

論文 / 著書情報
Article / Book Information

題目(和文)	福島第一原発事故により影響された森林流域における降雨流出，土壌侵食及び放射性セシウムの移行モデリングに関する研究
Title(English)	Modeling rainfall-runoff, soil erosion and radiocesium transport in a forested catchment affected by the Fukushima Daiichi Nuclear Power Plant accident
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学位種別(和文)	博士論文
Category(English)	Doctoral Thesis
種別(和文)	論文要旨
Type(English)	Summary

論文要旨

THESIS SUMMARY

専攻 : Department of
Department of Environmental Science and Technology 専攻

申請学位 (専攻分野) : 博士
Academic Degree Requested Doctor of (Engineering)

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要旨 (和文 2000 字程度)

Thesis Summary (approx.2000 Japanese Characters)

The Fukushima nuclear accident in 2011 resulted in ^{137}Cs contamination in large areas of northeast Japan. ^{137}Cs transport associated with hydrological processes across landscapes is of primary concern for contamination management and environmental risk assessment. Aiming to understand transport and fate of the Fukushima-derived ^{137}Cs , rainfall-runoff, soil erosion and watershed ^{137}Cs migration processes in a forested catchment (i.e. the Kuchibuto River catchment) were studied based on a distributed model, which was developed by improving the two-dimensional runoff erosion and export (TREX) framework in this study.

Firstly, for our continuous hydrological simulation in a typical Japanese forested catchment, the TREX framework was improved by newly including additional hydrologic processes such as evapotranspiration, subsurface and groundwater flows. Infiltration and interception parts were also modified according to the characteristic of our study catchment. Soil erosion and transport processes were simulated by considering multiple solid classes at fine spatial-temporal scales. Then, a watershed ^{137}Cs transport model was developed based on the improved TREX framework. Multiple solid particle classes, the effect of vegetation canopy/litter layer, ^{137}Cs downward movement in soil and radiocesium phases in water, which are important controlling facts for ^{137}Cs migration but were ignored in prior modeling studies in Fukushima, were considered in our study. The sources and sinks of ^{137}Cs transport coupling with critical soil erosion areas were identified in the studied catchment. The results of our study indicate:

- (1) The model calculated acceptable flow discharges, suspended solid (SS) and ^{137}Cs concentrations at the observation sites in the Kuchibuto River catchment during the simulation period (Jan. 1, 2011 – Dec. 31, 2014). This case study shows the model is a good tool for study of ^{137}Cs transport along with hydrological processes at the watershed scale in Fukushima, Japan.
- (2) For the case of the Kuchibuto River catchment, about 5500 t of clay, 52000 t of silt, 22000 t of sand along with $4.1 \times 10^8 \text{ m}^3$ water were transported to the Abukuma River from Mar. 12, 2011, when the accident began, and Dec. 31, 2014. The area-specific sediment yield was about 155 t/y/km^2 according to our simulated sediment budget. By the end of 2014, the total ^{137}Cs reduction was 3.39 TBq (including natural radioactive decay), which means about 90% ^{137}Cs remained in the catchment. This estimation confirms the necessity of artificial decontamination in the following years.

An estimated 4.85 TBq of ^{137}Cs remained in the vegetation layer. Hence, as a stock, this layer still stored a considerable amount of radiocesium. During the 3.5-year study, 0.57 TBq of ^{137}Cs was transported from the catchment. It mainly carried by eroded suspended sediment. During this period, the average ^{137}Cs reduction rate and reduction ratio by rainfall-runoff wash-off were 1.24 GBq/km²/y and 1.6%, respectively.

- (3) The ^{137}Cs reduction rate and reduction ratio by rainfall-runoff wash-off show spatial distributions related to the spatial variation of the ^{137}Cs contamination level and soil erosion. The ^{137}Cs reduction rate was higher in the upper stream areas, which corresponds to the initial ^{137}Cs distribution. In contrast, the ^{137}Cs reduction ratio and sediment supply ratio of the subwatersheds in the middle portion of the catchment were higher, which indicates that decontamination for critical erosion areas in the middle portion of catchment is also of the great priority. The sinks of ^{137}Cs , which accumulated a considerable amount of ^{137}Cs owing to sediment deposition, can be targeted areas for decontamination. The results of this study are useful for understanding transport behavior and fate of radiocesium and ultimately for assessing environmental risks at the watershed scale.

備考：論文要旨は、和文 2000 字と英文 300 語を 1 部ずつ提出するか、もしくは英文 800 語を 1 部提出してください。

Note : Thesis Summary should be submitted in either a copy of 2000 Japanese Characters and 300 Words (English) or 1 copy of 800 Words (English).

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