RADIOISOTOPES IN THE BOTTOM SEDIMENTS OF SELECTED ANTHROPOGENIC LIMNETIC ECOSYSTEMS ON THE UPPER SILESIA REGION

Summary

There have been presented the results of research on the radioisotopes contamination degree of bottom sediments in chosen anthropogenic water reservoirs of the Upper Silesia Industrial District.

In bottom sediments of reservoirs: Dzierżno Małe, Dzierżno Duże, Pławniowice, Kanał Gliwicki, Paprocany and Rybnik, the contents of radioisotopes of uranium ^{238}U (^{214}Bi, ^{234}Th, ^{206}At, ^{226}Ra), thorium ^{232}Th (^{228}Ac, ^{212}Bi, ^{214}Pb, ^{208}Tl), potassium ^{40}K, and cesium ^{137}Cs were determined.

Gamma radiation measurements were carried out by highly sensitive gamma radiation spectrometry technique with semiconductor detector type HPGe. The concentrations of gamma-radioactive radioisotopes included in the researched samples were in the range of energy from 100 keV for 3 MeV. The concentration of radioisotopes detected in the bottom sediments samples was obtained by its comparison with radioactive standard of soil of atomic agency in Vienna, type SOIL^{o}375 (IAEA). The numeric analysis was performed using IAEA software – program GANNAS, and own algorithms for determination of average concentration of individual radioactive series. The research results were compared with the concentrations of heavy metals determined earlier.

In bottom sediments of Dzierżno Małe reservoir, the ^{40}K concentration was in the range from 192 Bq/kg to 455 Bq/kg, the average being 356 Bq/kg. The concentration of cesium ^{137}Cs ranged from 0.8 to 33 Bq/kg, the average 24.4 Bq/kg. The concentrations of uranium ^{238}U progeny radioisotopes were in the range from 15.7 to 58.2 Bq/kg, the average 44.5 Bq/kg. The thorium radioisotopes concentration ranged from 8.5 to 29.3 Bq/kg, the average 24 Bq/kg.

In bottom sediments of Dzierżno Duże reservoir, the potassium ^{40}K concentration was in the range from 336 to 534 Bq/kg, the average 449 Bq/kg. The concentrations of cesium ^{137}Cs ranged from 10.1 to 66 Bq/kg, the average 26.9 Bq/kg. The uranium progeny concentration ranged from 67.4 to 184.0 Bq/kg, the average 126.5 Bq/kg. The concentrations of thorium progeny radioisotopes ranged from 29.0 to 109.0 Bq/kg, the average 53.8 Bq/kg.

In bottom sediments of Pławniowice reservoir, the potassium ^{40}K concentration ranged from 200.7 to 434.6 Bq/kg, the average 347 Bq/kg. The cesium ^{137}Cs concentration ranged from 14.2 to 280.6 Bq/kg, the average 204.7 Bq/kg. The concentrations of uranium progeny ranged from 29.3 to 210.6 Bq/kg, the average 144.5 Bq/kg. The thorium progeny concentrations ranged from 21.7 to 122.6 Bq/kg, the average 67.3 Bq/kg.

In bottom sediments of Kanał Gliwicki, the potassium ^{40}K concentrations ranged from 123 to 518 Bq/kg, the average 323.4 Bq/kg. The cesium ^{137}Cs concentrations ranged from 0.58 to 25.7 Bq/kg, the average 8.7 Bq/kg. The concentrations of the uranium progeny ranged from 5.7 do 105.5 Bq/kg, the average 54.0 Bq/kg. The concentrations of the thorium progeny ranged from 2.7 to 75.2 Bq/kg, the average 44.0 Bq/kg.

In bottom sediments of Paprocany reservoir, the potassium ^{40}K ranged from 176.2 to 359.6 Bq/kg, the average 236.8 Bq/kg. The cesium ^{137}Cs concentration ranged from 4.2 to 138.6 Bq/kg, the average 25.3 Bq/kg. The concentrations of uranium progeny ranged from 11.6 to 48.8 Bq/kg, the average 21.5 Bq/kg. The concentrations of thorium progeny ranged from 10.3 to 44.4 Bq/kg, the average 19.8 Bq/kg.

In bottom sediments of Rybnik reservoir, the potassium ^{40}K concentrations ranged from 192 to 470.6

Bq/kg, the average 315.9 Bq/kg. The cesium ^{137}Cs concentrations ranged from 3.1 to 104.7 Bq/kg, the average 52.5 Bq/kg. The uranium progeny concentrations ranged from 6.8 to 68.1 Bq/kg, the average 42.3 Bq/kg. The thorium progeny concentrations ranged from 7.2 to 56.6 Bq/kg, the average 33.7 Bq/kg.

The concentrations of radioactive isotopes, including cesium ^{137}Cs, natural isotope of potassium ^{40}K, uranium ^{238}U and thorium progeny, in muscle tissue of fish are small and constitute about 0.1% of the value determined for bottom sediments.

It is interesting to note that in zooplankton biomass (*Copepoda*) samples of Dzierżno Duże reservoir the presence of cesium has not been reported. It is worth noting that in the same samples considerable concentrations of heavy metals, particularly lead, were detected. It indicates discrepancies in bioavailability of heavy metals and cesium ^{137}Cs which may result from hydrochemical agents, and in consequence affect the process of pollutants accumulation in zooplankton organisms. A correlation between radioisotopes concentrations and organic matter in bottom sediments indicate the important role of biomass, particularly zooplankton organisms, in the process of transport of radioisotopes from water to bottom sediments.

A dependence of radioisotopes and heavy metals concentrations in bottom sediments of all researched reservoirs has been stated. A strong dependence of organic matter content in bottom reservoirs on radioisotopes concentrations was also noted.

Despite discrepancies among individual reservoirs in morphometry, hydrological conditions, catchment area and its development, a regularity can be noticed – the highest concentrations of radioisotopes occur in the deepest parts of reservoirs. In bottom sediments of Pławniowice reservoir the concentration of cesium ^{137}Cs was eight times higher than that of Dzierżno Duże reservoir, although Pławniowice reservoir is subjected to much lower anthropopresion. The research results are consistent with local small pollutants spots being the result of Chernobyl disaster.

Correlation analysis of isotopes concentrations with performed earlier determination of heavy metals concentrations (Pb, Cu, Mn, Cr, Cd) in the same samples of bottom sediments showed that allocation of both types of pollutants is very similar. It can be exemplified by a strong correlation between radioisotopes of uranium and thorium progeny and lead concentrations. This fact proves that both metals and radioisotopes undergo the same intra-reservoir transport processes the consequence of which is described allocation in ecosystem.

The potassium ^{40}K concentration is comparable with values found in the soil all over the world. The elevation of natural concentration of ^{238}U and ^{232}Th in relation to the values characteristic for soils results from anthropogenic character of the reservoir and especially from the fact that it is supplied by mine waters. The inter-dependence between concentrations of heavy metals and radioisotopes suggests that both groups of metals derive from the same sources. The relation between concentrations of radioisotopes and heavy metals in bottom sediments shows that these two groups of pollutants in limnetic ecosystems undergo the same processes of transport and allocation.

The concentrations of potassium ^{40}K, ^{137}Cs, uranium and thorium progeny, in the bottom sediments of researched reservoirs of Upper Silesia Region, are lower than permissible by Polish atomic law. The identified concentrations of radioisotopes in bottom sediments of the researched reservoirs do not contribute to increase of the natural background of ionizing radiation.