Quantitative estimate of ^{137}Cs load characteristics in Kuchibuto river watershed

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^{137}Cs has major impact on the environment due to its long half-life (30.1 years). To understand ^{137}Cs load characteristics in the watershed, we estimated the effective ^{137}Cs half-life in the Kuchibuto river watershed by calculating the ^{137}Cs load in the river. Watershed area is 22km^2, elevation is from 329m to 1,050m. Annual precipitation and average temperature is 1,158mm and 14°C respectively. The research watershed was covered with forest (74%), agricultural land (17.4%) and paddy field (7.6%). And, soil types are brown forest soil (51%) and Andosol (49%).
During the period from 6 July 2014 to 24 August 2015, we measured river discharge, SS, and ^{137}Cs concentration. Utilizing measured data, we attempted to estimate the ^{137}Cs load during non-observed period. First, Soil and Water Assessment Tool (SWAT) was utilized for river discharge estimate. Model warmup period was from 2008 to 2010. For the calibration, 2000 times simulation was conducted with Latin Hyper-cubic method from 1 October 2014 to 31 May 2015. Validation was also conducted from 6 July 2014 to 30 September and from 1 June 2015 to 24 August 2015. The model performance was assessed by Nash-Sutcliff efficiency (NSE) and regression coefficient (R^2). Particulate ^{137}Cs concentration was calculated by regression curves between discharge and suspended solid (SS), and SS and ^{137}Cs concentration. Regression curves were constructed from observed discharge[m^3 s^{-1}], SS[g L^{-1}] and ^{137}Cs concentration[Bq L^{-1}], and bias was compensated. Dissolved ^{137}Cs was also calculated by using the partition coefficient which was ratio of particulate and dissolved ^{137}Cs in the river. For uncertainty analysis, 95% confidential interval of ^{137}Cs load was estimated by using the composition of Gaussian distribution of each regression curves from1 October 2014 to 31 May 2015. Discharge uncertainty was estimated by the sequential uncertainty fitting (SUFI).
During the observed period (6 July 2014 - 24 August 2015), particulate and dissolved ^{137}Cs load was calculated at 6.1×10^8 and 1.5×10^6 Bq km^{-2} and these values were equal to 0.26% and 0.00065% of total ^{137}Cs deposition on the watershed (5.13TBq, 28 December 2012 at present). Through the hydrological simulation by SWAT, total load of ^{137}Cs from 2013 to 2015 were estimated. For about the model performance, NSE and R^2 for calibration and validation were 0.75, 0.76 and 0.50, 0.54 respectively. Especially, in September 2015, large scale rainfall event(165mm day^{-1}) was occurred and this event contributed to huge amount of ^{137}Cs discharge in 2015. Annual total ^{137}Cs load excluding this rainfall event in September 2015 was 2.41×10^8 - 2.86×10^8Bq yr^{-1} km^{-2} which was equal to about 0.1% of total ^{137}Cs deposition. Otherwise, annual particulate and dissolved load including the large scale rainfall event in September 2015 were estimated at 2.41×10^8 - 6.8×10^{10}Bq yr^{-1} km^{-2} and 8.7×10^5 - 5.76×10^7Bq yr^{-1} km^{-2} respectively and these values were equal to 0.1 - 29% of total ^{137}Cs deposition in this watershed. However, it needs to be paid attention that the estimation of this huge scale rainfall might have large uncertainty because our observed period did not cover such large event. Lastly, effective ^{137}Cs half-life with consideration of ^{137}Cs load was calculated at 4.33 years according to our point estimation, and it appears that total amount of ^{137}Cs in the watershed is decreasing to 0.82% of initial ^{137}Cs amount within next 30 years. However, according to our uncertainty analysis, uncertainty range of ^{137}Cs load was crossing over 2 - 3 orders, thus, effective ^{137}Cs half-life is also probably highly uncertain. Thus, to obtain more accurate estimate, we need to improve the model performance during the extremely high flow events.

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