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Assessment of ^{137}Cs and ^{90}Sr Fluxes in the Barents Sea

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On the basis of published and own data the annual balance of radionuclide income/outcome was assessed for ^{137}Cs and ^{90}Sr in the Barents Sea for the period from 1950s to the presnt.

The scheme of the isotope balance calculation in the Barents Sea included the following processes:atmospheric fallout; river run-off; liquid radioactive wastes releases, income from the Norwegian and the White Seas; outflow to the adjacent areas through the Novaya Zemlya straits and the transects Svalbard-Franz Josef Land and Franz Josef Land-Novaya Zemlya; radioactive decay.

According to the multiyear dynamics, the inflow of ^{137}Cs and ^{90}Sr to the Barents Sea was significantly preconditioned by currents from the Norwegian Sea. Three peaks of ^{137}Cs and ^{90}Sr isotope concentrations were registered for the surface waters on the western border of the Barents Sea. The first one was observed in the mid-1960s and was conditioned by testing of nuclear weapons. The increase of isotope concentrations in 1975 and 1980 was preconditioned by the discharge of atomic waste by the Sellafield nuclear reprocessing plant. Nowadays, after the sewage disposal plant was built, the annual discharge of nuclear waste from Sellafield plant is low. The Norwegian Sea was a major source of ^{137}Cs and ^{90}Sr isotope income into the Barents Sea for the period of 1960-2014. Currently, the transborder transfer of ^{90}Sr and ^{137}Cs from the Norwegian Sea into the Barents Sea constitutes about 99% of income for each element.

Atmospheric precipitation had a major impact in the 1950-1960s after the testing of the nuclear weapons, and in 1986 after the accident at Chernobyl Nuclear Power Station. In 1963, the atmospheric precipitation of ^{137}Cs reached 1050 TBq; and that of ^{90}Sr, 630 TBq. In 1986, a significant amount of ^{137}Cs inflow (up to 1010 TBq/year) was registered.

The ^{137}Cs isotope income exceeded the ^{90}Sr income in the 1960s-1980s, and equal amounts penetrated into the Barents Sea from the Norwegian Sea in the 1990s.

Before the 1990s, ^{137}Cs inflow exceeded outflow in the annual balance, but the opposite pattern is observed nowadays. This tendency of prevailing of ^{137}Cs outflow processes in the Barents Sea may be explained by natural decay and ecosystem self-cleaning of the radioactivity, which has penetrated previously. According to our assumptions, in total, 37400 TBq of ^{137}Cs penetrated, and 26300 TBq of ^{137}Cs were output from the Barents Sea during the period 1950-2010, i.e., 70.2% of this isotope was removed.

From the 1960s through the present, the inflow of ^{90}Sr exceeded the outflow. In total, 24800 TBq of ^{90}Sr penetrated, and 19600 TBq of ^{90}Sr were output through the northern and northeastern margins of the Barents Sea, i.e., 79.1% of this isotope was removed.

From 1960 through the 1980s, the income/outcome ratio in the Barents Sea was quite stable and constituted 1.4-1.5 for ^{137}Cs and 1.1-1.2 for ^{90}Sr. The increase of the impact of atmospheric precipitation on ^{137}Cs income was up to 42% in 1986 due to the Chernobyl disaster, and the income/outcome ratio increased to 2.6. The atmospheric income of ^{90}Sr in 1986 was minor, and the ratio stayed the same for this isotope.