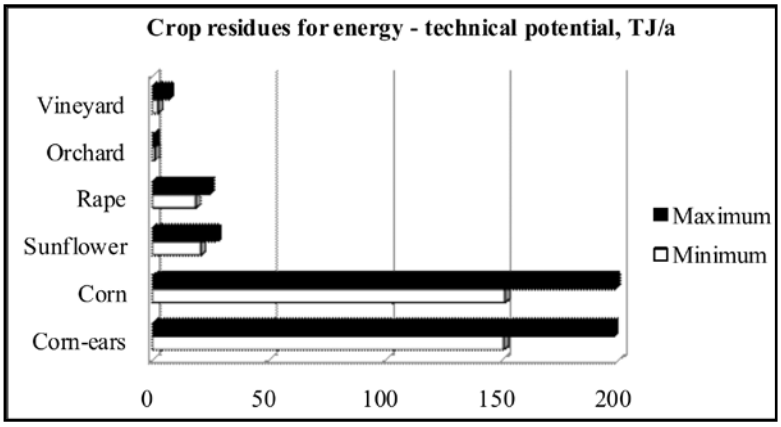

Figure 2. Technical energetic potential of agricultural crop residues in the AS

3.2.2. Energy crops

In the minimum case of energy crop production 500 ha were proposed to produce both energy wood and energy grass. The maximum case, in turn, assumes 3000 hectares for wood plantations and 1500 hectares to establish energy grass plantations. Based on these data, the total annual energetic potential was found to reach 165 and 700 TJ, as it is shown in *Fig. 3.*

Establishing energy plantations reduces the production area of traditional crops, so the energetic potential of crop residues ranges 344-376 TJ/a. Summed the total energetic potential from the agricultural sector, the result is 509-1076 TJ/a.

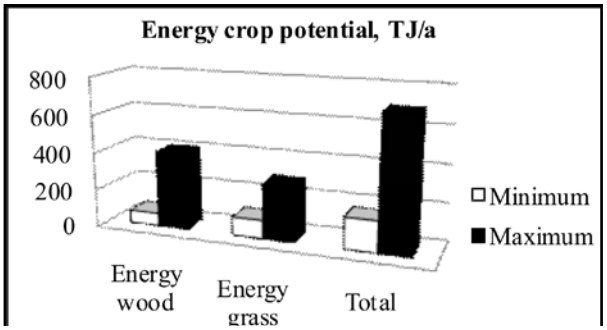

Figure 3. Potential of energy crops in the AS

3.2.3. Forest biomass

The AS comprises large areas of forests especially with species of oak, turkey oak, beech, hornbeam, robinia and conifers. The more than 24000 ha forest area takes up 32% of the subregion's total area. Based on the calculations introduced in Chapter 2.2.3, the theoretical energetic potential of forest wood reaches 1439 TJ, whilst the maximal technical firewood potential was found to be 624 TJ. The data used for the calculation, as well as the results are shown in *Table 3.*

Table 3. Calculation table for the determination of firewood potential

Denomination		Unit	Value
Total forest area		ha	24031
Rate of deciduous forests		%	91,9%
Gross increment	Conifers	$m^3/ha/a$	8,44
	Deciduous	$m^3/ha/a$	6,42
Heating value	Conifers	MJ/m^3	6840
	Deciduous	MJ/m^3	9360
Theoretical potential		TJ/a	1439
Residue formation		%	15%
Rate of firewood to net potential		%	51%
Max technical firewood potential		*TJ/a*	*624*

3.3. Analysis of the energy production and consumption structure (energy balance)

Table 4 shows the energy balance for the AS. It can be regarded just as an informative balance, because of the inaccuracy caused by estimating and

neglecting of certain data. However, there can be drawn important conclusions concerning the energy management rationalization of the AS.

As it can be seen in Table 4 there is no crude oil or natural gas production in the subregion. Coal mines were closed until 2004. For lack of accurate data about firewood production, the maximal technical firewood potential of 624 TJ/year calculated in Chapter 3.2.3 was considered. Regarding agricultural residues the balance includes only those residue types which are considered in the biomass potential analysis and their production (collection) is assumed to be equal with the utilized amounts within the subregion. Exploitation of other renewable energy sources (solar, wind, geothermal) is not widespread in the AS, so these were not included in the energy balance.

Table 4. Energy balance of the AS for the year 2007

Denomination	**Solid fuels**	**Oil products**	**Natural gas**	**Electri -city***	**District heat***	**Fire-wood**	**Agri residues**	**Total**
Production	0	0	0	0	0	624	56	680
Export	0	0	0	133	0	0	0	133
TPES**	5825	78	2882	-133	0	4105	56	12813
Conversion	5790	0	56	-1451	-423	3499	21	7491
Final energy consumption	35	78	2826	1319	423	606	35	5322
out of this residential	35	0	354	207	283	606	35	1521
Import	5825	78	2882	0	0	3481	0	12266
*comment:**sold amounts; ** total primary energy supply distribution and transmission losses are neglected								

There is only one energy conversion plant in the AS located in Ajka and operated by the Bakonyi Power Plant Plc. It produces combined heat and power based on imported brown and black coal, as well as power on biomass base. The generated heat is transmitted for the neighbouring industrial plants and the city. Biomass-based power production started in 2004 with 30 MW_e built-in capacities. The fuel mainly consists of firewood from forest management and industrial wood waste, but agricultural crop residues are combusted for smaller extent, too. For better handling of the fuel, 8-10% of brown coal is mixed to biomass. There are plans for establishing energy plantations in the region to increase the availability of biomass fuel.

Regarding the total final energy consumption it was found that natural gas has the greatest share with 53% followed by electricity with 25%. In the residential sector firewood is the most widespread energy carrier (39%) followed by natural gas (23%) and district heat (21%).

The energy balance shows that fossil energy carriers are covered only by import. The firewood balance is also negative because of the significant firewood demand of the Ajka Power Plant. (It has to be emphasized here that regarding the biomass-supply of the power plant not only the area of the AS has to be considered and studied. Namely, outside of the borders of the subregion but near to the power plant there are large forest areas. Analysis of the distance where the biomass supply is economic and environmentally sound was not considered.)

3.4. Utilization potential of solid biomass for energy production

The most important results introduced in the previous chapters are summarized in Table 5. Assessing them the utilization possibilities of solid biomass for energy purposes in the AS can be identified.

As it can be observed, there are no additional forest biomass reserves for energy production. Forest plantations could be an opportunity, but there is no notable intention for planting in the future [15]. However, an important amount of firewood could become available in case of applying up-to-date technologies with higher efficiency for the residential heat production.

Table 5 also shows that there is a significant additional biomass potential (454-1018 TJ/a) arising from the agricultural sector.

Table 5. Solid biomass potential and utilization possibilities for combustion in the AS

Biomass type	**Energetic potential, TJ/a**	**Currently used, TJ/a**	**Unexploited potential, TJ/a**
Forest biomass	max. 624	624	0
Agricultural crop residues	344-376	56	288-320
Szarvasi-1 energy grass	98-292	0	98-292
Energy wood plantations	68-406	0	68-406
Total	*1134-1698*	*680*	*454-1018*
Sector	**Energy carrier**	**Utilization purpose**	**Consumption in 2007, TJ/a**
Residential, communal	Natural gas	Heating, warm water	463
Industry, agriculture, services	Natural gas	Heating, warm water, other	2323
Ajka Power Plant	Forest wood	Power production	3499

The exploitable biomass is proposed to be used for replacing the natural gas consumed for heat production in the residential and communal sectors. Besides the application of smaller stoves and furnaces, village district heating systems and central heating of bigger institutions and their groups of buildings can be

realized on biomass-base, as it is also suggested in the energetic concept of the Middle-Transdanubian Region. Agricultural crop residues and herbaceous energy crops can be combusted first of all as pellets and briquettes, whilst wood from energy plantations is proposed to be applied mostly in the form of wood chips [3, 24].

As Table 5 shows the residential and communal consumption of natural gas for heat purposes can be replaced almost in full extent even with the minimum amount of potentially available biomass. Efficiency of up-to-date biomass combustion devices and that of fossil fuel-based technologies is considered to be very similar.

Biomass potential from the maximum case moreover ensures yearly 555 TJ of agricultural biomass which can be used for energy production in industrial and agricultural plants or to replace a part of the firewood amount combusted in the Ajka Power Plant.

4. Summary and conclusions

The paper introduces the analysis of solid biomass potential for firing purposes as well as the energy production and consumption structure of the AS. Based on these and the agricultural, rural development and energetic strategies relevant for the subregion, the possibilities of biomass utilization for combustion purposes were studied.

Results show a notable unexploited biomass potential in the AS concerning agricultural crop residues and energy crops. The forest sector does not include unutilized firewood potential; so it is possible to reduce the firewood consumption through the improvement of the combustion efficiency in the residential sector.

The energy balance for the AS shows a significant energy dependency on imported energy carriers, which is the result of the huge firewood demand of the Ajka Power Plant and the widespread natural gas consumption in the final energy using sectors. The solid biomass potential calculated for the AS is thus proposed to be utilized for the replacement of these energy sources. However, it is important to emphasize that small and medium scale technologies has more advantages to rural areas regarding economic, social and environmental development.

Results introduced in this paper can serve as base for identifying solid biomass-based energy production options according to the characteristics and capabilities of the AS. In the next step of the research work the greenhouse gas emissions, the economic and social effects of these options will be studied using system dynamics modeling approach.

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Acta Universitatis Sapientiae
Agriculture and Environment, 1 (2009) 116-122

Induced phytoextraction of lead from contaminated soil

Alžbeta HEGEDŰSOVÁ[1], Silvia JAKABOVÁ[1], László SIMON[2], Ondrej HEGEDŰS[3], Andrea VARGOVÁ[1], Katalin TÁLOS[4] Tímea PERNYESZI[4], Cornelia MAJDIK[5]

[1]Department of Chemistry, Faculty of Natural Sciences, Constantine the Philosopher University, Tr. A. Hlinku 1, SK-949 01, Nitra, Slovakia, e-mail: ahegedusova@ukf.sk
[2]Department of Land Management and Rural Development, Technical and Agricultural Faculty, College of Nyíregyháza, P.O.Box 166., H-4401 Nyíregyháza, Hungary, simonl@nyf.hu
[3]Regional Public Health Authority in Nitra, Štefánikova 58, SK-949 63 Nitra, Slovakia, nr.hegedus@uvzsr.sk
[4]Department of Analytical and Environmental Chemistry, Faculty of Science, University of Pécs, 6 Ifjúság, H-7624 Pécs, Hungary, e-mail: ptimea@ttk.pte.hu
[5]Faculty of Chemistry and Chemical Engineering, University Babes-Bolyai, 11 Arany J., RO-400293 Cluj-Napoca, Romania, e-mail: majdik@chem.ubbcluj.ro

Manuscript received 08. 24. 2009; revised 09. 20. 2009; accepted 09. 23. 2009

Abstract: Lead belongs to the most toxic elements. Harmful effect is not simple(complicated), because the contamination by lead decreases the plant production and has a possible admission into the human and animal food chain by accumulation in plant cells. The effect of EDTA as chelating agent (ethylenediaminetetraacetic acid) on lead accumulation was studied in maize roots and shoots using phytocells in acclimatized chamber during induced phytoextraction in the case of artificial contamination at concentrations of 50 $mg.kg^{-1}$ and 100 $mg.kg^{-1}$ in chernozem soil. The effect of EDTA treatment in a concentration of 5 and 10 $mmol.kg^{-1}$ significantly increases the uptake of lead in shoots in comparison with control experiments in the case of 50 $mg.kg^{-1}$ (500 % and 1823 % increasing) and 100 $mg.kg^{-1}$ (1790 % and 2600 % increasing) contamination. Similar experimental results were obtained in lead uptake of roots during EDTA treatment in a concantration of 5 és 10 $mmol.kg^{-1}$ soil contaminated by lead (50 $mg.kg^{-1}$ lead, 100 % and 250 % increasing), while in contaminated soil by 100 $mg.kg^{-1}$ lead the use of 10 $mmol.kg^{-1}$ EDTA concentration resulted in statistically significant increasing lead uptake (103 % increasing). The used chelating agent significantly decreased the biomass of roots and shoots, nevertheless the visible symptoms of phytotoxicity were not caused on the plants.

Keywords: lead contamination, maize, induced phytoextraction, EDTA

1. Introduction

A long term contamination of the Central European area exists by the global transfer from large industrial and energetic complexes together with regional effects. This had an extraordinarily negative effect on the heterogenic soil cover with increased and extremely high content of dangerous elements of natural origin. Ecological dangers caused by accumulation of dangerous compounds in soil may provide problems in producing hygienically safe food. Specially problem is that the bonding and mobility of contaminats may alter due to the acidity of soil. It is applied to heavy metals with high biotoxicity. During agricultural growth and harvesting the soil should not be contaminated, productivity and ecologically function of soil should be preserved for long period.

In the region of Slovakia within Europe has intensive vegetable growing. As earlier results show the accumulation of cadmium and lead may be the most important hazard factor in the topsoil [1-9]. The lead is one of the most toxic elements and get out to the environment by fuel burning and industrial production. Harmful effect of lead has complexity. On the one hand the lead by causing stress decreases the vegetal production on the other hand it may get into the human and animal food chain by accumulation in plant cells.

The uptake and toxic effect of heavy metals is influenced by several factors: soil quality, pH value, chemical form of heavy metal, presence of chelating agents, the materials produced by roots, kind of plant, concentration of heavy metals and period of contamination [1,7].

Recently the phytoremediation is a keenly developing environmental technology using plants. The term phytoremediation is used to identify a group of sanitation methods, which are based on the plant ability to accumulate the heavy metals without any significant damage to their metabolism. In more exact sense, phytoremediation is defined as sanitation technique, which uses plants for fixation, accumulation and decomposition of dangerous organic and inorganic environmental contaminants [8]. The method has been practically tested in several cases and has a number of cardinal advantages. Except of its lower price it is environment-friendly (minimal damage of surroundings and biological activity in soil, decrease in dust contaminant level, preservation of productivity and physical structure of soil) and suitable for different types of contaminants, it has low energy requirements (it merely uses the solar energy). The main advantage in comparison with classical physical-chemical methods is low cost, minimal amount of secondary waste, possibility of contaminant elimination from larger areas especially after phytoremediation techniques without polluted soil mining and last but not least minimum environment

violation, thus these approaches are respecting the environment and accepted by public.

As for disadvantages, the cleaning process lasts long; the possibility of soil decontamination is limited by the depth of pollution and possible admission of contaminants into the plant feeding animal food chain.

In the phytoremediation of environment several methods have been developed. For heavy metal remediation, phytoextraction and phytostabilisation are primarily used. In our study the phytoextraction was used. During continual phytoextraction special plants extract pollutants from soil using their roots and store them mostly in green mass (storing in roots only partial) and it is possible to repeat the whole process periodically until the acceptable level of total contamination is reached. The bio-mass obtained is consecutively processed to concentrate the pollutant by the use of microbiologic methods (composting), thermal methods (cremation or burning) or chemical methods (extraction). During induced phytoextraction chelate application in soil induces the transfer of metal to currently forming plant biomass, by which the use of fast growing plants (such as corn) is made possible.

Chelate-forming compounds such as ethylenediaminetetraacetic acid, ethylene-bis(oxi-ethylene-nitrilo)tetraacetic acid, citric acid, picolinic acid) getting out to the soil enhance the mobilisation of metals, thus the plants can uptake a large amount of metals by roots and the metals can be effectively transported from the roots to shoots [1,6]. After burning of harvested biomass containing contaminants the concentrated heavy metals can be recovered.

In the knowledge of the above mentioned premises in a soil moderatelly contaminated by lead the effect of EDTA as chelating agent on the uptake of maize roots and shoots using phytocells in acclimatized chamber.

2. Materials and Methods

Experiment with phytocells in acclimatized chamber – The natural, untreated chernozem topsoil (sand with clay and strow mortal, pH_{KCl} = 7,3) derived from experimental garden of Vegetable Research Institute in Nové Zámky. The samples were taken in the upper layer of topsoil in a depth of 20 cm. The air-dried soil samples were homogenized and filtered with a sieve of d = 2 mm. Homogenized soil samples of 1 kg were measured into the phytocells, then the samples were contaminated by lead at concentrations of 50 and 100 $mg.kg^{-1}$. Four weeks before casting cores lead(II) nitrate ($Pb(NO_3)_2$. $2H_2O$) solution was sparged on the topsoil. The control topsoil was not treated with lead(II) nitrate solution. Experiments repeated five times with phytocells were set using maize in an acclimatized chamber having area of 8 m^2 and

adjusted airspace. The temperature (20 °C), the humidity (60-70 %) and the lighting (max. 50 000 lux, exposition: 12 h light/ 12 h dark) were automatically set to constant values (Zea mays, var. Qintal) (*Figure 1*).

Figure 1: Experiment set with phytocells using maize in acclimatized chamber. (June 2008, Nitra, Slovakia)

In the control and contaminated phytocells 9-9 plants were grown. The water capacity of soil was adjusted to 50-60 %. As a medium a solution of nutrient salt (Knopp type) was added to the topsoil. The lead uptake by maize shoots was enhanced by adding EDTA in concentrations of 5 és 10 mmol.kg^{-1} in the fiveth and sixth weeks of the experiment (the whole amount of EDTA was middled). After the seventh week the experiment was stopped. After moulding (four times) of soils the maize roots were washed with tap water, distilled water and deionized water three times. The samples were dried, comminuted and ground (<1 mm). The root and shoot samples were excavated with concentrated nitric acid and hyrogen peroxide in a charring apparatus (ZA I type, JZD Zahnašovice, Czech Republic), then the lead concentration of samples were determined by atomabsorption spectrophotometry (ETA-AAS, SpectrAAS-200 Varian) at the Faculty of Natural Sciences of the Constantine the Philosopher University.

Statistically analysis – The experimental results were methodized and processed using Microsoft Excel program. The statistically analysis of experimental data was done with one-factor variance analysis, b-test of Tukey using SPSS program.

3. Results and discussions

The accumulated lead amount by maize roots was 0,632 $mg.kg^{-1}$, the accumulated amount by shoots was 0,039 $mg.kg^{-1}$ in contaminated chernozem soil using phytocells in acclimatized chamber. Adding EDTA solution in a concentration of 5 $mmol.kg^{-1}$ the value increased to 1,272 $mg.kg^{-1}$ in roots (100 % increasing), the value increased to 0,236 $mg.kg^{-1}$ in shoots (500 % increasing). In the case of defined contamination adding EDTA solution in a concentration of 10 $mmol.kg^{-1}$ increased the lead content to 2,214 $mg.kg^{-1}$ in roots (250 % increasing) and 0,75 $mg.kg^{-1}$ in shoots (1823 % increasing).

EDTA application in a concentration of 10 $mmol.kg^{-1}$ considerably enhanced the lead transport from roots to shoots.

In contaminated chernozem soil by 100 $mg.kg^{-1}$ lead, 1,176 $mg.kg^{-1}$ lead was accumulated by maize roots and 0,018 $mg.kg^{-1}$ was accumulated by shoots. EDTA application in a concentration of 5 $mmol.kg^{-1}$ this value increased to 1,379 $mg.kg^{-1}$ (17 % increasing) in roots, the value increased to 0,34 $mg.kg^{-1}$ (1790 % increasing) in shoots. In the case of defined contamination application of EDTA in a concentration of 10 $mmol.kg^{-1}$ increased the lead content in roots to 2,39 $mg.kg^{-1}$ (103 % increasing), in shoots to 0,486 $mg.kg^{-1}$ (2600 % increasing) (*Table 1*).

The experimental results confirmed that adding EDTA in a concentration of 5 and 10 $mmol.kg^{-1}$ statistical significantly enhanced the lead accumulation by maize shoots and shoots in contaminated soil by 50 and 100 $mg.kg^{-1}$ lead in comparison with control experiments.

Table 1: The lead uptake by maize roots and shoots using EDTA solution in chernozem soil (experiments using phytocells in acclimatized chamber, Nitra, 2008)

Treatments	Root	Shoot
	Pb (μg/gramm dried material)	
Control	0,084[a]	0,026[a]
50/0	0,632[b]	0,,039[a]
50/5	1,272[c]	0,236[b]
50/10	2,214[d]	0,750[c]
100/0	1,176[b]	0,018[a]
100/5	1,379[b]	0,340[b]
100/10	2,390[c]	0,486[b]

Note: One-factor variance analysis, b-test of Tukey. In the same column the values signed by various letters significantly ($P<0,05$) differ from each other.

In table 2 the biomasses of maize roots and shoots are included. The experimental data show that the lead contamination did not decrease the

biomass of shoots which can be explained by the resistivity of plant for lead. Adding of chelating agent enhanced the lead uptake by maize and statistical significantly decreased the biomass of roots and shoots, nevertheless the visible symptoms of phytotoxicity were not caused on the plants. This finding supports the earlier observations of Fodor: application of Fe-chelating agent can hinder the growth of plant [2].

Table 2: The effect of EDTA treatment on the biomasses of maize roots and shoots (total mass) (experiments using phytocells in acclimatized chamber, Nitra, 2008)

Treatments	Root	Shoot
	Biomass (g/ phytocell)	
Control	$9,5^{b}$	$47,3^{d}$
50/0	$9,9^{b}$	$43,3^{cd}$
50/5	$9,6^{b}$	$34,7^{ad}$
50/10	$7,8^{ab}$	$29,0^{a}$
100/0	$10,3^{b}$	$48,0^{d}$
100/5	$8,1^{ab}$	$38,5^{bc}$
100/10	$5,4^{a}$	$36,9^{abc}$

Note: One-factor variance analysis, b-test of Tukey. In the same column the values signed by various letters significantly ($P<0,05$) differ from each other.

4. Conclusion

The effect of EDTA as chelating agent (ethylenediaminetetraacetic acid) on lead accumulation in maize roots and shoots was studied using phytocells in acclimatized chamber during induced phytoextraction in the case of artificial contamination at lead concentrations of 50 $mg.kg^{-1}$ and 100 $mg.kg^{-1}$ in chernozem soil. In the case of a lead contamination of 100 $mg.kg^{-1}$ we established that the EDTA treatment in a concentration of 5 and 10 $mmol.kg^{-1}$ significantly increases the lead uptake (nighteen and twenty seven fold increasing) in maize shoots in comparison with control experiments. In the case of a lead contamination of 50 $mg.kg^{-1}$ the uptake was significant as well, nighteen fold increasing in comparison with blank test. Similar results of lead uptake in roots were obtained from the EDTA treatment in a concentration of 10 $mmol.kg^{-1}$ in the case of contamination of 100 $mg.kg^{-1}$ in soil. At defined lead contamination the EDTA application at 5 $mmol.kg^{-1}$ concentration did not caused a significant increase of lead concentration in roots.

The above mentioned experimental results proved the earlier observations of GRČMAN (GRČMAN et al. (2003)). According to him the EDTA treatment of soil facilitates the lead uptake by plants. Adding EDTA to the soil HUANG has measured a lead concentration of 10,6 $mg.g^{-1}$ in maize shoots that is the highest value in the literature HUANG et al. (1996).

On the basis of our results it can be assessed that adding EDTA in a concentration of 10 mmol.kg^{-1} to a temperately contaminated soil (50 mg. kg^{-1} Pb), the lead content in shoots is increasing with 1823 %.

If all parameters are realized under continental climate, then the lead contamination in soil can be decreased with adding of EDTA and maize cultivation within one year and thus the soil can be adapted for gardening. As the maize has a large green biomass, its temperately contaminated biomass can be utilized by the following methods: burning and composting at controlled conditions. During composting the accumulated heavy metals are not transformed, their amounts are not decreased, thus the utilization of the formed compost for agricultural purposes depends on their limited concentrations and average concentrations in soil as well. During burning the forming heat needs to be utilized as energy. The forming residual cinder with high amounts of heavy metals can be treated in the following manners: deponation in dangerous waste dumpsite or recovery of metals from cinder during phytomining.

Acknowledgements

Publishing of this journal is supported by the Institute for Research Programmes of the Sapientia University. The scientific work was supported by VEGA 1/4370/07 and OTKA T043479 research programmes.

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Acta Universitatis Sapientiae
Agriculture and Environment, 1 (2009) 123-129

Delimination of the Szerencs-hilly country and the Harangod region, and the latter's geographical conditions

Ferenc SPÉDER[1]

[1]Department of Geography, Faculty of Physical Geography and Environmental Sciences, University of Miskolc, Miskolc, Hungary, e-mail: ecosferi@uni-miskolc.hu

Manuscript received 09. 05. 2009; revised 10. 02. 2009; accepted 10. 10. 2009

Abstract: The Harangod-region is the eastern part of the North-Alföld alluvial deposit slope. It is bordered by the Hernád from west, by the Gilip and Takta from east, and by the Sajó from south. Each and every author mentions a different northern border for the area. László Boros [1] draws the Szentistvánbaksa-Hernádkércs-Monok border between the Szerencs-hilly country and the Harangod region.

The rain and the dissolution water forms the slightly isoclinic area with surface and ruled erosion. The loamy layers beneath the loess are especially appropriate for runner, which lead to land slides, mostly in the Hernád's left high banks, moreover the bank is destructed and ripped by the river's undermines.

Keywords: creep, land border, loess, land slide

1. Introduction

The Harangod region is slightly mentioned in the books. The aim of my research is the geographical examination of the region, which partly extends to the natural elements that has some kind of effect on the local economy and settlement-network. The aim of this essay is to give a short introduction about the geographical capabilities of the region.

2. Material and Methods

In the literature, the micro-region is mentioned as Harangod or Harangod-region. It's name has several origin. According to the most well known source, it got the name after the bells (in hungarian harang) of the hajdú lookouts. These bells were clanged when the enemy got close in the 17th century, to arouse the

attention of the defenders in Rákóczi flocks around Szerencs. „And since that time the whole province is still place of Harangod, Harangok." [2]. Imre Galuska [3] doubts it, he mentions that the Harangod as a brook's name appeared earlier than the 17th century, although, it was not there (the Harangod to the east from Csanád; the Harangó brook running down from the Cserehát to the Hernád). He assumes, that the Harangod-brook got the name first, than the settlement and after that the micro-region. The brook might got its name after the catholic brazen-caldron (bell/harang) or after the blue-bells (harangvirág) blooming on the banks [3].

3. Results and discussions

A. Delimination of the Harangod-region

The Harangod-region is the eastern part of the North-Alföld alluvial deposit slope. It has a 350 km^2 area. It is bordered by the Hernád from west, by the Gilip and Takta [1,4] from east, and by the Sajó from south. The northern border is questionable.

In the Hungarian micro-region cadaster system [5] it only has 150 km^2, therefore the borders do not cover the real location. Based on the essay „A kárpát-pannon térség tájtagolódása" [6] the accurate delimination is difficult, because it does not contain a detailed micro-regional analysis.

Szerencs-hilly country's (which is a micro-region in the Tokaj-mountains) southern delimination [7] is easily identifiable with the two, above mentioned author's [1,4] line that deliminates the northern border of the Harangod: we move up from the mouth of the Gilip-brooke, we arrive to the Majos-hill then we move to north along the Kaptár- and Hosszú-hill, Ingvár, Nagy-Répás-peak, to west we find the Tetétlen, Baksa-mound and at the end the border of Szentivánbaksa (1. diagram).

Zoltán Pinczés [7] says the border between the Szerencs-hilly country and Harangod-region is artificial, while László Boros [1] says the border is doubtful. The most probable border is the above mentioned version. Above all, because the area between the above mention line is a geographical unit, and if we take a look at it's land use, the micro-region is quite unified in that area too.

B. The evolution the Harangod-micro-region

The region's oldest surfacial rocks can be finding in the northern parts of the region, at the border of the Szerencs-hilly country. The technical literature mentions it as the hilly country's fifth [8] and third [7] range. The transition

between the two micro-regions is formed by the volcanic hills, which are in the right bank of the Gilip-brooke.

From south (Legyesbénye) to north the riolit-cones (domes) of Majos-, Kaptár-, Hosszú-hill and Invgár can be find, one after the other (Szerencs Riolittufa Formation, Kishuta Riolit Department). The line is closed by the Nagy-Répás-peak. It's base rock is different. It is from acid pyroxene andesit (Baskó Andesit Formation). The formementioned hills are from the riolit bursts at the early-szarmata[1], the latter one is the result of the andesit volcanic action at the late-szarmata [9].

The region's further evolution was helped by the pannon[2] era's sea-suffusion, and it's sediment-formation, where limestone, pebble, clay, sanded clay, and loamy sand were sedimented [1]. These are visibly layered e.g. at the Hernád's highbank.

At the frontier of the early- and late-pannon, the Pannon-lake became swampy, smaller lakes rained, while the Hernád's left bank lifted, and became lean. At the lifted, one-time boggy lakeshore, a slight coal-formation went on. Pál Rozlozsnik [10] describes this coal as lignite and coal-slate, while László Boros [1] mentions sub-bituminous coal. Nowadays we know, that according to the German nomenclature, the soft sub-bituminous coal is identical to lignite [1], therefore we can accept the term of sub-bituminous coal. This coal was mined between 1920 and 1950 by the local people in Alsódobsza and in it's surrounding.

At the end on the pannon era, significant part of the Harangod-region became drough. This surface had given place to the rills that came form north until the end of the Pleistocene, among them, the sediments of the Ancient-Hernád [12].

In the Pleistocene, the Harangod-region was a periglaciar area. Due to the lack of rainwater, the rill's sediment transportation was dropped, therefore the wind could blow out the fine dust from the silt-cones, and loess formation began. It's thickness decreases from the Hernád's highbank (Alsódobsza – 8m) to east [1].

C. Morphology, surface formation in our days

Nowadays, the silt-cone plain's surface is mostly formed by water. The rainwater and the fusible-waters create derasion valleys with erosion, and deep caldrons with line erosion. The formementioned slowly forms the soil, grades the surface, while the latter, especially at sudden rainfalls, form fastly receding

[1], [2] Regional eras

gullets. Characteristically, these evolve in places with high relief energy, such as the Hernád's highbank.

The most spectacular formations are in the Hernád's highbank, and were formed by the sloping mass moves without supplier agent between Gibárt and Gesztely. It has two types: creep and ripping.

C. 1. Creeps

It's formation is influenced by several factor. The most important is the runner. The pannon layers under the loess are the most appropriate for runners. In this case sand is proper water-conductor, and they evolve in the border of loamy, slobby layers [13]. These loamy, slobby layers are given in the pannon complex, while the water which is needed to the humidity flows thruogh the loess, and it increases the weigh of the creeping layer. According to József Szabó [13], runners are usually evolve in the pannon layer, therefore it could not be linked directly to the first, under loess watertight layer. The necessary water amount is mostly from the spring thaw and summer rains, therefore creeps are more often these times.

Considering the creep types, the above soles are in the majority. The under sole and sole creeps are rare [13].

The form types are various. Tongue-shaped, coffin-shaped and staged creeps are occurent, and drawer creeps based on the coffin-shaped creeps slided clay [1].

Regarding their age, because there are no creeps covered, buried by loess, we can assume that there were no creeps before loess formation, else they were absolutely erosed [13].

C. 2. Ripps

Sloping mass moves without runner, the main cause is the sinuous Hernád's bank demolition. The undermined, week, support less substance falls. We have documentation about younger creeps and ripps, because significant settlements had to move (e.g.: Alsódobsza 1740, Csanálos 1865, Sóstófalva (Hoporty) 1870) [1,4].

*D. Harangod-region's climat*e

According to the climate classification of György Péczely [14], the region is in the warm-dry climate scope. The mean yearly temperature slightly differs from the national (10°C), it is 9,5 - 10°C. The yearly temperature oscillation is

24-24,5˚C [15]. The number of summer days is 80-90, while the number of swelter days could be 20-25.

The number of freezing days is 90-95, the number of winter days is 25-30. The number of coldest winter days is 10-15 [15].

From the agriculture's aspect (which is the most important industry in the region) the most important period of the year, is when the temperature is constantly above 10˚C, it is from 12 April until 15 October [1]. The number of snowy days is also important, regarding the frost defense in the case of the autumn fling. This is only 10-15 day in the Harangod-region [15]. The yearly fall amount is 525-550 mm, which is low in nation-wide.

E. Hydrogeology

The region is poor in constant surfacial rills. The most significant waters are the Hernád, Gilip, Takta and the Sajó; these are also forming the region's border. In it's area, only the Harangod-brooke is significant, although this, and the Gilip-brooke are periodic at their spring. The reason behind the abscense of larger, constant waters is the little rainwater, slight slope, and the loess's good water-receiving feature. It is also poor in springs, layer-springs can be fin din the Hernád's highbank [1].

F. Soil

It's soils are mostly loess based kastonozem, chernozem with secondary carbonates. Near by the watercourses fluvisol and solonetz are typical [5].

G. Natural flora and agriculture

Due to the plough lands, that cover 90% of the region, it's natural flora can be find only in a few places. Significant, protected botanical associations can be find in the uncultivated areas. In the Hernád's highbank, the erosing loess wall gives place to loess flora (heverő seprőfű, harasztos káposzta, apró nőszirom, etc.), tátorján (Crambe tataria), which is protected by the Megyaszó Tátorjános Nature Reservation. The inner rills of the region somewhere followed by swamp meadows [16].

4. Conclusion

Based upon the above mentioned facts, the Harangod-region's research has to be continued in two lines. On one hand, nature- and landprotection, because nature reservs has slight role in education, and interesting parts are waiting to be introduced and protected, such as the Hernád-high bank.

On the other hand, the analysis of the agricultural area's potential, considering the preservation of the flora's remains, and cultivation in accordance with the soil types.

Acknowledgements

Publishing of this journal is supported by the Institute for Research Programmes of the Sapientia University.

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Agriculture and Environment, 1 (2009) 130-134

Industry establishing effects of mineral raw materials in the Dorog micro-region

Zsófia VÖRÖSKŐI[1]

[1]Department of Geography, Faculty of Human Geography, University of Miskolc, Miskolc, Hungary, ecojeger@uni-miskolc.hu

Manuscript received 09.30. 2009; revised 10. 25. 2009; accepted 10. 30. 2009

Abstract: The Dorog micro-region extends on the countries eastern border and includes 15 settlements. The region has a favorable position, it's local and positional energies are significant. The potential energy is given by the fact, that the River Danube are Budapest are close, while it's local energy was given by the coal for quite a long time. Nowadays it has not got such significance, but it had an important role in forming the industrial structure of our days. Lignite mining was the reason of changes in what the region went through. The population did not work anymore only in the agricultural areas, they started to work in the mines too. Two settlements passed through serious changes. Dorog became a town as the industry's graceful effect, and Tokod became a parish. The coal mining attracted several attaching industries, such as chemical industry and other tightly attaching industries. Not only coal, but sand and limestone brought changes to the settlement's life, and their effect is still appreciable. I am about to present this change in my essay.

Keywords: mining, coal, industrial geography

1. Introduction

In the Dorog micro-region mining had some kind of bond with 10 settlements. As an extractive industry, it allured processing industry to the area. Because of it's determining role, mining had a great influence in the region's process to become a heavy industrial centre. From industry establishing aspect, the area has every feature to become a heavy industrial centre.

2. Material and Methods

The introduction of industry and changes in the industry's structure in the Dorog-micro region is part of my PhD research. From this enormous subject, I analyze the raw materials and the industry built on it. Particularly I use interviews and the technical literature. The written documentaries are supplemented by fieldwork experiences.

In my essay, I am going to survey the minerals role from the bunch of natural elements that had some kind of effect on the industry's geographical post.

3. Results and discussions

A. Geological structure

The Dorog coal-basin is enclosed by the River Danube, the Pilis and the Gerecse. The base of the basin is the Triassic dachstein limestone and dolomite [1]. The water, that constantly endangered the basin's mining, came from the karstic hollows of the basis. The sea sedimentation continued in the Jurassic and in the Cretaceous era. After the sea's shrunk back, as the effect of the hot but rainy climate, the basin collected the dross and other erosion products that came from the neighbors. These parts were rich in flora and fauna, later; their remains were covered and separated from air by shoreline a deposit that is how the coal-sedimentation began. The coal yards were made of arboreal and boggy, non-arboreal plants. Their age is early and mid Eocene and Oligocene [2]. The limestone and the dolomite are covered with broadly 10 meter of thick coal yard. The bitumen content raised during the coal-sedimentation as an effect of the alkaline water in the karstic area. The average heating value of the eocenic lignite is 16500 kJ/kg, but we can find some with a value over 20000 kJ/kg [3].

After the Eocene, in the basises Oligocene sand, marl, pebble, on the edges pannon delta pebble, clay, sand and fresh-water limestone were deposited. The quaternary period's deposits are being represented by the fresh-water limestone, loess, slope-silts, living water sand and pebble [4].

B. Coal and industry

From the energy source materials, the Eocene lignite had the greatest quantity. Coal mining became the foundation of the heavy industry, and several other industries settled down in the area to serve it. Coal mining started in the basin at 1781. In the XIXth century coal was brought to the surface in Csolnok,

Tokod and Sárisáp. Huge amount of coal became an ingredient at brick fabrication and at lime-burning. Since 1838 the Dorog coal mining has documentations too [5].

At the end of the century, they had to go deeper and deeper to find coal, and – because of the local conditions – they had to count with serial water bursts. Later, this fact determined the profile of the miming machine factory, because it's main product was the suction-pump. Among pumps, they produced sorter machines and sand-extracting machines. Later, as an operable part of the corporation, the factory got separated from the Dorog Coalmines and started to operate individually. Nowadays it's name is Techno-Product Kft. and privately owned.

The Dorog Power plant - which was established in 1906 – helped to save mines from water bursts. In the same year silt sealing was installed. In 1924, a coal still was introduced to use up the coal dust and for the coal's chemical utilization. This facility was closed in 1967 [5]. After that, the corporation became the Dorog plant of the Kőbánya Pharmaceutical Factory. In 1984 the company, in conjunction with two other corporations, founded a refuse burner in Dorog. Nowadays it is called SARPI Dorog Enviromental Kft, and it's main profile is hazardous waste disposal.

In 1931 „A" briquette factory was installed in Dorog to utilize the coal dust and make it saleable. In 1948 a „B" factory was installed too. Both plants were in use until 1992. After the war, the request for coal was enormous due to constructions and expansions. The fuel satisfied residential needs, there were no power plant use attached, which later meant disadvantage. The golden ages of coal mining in the area were between 1960 and 1967. Coal sorter was built in Tokod in 1966. However, at this time, the conversion of energy structure began; therefore the coal mining was dropped. In 1971, new mines were established near Tokod and Kesztölc. In 1982 the Lencsehegy II. mine (near Kesztölc) was established from company loan. Three years later in Tokodaltáró a new, up-to-date briquette factory was installed to utilize the coal dust from Lencsehegy. From 1992 only the Lencsehegy II. mine was in use until 2003 when the company was divested [5].

C. Building materials and building industry

From building materials limestone and sand mining was important. Six settlement had own stone-pit, from these two is out of use. The first quarry was opened in 1905 by Sándor Schmidt. This mine is the still working limestone mine in the Hungária hill near Dorog [5]. The mine is the property of the Baumit Kft among the Tokod mine. The plasterwork factory, which represents the building industry in the micro-region, is based on these mines.

The stone mines in Kesztölc and Bajna work in low capacity and serve local needs. The situation of the mine in Kesztölc is notable, because it is in the border of Duna-Ipoly National Park, therefore it needs considered cultivation. These material occurrences did not allured attached industries.

Sand mining went on in Máriahalom and Tokod. The sand from Máriahalom was used in constructions. Due to the small size of the mine, it served local needs. The Tokod sandmine was more significant. In 1892 glassworks, later glass factory settled down in Tokod because of the sand's great quality. From 1906 coal mining needed huge amount of sand, it is a necessary material in silt sealing. Thanks to the glass factory, Tokod became an important centre in the basin after Dorog, and affected the building a new briquette factory there in 1966.

D. Other raw materials

From other raw materials in the Dorog micro-region, the Cornish-stone mining was important. It is only mined in the border of Sárisáp. The mineral is necessary in producing china and fine-ceramics.

E. Industry nowadays

Initially the natural elements determined what kind of industry could settle down in the area. Nowadays the attached industries provide modern, up-to-date factories in the region, such as the battery factory of Sanyo Hungary Kft in Dorog, or the Rosenberg Hungária Kft in Tokod produces HHVAC (heating, ventilation and air conditioning) appliances. These factories used the good potential energies in the decadent heavy industrial region.

4. Conclusion

With using the raw minerals and the opportunities given by the exposure in the Dorog micro-region different industries settled down. These always were that kind of industries which satisfied the economical needs. There are factories with a great past, such as the Kőbánya Pharmaceutical Factory which is now Richter Gedeon Chemical Industry. Interesting; but in the region, there is no cement factory, paper factory or automotive-factory although these are popular industries. The reason could be that the Dorog micro-region is in a close connection with the Esztergom micro-region. In the nearby regions these „missing" industries can be finding. The manpower moves freely in the regions that almost fuse. We need further research to reveal why the two regions are in

this close connection. Furthermore, we have to examine how unique or how general this connection between micro-regions.

Acknowledgements

Publishing of this journal is supported by the Institute for Research Programmes of the Sapientia University.

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Agriculture and Environment, 1 (2009) 135-143

Renewable energy sources in northwest Hungary

Mihály KVASZ[1]

[1]Civil Engineer MSc, PhD-Student at Széchenyi István University, Interdisciplinary Doctoral School of Engineering, Modelling and Development of Insfrastructural Systems, Győr, Hungary, e-mail: kvasm@t-online.hu

Manuscript received 08. 02. 2009; revised 10. 25. 2009; accepted 10. 30. 2009

Abstract: In our days, utilization of renewable energy sources, among others e.g. water-, sunshine-, wind-energy, geothermic energy and bioenergy, is coming more and more to the fore. In this study examples and possibilities realized already in the practice in North-Western Hungary for utilization of renewable energy sources are presented. One of the energetic curiosities of North-Western Hungary is that nearly all kinds of renewable energy sources can be found here, with numerous examples, lots of projects under preparation or already wrecked, among them some that are considered real rarities.

Keywords: sustainable development, environment, wind energy

1. Introduction

Mineral oil and natural gas are not products of an inexhaustible supply and time shall come at a time when the reserves explored all over the world can not replace the older ones any more so the total production of the world shall reach a peak then.

According to the researches huge capacities are yet hidden in the depth of the Earth; however, a major part of them is only a “theoretical stock” since they can be found at very unsafe, doubtful places hard to achieve: In countries of the third world where civil war plays an everyday danger, or lays deep under the ice cover of the Arctic. [6]

Under such a situation it is worth while paying more and more attention to the utilization and exploitation of the domestic possibilities for renewable energy sources, and the analysis of their system integration or “island”-like isolated application).

According to the Hungarian Law, in Hungary there exist five kinds of renewable energy sources: Geothermic energy (in English literature: geothermic energy; by Hungarian neology: heat of the Earth), solar energy, wind energy, bioenergy (biomass, biogas, biolith fuel), and water energy. Thermal utilization of *wastes* (communal garbage, industrial residues, and municipal wastes) as secondary renewable energy source under certain conditions can also be classified into this kind. In case of renewable sources, limitations are determined for the state subvention and support by the Hungarian Government.

It is not allowed to give subvention for the production of water energy plants of capacities over 5 MW, the production of energy plants of capacities below 0.1 MW, and the energy production from wastes that do not fulfil the prescribed conditions.

Therefore it is of importance to know that electrical energy from not every renewable source is given subvention or support. [2] Technologies for the utilization of energy carriers are already available but technical developments are, however, steadily running. At the present, renewable energy sources share a ratio of about 5 to 6 percent within the total energy use. This fact is in agreement with the United Nations Framework Convention on Climate Change. [3]

2. Materials and Methods

2.1. Utilization of Geothermic Energy

Under the Carpathian Basin, and especially under the surface of Hungary, the envelope of the Earth is thinner than the average therefore the geothermic opportunities are here very favourable. Medium value of convection heat flowing out of the depth of the Earth amounts 90-100 mW/m^2 being about the

double of the continental average. Average value of the geothermic gradient that is the temperature rise for one unit depth increase is 0,020-0,033 °C/m generally on the Earth while this figure achieves 0,042-0,066 °C/m as Hungarian average.

Owing to the above thermal facilities, layer temperature in 1000 m depth is as high as 60 or even more. Thermal isoterms in 2000 m depth show significant fields with temperatures of more than 100 °C. Thermal energy carrier is represented in the Carpathian Basin mainly by thermal water filling up the porous-permeable ranges of the rock bed sediments of great thickness of even more than 6 km at some places.

When considering an analysis of the state of thermal water utilization the following can be diagnosed: (1) Geothermic energy is not a kind of alternative but rather an additive energy source that may be used together with the other – mostly fossil kinds of – fuels as a supplementation. (2) Geothermic energy is in the practice an unremitting energy; however, in Hungary it is concentrated only on certain places thereby considered as local source of energy.

Currently, there are more than 200 thermal springs used for water supply to medical and public baths, spas and wellness centres. At the moment there exists no production of electric energy based on geothermic energy. [3]

2.2. Utilization of Solar Energy

Human mankind was always keenly interested in what is the reason or origin of the energy coming from the Sun. During the ancient history it was thought that the heat of the Sun originates in the fire burning within or on the surface of the Sun. Famous German philosopher Kant believed in the 18th century the Sun consists of inflammable materials which, when combine with the oxygen to be present on the celestial body, produce a burning process thus generating heat.

The real solution was given by the theory of Albert Einstein expressing the statement that a huge amount of energy is accumulated in any body with rest mass.

Now it is known that life on Earth is made possible by the heat of, by the radiation of the Sun.

The organic compounds stored in the plants can thank for the existence to the warm of the Sun. Formation of mineral oil, natural gas or coal can also be drawn back to the heat of the Sun. In our area use of solar collectors is although

getting wider spread but can not achieve a remarkable extent due to the significant investment demand.

2.3. Wind as an Energy Source

Total kinetic energy of the wind is estimated to 100 TW but only a certain part of it can be utilized. Work capacity of the wind is proportional with wind speed on third power. Economic considerations show that wind is worth while being utilized mainly on areas where wind speed exceeds 4-5 m/s in yearly average. Such conditions are in general experienced on see-shores and similar places, wind speed is being strongly decreased by internal friction when going to the mainland centre. Hungary is considered a relatively wind-free recess, a calm belt, even this is sometimes disaffirmed by some local heavy storms. The average wind speed is 1.8 m/s in Budapest; and a figure of 5 m/s is not exceeded even in the area of the town Mosonmagyaróvár which is the most windy corner of the county. In the contrary, in Nyíregyháza (at the Eastern border) there have been measured wind speeds of 4-5 m/s or more but not with frequencies and for durations as on see-shores.

2.4. Direct Combustion of Biomass

Mass of organic matters modified to and called biomass can be created by the followings: On one side, wastes of organic origin (from animals or plants) that were hardly utilized or exploited; and on the other side, living vegetative raw materials planted as renewable energy sources directly for the purposes of the energy branch. Its wide spectrum of usage extends from direct combustion through electric energy production to utilization as different (lighter or heavier) fuels.

Energetic usage of biomass is neutral from the point of view of CO_2-load that means the same quantity of carbon dioxide is resulted in combustion as the amount used by photosynthesis in the plants. Biomass represents the fourth greatest source of energy, after coal, mineral oil and natural gas. This produces about 14% of the energy used worldwide, and near 35% in the developing countries. In our region, however, energy production based on biomass is not typical. [3]

2.5. Utilization of Water Energy

Usage of water energy was one of the major and basic ways of energy production in Hungary till the end of the last century, especially in flour milling industry. According to a statistical review from 1885, there were 22,647 water-wheels and 99 water turbines in operation on the territory of Hungary of that time, producing a total energy of 56 MW. Nearly 58% of water power stations with power capacities below 100 kW working in our days were constructed before the Second World War. Technically useable water energy potential of Hungary is about the level of 1000 MW, a figure which is much higher than that of really utilized or useable, in fact. Percentage distribution looks like similar to the following values for different rivers: Duna (Danube) 72%, Tisza 10%, Dráva (Drave) 9%, Rába and Hernád 5%, others 4%. The energy recoverable in case of total utilization is 25-27 PJ, an amount equal to yearly 7,000-7,500 million kWh. On the contrary, the reality reflects the fact that there is – and in the near future, there will be – no engineering object suitable for electric energy production at the rivers of Danube (Duna) and Drave (Dráva). Utilization of the water energy potential of the rivers Duna (Danube), Tisza and Dráva (Drave) on the Hungarian sections is not considered as actual task owing to mainly political reasons.

2.6. Geothermal Possibilities

Numerous experts say heat-pumps have now in the revival era. A heat-pump can be used on warm summer days for cooling, too, in certain cases. It is often used for this purpose in regions of developed countries with warm climate. Heat-pumps operating with air as medium are very easy to install but their work-number is very low in the season with the highest energy demand (i.e. in winter), too, owing to the low boiling temperature. In case of soil-heat collectors (in horizontal designs) and soil probes (in vertical designs for 20-150 m depths) an energy utilization work number can be achieved which can be found between those of the equipments operating with ground water as medium and air as medium. When a new house is under construction it is relatively easy and simple to install soil-heat collectors since the surrounding around the house and the garden are not yet ready. Installation of heat-pumps is expensive, but at the same time, their operation is economical and environmental friendly therefore those who decide for the installation of these kinds of equipments should be given subvention and support, in any case. [3]

3. Results and discussions

One of the energetic curiosities of North-Western Hungary is that nearly all kinds of renewable energy sources can be found here, with numerous examples, lots of projects under preparation or already wrecked, among them some that are considered real rarities.

I wish to present some examples, without the demand on perfection:

3.1. Utilization of Bioenergy

It is the most common to utilize agricultural by-products as direct and secondary fuels for heat energy production. Greatest part of the wastes from logging work can be obtained with 8-10% energy input, and then used; a good example for this usage is the Heating Energy Plant of Tata ("Tatai Hőerőmű") where two ovens each of 3.5 MW capacity are operated with wood chips since 1998.

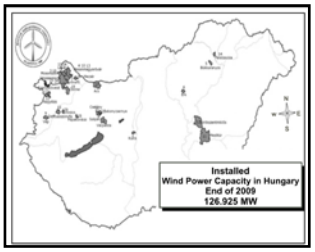
Specific energy demand of briquetting of sawdust, cortex, etc. after drying is only 6-8 percentage of the heating value of a bio-based fuel. By-products are sold for municipal purposes of usage mainly in the form of briquettes. This briquette manufactured directly from wastes of secondary logging work is a good quality fuel. [4]

3.2. Wind Energy

On several places in the country, inclusive the Wind Park at Mosonszolnok built as the very first in Hungary (*Pic. 1.*) there are wind turbine power stations put into operation.

Moreover, the capacity of nearly one of the blocks in the Nuclear Energy Plant in Paks is given final permission of environmental protection type; however, these facilities can temporarily not be built in lack of electricity supplier's allocation.

There are no domestic examples for "island"-like operation yet, although a real solution might be established on this kind of isolated "island"-like work on hydrogen-based technology. [5]



Picture 1: Wind turbine power stations in Hungary (as of 31.12.2008)

3.3. Water Energy Source

The Dunakiliti Danube Dam (*Pic. 2.*) built as part of the former Gabcikovo-Nagymaros Dam that is already constructed in the final form but never operated in accordance with its original function owing to violation of contract should be suitable for producing water energy but this opportunity is not utilized mainly because of political considerations.

There is a decree of the Hungarian Parliament from 1992 that adjudicates a ban on putting The Dunakiliti Danube Dam and Dam into operation. This is today not only squandering from the point of view of water power utilization; the dam might play an important role in water supplementation for the traditional geographic region of "Szigetköz" as well as in the rehabilitation and reconstitution of the Danube riverbed.

Picture 2: The Dunakiliti Danube Dam

A small hydroelectric power plant of the company HUNAG Kft. in Márialiget was constructed. In the small water energy station constructed from a former water mill there were 2 turbines type GANZ Francis put into operation, in accordance with the water right permission for operation issued by the Sub-Prefect (traditional position of Lieutenant's Deputy) of County Pozsony in 1929

and valid since then, which were replaced in 2005 for a 132 kW fully automated Francis turbine type KÖSSLER. [4]

3.4. Geothermic Energy Source

The heating system of the plant hall of the company HEFTER HUNGARY Kft. in Nyul is based on geothermic energy source. The heating of the plant building of 10,000 m^2 ground-space is fulfilled by a ground water heat-pump system constructed on the basis of the experiences of the German main factory.

The heating system of the HOTEL ORCHIDEA**** in Lipot is based on thermalwater energy. Thermal water (as 68°C) goes to energy change block firstly, and after fill to thermal spa basin.

4. Conclusion

We must more and more think of high priority to renewable energy sources, and all possibilities in the future. There are several opportunities for using renewable energies in the region we should care.

The main obstacle for using renewable energies is the legal environment, what should be overhelmed because of recent days gas-supply security problems like russian-ukrainian gas dispute. The changing strategies in dotation could cause unexpected results in finance like CHP – CoGen.

The societal risk of renewable energy projects are also high – renewables could not be competitive without societal acceptance and dotation by the state [1].

Acknowledgements

Publishing of this essay is supported by 5th. Conference on Environmental Science of Carpathian Basin, March 26–28, 2009. Cluj, Romania.

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Acta Universitatis Sapientiae
Agriculture and Environment, 1 (2009) 144-150

The relationship between railway gauges and topographic features on the example of the Hungarian Bükk Mountains

András HEGEDŰS[1], Gábor JÉGER[2], János VÁGÓ[3]

[1]Department of Geography, Faculty of Physical Geography and Environmental Sciences, University of Miskolc, Miskolc, Hungary, ecoeged@uni-miskolc.hu
[2]Department of Geography, Faculty of Human Geography, University of Miskolc, Miskolc, Hungary, ecojeger@uni-miskolc.hu
[3]Department of Geography, Faculty of Physical Geography and Environmental Sciences, University of Miskolc, Miskolc, Hungary, ecovago@uni-miskolc.hu

Manuscript received 09. 02. 2009; revised 10. 10. 2009; accepted 10. 12. 2009

Abstract: In our research we looked for the answer whether there is a proveble relationship between the topographic features and the gauges in the Bükk Mountains and in it's neighbourhood. The Bükk is characterized by diverse topography and extensive railway network.

In the Bükk Mountains and in its direct surroundings a railway network with four different gauges were built in the last nearly one and a half centuries. These railways clambered up from the hills of the mountain margin pedimentation along the deep canyon-like valleys to the 800-850 m high Nagy-fennsík.

Keywords: narrow-gauge railways, digital topographic model

1. Introduction

We find an exceptionally wide spectrum of the railway gauges in the Bükk Mountains and in its direct surroundings, from the 600 millimetre railroads until the 1435 millimetre gauges. The gauge of a railway depends on 3 different aspects in the area. The first one, and maybe the most important is the available source of funds. The second aspect is the quantity and the frequency of the deliverable merchandises, while the third aspect is the terrain.

2. Material and Methods

This paper examines the possibilities given by the different land features, and tries to look for a relationship between the railway gauges and the topographic features. The field observation of the topographic features was

complemented with analysis of a digital terrain model. We examined how, and in what kind of researches can this DTM be used.

3. Results and Discussion

A. Bükk Mountains

The Bükk Mountains are the southernmost member of the North-Western Carpathians, and also this is the largest part of the North-Hungarian Mountain Range, and it has the highest average altitude. Although the altitude of the mountains do not reach the 1000 metres (Istállós-kő, 959 m), but some 50 of its peaks rise above 900 m. The eastern border of the Bükk is the Sajó river, and on the west the Tarna valley borders it. The Hevesaranyos–Mikófalvi basin separates it from the Ózd–Pétervásárai hills in the northwest. The strongly uplifted central part of the Bükk lowers in the north to the Bükk-Hát and in the south to the Bükkalja, and towards the Heves–Borsodi plains [1].

The geological structure of the Bükk is one of the most diverse in Hungary. Most of its rocks are sediments with a sea origin – mainly limestone, clay and shale, radiolarit, dolomite and sandstone. These rocks were formed cca. 310-330 million years ago, from the second half of Carbon period until the end of the Jurassic period. Between the sediment layers in the middle-late Triassic as a result of an undersea volcanic activity porfirit (metaandezite) and diabase (metabazalte) are formed. The mountain's complicated, folded – overfolded, imbricate structured, thrust sheeted structure were formed at least in two sections between the Late-Jurassic and the Early-Eocen. In the first half of the Tertiary, in the early and middle Eocen the mountain was situated on the margin of the tropical and the warm-temperate zone, in a wet, warm, littoral environment, where the geomorphic evolution was directed by chemical weathering and erosion of the watercourses. Due to these erosive processes the relative height of the structural-geomorphological units formed by tectonic movements in the Cretaceous (synclines, anticlines, uplifted-overthrusted nappes) gradually decreased, and the Bükk was planed into a peneplain separated by wide, flat walleys. The separation of it's big regions: the Bükk plateau, the South-Bükk, and the North-Bükk started at the end of the Pliocene. [2].

B. Railroads in the Bükk area

Several railways were built on the territory of the Bükk Mountains in the last one and a half centuries. Being connected to the national railway system the Füzesabony-Miskolc-Putnok, and the Putnok-Eger-Füzesabony railway -

founded on the front of the 1900 years- the railway embraces the mountain range [3].

The area enclosed by the above mentioned railways is not equal exactly with the territory of the Bükk. In this paper we've examined only those railroads that include the valleys reaching into the mountain. At the beginning of the XX. century were the narrow gauge railroads used in Nagyvisnyó, Szilvásvárad, Felsőtárkány, Lillafüred [4], Miskolc and on the Bükk Plateau. We've examined the relationship between these railways and the topographic features. In these days we cannot find a line that works on its total length anymore, only the lines at Szilvásvárad, Felsőtárkány and Lillafüred are still used on some stages (Figure 1.) [5-6].

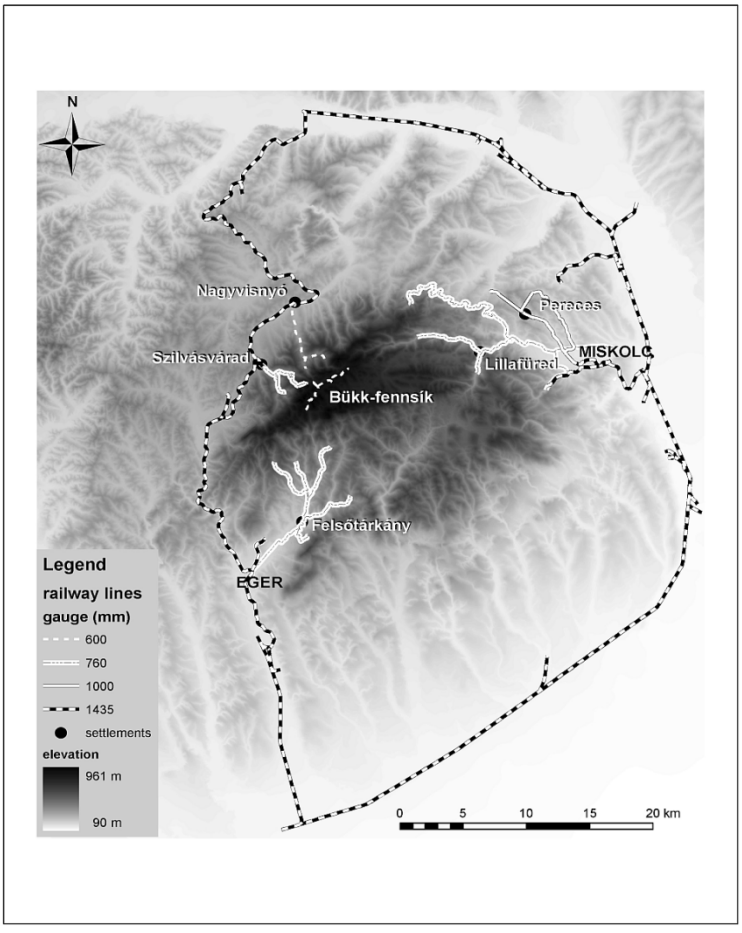

Figure 1.: The important railways of the Bükk and its neighbourhood

These railroads supplied the needs of the industry in the time of their building. Primarily the trees exploited from the forests, and the products of mines in the valleys were transported on these railways to the nearby villages, cities. Their building was not only determined by the quantity of the deliverable goods, but the the relief parameters were also important in the choice of the gauges.

The Diósgyőr - Pereces - Lyukóbánya 1000 mm wide railroad had the largest performance and the largest traffic [7], and this railway moved in the valley with the smallest elevation. It was necessary to build some structures, like the country's longest railway tunnel [8] on this line, which raised the costs. Due to these conditions, the railway lines of the Bükk Mountain range were built with narrow gauge.

Although these lines were perfectly suitable for the exploitation of the resources of the Bükk, nearly all of them were closed. The closures started at the 1960-70's, when the socialist government opted for the development of the road transport and the public roads, as a major goal. Due to this politics the Hungarian narrow gauge railways one after the other were abandoned [9-10].

C. Relief parameters and gauge

For the analysis of the relationship between the gauge and the topographic features we made field examinations, and we analysed the 10 metre resolution digital elevation model of the Bükk. We defined the most important parameters of the surface directly around to the rails with the help of the DEM: altitude above sea level, slope angle, relief energy by hectare and square kilometre, slope shape (curvature).

A close relationship can be seen between the gauges of the railways and the average altitude of their surroundings: the gauge is in inverse proportion to the altitude (1. table). Among the examined lines the railroad of the Nagy-fennsík with a smallest gauge (600 mm) runs on the highest average altitude (864 m), while the line with the widest gauge (1435 mm) is situated on the lowest part of the mountain(166 m) (1. table). Of course this widest railway also climbes up to relatively higher (~390 m) sections, but the length of these sections compared to the total length of the line is insignificant. It's remunerative to build more expensive constructions, like tunnels and ~10 m depth railway cuttings on these short sections to drive through the wide gauge lines. These objects are not part of the the digital elevation model, therefore in the area of these constructions the altitude of the DEM's surface is higher than the elevation of the railway. The deflections on the examined area are some 10 metres: at the tunnel nearby Szarvaskő 42 meters, and at the Nekézseny railway cutting 20 meters.

Table 1: Some relevant data of the examined railways in the Bükk area

Railway	gauge (mm)	lenght (km)	average elevation (m)	Lowest elevation (m)
Nagyvasút	1435	246	166	95
Pereces	1000	19	197	158
Lillafüred	760	18	267	170
Mahóca	760	18,2	316	216
Szilvásvárad	760	7,7	448	359
Felsőtárkány	760	13,3	246	185
Sikló	760	0,7	716	606
Fennsík	600	7,7	864	804
Nagyvisnyó	600	7,3	372	274

Similar relationship can be observed between the lowest altitude of the railway lines above sea level and the gauge: when the lowest section of the line is high, it was built with a narrower gauge (1. table). The reason of this is, that it was possible to build the narrower gauge lines a with a smaller material costs (easier rails, smaller ties, easier engine), therefore it was cheaper to transport the stocks onto the site. It's important, that these railways are in a foresty mountain range, which is situated far from the major traffic roads of the neighbourhood areas.

Examining the slope angles of the surface close to the raillines, it is verifiable that in the surroundings of the 600 -760 mm gauges the average gradient of the slopes is higher, than in the area of the 1000 - 1435 mm railroads (2. table). Examining the maximums of the slope gradients astonishingly large values can be seen. The reason of this is that the Bükk is characterized by gorge-like valleys with steep slopes, and generally narrow, waterlogged, occasionally inundated valley bottoms. Therefore the lines running along these valley bottoms often lead in the valley sides. As the earthworks, comprising the creation of the railway cuttings are exceptionally energy and cost efforts were made to build as narrow railway lines as possible and still sufficient.

The rate of relief energy (relative relief) indicates the dissection of the surface. Just as well in the case of the slope angle, the examination of the relief energy indicates, that the average value of the relative relief in case of the railroads with a smaller gauge is lower, than in case of the bigger gauge tracks (2. table). That means that on more dissected terrain tracks with narrower gauge were built. This is true in the case of the line on the Nagy-fennsík, where the average slope of the surface is small, but on the other hand, because of the

proximity of the plateau edge the morphology of the plateau is relatively dissected.

The slopes are characterized not only by their steepness, but their shape as well. Concave, straight and convex slope sections can be distinguished upon their curvature. Using an elevation model the curvature value with a grade direction, with a strike-direction and both directions can be defined. Along the narrowest lines of the area, at Lillafüred and Nagyvisnyó the high average curvature value indicates, that these railroads were established often on convex slopes (2. table). So another relationship can be presupposed between the shape of the slopes and the gauge of the railway lines running on them. The high slope angles, the high relief energies and the convex valley sides indicate, that in the rising mountain range the incised valleys, valley sections are the most typical ones.

Table 2: Some relevant data of the examined railways in the Bükk area

Railway	Average slope of the surroundings (°)	Average relief (m/km^2)	Average relief (m/ha)	Average curvature
Nagyvasút	3,2	47,5	6,4	0,05
Pereces	6,1	88,3	12,1	0,11
Lillafüred	12,6	186,8	26,4	0,27
Mahóca	11,8	162,3	23,3	0,02
Szilvásvárad	20,4	247	38,1	0,14
Felsőtárkány	6,3	122,8	14,6	0,28
Sikló	22,6	345,2	41,1	0,24
Fennsík	15,4	153,6	30,6	0,03
Nagyvisnyó	9,2	179	21,6	0,51

4. Conclusion

In our examinations we found a strong relationship between the railway gauges and the major parameters of the surface: the altitude above sea level, the slope angle, dissection of surface (relief energy), and slope shape.

In the valleys with narrow, deep, valley bottom, where it is often necessary to build the track in convex valley sides, the narrow gauge railway lines are typical, just as well, on the plain characterized Nagy-fennsík, where the narrow gauge railroad could be built at a lower price because of the high average altitude.

The aim is the minimisation of the expenses in both cases. In the case of the valleys with the reduction of the earthworks, and in case of the Nagy-fennsík with the reduction of the quantity of stocks and transportation expenses.

The researches made by using a digital elevation model led to results in harmony with the examinations on the field. It's verifiable, that with a suitable resolution and accuracy, digital elevation models can be applied well in these researches. All these bring up the opportunity of the researches made by this model being applicable with a suitable result on other similar areas as well.

Acknowledgements

Publishing of this journal is supported by the Institute for Research Programmes of the Sapientia University.

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Acta Universitatis Sapientiae
Agriculture and Environment, 1 (2009) 151-156

The experiences of the environmental noise effect examination of industrial and service enterprises

Angelika CSERNY[1], Károly TÓVÁRI[1], Endre DOMOKOS[1]

[1]Institute of Environmental Engineering, University of Pannonia, Veszprém, Hungary
e-mail: cserny@almos.uni-pannon.hu
e-mail: karoly.tovari@gmail.com
e-mail: domokose@uni-pannon.hu

Manuscript received 09. 20. 2009; revised 11. 05. 2009; accepted 11. 06. 2009

Abstract: Nowadays, the biggest part of the noise immission arises without doubt from the traffic. On the other hand even the effects of the industrial activities mustn't left out of consideration. Last period industrial sites, commercial and catering establishments were examined by the authors. Many of them have an impact area which doesn't affect any protectable object, but the authorities order an instrumental measurement only if the impact area is probably larger than the presumed impact area. The smaller impact area is always in the noise source operator's interest. This is why the unambiguous clearing up is important in time.

Keywords: impact area, noise regulation

1. Introduction

The most important principle of the noise and vibration regulations is that always everyone has the right to environment free from noise and vibration. The elimination of these harmful effects has to be ensured during the working hours, outdoor activities, entertainment – and the protection of the relaxing and sick people is ordered particularly. This is why the noise immission standards vary according to the character of the protectable area and the part of the day, too. Further condition that the standards have to be achieved in front of the door and window of the protectable facades (but not only the facade with door or window is protectable), since everyone has the right to live beside opened doors and windows both in one's residence and workplace.

Nowadays, the biggest part of the noise immission (that people living in populated settlements are compelled to suffer) arises without doubt from the traffic and transport. On the other hand even the effects of the industrial

activities and noises deriving from different commercial services and from the catering industry mustn't left out of consideration.

Since January 2008 new regulations came into force in connection with the protection of against environmental noise and vibration in Hungary. The decree 284/2007. (V. 29.) realizes the general and essential rules of the protection against the harmful noise and vibration to preserve the human environment and health. The departmental order 93/2007. (XII. 18.) on the noise emission standards determination and the noise emission control and the departmental order 27/2008. (XII. 3.) on the determination of the environmental noise and vibration immission standards are connected closely to the decree.

Determining noise emission standards is ordered by the regulation to limit noise. For the sake of this, everyone who operates noise sources, had to apply (should have been applied) for an emission limit value until the end of last year. Actually only a few people met the obligation until the deadline. Mainly smaller enterprises gave their reason for that: they didn't know the law or thought it didn't apply to them. But in the first part of this year, many enterprises suddenly realized (or maybe they were afraid of fine), that they should make up for what they had missed. Some agreed to the presumed impact area which always means the site including the noise source and the 100 m area around the site. Others made their noise emission measured and took the advantage provided by the law that in case of an impact area which doesn't reach any protectable object one doesn't have to apply for noise emission limit value.

2. Materials and methods

Last period industrial sites, commercial and catering establishments by the dozen were examined by the authors. These activities can be grouped by the following:

- vehicle spares manufacturer enterprises
- building material trades
- fur currying and cleaning site
- wood processing sites
- briquette manufacturer factory
- bakery
- garden machine service and trade
- soda-water bottling plant
- machine hire service
- car repair services
- technical department store
- music amusement places, etc.

An example of the noise emission and impact area determination

An example, one of the above examinations at small and medium enterprises, as an interest the furrier business was chosen by the authors. The examined locale is found in the inner of a city in the Transdanubia. It takes place in planes in an area classed as "provincial, suburban residential area". The fur currying workshop can be found in a separate, one-storey building (with insulated ceiling, slate roof, inside-outside plastered brick wall and double window pane) next to the contractor's dwelling-house. The indoor height of the workshop is 3 m. Leather and fur is curried and prepared as well as fur clothing and blanket is cleaned on the site.

Technological order: leather soaking in cold water for a half day, the removal of the needless parts from the leather, washing in warm water, rinsing, after about a week long tanning greasing and drying. Expanding, ironing, degreasing than expanding and ironing again and the burnishing of the leather come after. Finally the machine-operation ends after cutting.

The machines are a scythe machine, a burnishing, an ironing and a cutting equipment. All of these equipments are found in the preparatory workshop. The polluted air from the ironing machine gets to the dust separator, which is put behind the building with covering and brick wall. The average of the measured noise levels is 62,0 dB in front of the opened door and during working extractor.

General activities were going on in the time of the noise measurement on the site. Mechanical activities (involving noise) are done average 5-10 % of the working time also not more than an hour a day. The door of the workshop was all the opened during the noise measurement. In the time of the examination only one customer arrived to the site and according to the customer's information only two or three customers visit him a day. So the additional traffic can be left out of account and the short time parking is solved in front of the property. The average of the measured noise level in the preparatory workshop in case of working machines is 74,2 dB.

How the examination was carried out

The measuring points – position (distance from the protectable facades), height – and the measuring time were set according to the relevant standard. Background noise (L_{Aa}), noise pollution level (L_{Aeq}, equivalent sound pressure level) and background level (L_{A95}) were measured with "A" acoustic filter. Five minutes intermediate time intervals were chosen and the measurement was repeated three-three times on each of the measuring points.

The measurement was carried out by the following first class accuracy instruments: integrating sound level meter CEL-430/1 and acoustic calibrator CEL-110/1, integrating sound level meter Brüel&Kjaer 2250, acoustic calibrator Brüel&Kjaer 4231.

3. Results

The difference (ΔL_A) between the examined noise (L_{Aeq}) and the background noise is smaller than 3 dB at each measuring points, so there is no need for background noise correction. In accordance with the relevant standard, the "A" equivalent sound pressure level of the examined noise is smaller than the "A" equivalent sound pressure level of the background noise in case of each measuring points can be declared. The results of the measurement are visible in Table 1, where L_{TH} is the relating immission standard.

Table 1: Results of the measurement

Measuring points	**L_{Aa} (dB)**	**L_{Aeq} (dB)**	**ΔL_A (dB)**	**L_{A95} (dB)**	**L_{TH} daytime (dB)**
M1	47,2	48,7	1,5	41,0	50,0
M2	45,1	47,5	2,4		
M3	46,4	49,2	2,8		
M4	46,0	47,5	0,5		
M5	48,8	49,1	0,3		

The impact area of the examined fur carrying and cleaning activity was determined by SoundPlan 6.5 noise pattern managing, modelling and mapping software. (Fig. 1) In accordance with the regulation, the impact area has to be calculated allowing for the standard, the background noise and the noise immission. If the background noise is lower than the standard, but the difference is not bigger than 10 dB (as in the example), the impact area is defined by the line where the noise immission corresponds to the background value.

There isn't any protectable object inside the boundary of the impact area can be determined after leading up the above to the map. (Fig. 2) Due to this the environmental noise emission level determination is unnecessary; the contractor doesn't have to apply for it. On the strength of the measurement it can be declared that harmful noise pollution doesn't derive from the fur carrying and cleaning activity on the site.

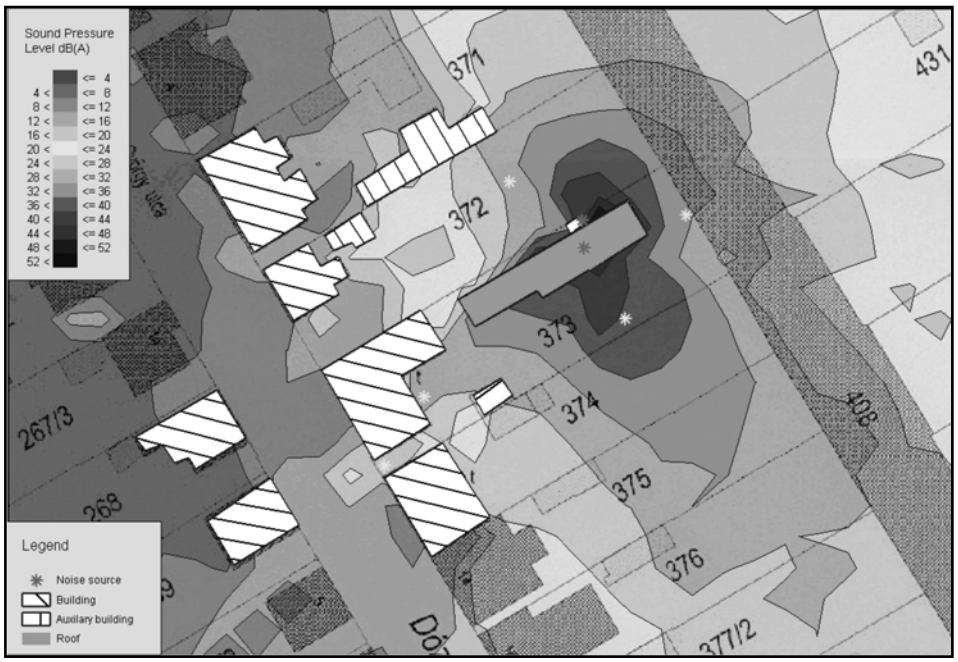

Figure 1: Noise pattern

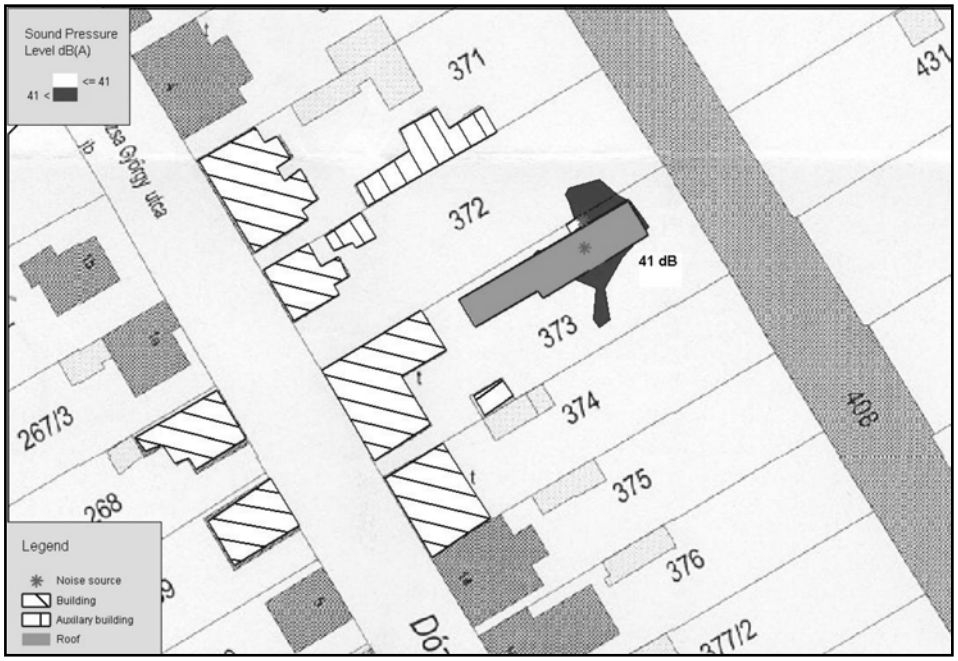

Figure 2: The determined impact area

4. Conclusions

Most of the examined industrial and service enterprises have formed their technology in that way that the environment isn't polluted by harmful noise from them. In case of a smaller part of the enterprises the impact area doesn't exceed the property including the noise sources (and they are the only users of the property). Mostly – as it is demonstrated in the example as well – the impact area exceeds the boundary of the property but there isn't any protectable area, building or room. The authorities order the determination with instrumental measurement and calculation only if the impact area is probably larger than the presumed impact area. But the smaller impact area – and possibly the exemption of emission limit value determination – is always in the noise source operator's interest. This is why the unambiguous clearing up is important in time.

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The Pereces 1000 mm gauge railway's environmental effects

Gábor JÉGER[1]

[1]Department of Geography, Faculty of Human Geography, University of Miskolc, Miskolc, Hungary, e-mail: ecojeger@uni-miskolc.hu

Manuscript received 09. 10. 2009; revised 10. 15. 2009; accepted 10. 19. 2009

Abstract: To serve the Diósgyőr ironworks a railroad was established with a gauge of 1000 millimetres. From the middle of the separately standing settlement it moved north from to Lyukóbánya and Pereces. For a long time from the mining district the coal was transported on narrow gauge railroad into the smelters .

Operation and shutdown had significant enviromental effects. The steam engines thick smoke painted the surrounding houses, the expanding Miskolc slowly sentenced the railroad to death. The shutdown was part of the 1968 traffic conpetion policy, despite that serious sums were spent on it's protection and renovation a few years earlier.

Keywords: narrowgauge, coalmine, railway shutdown, political concept, Miskolc

1. Introduction

With the upswing of the iron metallurgy and the continous development of the ironworks, the city's industry and the population had increasing coal needs in Miskolc. Therefore the settlement had to involve newer areas into the production and had to seriously exploit the existing mines. Today's Pereces and Lyukóbánya was revealed(1. figure)and the traffic was developed, due to the significant environment changes in the mood of the valleys, and their appearance was totally changed.

This two quarter belong to Miskolc from first of January 1945 ([1]), and they are deteriorated state miner settlements. In the XIX. they did not exist, however in the middle of the XX.century they had blooming mining colonies, a few decades later they were totally declined.

2. Material and Methods

The publication is a part of a PhD research. The basis of the research the Hungarian and the foreign country traffic geography literature processing, which ground ingresses complement primarily. An important role is received the manuscript existing record office substances.

The literature deals with the effect of the traffic have on environment little. It is possible to examine this excellently on a Pereces area. The examined area one the past century Miskolc's part was transformed significantly.

I would like to present this change, to expand the pretzel vendor literature being about 1000 millimetre railroads in one.

3. Results and discussions

A. The 1000 millimeter, narrow-gauge railway in Pereces

In the Pereces valley beside Miskolc, mines were planted from 1860 to exploit the treasures of the land, from 1870 the train’s service begun with steam traction on the orbit built in 1869 between Diósgyőr and Pereces [2]. In order to bring the coal to the surface smoothly and to transport it to the Diósgyőr iron furnaces a railroad was built. At the beginning, when the mines were installed, simultaneously, the rail threads were set up, and initially horses towed the wagons, then from 1880 the coal was transported with steam traction to the ironworks, and the workers to the mines.

The building operation entailed exceptionally big earthwork and significantly influenced the landscape’s look. This happened in spite of the fact that they were struggling to build the line in a low-cost way, and with small amount of energy expenditure. There was an aim to force the rail to the level of the existing road, however they met with difficulties. More tunnels were established on the line because the relief was structured (1. figure), the first was built 2300 metres long, and was built in 1881 ([2-3]), while the second, a 1800 metres long, had been realized int he middle of the XX. ([4]).

The mines were opened continuously on Pereces and in it’s neighbourhood, the mines were deepened, as a result of increasing transportation claims ([5]), the railroad developed continuously. A big station with five track were founded on Pereces, while in Barossakna at one of the line’s endpoints a shunting yard with six track were worked up, directly next the containers. The most considerable intervention was the Pálinkás station, which was the most considerable interim railway station, along the line. A hump was built up here to compose the wagons and fittings.

The railway and the establishments attached to it became the central character of the peoples life, and determined their environment (2. figure).

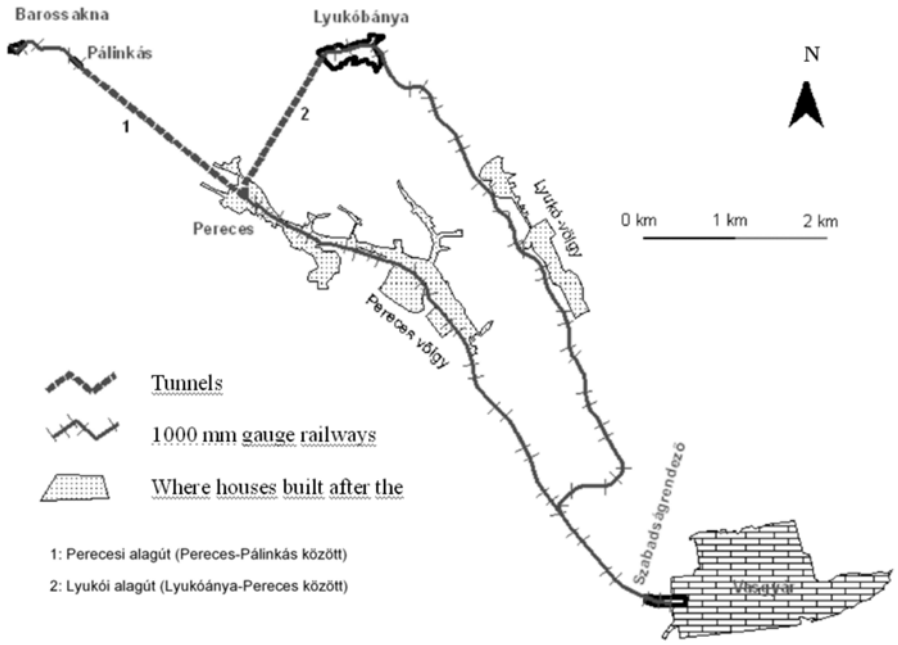

Figure 1: The 1000 milimetre, narrow-gauge railway in Pereces *(1. Pereces tunnel between Pereces and Palinkas; 2. Lyukó tunnel between Pereces and Lyukóbánya)*

Figure 2: 1000 millimetre fitting on the line

The railway line reached the 19 kilometres lenght with the construction of a tunnel. It was the largest longitude on the 1000 millimetre Pereces mine railway during it's existence. From this length, 4,1 kilometre ran in a tunnel, which shows well the articulateness of the surface. It was one of the reasons, that not normalgauge line were planned, with the narrow-gauge line the expenses were smaller, but it was enough to transport the mined quantity. It was in its prime after the construction of the second tunnel in the years between 1950-60. But the already mentioned, 1968 conception of traffic policy ([6-7]) soon ended it's blooming.

The public road received the coal transport. This happened because, according to a survey in the late 1960's, by this time, ([8]) considerable renovations was needed. Despite the fact, that the railway worked well, thousands found work around it. At last, but not least, in 1957 ([9]) three years after the control was handed to the MÁV (National Railway Corporation) ([2]) the Lyukóbánya and Pereces lines were renovated, but an another renovation would had been extremely expensive [10-11]. Anyway the political life turned towards the public road at this time, the development of the public road became more important, and money was spent on road-1s renovation, rather than to the railway.

The railway quickly ended, it only took a few years. The last fittings used the line 31 December in 1971, officially from first of January 1972 the 1000 millimetre mine railways were shutdown.

B. Changes after the railroad's shutdown

The traffic ceased on paper after 1972, and the coal was transported only on public road, however the train service did not cease totally, part of the remained outside values, and the fittings from Barossakna, Lyukó and Pereces were transported to the ironwork's shunting yard (1. figure), which was the soul of the whole line.

Luckily, they did not squander the full substance of the railroad. The engines were used on other lines with 1000 millimetre gauge. Until 1992 ([12]) a system connected the Borsodnádasd record factory with Ózd. Still serviceable wagons and engines were transported from the Pereces line. Unfortunately, most of the engines built because of the tunnels (3. figure) were destroyed. Nowadays, these machines advertise the former development of the Hungarian machine industry.

The traffic grew with directing the railway traffic to the public road. But not only lorries carved considerable burden to the environment buses were air polluting too. In the Pereces and Lyukó lines not only cargo transport, but passenger transport went on. As a result of this, from 01.01.1972 the railway

line was officially closed and it’s passenger transport was transferred to coaches. From this time, coaches became transport devices in the public traffic, such as it happened earlier along the Lillafüred line [1,13].

With this not only the Pereces and Lyukó-valley became more stressed, but the city was too, because the coaches departed from the Újgyőri main square (early Marx tér), so the transport between the ironworks and the mining fields got into one of Miskolc's newly developed centres. It got it’s chance of exist and importance from the metallurgy.

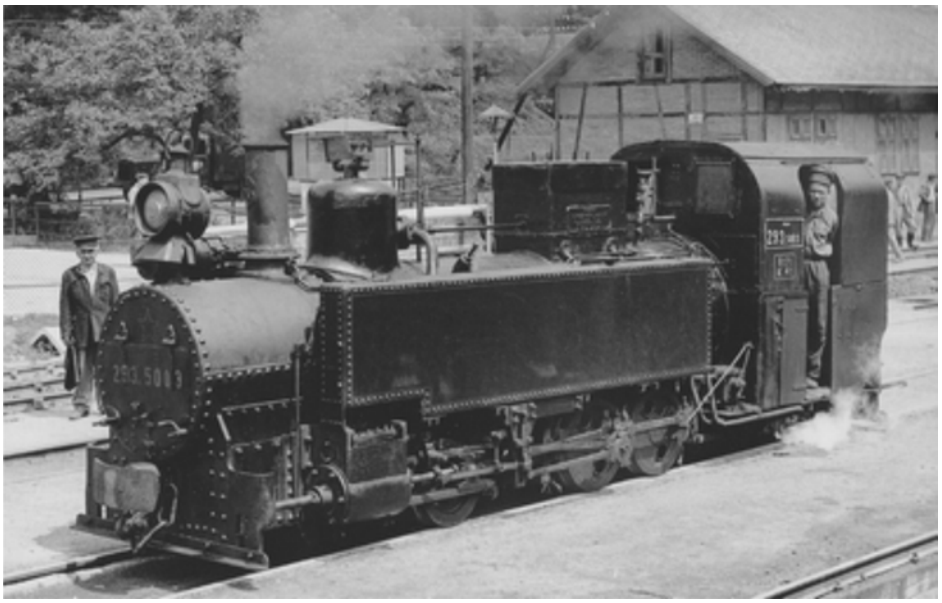

Figure 3: Tunnel engine at Pereces station

4. Conclusion

The life did not stop on Pereces and Lyukóbánya with the railroad”s shutdown, however an irreversible process had begun. The former narrow-gauge railway values, artifacts are absolutely forgotten nowadays. The former tunnels were filled up, the tracks were picked up, the railway stations are used as mineyards or new buildings took their place.

The former railway lines are dirt-, and macadam roads between the houses in Lyukó and Pereces. Only the few art objects, extending above the living waters, remind the passers-by to the extensive railway system that once worked there.

With the regression of mining, the two settlement devolution began. The minority banked up the former mine camps continuously and in the 1980's the area's erosion had started.

Both valley (1. figure) practically eroded. There are only signs of the former industry, int he same way, than the untouched enviroment from 150 years ago. The industrial activity, any kind of it, influences the area's future and future look significantly. The local narrow gauge railway's shutdown and liquidation left serious wounds on the landscape. This area, is a good example that we have to make an effort on not allow unused areas alone. The conservation of the values and the protection of the nature have to be equally important. If it would work now, or would worked in 1970's and 1980's, maybe our homeland's longest narrow-gaguged tunnel could be tourist destination (1.diagram). The tunnel engines could operate as industrial memories (3. figure), and Pereces and Lyukó could be one of the most important national narrow-gauge railway.

Acknowledgements

Publishing of this journal is supported by the Institute for Research Programmes of the Sapientia University.

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Acta Universitatis Sapientiae
Agriculture and Environment, 1 (2009) 164-171

Environmental awareness at primary level

Beáta KOSZTIN-TÓTH[1]

[1]Debrecen University, Department of Biology and Environmental Education Methodology,

Debrecen, Pf.:85 4010 Hungary, e-mail: tokobe@freemail.hu

Manuscript received 30.08.2009; revised 15.09.2009; accepted 18.09.2009

Abstract: Scientific teaching has to provide knowledge in which concepts and phenomena are understood and learned with enthusiasm by pupils. As acquired knowledge should be used in practice after students leave public education. Furthermore, recognizing global environmental and social problems we should take steps towards educating a more environmentally aware generation.

In our study we examined environmental awareness of 232 Hungarian pupils in class 4. We wonder how much pupils are environmentally aware at the age of 11, whether there is difference between schools and whether the teaching method we used determines pupils' environmental awareness or not.

Keywords: Scientific teaching, environmental attitude, primary school, Rostock Model

1. Introduction

Environmental education can be considered as a kind of answer to the environmental crisis caused by humanity. In 1992 at the Conference of Environment and Development organized by the United Nations, the document of Agenda 21 was accepted. According to it education has an essential role to help sustainable development. We must admit that if we manage to obtain a certain demanding care towards our local surroundings and involve it into our every day life then we will be able to treat, moderate or at least not to increase destruction of our environment.

Although environmental education was the topic of several international meetings (1975.Belgrade,1977.Tbilisi) in the ’70s, in Hungary it was not an important question to deal with for a long time. Then the ’90s saw a sudden determinant change in this field. In autumn 1998 a new national curriculum came into practice which declared that environmental friendly behavior should be a moral principle leading our life. Furthermore, this document treats environmental education as an interdisciplinary, a so-called cross-curriculum topic, which has several meanings. On the one hand, meeting the taken international requirement and on the other hand, putting environmental education, as part of the civil education among the tasks of the state. We seem to have made great steps but still there is a lot to do.

As during environmental education local environment and every day life become the topic of subject at school, habits and values are transformed in us which means a new standard of living as well. So environmental awareness can be interpreted such a lifestyle characteristic in which people ’s tiny environmental friendly habits and costums are rooted. This kind of awareness is based by emotional attitudes [3].

The lifestyle which takes responsibility for the environment and its distinct factors have been investigated by several scientists. Hines [4] describes the model of the behavior responsible for the environment which states that cognitive knowledge of the environment is crucial but not enough for such a kind of behavior. Beyond knowledge of environmental problems for responsible action several skills, appropriate attitude and values are essential. Jaeger [5] and Dietz [2] investigating socio-cultural factors such as teamwork, social relations etc. came to the conclusion that these ones influence environmental awareness more than the worry about environmental problems. Kollmus and Agyeman [6] divide influential factors into two groups in their model. According to it our environmental awareness is influenced by such inner factors like our environmental knowledge, motivation, attitudes , values, emotions, habits and our responsibility.

The above mentioned surveys’ results are in harmony with those of the Hungarian opinion polls. Therefore cognitive knowledge of the environment does not seem to be enough to help sustainable development [7]. According to the rewritten national curriculum in 2003 the aim of the environmental education is to help environmental awareness develop in students behavior, lifestyle so that the next generation could prevent environmental crisis from being more serious and help living nature survive and sustainable development.

During our survey we investigated the attitude of environmental awareness among primary school pupils in class 4. Our questionnaire was filled out by 232 pupils (64 pupils in Budapest, 168 pupils in Debrecen) in November 2008. We would have liked to know that

- in what extent pupils' every day life is influenced by environmental awareness,
- whether there is difference in environmental awareness between pupils from the capital city and from a smaller provencial town,
- whether there is difference in environmental awareness between pupils taught with a traditional method and with an experimental method called the Rostock Model.

2. Materials and Methods

We drew up a 25-item questionnaire. After each item there were numbers from 1 to 5 in which pupils had to circle the one which seemed to be true for their lifestyle and their feelings. These items were statements composed in first person singular and involved five topics. These were the following: protection of animals and plats (7 items), saving water (5 items), waste management (4 items), saving energy (4 items) and general environmental protection (5 items).

As one of the aims of our survey is to see the difference in effect on environmental awareness between the traditional method and an experimental one which is called the Rostock Model, it is essential to devote some lines to this new method.

The Rostock Model is based on an international cooperation (Germany, Hungary from 2004, Lithuania and Poland from 2006), a conception of didactics for helping scientific reasoning develop at primary schools which roots in the pedagogical theory of Wygotski [8], Bruner [10] and some Anglo-American researchers [9,11].

Wygotski's Socio-cultural theory [8] is mainly a learning theory, which centre there is a term of the levels of current development. According to it the child with help can get to a higher level of cognitive development and in this process the language, social and physical environment play important roles. He thinks that the quickness of maturation varies in broad lines, within it the most important is the social cooperation which determines the development. On the basis of his theory, learning is a social cooperation and during it pupils work in different ways.

Bruner [10] determined - similar to Wygotski - that socio-cultural environment has a crucial role so the schoolchild is confronted with problems that lies at the border of his horizon of experience and that lure him to the next developmental stage. The child's intellectual development can be cultivated by well thought-out intermediary questions. Neither easy questions nor hard ones initiate learning process. As the child himself can answer easy questions without any help, while difficult ones cannot even be answered or only with the help of others. Bruner puts emphasis on the support coming from outside which supposes social characteristic features of learning.

There is another theoretical base, the theory of „conceptual change" which is in harmony with that of Wygotski and Bruner. In the USA were already in the early eighties investigating both the concepts pupil possess about scientific phenomena and how these concepts change. American researchers developed the theory of „conceptual change," which was later applied to the primary stage by Susan Carey [1] .The theory's central assumption is that cognitive structures develop relatively continuously and in relation to specific fields. Through complex linking patterns and patterns of complex abstraction, these cognitive structures can be restructured. Therefore, formal-logical thinking is not the result of processes of development independent of the child's age, but rather the result of the structure and density of the child's knowledge. According to Clarke [9] understanding is important in learning process, which important tool is the connection between experiences from every day life of the child and acquired knowledge. Such knowledge can support generative themes which helps pupil's skills become transferable and interdisciplinary [11]. Themes like 'Water' can be dealt with in one or more subjects, which are interested in both by teachers and pupils. Learning these themes provides applying several theoretical and practical ideas and using problem-solving strategies, furthermore they give the opportunity to study complex phenomena, too. That's why the Rostock Model emphasizes the social characteristic of learning and understanding, interactive developmental learning. Beyond that it pays attention to pupil's individual needs, motivation and their emotions. Among aims of the Rostock Model there is the improvement of problem-solving thinking and metacognitive skills, for its tool it applies group and individual work. In this process reflecting and explaining experiments to understand the given phenomena is crucial.

In the centre of the lessons there was defining the exact aim of acquiring the knowledge, realizing it by pupils, how to get knowledge, understanding acquired knowledge and realizing shortcomings as well. These aims of didactics are put into practice by consideration for teacher's instructions, discussions between teacher and pupils or between pupils, individual and group work, experiments, describing and drawing phenomena, using experience from every day life and the nature of thinking and language of the child (Figure 1.)

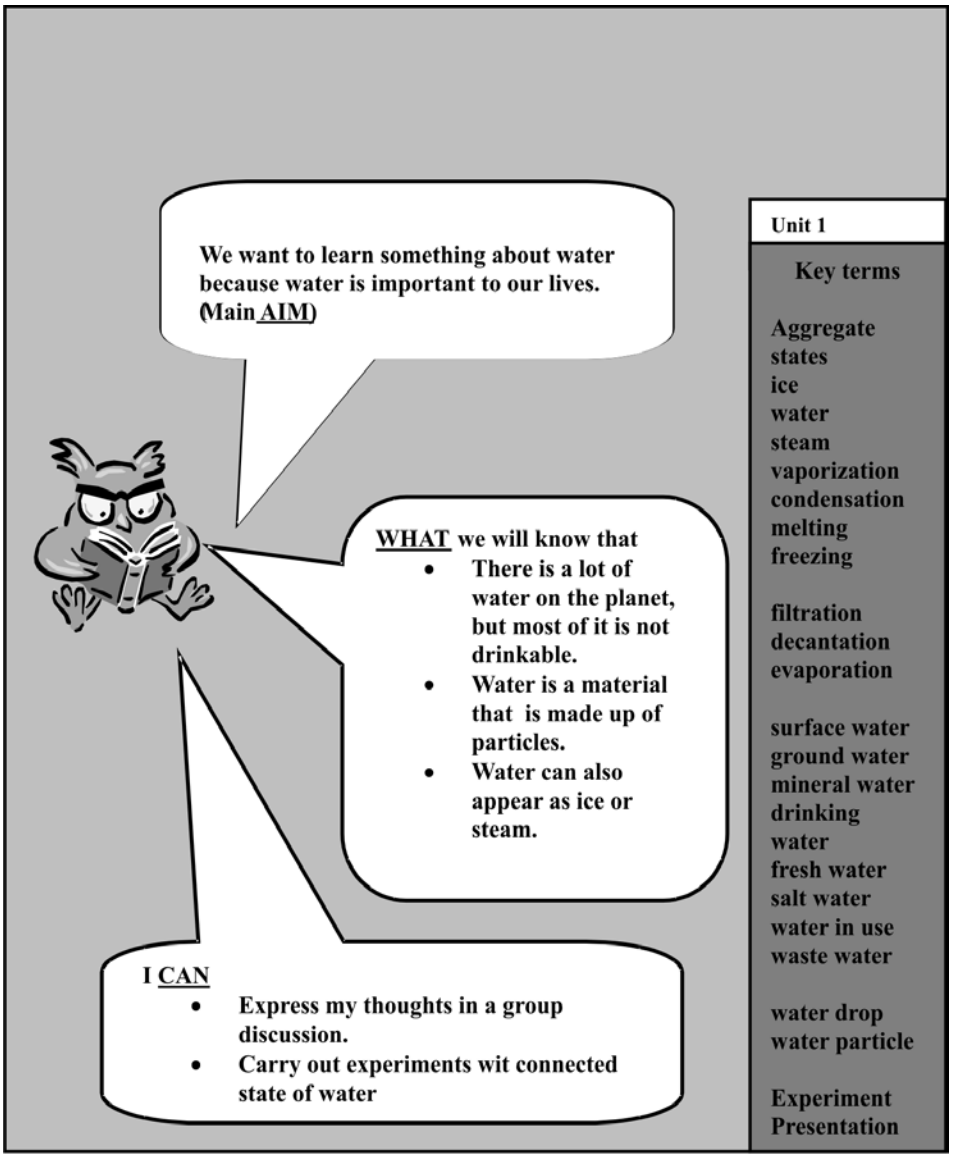

Figure 1: That help to make children aware of triple concepts (aim, what, how) of Rostock Model.

3. Results and discussions

Figure 2 shows the frequency of the total points got by the pupils. We can see maximum values between 95 and 105 points which means better that average environmental awareness (80%). Altogether about the half of the examined pupils are 80 per cent or even above environmental aware which appears especially in topics of water and energy saving and protection of animals and plants. While one third of the pupils can be said to be 50 per cent environmental aware, unfortunately 20 % of the pupils can not be said to be sensitive to environmental problems.

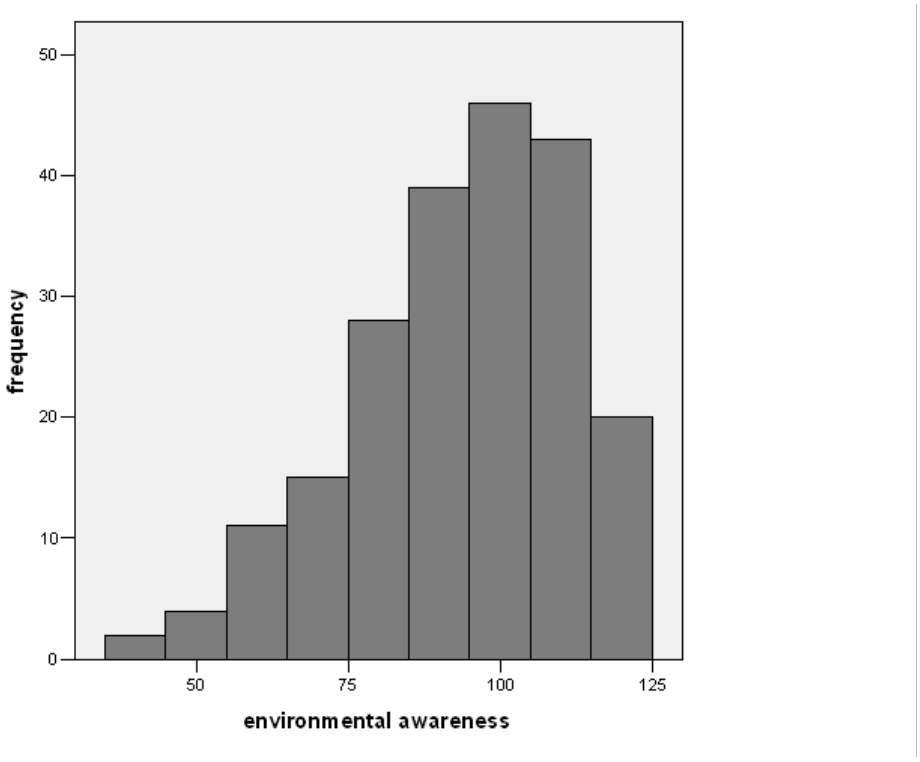

Figure 2: Environmental awareness among primary school pupils in class 4.

Although these pupils have not been taught global environmental problems, environmental friendly habits and demands have appeared in every day life of

at least two third of them. It follows from their age that external models are crucial in their life. But whether their attitude will be strengthened or weakened by puberty? How will affiliation affect them, from which group will some pupils become dominant personalities? We think that it would be worth making another survey with them to see changes by the end of their primary education.

Protection of animals and plants seems to be preferred by pupils. They are willing to help look after and feed wild animals in forestry or zoo, feed birds in winter and would not like to buy fur coat made of real fur or cosmetic products tested on animals. More than half of the pupils are sensitive to this topic.

We got very nice results in the topic of *water saving.* More than 60% of the pupils at least 80 per cent of their every day life try to save water which means that they turn off water while cleaning teeth and prefer having a shower to bath.

70% of the pupils are willing to pay attention to *save energy* and they switch off lights when they do not need them.

About *waste management* pupils appear not to have such a positive attitude. Most pupils do not have distinct behavior toward the topic. What's more one third of them do not think that it is an important field of environmental protection.

Results about the topic of *general environmental protection* show average frequency. 20% of the pupils got 60% of the points. Unfortunately, one third of the pupils are not really interested in the topic which means that they do not care about environmental problems, neither from the media nor from their parents they get any information about it.

Beyond the above-mentioned facts we wanted to know whether the situation of the school where pupils learn has relation with their environmental awareness or not. As we have already referred to we made our survey in two kinds of places: capital city and a provenvial town. Results show that values of the average environmental awareness is above 74% in the provencial town, while this value is only 66% in the capital city.

The connection between the applied teaching method and pupils environmental awareness does not seem to be evident. There were two experimental classes we examined. The difference was spectacular in the case of one of the classes. While there was no difference between the control and the experimental class in the other school.

4. Conclusion

As a conclusion we must admit that the success and efficiency of environmental education depends on several factors. We have started an experiment with a new method, called Rostock Model which is showed to have positive effects on pupils' environmental awareness. Our results are very

encouraging. We are going to make another survey within four years to see why and in what extent pupils' behavior changes in the future.

Acknowledgements

Publishing of this journal is supported by the Institute for Research Programmes of the Sapientia University.

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Acta Universitatis Sapientiae
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ISSN 2065-748X
http://www.acta.sapientia.ro

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RO 400112 Cluj-Napoca, Romania
Str. Matei Corvin nr. 4.
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Publication supported by