Radiocesium transport processes and their temporal variation in Fukushima, Japan

*大澤 和敏[1]、西村 拓[2]、溝口 勝[2]
*Kazutoshi Osawa[1], Taku Nishimura[2], Masaru Mizoguchi[2]

1. 宇都宮大学、2. 東京大学
1. Utsunomiya University, 2. The University of Tokyo

Huge amounts of radionuclides, especially radiocesium (^{137}Cs and ^{134}Cs) and radioiodine (^{131}I), were released to the atmosphere by the accident at the Fukushima Daiichi Nuclear Power Plant (FDNPP) in March 2011. The FDNPP accident resulted in considerable deposition of radiocesium on the soil in and around Fukushima Prefecture. Residents within the seriously contaminated area were forced to move. Intensive decontamination efforts, including removal topsoil and vegetation around houses and agricultural lands, were conducted between April 2013 and March 2017. However, a large amount of radiocesium remains in forests, which were not the target of decontamination efforts. The remaining radiocesium has been redistributed with water and sediment transport. In this study, rediocesium transport processes and their temporal variation were investigated from the results of our river monitoring and the review of some literatures.

Radiocesium transfer involves two main forms of radiocesium: dissolved and particulate. Radiocesium was transported mainly by the particulate radiocesium bound to suspended sediments, SS during rainfall events. Radiocesium is selectively adsorbed onto fine particles such as clay, silt, fine sand, and organic matter.

Generally, radiocesium transportation occurs during the rainfall from March to April which is the snowmelt period, the rainy season from June to July, and the typhoon period from August to October. At these times, radiocesium-containing soil is eroded and flows down, but a part of sediments containing radiocesium deposits at the water's edge such as floodplains. If greater flooding occurs than the previous runoff, the deposited radiocesium is resuspended. It is supposed that the amount of radiocesium deposits increases until the rainy season and flushes radiocesium deposited by typhoons accompanied by high rainfall intensity. It is also considered that the sedimentation increases remarkably during the snowmelt period, because the topsoil was eroded easily due to the freezing and melting action.

Riverine particulate ^{137}Cs concentrations of SS decreased rapidly after the flooding of Typhoon Roke in September 2011. Similar abrupt change was detected after the flooding of Typhoon Etau in September 2015. These two events flushed a large amount of particulate radiocesium out from easily erodible sites, such as the headcut of gullies, river floodplains, and bared agricultural lands just before removing top soil as the decontamination works. The result of this exhaustion of easily erodible radiocesium source would have decreased abruptly subsequent radiocesium export.

As cesium dynamics in the future, it is conceivable that radiocesium remaining in the forests is slowly and long-term transported as a dissolved component. Dissolved radiocesium are thought to be highly incorporated into crops and it is necessary to pay attention to the trend.

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