Investigation on distribution of radioactive substances in Fukushima
(13) Assessing the impacts of land cover and land-use change on soil erosion, hydrological process, and radioactive Cesium discharge in headwater catchments in the Fukushima prefecture

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This study aims at investigating the impacts of land cover and land-use change on Cesium discharge, soil erosion and hydrological process. We found that the land-use change, associated with the decontamination works, resulted in a critical increase in sediment yield and runoff coefficient, and a change in the critical Cesium and sediment source area.
Keywords: Decontamination works, Land-use change, Hydrological process, Soil erosion

1. Introduction

Decontamination works (removing the contaminated topsoil and vegetation, and recovering the area with uncontaminated soil) were performed in highly contaminated farmland and grassland, in order to reduce the radiation levels within the Fukushima area. Along with the significant reduction of radiation levels, such works have contributed to a critical change in land-use and soil properties of the decontaminated areas, which may influence the ^{137}Cs discharge, soil erosion, and hydrological processes. This study aimed at investigating such impacts at plot and catchment scale.

2. Material and Methods

We monitored the sediment, water and radioactive Cesium (^{137}Cs) discharges, at plot and catchment scale. Two USLE-type plots with a length of 22.13 m and a width of 5 m, were installed in 2011 and 2013. Those plots present the use of a grassland area before and after the decontamination works. Four forested headwater catchments with different grassland fractions (0 %, 1.5 %, 19 %, and 23%) were selected to investigate the impacts of land cover on ^{137}Cs discharge. In one of those catchments (the Iboishi-yama catchment), decontamination works were conducted in 29 % of the catchment area in December 2013.

3. Results

First, our results showed that from 96 % to 99 % of the total discharged ^{137}Cs, in the four headwater catchments, was associated with suspended sediments. The decline rate of the dissolved ^{137}Cs (stream water) was related to the grassland area extent in the different catchments. Second, in the Iboishi-yama catchment: the sediment rating curves showed an increase in sediment yield by ~ 6 times after the decontamination works; The hysteresis loop analysis showed an increase in counterclockwise hysteresis after the decontamination works. This suggests a change in the critical sediment source area; The rainfall-runoff events analysis showed an increase in runoff coefficient. Third, the plot experiments showed a significate increase in sediment discharge (about 7 times) and water discharge (about 3 times) after the decontamination works.

4. Conclusion

The results of the present study provide a clear evidence of the sensitivity of the hydrological process, soil erosion and ^{137}Cs discharge to the land cover and the land-use change. The land-use change, associated with the decontamination works, in a radical decrease in the ^{137}Cs discharge, a change in the critical sediment and radio-cesium source areas, and an increase in sediment yield and surface runoff in the Iboishi-yama catchment and the decontaminated plot.