RADIOLOGICAL MAP OF POLAND AFTER THE CHERNOBYL ACCIDENT (1988-1995)

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Introduction

Our investigations has been performed in the frame of Polish environmental monitoring system. At Central Laboratory for Radiological Protection, Dosimetry Department a project on „Radiological map of Poland” has been realized since 1988. The measurements and soil sampling were carried out in 1988, 89, 90 and 92 in 340 points located all over Poland using the net of meteorological stations of the Institute of Meteorology and Water Management. In 1994 the number of these points was reduced to 69.

Our investigation give the following possibilities:
- to create the base of computer-stored radiological data for the whole country,
- to obtain a set of radiological maps of Poland.

Methods and measurements

At each point were performed gamma radiation dose measurements. In the same sites soil samples were collected to determine concentration of the natural radionuclides and cesium isotopes by means of spectrometric analysis. Gamma dose rate was measured using three thermoluminescent detectors sets mounted 1 m above the earth surface. The annual gamma dose was calculated on the basis of measurements carried out in two six-month periods. Each sample of soil from the 10 cm surface layer was taken by a knife-edge pipe in six points laying at the circumference of a circle of 2 m radius and in the centre of the circle. The measurements of the radionuclide concentrations in soil samples were made using spectrometers with HPGe detectors located in low-background lead shielding houses. The time of each measurements was 60 000 s. The program of environmental investigations also included measurements performed in selected places using our mobile radiometric laboratory. These measurements were carried out by means of high pressure ionization chamber and an „in situ” method using portable spectrometer with a HPGe detector.

Results

The results can be presented in form of maps produced in „Sinus” or circle cartodiagram systems. The program „Sinus” extrapolates 340 results of the point measurements to the closest vicinity covering the whole area of Poland. The circle cartodiagram program merely visualizes results of the investigations in the very measurements and sampling points.

The mean gamma dose rate of the outdoor radiation in 1989 in Poland was 45.4 nGy-h⁻¹ (without cosmic radiation). The values for individual measurement points range from 17.7 to 97.0 nGy-h⁻¹.

The contribution of each radionuclides to external radiation dose rate can be calculated on the basis of spectrometric measurements of the soil samples. For instance, at the points in which ¹³⁷Cs concentration are the highest in Poland, the gamma dose rate due to cesium isotopes was twice as much as the gamma dose rate due to natural isotopes. These results were confirmed by „in situ” measurements.

The mean values and range of ¹³⁴Cs and ¹³⁷Cs concentration in the soil in Poland in 1988-1992 are presented in Table 1.
Table I. $^{134}\text{Cs}$ and $^{137}\text{Cs}$ concentration in the surface layer of soil in Poland in 1988-1992

<table>
<thead>
<tr>
<th>Isotope</th>
<th>Concentration [ kBq·m$^{-2}$]</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>$^{134}\text{Cs}$</td>
<td>0.99</td>
<td>0.72</td>
</tr>
<tr>
<td></td>
<td>0.03 - 20.07</td>
<td>0.04 - 8.99</td>
</tr>
<tr>
<td>$^{137}\text{Cs}$</td>
<td>4.67</td>
<td>4.68</td>
</tr>
<tr>
<td></td>
<td>0.21 - 81.00</td>
<td>0.74 - 57.79</td>
</tr>
</tbody>
</table>

Map in „Sinus” system in the Fig. 1 shows $^{137}\text{Cs}$ concentration in 1988, for the 10 cm thick surface layer of the soil. Distribution of the average annual gamma dose rate due to natural and artificial radionuclides in the area of Poland in 1989 is presented in Fig. 2. Changes of $^{134}\text{Cs}$ and $^{134}\text{Cs}$ mean concentration in: 1988-1992 for 340 sampling points are presented in the Fig. 3. Our investigation performed in 1988 - 1995 revealed that cesium still appears, mainly in upper 10 cm surface layer of soil.

Contribution of different radiation sources to the annual effective dose equivalent to average individual in Poland in 1991 is given in Fig. 4. The value of the total effective dose equivalent of ionizing radiation to which statistic inhabitant in Poland was exposed was 3.6 mSv [1].

Fig. 1. $^{137}\text{Cs}$ concentration in Poland in 1988 for the 10 cm thick surface layer of the soil.
Fig. 2. Distribution of the average annual gamma dose rate in Poland in 1989.

Fig. 3. Changes of $^{134}$Cs and $^{137}$Cs mean soil concentration in 1988 - 1992 in Poland.
Fig. 4. Contribution of different radiation sources to the annual effective dose equivalent (3.6 mSv) to average individuals in Poland in 1991.

Reference