COEFFICIENT OF SOIL DECONTAMINATION FROM STRONTIUM-90 AT THE TERRITORY OF EAST URAL RADIOACTIVE TRACE (EURT)

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The knowledge of coefficient of soil decontamination is necessary for predictions the dynamics in development of radioactive situation, for retrospective estimation and reconstruction of the initial radioactive contamination levels of territories.

By effective coefficient of soil decontamination from radionuclides (CSD) we mean the multiple of a nuclide completely removed from the soil as a result of its physical decay, active removal of radionuclides from the ground into water ecosystems, as well as biogeochemical and wind migration beyond EURT borders. Its dimension can be expressed in the divisible relation (in how many times?), in percentage, as well as in periods of half-desintegration, if the process of desintegration is the exponent. The calculation is made on a complete nuclides supply in soil.

The objective of the study is to calculate the effective coefficient of soil decontamination from ^{90}Sr on the basis of the analysis of the experimental materials received at EURT territories in Sverdlovsk region.

Three sources of the information were taken.

1. Minimum and maximum data received by central plant laboratory of combinate No 817 (CPL), Leningrad scientific-research institute of radiation hygiene Ministry of Public Health of the USSR (LSRIRH) and Institute of Applied Geophysics AS of the USSR (IAG), as well as data of Experimental scientific-research station at PA "Mayak" (ESRS PA "Mayk") in 1957-1962 for the same settlements. For these settlements we have out own data for the period of 1992-1994.

The comparative analysis of these data for the same local sites is given by the following coefficients (tab. 1):

Table 1.

Coefficient of soil decontamination from ^{90}Sr received by the comparative analysis of various initial data

Statistical parameters	CPL, IAG LSRIRH (at minimum values)	ESRS at PA "Mayk"	CPL, IAG LSRIRH (at maximum values)	On the integrated data (CPL, IAG,LSRIRH ESRS at PA "Mayk")
Mean	4,53	3,74	6,91	4,96
Confidence level (95%)	3,13 - 5,92	2,86 - 4,63	5,09 - 8,74	4,09 - 5,82
Standard error	0,71	0,45	0,93	0,44
Minimum	1,28	1,03	2,56	1,03
Maximum	10,29	7,18	13,71	13,71
Count	14	16	13	43

On evidence of ESRS at PA "Mayak" - 3,7±0,7, on minimal values of CPL, LSRIRH and IAG - 4,5±0,5, on maximal values of CPL, LSRIRH and IAG - 6,9±0,9. Basing on the integrated data of all organizations the effective coefficient is equal to 5,0±0,4 (range from 1,0 up to 13,7; confidence level at P=0,95: from 4,1 up to 5,8, n=43). At defectation of the doubtful minimum variables giving coefficients less than 2,4 (i.e. coefficient on pure physical decay of ^{90}Sr, fig., curve 1), the CSD becomes equal to 5,5±0,5 (range from 2,4 up to 13,7, confidence level at P=0,95: from 4.6 to 6,4, n=37).

2.The second source of calculation - data from the analyses of practically annual selections of undisturbed soil samples from 1975 till 1992 on two far remote experimental plots of radiological laboratory of chemical station of the Sverdlovsk region. These coefficients were calculated for practical purpose, and in the table they are submitted in percentage of soil decontamination of ^{90}Sr per year. CSD depends on a long period of time after the accident (tab. 2). So, in the first year the coefficient decounts for 6,2 percents, within the first five years - for the average of 5,8% per year, in the first decade for 5,3 and throughout the whole 36 year-long period - on the for average of 2,7% per year, i. e. the migration of ^{90}Sr has the tendency of decrease in time, the process of decontamination is not submitted to the exponential law (Fig., curve 2). According to these obtained data the CSD for the period from 1957 till 1993 is more then 5.

3. The third source of the information - materials of Sverdlovsk regional Sanitary Epidemiological Service. The comparative analysis was conducted for *the same areas of radioactive contamination* (more than 250 km^2) on the 1958 map (more than 10 Ci/km^2) and on the 1968 map. At comparing the levels of pollution it was revealed, that only in a compared decade the density of radioactive contamination by ^{90}Sr has decreased 5 times. Taking into account, that this coefficient concerns only to the first decade and not to the whole 36 year-long period, as we have calculated from the above reasoning it clear that of soil decontamination was much more, than five times.

Table 2

Coefficient of soil decontamination from ^{90}Sr, percents per year.

Years	Coefficient	Years	Coefficient	Years	Coefficient
1958	6,21	1970	4,97	1982	3,73
1959	6,11	1971	4,87	1983	3,63
1960	6,00	1972	4,76	1984	3,53
1961	5,90	1973	4,66	1985	3,42
1962	5,80	1974	4,56	1986	3,32
1963	5,69	1975	4,45	1987	3,22
1964	5,59	1976	4,35	1988	3,11
1965	5,49	1977	4,25	1989	3,01
1966	5,38	1978	4,14	1990	2,92
1967	5,28	1979	4,04	1991	2,84
1968	5,14	1980	3,94	1992	2,76
1969	5,07	1981	3,83	1993	2,68

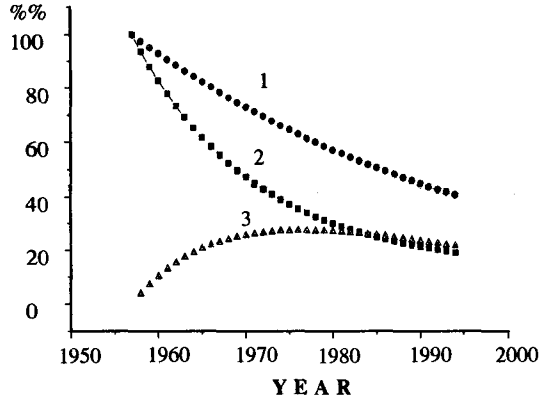

Fig. Dynamics of soil decontamination from ^{90}Sr.
Residual contamination, 100 per cent in 1957: 1 - On the physical decay, 2 - On the effective decay of soil decontamination. 3 - On the cumulative biogeochemical decontamination

Thus, the most probable coefficient of soil decontamination from ^{90}Sr in the Urals region for a 36 year-long period after the accident is equal to five.

In the following discussion of the received data we would like to call attention to the following:

On a data (Ionizing Radiation Levels and Effects, 1972) the soil loses in a year up to 2,5% ^{90}Sr at the expense of mechanical processes. Proceeding from these given during 37 years quantity of strontium has decreased in 2,8 times, we have this value equal 2,6. It should be noted, that the coefficient 2,8 takes into account not complete migration of nuclide from soil, as far as in it has a share of ^{90}Sr, entering of vegetable cover, with further partially coming back in soil.

Here we are dealing with the effective coefficient of soil decontamination from ^{90}Sr, which includes, as was stated above, its physical decay (this coefficient is equal to 2,4 per 36 years, fig., curve 1), active removal of radionuclides from the ground ecosystems into water ecosystems (lateral migration at the bottom of the lakes, bogs, rivers and ocean), as well as biogeochemical and wind migration beyond the EURT borders.

The correctness of application of the calculated coefficient of soil decontamination should especially draw attention to the analysis of highly-contaminated continuous of plots at EURT-territories (in "head part" of trace, for example) with virtually closed biogeochemical radionuclides cycle.

It should be especially noted that the biogeochemical decontamination in the first years after the accident was higher and in the subsequent years the availability of ^{90}Sr has sharply decreased. The dynamics of ^{90}Sr migration is so, that already since 1983-1985 the active biogeochemical soil decontamination in EURT zone is accounted for by the physical decay of ^{90}Sr (fig., curve 1, 3). It does not mean, that ^{90}Sr penetration to animals (including humans) can be relatively low, on the opposite, migration of ^{90}Sr can be higher than the legal normative statements, that should be taken properly into account in practical activities.