

Evaluation of Natural Radiation Dose of People in Aomori Prefecture and Forest Ecosystem in Rokkasho

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Abstract

The natural background radiation dose is important for evaluating the significance of the dose from the small amounts of radionuclides that are being released from the first commercial spent nuclear fuel reprocessing plant in Rokkasho, Japan. In this study, the background radiation dose of Aomori Prefecture residents was assessed, and a dose evaluation method for the forest ecosystem in Rokkasho was developed to study environmental protection.

Natural radiation consists of cosmic rays, environmental γ -rays and radiation from Rn and internal radionuclides. The cosmic ray dose rate can be estimated from the height above sea level and magnetic latitude of the target area. Radon concentrations have already been measured throughout the prefecture, and dose rates from Rn were evaluated. Although we previously measured environmental γ -ray dose rates throughout the prefecture, measurement points around Rokkasho were scarce. In this study, the dose rates were measured in areas surrounding Rokkasho to get their detailed distribution. The internal dose rate was also evaluated by analyzing radionuclides in the so-called total diet and individual food item samples collected in Rokkasho and Aomori City. The cumulative γ -ray dose at five locations in Noheji Town was measured using glass dosimeters in FY 2008. The dose rates ranged from 22 to 28 nGy h⁻¹, and were lower than the mean dose rate in Aomori Prefecture. The sums of the committed effective dose due to annual ingestion of natural radionuclides in the total diet samples and the effective dose rate from ⁴⁰K cited in the literature were estimated to be 0.56 mSv for agricultural farm workers in FY 2008 and 0.65 mSv for office workers during FYs 2006-2008. Over 98% of these doses were attributed to ²¹⁰Po, ⁴⁰K, ²¹⁰Pb, ¹⁴C and ²²⁸Ra. Analytical results of polished rice and processed cereals (breads and noodles) showed that the committed effective doses from natural radionuclides ingested annually through the products were 0.049 and 0.042 mSv for the farm and office workers, respectively, corresponding to 13 and 9% of each committed effective dose.

Small mammals, mice and moles, and a predator, the fox, were selected as representative animals of the forest ecosystem in this study, and their radiation doses derived from natural sources, i.e. environmental γ -rays, Rn, and internal radionuclides, have been planned to be measured from FYs 2006 - 2010. The small mammals in coniferous forests were caught using traps, and their natural radionuclides burdens were analyzed in 2008. Environmental γ -ray dose rates and Rn concentrations were also measured in the forests. The mean internal dose rates of the mouse (*Apodemus argenteus*) and mole (*Urotrichus talpoides*) were estimated to be 44 nGy h⁻¹ and 0.50 μ Gy h⁻¹, respectively, with dose conversion factors using a very simple phantom. An almost 10 times higher body burden of ²¹⁰Po in moles than mice led to this difference. The environmental γ -ray dose rates ranged from 24 to 31 nGy h⁻¹, and the range of the mean ²²²Rn concentration was 3 - 10 Bq m⁻³ during May-December 2008. The radon equilibrium factor varied from 0.16 to 0.33, being lower than those reported for general outdoor environments. All these results for coniferous forests were comparable with those for beech forests and oak forests obtained in FYs 2006 and 2007, respectively.

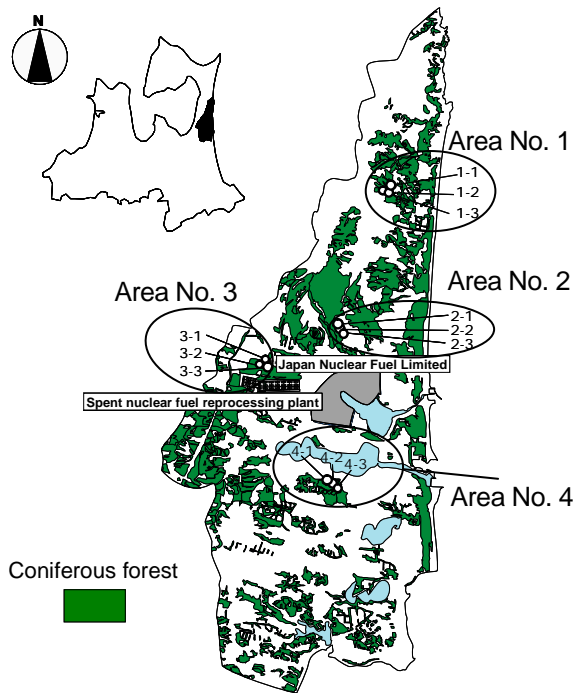


Fig. 1 Sampling sites (○) for small mammals and the distribution of coniferous forests in Rakkasho.

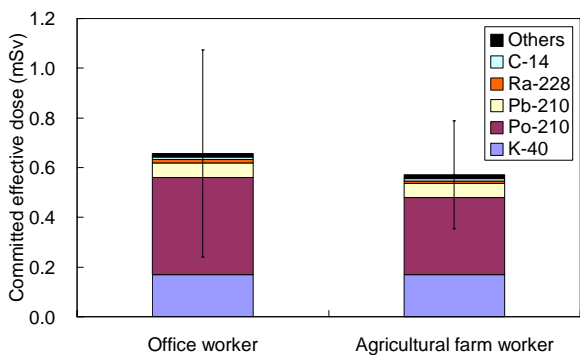


Fig. 2 Mean committed effective dose from natural radionuclides ingested annually through total diet samples of agricultural farm workers in FY 2008 and of office workers during FYs of 2006-2008 in Rakkasho Village and Aomori City. Each error bar shows a standard deviation of results from 8 farm workers and 24 office workers, respectively.

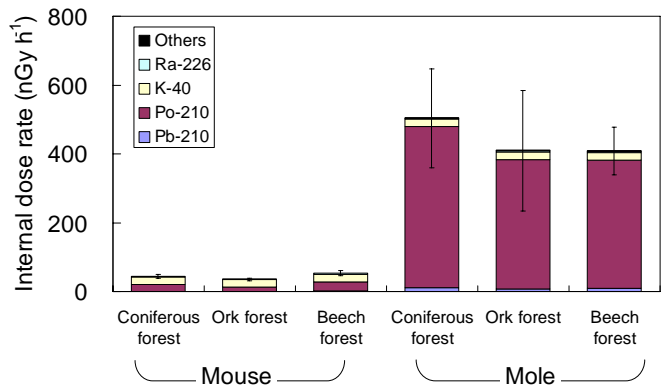


Fig. 3 Mean internal radiation dose rates of mice and moles in beech (2006), oak (2007) and coniferous forests (2008) of Rakkasho from natural radionuclides in their bodies. “Others” means the sum of doses for ^{137}Cs , ^{232}Th , and $^{234,238}\text{U}$. Error bars show a standard deviation of results of 20 samples.