A model for determining the Cs-137 loss based on the transport distance model using runoff records in southern Arizona

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Recently, desertification because of overgrazing in semi-arid areas has been a serious problem especially in southern America. Overgrazing causes decrease in vegetation and water erosion take away nourishment as well as soil, so if vegetation changes into shrub from grass, desertification will become worse. Therefore, estimating soil erosion is very important to understand desertification occur.

Although Cs-137 has been used for estimating the erosion rate in various environments, Profile Distribution Model (Walling and Quine, 1990) which estimates soil erosion rate from the Cs-137 inventory is just one dimensional model which assumes eroded soil will immediately flow out from the transect. However, interrill erosion is known to be a main process in semi-arid grassland, so eroded soil should stay in the studied transect. Parsons et al., 2004 developed the transport distance model in which smaller particle transported through longer distance than the coarse sediment. Since strong affinity of Cs-137 to fine soil particle has been studied (He and Walling, 1996), a completely new and novel understanding of the sediment transport and Cs-137 behavior will be available if combining the transport distance model and the size affinity of Cs-137. Therefore, the purpose of our study is to investigate the relationship between erosion rate and the Cs-137 loss, and the effect of the difference in particle size on the Cs-137 loss considering erosion and deposition processes based on the transport distance model.

Process of erosion was assumed as detachment by rainfall impact and deposition by flow energy occurred in grass and shrub hillslope which was 10 m long, 1 m wide, 10 % slope. Detachment and deposition were simulated at 0.1 m slopelength intervals. Original soil was set in a matrix of 50 % 0.1 mm, 10 % 0.5 mm, 20 % 1.0 mm, and 20 % 2.0 mm. Net erosion rate can be estimated by subtracting deposition rate from detachment rate. Precipitation and runoff data in Walnut Gulch Experimental Watershed as input value for my model were obtained at Southwest Watershed Research Center website (http://www.tucson.ars.ag.gov/dap). Runoff depth was calculated using data derived from rainfall simulator experiment in Walnut Gulch Experimental Watershed by Parsons et al., (1996b). Detachment rate was calculated from equation by Morgan et al., (1998), which requires runoff depth, precipitation and detachability estimated from Posen & Savat (1981) data. Deposition probability for each particle size was estimated from the median transport distance using the experimental data set by rainfall simulator by Parsons et al., (1998). Erosion rate in the range from 0.1 mm to 2.0 mm of particle size was computed by multiplying detachment rate and deposition probability. Cs-137 detachment rate and deposition rate were estimated with Cs-137 concentration profile. Finally, the Cs-137 loss was estimated by subtracting Cs-137 deposition rate from Cs-137 detachment rate.

As a result of this calculation, comparing the particle size of 0.1 mm with 1.0 mm, erosion rate of 0.1 mm is three times as large as that of 1.0 mm. The maximum of the Cs-137 loss of 0.1 mm is five times larger than that of 1.0 mm. These results suggest a possibility of overestimating erosion rate using Cs-137 model in interill erosion areas where the fine sediment particle is dominant over surface materials.

Comparing the model with the Profile Distribution Model, although further study considering temporal changes in Cs-137 profile distribution is required, relationship between erosion rate and the Cs-137 loss may be able to be characterized by one dimensional function.