学位論文要旨

Title: Investigation on environmental dynamics of radioactive Cs released from Fukushima nuclear power plant accident

(福島原発事故に伴い放出された放射性 Cs の環境動態についての研究)

NGUYEN TAT THANH

By the Fukushima Nuclear Power Plant accident, a large number of radioactive materials, especially radioactive cesium (^{134}Cs and ^{137}Cs) with a quite long half-life of 2.06 and 30.07 years, respectively had been released into the air. Because of long half-life, radioactive cesium can remain in environment for several decades to a hundred years in non-decontamination work conditions. Radioactive cesium causes harmfulness to human such as disordering the function and metabolic activity of kidneys, myocardium and so on if they are absorbed into body. Recent research after Fukushima Nuclear accident also pointed out that the big impacts on the environment such as the morphological effects on pines, high abnormality rate in the pale grass blue butterfly, reduction of the body weight and head size of monkey babies. To protect humans and the environment from radioactive cesium, it is necessary to investigate the distribution and change of them following the time. Some researchers have evaluated the distribution of radioactive cesium in the soil in post-accident period; however, an investigation on the change of the radioactive cesium for later years and transfer of the radioactive cesium from soil to young plant growing on the contaminated soil is not conducted. Therefore, environmental dynamic and transfer of radioactive cesium from depth profile soil to young pines is the purpose of this investigation.

Generally, the research movement of radioactive cesium in soil has been conducted based on depth profiles of soil cores with a particular year by many researchers. The movement of radioactive cesium in Fukushima soil also has been estimated by some researchers after several months of the accident. The long-term monitoring of movement to find out their movement tendency has not been conducted. With depth profile obtained by ordinary method (by gamma measurement), monitoring movement of radioactive cesium is quite difficult because their migration velocity in the soil is a range from millimeter to centimeter per year. Then, to obtain depth profiles with millimeter depth-bin width, and unfolding technique using an imaging plate is proposed in this study. The proposed technique has been tested for the movement tendency of radioactive cesium in the sampled Fukushima soil. The results show the depth profiles with millimeter depth-bin width which are consistent with gamma measurement.

Migration velocity and diffusion coefficient as movement indexes of radioactivity in the soil are considered independently with the time by some researches for Fukushima soil. Using depth profile by the unfolding technique combined with those by gamma measurement method for fitting with the function derived the Bossew and Kirchner-model for transportation of radionuclides in soil, the dependence of migration velocity with the time as an exponential function was obtained. From the results of the fitting, the migration velocities of the Fukushima soils show a saturation over the years.

Along with the vertical movement process, radioactive cesium in the soil is transferred to plant by root uptake process of plant. The transfer from soil to plant is estimated by the ratio of radioactivity concentration in plant and radioactivity concentration in soil and named transfer coefficient. This transfer coefficient is used for homogeneous distribution in soil of radioactive cesium. In Fukushima soil, depth profiles showed that distribution is not homogeneous. To obtain the transfer coefficient considering the depth profile, a new formulation of transfer coefficient from soil to root, and translocation from root to plant indexes were proposed. The proposed transfer coefficient was tested. The results show stable values of transfer coefficient not only the homogeneous distribution soil but also the depth profile soil.