"Hillslope Erosion Assessment using 137Cs radionuclide in Granite and Sedimentary rock basins in South Korea"

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Abstract

The soil erosion processes have estimated using spatial distribution of 137Cs radionuclide in Granite and Sedimentary Hillslopes in South Korea.

The local variability of 137Cs inventory indicates that was related positively to organic matter content, clay content and water content and negatively to hydraulic permeability and slope gradient for bulk samples in different landforms within Granite and Sedimentary rock basins.

The vertical variability of 137Cs inventory shows that most of 137Cs concentration and organic matter were accumulated between 0 and 2cms and gradually decrease with soil depth in incremental samples in both basins. The vertical variability of 137Cs inventories shows that 137Csinventories increase as we go to toward downslope in both basins.

Finally, the soil loss values indicate that hillslope erosion processes are more intensive in Granite rock basin than those in Sedimentary rock basin.

Keywords: 137Cs inventory, Granite and Sedimentary rock basins, soil erosion intensity, Korea

Introduction

The determination of rates of soil loss is provided by variations in the 137Cs inventory of sampled soil profiles. A few researchers have related soil losses quantitatively with radionuclide levels and losses. The loss of fallout from soil 137Cs at a site by comparing base levels of 137Cs at adjacent non eroded sites with actual levels at the time of sampling (Ritche, 1974). The sediment which transported

by pipe within soil has included the 137Cs and 7Be and 137Cs radionuclide more accumulated in the litter layer in forest soil (Onda et al, 1995). The organic matter content played the most important role in the retention and relative mobility of 137Cs in the soil in Korea (Myung-Ho, Lee et al, 1998).

The purpose of this study is not only to establish base-line of 137Cs inventory in the undisturbed soils due to the global nuclear weapon test, but also to investigate the effect of organic matter content, clay content and hydraulic permeability on the deposition of 137Cs in the soil and estimate the soil erosion rate involving the spatial distribution of 137Cs in Korea.

Materials and Method

1. The study areas

1.1 Granite basin

The basin is located in west-south side of the Gohuan Mountain (134m), at north-east part of Seoul, Geonggi-Do. The basin area is 1.2ha and the mean altitude is about 75m a.s.l. The bed rock is covered by Massive Granite rock of Daebo intrusives (Km7) in Jurassic, Mesozoic (KIGAM, 1999). The average temperature is 130C. The mean annual precipitation is about 1100mm. The forest is covered by Deciduous and Broad Leaved Trees. There is Hillslope red-yellow soil developed in basin.

1.2 Sedimentary basin

The drainage basin is located in north-west side of Geumo Mountain (411m) in east-south part from Yeoncheon city, Kyeonsangbuck-Do. The basin area is 7.5ha. The basin mean altitude is about 150m a.s.l. The geological formation is occupied by the Cretaceous Sedimentary Rock, Mesozoic (KIGAM, 1999). The mean annual precipitation is about 1300mm, and the mean annual temperature is 190C. The forest is covered by Deciduous and Broad Leaved Trees. The soil cover is characterized by *Mountain brown soil*.

2. Soil sampling and Gamma-Ray analysis

The bulk samples were collected with 10 cm depth from 14 and 9 different surface points in the Sedimentary and Granite basins, respectively. The core samples

were collected with 30cm depth from different landforms such ashead slope, crest flat, crest slope and head hollow. The incremental samples were determined with interval of 2cm depths. Also bulk and core samples were taken from the undisturbed soil at reference site where has a high feasible for remained as no human impact and other disturbances since anend of 1950s and first of 1960s. Gamma-ray spectrometric analysis were made soil samples using a HPGe Detector, Ortec 919E (Model GMK50F) at Korean Atomic Energy Research Institute (KAERI). 137Cs radioactivity was measured by counting the gamma emission for 7200 sec and by the photopeak at 662 keV. Samples were measured either in Marinneli beakers. The areal (in Bq/m2) was obtained from the product of specific activity (in Bq/kg), the bulk density (in kg m3) and depth (in cm).

Results and Discussion

3.1 Bulk sampling result

The results of bulk sampling which measured in local different landforms alongHillslopes in different bedrock basins are shown that 137Cs inventory in Sedimentary rock basins is greater than that in Granite rock basin. The average activities of 137Cs inventory were 2222Bq/m2 and 3366Bq/m2 in the reference sites in Granite and Sedimentary rock basins, respectively.

Relationships between organic matter and 137Cs inventory, between clay content and 137Cs inventory, and between water content 137Cs inventory show the positive correlation in different landforms within basins. For example; the correlation between them were R=0.36 and 0.28 in Granite and Sedimentary rock basins, respectively. Whereas relationships between hydraulic permeability and 137Cs inventory and between slope angle and 137Cs inventory show the negative correlation in different landforms within basins. For example; the correlation between these properties werer=-0.24 and r=-0.32 in Sedimentary and Granite rock basins, respectively.

3.2 Incremental sampling result

The incremental sampling was used in order to determine the vertical distribution for the variability of 137Cs inventory within soil which distributed in

local different landforms along Hillslopes. At most sampling points, the 137Csconcentration profile shows an exponential curve with the highest concentration in the surface layer (0-2cm) and a gradual decrease with soil depth at reference sites in both of basins. The result of 137Cs vertical distribution within incremental sample shows the 137Cs inventory in Sedimentary basin was greater than that in Granite basin. So it demonstrates that erosion processes in Granite basin have an intensive than that in Sedimentary rock basin. The vertical variability of 137Cs inventory in incremental samples shows an exponential curve, with the highest concentration in the surface layer between 4 and 6cms and gradually decreases with soil in upslope and middle slope and on the downslope, where high 137Csaccumulation between 0 and 2cms suggest 137Cs inventory was redistributed by erosion from upslopes in Granite rock basins.

3.3 Assessment of Soil erosion rate in Hillslope

The soil erosion rates were estimated using 137Cs loss with soil depths, consequently the erosion intensities were mapped in both of basins. The spatial variations of 137Cs inventory of bulk samples revealed widely among local landforms of hillslopes within both of these different rock basins. The average value of the erosion rate were 22.3 t/ha and t/ha 24.2 in Sedimentary and Granite basins, respectively. These values represent that hillslope erosion processes are more intensive in Granite basin than that in Sedimentary basin. Especially, straight part of middle slope and upper slope are more sensitive to erosion comparing with crest flat and lower slope.

Conclusion

The soil erosion processes haveestimated using spatial distribution of 137Cs radionuclide in Granite and Sedimentary Hillslopes in South Korea.

The vertical variability of 137Cs inventory shows that most of 137Cs inventory was accumulated between 0 and 2cms and gradually decrease with soil depth in incremental samples in both basins. The high sand content of the soils in Granite basinprobably allowed penetration while cracking in the soil due to swelling clays due to rain and to the migration of clay from the surface into deeper soil

layers. The soils in Sedimentary rock basin have large soil moisture, large organic matter content and clay contents, consequently soil creep and solifluction processes appear and slight erosion dominates for spatial variability of the erosion rate than that in Granite basin. The Granite rock basin had a severe erosion intensity than that in Sedimentary rock basin.