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The impact of Ignalina Nuclear Power Plant on Carbon-14 content in Lake Druksiai, Lithuania

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Nuclear Power Plants (NPPs) and nuclear fuel reprocessing sites are main producers of anthropogenic radiocarbon. Anthropogenic ^{14}C can be released into the environment in gaseous forms, with liquid effluents or with spent nuclear fuel [1]. During photosynthesis radiocarbon can be easily assimilated into the plants. As a result, carbon-14 can be transported through the food chain and accumulate in a human body. Therefore, radiocarbon is considered a primary source of increased human radiation dose from industrial nuclear activities [2].

Main goal of this research was to evaluate the influence Ignalina NPP on carbon-14 content in the Lake Druksiai. The sediment core was collected from the Lake Druksiai. The ages of sediment layers were estimated using ^{137}Cs and ^{210}Pb dating methods. ABA (acid-base-acid) chemical pretreatment procedure was used to extract humin (HM) and humic acid (HA) fractions from the sediments. Chemically pretreated samples were graphitized with the Automated Graphitization Equipment AGE 3 (IonPlus AG). Carbon-14 measurements in prepared samples were performed using the single stage accelerator mass spectrometer (SSAMS, NEC, USA).

Radiocarbon content was measured in the sediment core which covers all phases of the NPP exploitation (commissioning, operation and decommissioning). These measurements in HM and HA fractions showed that after the start of the operation of the Ignalina NPP in 1983, the ^{14}C concentration in these organic fractions increased by 4 pMC and 3 pMC, respectively. In addition, a sharp increase of radiocarbon content (concentration almost doubled) in HA fraction was observed in the year 1999. Similar increase in ^{14}C activity in fish samples from Lake Druksiai was measured. In HM fraction such drastic changes in radiocarbon concentration were not observed. These results suggest that ^{14}C enriched effluents were released from the Ignalina NPP in 1999.

[1] Z. Ezerinskis et al., Annual Variations of 14C Concentration in the Tree Rings in the Vicinity of Ignalina Nuclear Power Plant, Radiocarbon 60, 1227–1236 (2018).

[2] IAEA, Generic Models for Use in Assessing the Impact of Discharges of Radioactive Substances to the Environment (2001).