Thesis Summary

^{137}Cs Migration from Sloped Forest Catchment to Water Body and Its Contribution to Air Dose Rate
(傾斜森林集水域から水域への ^{137}Cs の移行とその空間線量率への寄与)

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The Fukushima Daiichi Nuclear Power Plant (FDNPP) accident that occurred on March, 2011, caused a substantial amount of radioactive materials released to the environment. Among the radioactive materials released to the environment, radiocesium (^{134}Cs and ^{137}Cs) beside radioiodine (^{131}I) is the most major released volatile radionuclide having a direct impact on land contamination. The longer ^{137}Cs half-life (30.2 years) in comparison to ^{134}Cs (2.06 years) and ^{131}I (8 days) has made the ^{137}Cs as the main radionuclide of interest to be studied. Forest area covers more than 60% of the contaminated zone and has higher radiocesium inventory in comparison to other land use, that is a disadvantage as forest is one of source of food. Furthermore, forest can be source of radioactive particulate contamination for lower area like water body (river, lake, reservoir etc.) that can contaminate water resource. The understanding of radiocesium migration behavior is key to the assessment for the long-term radiation hazard risk and its countermeasures. The radiocesium distribution and migration in terrestrial environment after FDNPP accident have been widely investigated, however, there are still some questions about the factors that influence the migration. Furthermore, alternative method to estimate future radiocesium migration and air dose rate derived from radiocesium is still needed. Background and objective of research are given in detail in Chapter 1.

Chapter 2 shows the methodology of the research. The study area is in Ogi reservoir catchment area, Kawauchi village, Fukushima, which is located about 18 km southwest from FDNPP. Air dose measurement and soil and sediment core sampling were conducted on March 15 and 16, 2018 in a steep slope forest and transition zone of the catchment area and reservoir. The air dose rate was measured by a portable gamma survey meter with a NaI detector (ALOKA MYRATE PDR-111) about 1 m above the ground. The soil and sediment core samples were cut each 2 cm and 1 cm increment, respectively. The samples were dried at room temperature and further dried in oven (105^{o} C, 24 hours). The prior dry sieving (2 mm sieve) was performed using electric horizontally rotating sieve (SKH-01, AS ONE).

The activities of ^{134}Cs and ^{137}Cs were measured by gamma spectroscopy with HP Ge detector and multichannel analyzer (GEM 30-70, ORTEC), at energy peak of 604 keV and 662 keV for ^{134}Cs and ^{137}Cs. Physicochemical property of the soil (pH, Organic Matter content, Silt and clay fraction, Exchangeable cation, Cation exchange capacity and base saturation) was also measured.

Chapter 3 presented the results of initial study that was conducted in Hibara Lake, Yama District, Fukushima. The results show the shallower accumulation of ^{137}Cs in the sediment layer of lake closer to flat area but deeper accumulation of ^{137}Cs in the sediment layer of lake closer to slope surrounding area. The result shows the importance of slope for ^{137}Cs migration. And the result also shows the higher activity concentration of ^{134}Cs and ^{137}Cs in silt and clay fraction of soil (particle size $<75\mu m$) than sand fraction, suggesting that the radiocesium migration occurred through soil fine particle migration.

Chapter 4 discussed the factors that influence radiocesium retention and migration. The results show that the radioactive contamination is strongly retained in sloped forest area after 7 years. It was due to the vertical migration as a dominant mode of radiocesium migration in forest. The high abundance of organic matter and less fine particle in soil surface are factors that cause the radiocesium vertical migration in forest. The role of soil bacteria was analyzed in migration of the radiocesium by laboratory experiment. The result shows that soil bacteria have an ability to absorb Cs. Furthermore, soil bacteria are also capable to desorb Cs from soil matrices, probably through the decomposition of biomass and organic matter in the soil.

Chapter 5 introduced the ratio of ^{137}Cs in soil to ^{137}Cs in sediment ratio for investigation of radiocesium migration for the first time. It was assumed that ^{137}Cs in sediment is related with ^{137}Cs in soil. When ^{137}Cs in soil decreases with time progress, ^{137}Cs in sediment will increase with time progress. The time dependency of soil to sediment ratio was shown, suggesting the potential of the ratio for analyzing ^{137}Cs migration in future.

Chapter 6 reported the ratio of air dose rate 1 m above the ground to ^{137}Cs inventory in the soil for estimating the future dose derived from ^{137}Cs by considering that there is a relation between ^{137}Cs in soil and air dose rate. It is known that the ratio decreased in short time and then became relatively stable after Chernobyl nuclear accident. We firstly applied the ratio to the FDNPP accident. We discussed the ratio from the point of vertical migration of ^{137}Cs that cause the increase of distance between ^{137}Cs and the detector or geometry change and soil shielding effect. The ratio will be relatively stable or less changeable after the immobilization of ^{137}Cs in soil layer especially in soil mineral layer.

Chapter 7 shows the general conclusions.