Secinājumi

1. Sivēnu apstarošana ar UV stariem, ievērojot optimālās apstarošanas normas, veicina to veselības stāvokļa uzlabošanos, dzīvmasas pieaugumu un nobeigšanās gadījumu samazināšanos.
2. Aprēķinot pārvietojamās UV apstarošanas iekārtas, nepieciešams ņemt vērā, ka apstarošanas laikā sivēni var stāvēt, gulēt vai haotiski pārvietoties pa aizgaldu.
3. Formulas (4), (9) un (10) dod iespēju noteikt dzīvnieku saņemto UV starojuma ekspozīcijas lielumu un otrādi - pēc uzdotās apstarojuma normas noteikt pārvietojamas apstarošanas iekārtas parametrus.

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SUBDIVIDING OF THE TERRITORY OF "EKRANAS" PLANT ACCORDING TO DANGEROUS POINT SUMMARY POLLUTION CODES

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ABSTRACT. According to factor analysis results of topsoil geochemical data it can be seen that the pollution on extremely contaminated territory of "Ekranas" plant in Panevėžys is polygenous. According to technogenity level four of the seven distinguished factors are technogenous: one of them Mo-Cr-Mn-Ni-Cu-W-Sn-Co-Ag is characteristic of metal processing enterprises, the second one Y-Cd-Zn – of electrical engineering, partly – metal processing, the third Sb-Pb-Sr-Ba-Li-U-As one – of special (kinescopes) glass production, the fourth La-Ce one – of its polishing. These paragenetic associations were used for determination of dangerous point summary pollution codes and subdivision of the territory of "Ekranas" plant into zones according to them.

Introduction

Industrial enterprises are the main pollutants of the urbanised territories. Some of them are heavily contaminating not only their own territory but even the surrounding part of the town. According to Geochemical atlas of Panevėžys (1997) the enterprises of electrical engineering are among them. Their territories are centres of multielement pollution including not only common spectrum of elements-contaminants but often also complementary elements the content of which is usually below the detection limit of DC Arc Emission Spectrometry. Total summary contamination index Z_s computed on the basis of recommended methodics (1987) including all main elements-contaminants

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often exceeds the allowable level (16) many times and is therefore very dangerous for biota. “Ekranas” plant in Panevėžys is a good example (FIG. 1). Great content of Li, La, Ce, Sb, Cd and W is observed in its topsoil in addition to common elements-contaminants characteristic of other enterprises.

The pollution on the territories of the plants is often polygenous because usually there are several sources of emission related with different industrial activity in various shops of the plant. When the emission of the elements in these shops is intensive the aureoles formed by them greatly overlap. Therefore according to topsoil geochemical investigation data it is important to find out what part of the territory is affected by each kind of pollution, which of them exceed the allowable level and which of the sources is the most intensive and therefore the most dangerous.

“Ekranas” plant in Panevėžys has been investigated for this aim and subdivided into zones using dangerous point summary pollution codes determined on the basis of comparison of paragenetic associations as understood by Smirnov (1981) according to their partial summary contamination indices in topsoil at each sampling site.

Sampling and analytical methods

The samples (N=91) were taken from the upper (0-10 cm depth) soil layer according to “the envelope” of 1 m * 1 m size principle. They were air-dried, sieved through nylon sieves (choosing fraction <1 mm). Organic matter mineralisation at 450^0 C was accomplished and after this – sample mechanical pulverisation. The main analytical methods included DC Arc Emission Spectrometry (DC Arc ES) for determination of Li, B, Ga, P, Mn, Ti, V, Cr, Co, Ni, Cu, Zn, Pb, Mo, Ag, Sn, Zr, Y, La, Yb, Sc, Ba, Sb, Cd, W amounts (using spectrograph DFS-13 and microdensitometer DM-100 for spectral lines deciphering), as well as XRF for determination of Sr, As, U content (using analyser ARF-6). The international reference materials OOKO 153 and OOKO 151 were used for quality control of DC Arc ES results.

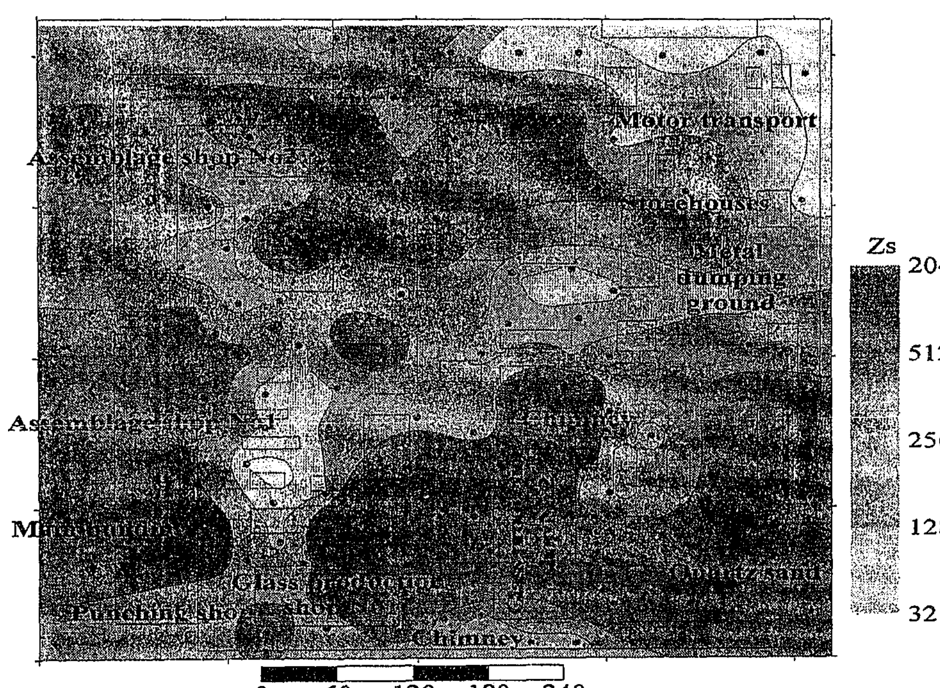

FIG. 1. Distribution of total summary contamination index Zs including 28 elements (Li, B, Ga, P, Mn, Ti, V, Cr, Co, Ni, Cu, Zn, Pb, Mo, Ag, Sn, Zr, Y, La, Yb, Sc, Ba, Sb, Cd, W, Sr, As, U) in topsoil of “Ekranas” plant

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Mathematical methods

In order to find out differently contaminated sites on "Ekranas" territory the following standard methods for analysis of urbanised territories were used. First of all principal component analysis with varimax rotation for correlation matrix of logarithms of air-dried concentrations of 28 elements was applied and only essential at 0,05 significance level factor loading coefficients were shown. The elements having the greatest correlation with a factor comprise its kernel. Paragenetic associations were found out according to it. They were also distinguished using hierarchical cluster analysis by complete linkage method. In this way the relationship between them could be better observed. The description of these methods can be found in publication of Kim and Muller (1989).

The factors can be simple and polar. The kernel of polar factor can be subdivided into two subgroups: one of them unites the elements positively correlating with it, the other one – negatively. According to average values of accumulation characteristics most often it is possible to conclude which part of the factor is technogenised and which one natural. Therefore next to factor loading matrix that shows paragenetic associations the following statistical characteristics of element concentration coefficients are usually presented: median, mean, maximum and coefficient of variation, as well as the number of samples N with greater than 2 concentration coefficients (if $N>2$, the element can be attributed to contaminants). For each factor kernel or part of it the technogenity level (TL) can be determined as the average value of median concentration coefficients comprising it. The simple factor kernel is considered to be technogenous association (T) if its TL is greater than 1,3 and at least for one element more than in two samples concentration coefficients $CC>2$ ($N>2$). If $TL<1$ and $N\leq2$ it is considered to be natural association (N), in all other cases – natural technogenised (NT). Technogenised part of kernel with high accumulation level (both $TL>1{,}3$ and at least for one element $N>2$) is technogenous (T) association, with low (in all other cases) – natural technogenised (NT) and natural part of the factor – natural (N) association.

The concentration coefficients were computed using different background values. For the greater part of the elements they were determined on the territory of almost unpolluted enterprise of water supply after consecutive elimination of anomalies that was described by Zinkutė (1995). For Li, La, Ti, Zr, Y, Sc, V, As the median values on the territory of the town were used. For Cd and Sb 0.3 ppm, for W – 1,2 ppm were chosen approximately because their local background could not be determined as their concentration in unpolluted territories was below detection limit.

Partial summary contamination indices Z_s were calculated for elements from the kernels of technogenous paragenetic associations. Each of these associations was indicated by its characteristic contaminator. Different combinations of association order are possible ranking them according descending values of Z_s. In this way the *point summary pollution* codes (PSP-codes) were determined. As it was very important to consider the contamination exceeding the allowable level *dangerous point summary pollution* codes (DPSP-codes) were introduced including only associations with partial summary contamination index exceeding 16. According to DPSP-codes the territory of "Ekranas" was subdivided into zones.

Results

Seven factors were distinguished on the territory of "Ekranas": four of them were technogenous – F2: Sb-Li-Ba-Pb-Sr-As-U (TL=35.30), F3: Y-Cd-Zn (TL=6.24), F1: Mo-Cr-Mn-Ni-Cu-W-Sn-Co-Ag (TL=1.70), F5: La-Ce (TL=1.61), two – natural technogenised (their kernels were Sc-Ti-Zr-B and Ga-V) and one – natural (P) (TABLE 1). The separation of the latter 7 non-polluting or slightly polluting elements from contaminants was proved by cluster analysis results (FIG. 2).

TABLE 1

Factor analysis results and accumulating associations of topsoil geochemical data from "Ekranas" plant in Panevėžys

Characteristics of accumulation					Ele-	Factor loading matrix						
Median	Average	Maximum	CV	N	ments	F1	F2	F3	F4	F5	F6	F7
1,75	3,03	22,23	114,8	36	Mo	86	31					
1,46	2,20	11,35	92,7	26	Cr	82		32				
1,41	1,70	7,44	61,2	17	Mn	82					25	
2,26	3,93	31,56	121,1	54	Ni	80		36				
2,18	4,43	31,07	117,0	52	Cu	80	21	32				
1,97	7,04	185,16	295,2	38	W	74					-24	30
1,57	2,67	21,20	115,9	31	Sn	68	25			37		
1,17	1,28	3,84	36,3	6	Co	66		51			27	
1,53	3,15	64,20	217,8	36	Ag	53	32	53				
1,70	**3,27**	**42,01**	**130,2**	**T**								
196,33	291,90	1605,33	92,7	91	Sb		85			25		
1,83	2,43	18,53	94,8	35	Li		84				33	
5,18	8,07	70,87	114,0	85	Ba	21	83					
34,41	66,47	392,02	111,3	91	Pb	37	69	29				
6,54	10,93	59,45	104,1	86	Sr	32	67			29	-34	
1,38	1,53	3,66	31,0	14	As		61	-24	37			
1,46	1,42	2,40	25,1	5	U	22	48	-42		35		
35,30	**54,68**	**307,47**	**81,9**	**T**								
1,72	10,00	231,08	312,3	37	Y			92				
12,18	59,58	1525,83	304,1	91	Cd			89				
4,82	10,16	94,02	131,9	82	Zn	41	22	78				
6,24	**26,58**	**616,98**	**249,4**	**T**								
0,95	1,04	2,03	36,4	1	Sc	-22			79			-21
1,04	1,13	2,93	33,8	2	Ti				79	35		
0,97	1,23	4,79	64,9	12	Zr	-27			74	27		
1,04	1,24	10,24	82,6	5	B				58		-29	34
1,00	**1,16**	**5,00**	**54,4**	**NT**								
2,06	6,72	93,76	206,1	49	La		27			89		
1,16	1,94	14,88	113,6	16	Ce	23	28			88		
1,61	**4,33**	**54,32**	**159,9**	**T**								
1,01	1,02	3,73	39,7	1	Ga						91	
1,03	1,03	1,49	18,7	0	V	21	-31		58		59	
1,02	**1,03**	**2,61**	**29,2**	**NT**								
0,82	0,95	5,62	67,5	2	P							87
0,82	**0,95**	**5,62**	**67,5**	**N**								
					FV	33	15,4	9,0	7,8	5,4	5,0	4,0

The elements of the first factor are characteristic of metal processing enterprises, especially W and Ni (59.3% of samples with its CC>2). According to cluster analysis results it turned out that this association is the closest to the kernel of the third factor Y-

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Cd-Zn that also partly characterises metal processing and electrical engineering. The main pollutant in the latter is Cd (CC>2 in all territory of the enterprise). Essential correlation of Cr, Ni, Cu, Co, Ag, Zn with the first and the third factor confirms the overlap of these groups and their similarity. The main contaminant in association Sb-Pb-Sr-Ba-Li-U-As is Sb (CC>2 in all territory of the enterprise). This group is the closest to the kernel of the fifth factor La-Ce where the main pollutant is La (CC>2 in 53.8% of samples).

Notes: FV – per cent of total variance explained by the factor. Average values of accumulation characteristics and types of different paragenetic associations are shown in bold and shaded. N – number of samples where CC of an element exceeds 2, CV – coefficient of variance.

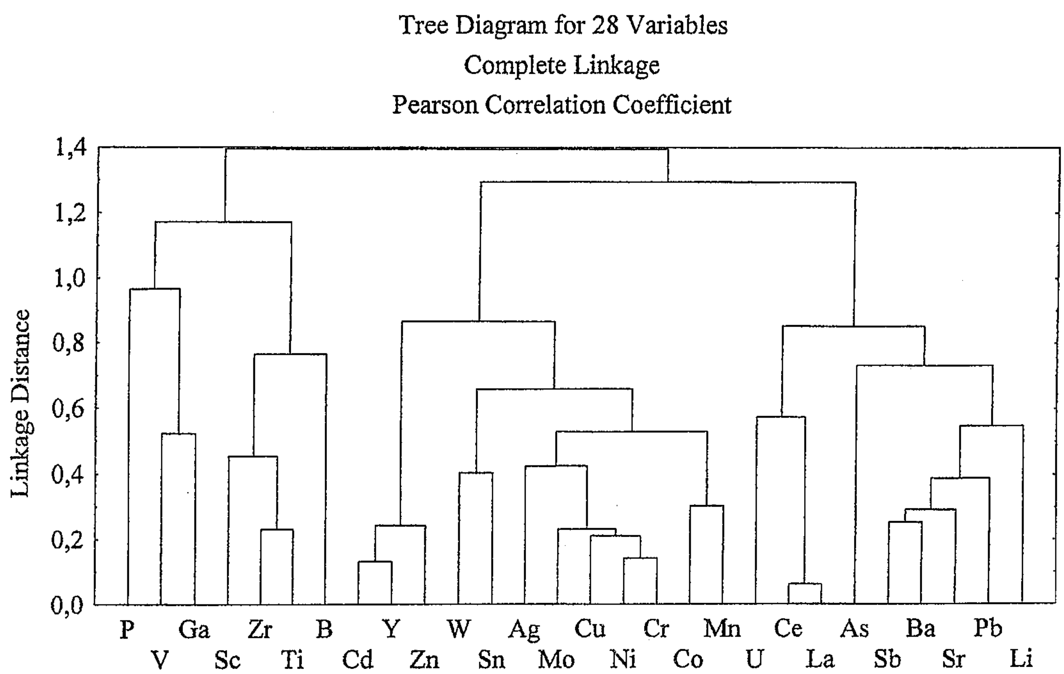

FIG. 2. Paragenetic associations in topsoil of "Ekranas" plant distinguished by cluster analysis

Mapping scores of different technogenous factors confirmed that each of them affects slightly different parts of the plant though there is also great their overlap (FIG. 3).

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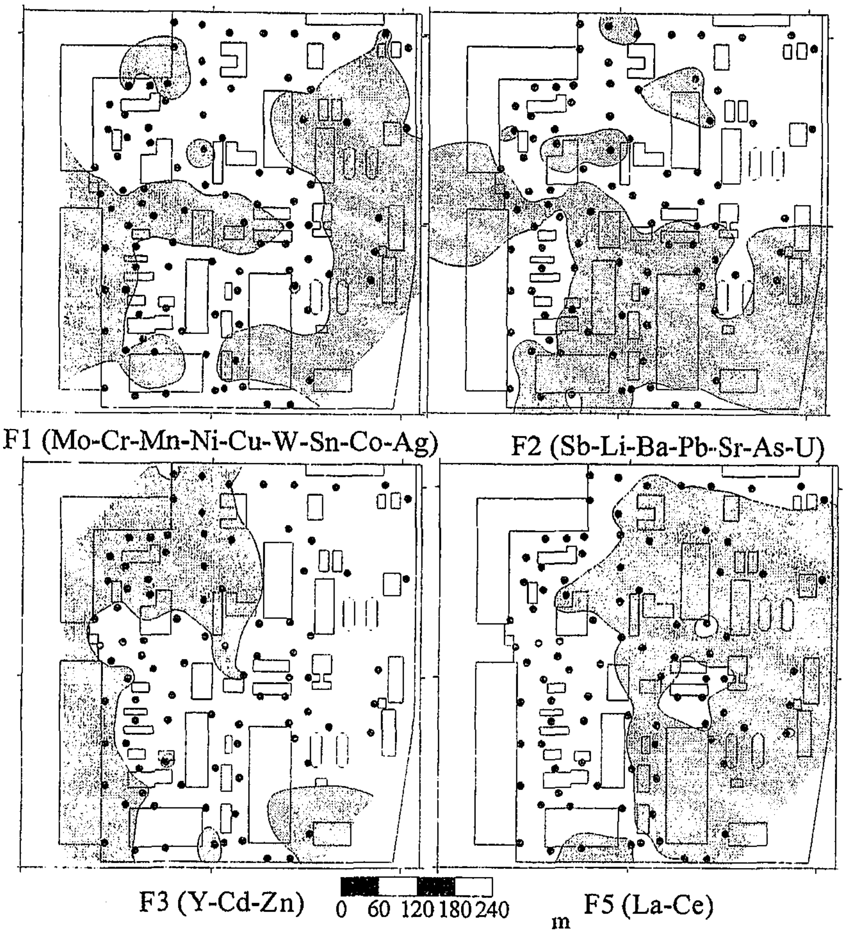

Fig. 3. Localisation of different type of pollution in "Ekranas" by mapping positive scores of four tecnnogenous factors

Technogenous association Sb-Li-Ba-Pb-Sr-As-U with the greatest TL contaminates mainly the surrounding areas of both glass production shops, W-association – the main building with assemblage shop No.1 and punching shop, part of assemblage shop No.2 and the eastern part of the territory with metal dumping ground. Mainly western part of the territory is polluted by Cd-association related with electrical engineering, while mainly eastern – by La-association indicating glass polishing.

In each site of the territory of "Ekranas" plant four partial summary contamination indices Z_s were calculated including elements from the kernels of different technogenous associations. Each technogenous association was indicated by its characteristic accumulating element: W, Cd, Sb, La. *Point summary pollution* codes (PSP-codes) were determined according to descending order of Z_s values (TABLE 2). *Dangerous point summary pollution* codes (DPSP-codes) were also determined in which only technogenous associations with partial summary contamination index exceeding the allowable level were included. The number of them was greater (14) as they depended first of all on the number of technogenous associations for which Z_s exceeded the allowable limit, i.e. complexity of dangerous pollution. It turned out that the greatest number of samples was where partial contamination index only of one technogenous association exceeded 16, i.e. where pollution was single. In all of them unallowably contaminated Sb-association. The number of samples with more complex pollution was lower. Not detailing the fourfold contamination ten different zones of main DPSP-codes were distinguished on the territory of "Ekranas": in fours twofold and threefold, one single and one fourfold contaminated (TABLE 2).

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TABLE 2

Statistical summary about the number of PSP-codes, complexity of pollution and DPSP-codes in topsoil of the territory of "Ekranas" plant in Panevėžys

Summary about PSP-codes			Summary about complexity of pollution		Summary about main DPSP-codes		
Number of PSP-code	PSP-code	Number of samples	Complexity	Number of samples	Number of DPSP-code	DPSP-code	Number of samples
1	SbCdWLa	60	4	7	1	Sb	39
2	SbWCdLa	10	3	18	2	SbW	3
3	SbCdLaW	7	2	27	3	SbCd	21
4	CdSbWLa	5	1	39	4	SbLa	1
5	SbLaCdW	3	At all:	91	5	CdSb	2
6	SbWLaCd	3			6	SbWCd	7
7	SbLaWCd	2			7	SbCdW	6
8	CdSbLaW	1			8	SbLaCd	1
At all:		91			9	CdSbW	4
					10	All	7
					At all:		91

Though the main type of contamination by Sb-association exceeds the allowable level on the whole territory of "Ekranas" but supplementary overlapping pollution is added to it. Additional codes of zones indicate which types of contamination exceed the allowable level and their relative importance (FIG. 4). This enables to subdivide the territory of "Ekranas" into zones taking into account the poligenity of pollution and contribution of each type of it. In this way the areas of different pollution aureoles and their overlap can be revealed.

There are four places with fourfold contamination on the territory of "Ekranas": one – in the southern part, at the glass production shop No.2 and three – in the northern part, one of them near metal dumping ground. They are characterised by the highest total summary contamination index.

Four relatively separated parts with more complex contamination can also be distinguished on the territory. The first one is around glass production shop No.2 and is characterized by fourfold pollution surrounded by twofold large SbCd anomaly. It indicates that not only Sb and La, but also Cd is probably related with glass production. The second one is in the western part of the territory, near main building. and extends to the central part of the territory. In the centre of it, near assemblage shop No.1 there is threefold SbWCd pollution, showing that metal processing with emission of W-association metals must be characteristic of this shop. To the north and to the south of it the relative importance of Cd-association characteristic to electrical engineering increases as threefold SbCdW pollution is observed. Both these types are also observed at glass production shop No.1, so probably there is also their emission in high temperature processes. In the north-western part of the territory, eastwards from assemblage shop No.2 there is threefold SbCdW pollution surrounded by Cd anomaly. This shop is probably engaged in electronics. Eastwards from it, in the central part of

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the territory fourfold DPSP-codes SbCdLaW, SbLaWCd and SbWLaCd show the relative importance of La-association related with glass polishing.

Fig. 4. Subdivision of "Ekranas" plant in Panevėþys into zones according to dangerous point summary pollution codes
Notes: 1.The main association related with special glass (Sb, Pb, As), kinescopes (Li, Sr) and luminophores (Ba) production exceeds the allowable level on the whole territory of the plant. The codes of zones show the relative importance of additional pollution

Conclusions

1.There are four technogenous associations of elements in topsoil of "Ekranas": one of them Mo-Cr-Mn-Ni-Cu-W-Sn-Co-Ag is characteristic of metal processing enterprises, the second one Y-Cd-Zn – of electrical engineering, partly – metal processing, the third one Sb-Pb-Sr-Ba-Li-U-As – of special (kinescopes) glass production, the fourth one La-Ce – of its polishing. W, Cd, Sb and La are characteristic elements of these associations.

2.The main and the most dangerous in the plant is Sb-association. The sources of emission for these elements are both glass production shops with high chimneys. Therefore all the territory of the plant is extremely dangerously contaminated by it and all DPSP-codes include this association.

3.Cd-association, related with electrical engineering, is on the second place according to technogenity level. Its main sources are near both assemblage shops, but it

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is also widely spread on the whole territory. Therefore it most often adds to Sb-association in twofold pollution and is always included in threefold pollution.

4.W-association, related with metal processing, is on the third place according to technogenity level. It is related with both assemblage shops and metal dumping ground. Almost all DPSP-codes of threefold pollution include this association.

5.La-association related with glass polishing is the least dangerous and is mainly observed in topsoil of the central part of the territory. It adds to other technogenous associations in local points, usually where the greatest total summary contamination index is observed.

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