Distribution of radiocarbon in the forest ecosystems soil of the Republic of Kazakhstan

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One of the most reliable methods for assessing climate change is the dating method based on the use of a radioactive carbon isotope – radiocarbon (^{14}C) with a half-life of 5730±40 years. To conduct research on the ^{14}C distribution in the soil, the sampling sites should not have man-made disturbances and be sufficiently enriched with carbon. Forest soils are more suitable for such research.

Forests of Kazakhstan make up only 5% of the territory and are distributed extremely unevenly. Due to the fact that saxaul forests are widespread on soils that are highly depleted in organic matter, and mountain forests are difficult to access with a high proportion of rock fragments in the soils, flat areas of the forest-steppe zone of Kazakhstan were selected for the research. Birch-aspen forests, island and ribbon pine forests grow in this area. The purpose of this work is a preliminary assessment of the ^{14}C content in the forest ecosystems soils at the flat part of Kazakhstan.

The research objects were the soils of aspen and pine forests of the Beskaragay district of the Abai region (eastern Kazakhstan) and birch and pine forests of the Burabay district of the Akmola region (northern Kazakhstan). Forest litter samples and layer-by-layer soil sampling were carried out on sites with an undisturbed surface of 1 m^2 using a pit excavation method at intervals of 10 cm to a depth of 50 cm. Laboratory studies included soil sample preparation using a “Pyrolyser-6 Trio” (by Raddec International Ltd, UK). Determination of ^{14}C content by liquid scintillation counting using a highly sensitive “SL-300” alpha-beta radiometer (by Hidex). Physicochemical parameters of soils (organic matter and hygroscopic moisture) and mechanical composition were also determined.

According to the obtained results, the ^{14}C maximum concentration for all the studied areas was recorded in the forest litter: up to 410 Bq/kg (Beskaragay district) and up to 50 Bq/kg (Burabay district). The results of the ^{14}C vertical distribution in the soil profile showed that for the Beskaragay district forests, the maximum values were recorded in the upper layers: in the aspen forest at a depth of 20 cm - 330 Bq/kg; in the pine forest at a depth of 10 cm - 250 Bq/kg. In the soils sampled in the Burabay district forests, the ^{14}C content throughout the profile is below the detection limit (DL $<$6 Bq/kg).

High values of ^{14}C content in the Beskaragay district soils indicate the presence of "bomb" ^{14}C [1], since this area is located in the zone of radioactive fallout from the 1949 nuclear test conducted at the territory of the Semipalatinsk nuclear test site. Although, if we compare the pine forests of the two districts, the organic matter content in the Burabay district soil is an order of magnitude higher than its content in the Beskaragay district soil, while the content of ^{14}C in the soil of the pine forest of Burabay district is below the DL, in the soil of the same forest of Beskaragay district it reaches about 250 Bq/kg. Comparatively higher values of ^{14}C content in soil and forest litter were found for areas with heavier mechanical composition of soils and increased content of hygroscopic moisture: Beskaragay district aspen forest. In the aspen forest, in contrast to the pine forest of Beskaragay district, a high content of organic component in the soil is also noted (according to the results of determining the physicochemical parameters).

In the absence of ^{14}C in the soil of the Burabay district forests, its content in the forest litter reaches 50 Bq/kg, which indicates the entry of ^{14}C from the atmosphere (capture in the form of $^{14}CO_2$ by plants during photosynthesis). The ^{14}C content in the forest litter of the Beskaragay district forests at levels from 340 to 410 Bq/kg, probably indicates two sources of ^{14}C entry both from the atmosphere and from the soil.