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Effect of topographical condition on radioactive cesium pollution of herbaceous plants in a mountainous grazing pasture after Fukushima Dai-Ichi Nuclear Power Plant accident

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Introduction

The Great East Japan Earthquake on 11 March 2011, followed by tsunami, incurred the accident of the Fukushima Dai-Ichi Nuclear Power Station (NPS). The radioactive fallout was dispersed by wind and deposited in large part of eastern Japan by rainfall or snowfall after the accident (Chino *et al.*, 2011; Katata *et al*., 2012; Terada *et al*., 2012). That caused extensive pollution by radioactive cesium (Cs) (the sum of 134Cs and 137Cs) in agricultural lands (MEXT, 2011) including permanent pastures and meadows. In mountainous areas, it can be thought that radioactive Cs migrated from convex to concave regions by snow melting and rain water, therefore radioactive pollution is higher on concave areas than convex areas. In this study, air dose rate and radioactive Cs concentration in aboveground part of plant were monitored for three years on mountainous grazing pastures in north-eastern region of Japan.

Materials and Methods

The study was conducted in mountainous grazing pasture (94 ha), the Field Science Center, Tohoku University, Japan (38° 44' N, 140° 15' E, 515–635 m in elevation). The FSC is 150 km apart from the Tokyo Electric Power Company's Fukushima Dai-Ichi NPS. Dominant plant species of this pasture are *Anthoxanthum odoratum*, *Carex albata*, *Rumex acetosella* and *Pteridium aquilinum.* On the pasture, 19 convex and 18 concave locations (radius 2 m each) were allocated in mid-June 2012. The position of each location was confirmed by a handy GPS (eTrex®, personal navigator®, GARMIN, Olathe, USA). The distance between the sampling sites was 50 m or more apart each other. The measurements of air radiation dose rate and collection of aboveground part of plants were done on 12 June–24 July 2012, 20 June–24 July 2013 and 1–8 July 2014. Air radiation dose rates (μSv/h) were measured by an environmental radiation monitor (γ survey meter TCS-172B, Hitachi-Aloka Medical, Ltd., Tokyo, Japan) at a height of 1 m at the locations. The measurement was done in the same day of plant collection, but it was postponed until the following day when it rained on the measurement day. Aboveground part of plants was cut at a 3 cm height from the ground, and the samples were air-dried at 70°C for 72 h, then milled to pass 2 mm screen in order to produce homogenous samples. All the samples were stored in dry condition until the analysis of radioactive Cs concentration. Using the plant samples, the activity concentrations of 134Cs and 137Cs were determined by a gamma counter (WIZARD2® 2480, PerkinElmer, Waltham, USA) equipped with NaI detector. Measurement protocol was provided by Perkin Elmer, Japan. Each sample was loaded into a plastic vial (20 ml) and weighed, and radioactive Cs concentration was measured for 1,800 s. Radioactive Cs concentrations, the average of duplicate samples, were expressed as total activity of 134Cs and 137Cs per unit dry weight (Bq/kg DM). Standard deviation of each measurement with the gamma counter was less than 10%. The activities of plant samples were corrected for radioactive decay to each sampling date in order to compare Cs concentration of plants with yearly change.

Results and Discussion

Air radiation dose rate and radioactive Cs concentration in plants were higher on concave locations (0.08–0.29 μSv/h, 616–15,957 Bq/kg DM) than convex locations (0.05–0.16 μSv/h, 223–5,835 Bq/kg DM) throughout the three years, showing decline over time. There were positive relationships between air radiation dose rate and radioactive Cs concentration in plants (r=0.391–0.593, P)

Conclusion

These results indicate that radioactive pollution is higher on concave areas than convex areas in mountainous pastures, suggesting that radioactive Cs migrated from convex to concave regions by snow melting and/or rain water after the fallout of radioactive substances. The results also indicate the spatial variability of radioactive Cs is stable over a prolonged period.

References

Chino, M., H. Nakayama, H. Nagai, H. Terada, G. Katata and H. Yamazawa. 2011. Preliminary estimation of release amounts of 131I and 137Cs accidentally discharged from the Fukushima Daiichi Nuclear Power Plant into the atmosphere. *J. Nuclear Sci. Technol.* 48: 1129–1134

Katata, G., M. Ota, H. Terada, M. Chino and H. Nagai. 2012. Atmospheric discharge and dispersion of radionuclides during the Fukushima Dai-ichi Nuclear Power Plant accident. Part I: Source term estimation and local-scale atmospheric dispersion in early phase of the accident. *J. Environ. Radioactiv.* 109: 103–113

MEXT, 2011 Ministry of Education, Culture, Sports, Science and Technology, Japan (MEXT). 2011. *Preparation of distribution map of radiation doses*, etc. (Map of radioactive cesium concentration in soil) by MEXT. http://radioactivity.nsr.go.jp/en/contents/5000/4165/24/1750_083014.pdf

Terada, H., G. Katata, M. Chino and H. Nagai. 2012. Atmospheric discharge and dispersion of radionuclides during the Fukushima Dai-ichi Nuclear Power Plant accident. Part II: Verification of the source term and analysis of regional-scale atmospheric dispersion. *J. Environ. Radioactiv*. 112: 141–154.