Sediment Discharge in Granite and Gneiss Catchments in KOREA

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I. Introduction

The runoff process plays a important part in controlling the amount of sediment reflecting the erosion and transportation process. The essentials for the hydraulic and geomorphologic process in the catchments, and the formation of topography in the head watershed are generated by subsurface discharge and sediment delivery (Sakura *et al*, 1987). The study of sediment discharge generated from runoff processes in small catchments is crucial research to reveal the soil erosion caused by water and mass movement, and to determine the origin of sediment deposited in footslope and toeslope of hillslopes. We have carried out the measurement of sediment deposition generated from subsurface flow during rainy season in granite and gneiss catchments and considered the implications between the amounts of moved sediment, and the origin of the particles in eroded sediment.

1. Experimental Catchments

1) Gneiss catchment (Gn)

The Gneiss catchment is located at longitudes of 127°07′ E and the latitudes of 37°33′ N. The drainage area of the Gn catchment is 0.0754 km^2. The bedrock was composed by Pre-Cambrian banded gneiss rock intruded as a limesilicate, magmatitic gneist, mica schist and talc schists. (KIGAM, 1999). The drainage density is 8.1km/km^2. The mean annual precipitation is 1250mm. The soil cover is characterized by type of Mountain forest brown soil. The humus of soil cover is 0.25-0.3m or soil cover is comparative thickness, more than 0.5m. The most of soils along soil profiles are colored by brown and black brown. The soil texture is formed by fine sand, medium silt clays. Slope is 22°, soil pH is 5.6-6.0, total soil thickness is over 0.75m, stoneness is 15-50% (Land Classification Survey, Korea, 1980). There is forest cover of Deciduous Broadleaved tree.

2) Granite catchment (Gr)

The granite catchment is located at longitudes of 127°02′ E, and latitudes of 37°43.5′ N. The drainage area of the Gr catchment is 0.0546 km^2. The bedrock is composed by granite rock of Jurassic Daebo intrusion rocks. The mean annual precipitation is 1300mm. The soil cover is dominated by type of Hillslope red and yellow soil, there is the humus of organic soil cover is thin, approximately 0.1m. The soil cover is less 0.2m, everywhere bedrocks exposure. The soil texture is formed by fine graveled medium sand. There is forest cover of Deciduous Broadleaved tree.

II. Methods of Measurement

1. Surface discharge

The rain gauge (TBRG Davis 0.2 mm tipping bucket) was installed at the experimental watersheds. The data of rainfall was logged automatically by data logger (EME System OWL2c logger 0498) with the interval of 10 minutes.

2. Sediment yields

To collect manually sediment yields, we installed the buckets of 50×80cm in Gr and Gn catchments. The amounts of sediment were measured by KC-2000 (Rated voltage-DC9V/60mA, Hana instrument No.HO2-01984). We used the sieving method and Folk and Ward method (Phi, ϕ) to determine the particle sizes of deposited sediments and the textures of soil samples.

3. Soil Sample

The soil samples of each soil layer in shoulder, backslope and footslopes were collected at 10 points along Mountain slopes in the catchments. The detection of the hydraulic conductivity (*Ks*) was used the instrument of permeameter, 4 Fold type DIK-4010 and method of Falling Head Method. The Saturated hydraulic conductivity (*Ks*, cm/sec) is calculated as follows; $Ks=(2.3aL/At)*ln(H_1/H_2)$, where; a (0.503cm^2) is surface area of scale tube, A (19.6cm^2) is surface area of sample, L (5.1cm) is thickness of sample, H_1, (17cm) is height from the upper line of scale tube to the water surface of the lower part of sampling tube, H_2, (7cm) is height from the lower line of scale tube to the water surface of the lower part of sampling tube and t (sec) is time.

III. Results and Discussion

1. Gneiss catchment

The total precipitation shows 1397.8mm with seasonal variation of rainfall. In general, it rains much in summer, but it rains little in winter (fig. 1). The most amount of precipitation were 142.4 mm.day^{-1} and 105.2 mm.day^{-1} in Aug 24, 2003 and in Jul 16, 2004, respectively.

The amount of total sediments generated by subsurface flows in Gn catchment is 86.3kg or over 8 times as much as those in Gr catchment in August, 2003, Whereas the amount of sediment in Gn catchment in July, 2004 is 4.6 times as much as that of Gr catchment or the sediments of 45.4 kg were generated. The amount of sediments were generated in 2003 was about 2 times as much as those in 2004 (Fig. 1).

Comparing with sediments deposited in granite basin, the textures increased for fine gravel, medium silt and coarse clay and decreased for sand materials. The sediment of gravel and silt decreased, also sand and clay yield increased in 2004. Especially, coarse sand, fine silt and clay are much, whereas fine sand and coarse silt are less.

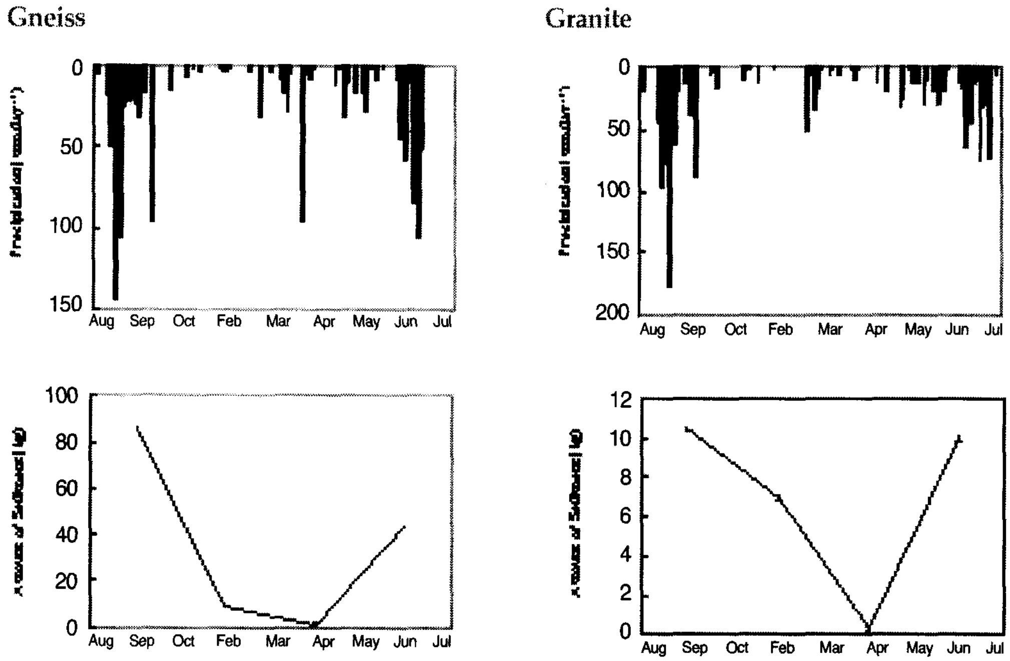

Fig. 1. Precipitation and amount of sediment in Granite and Gneiss Catchments

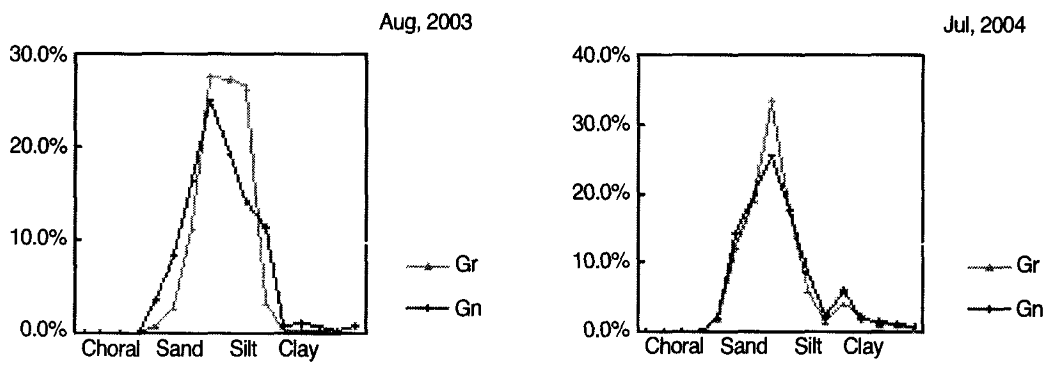

Fig. 2. Particle size of sediments deposited in Granite and Gneiss Catchments

The average saturated hydraulic conductivity (*Ks*) of soil is lower than that in Gr catchment. The minimum value of total hydraulic conductivity showed 5.8×10^{-4}cm/s in B horizon of 35-98cm in backslope or straight section of slope. It means that lower hydraulic conductivity is caused by soil textures composed of fine silt and clay mineral (Fig. 3). The textures of each horizon in soil layer are dominant the medium sand, and fine silts. Generally, the soil textures in each horison demonstrated that most of sediments were deposited from backslope and footslopes in A horizon of soil layer, whereas some sediment deposited from shoulder slope in B horizon of this catchment.

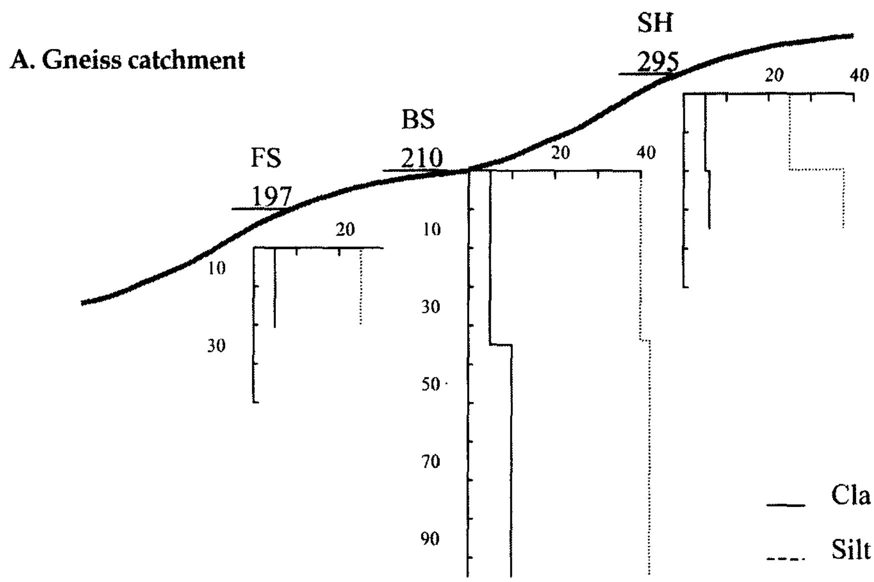

Fig. 3. Distribution of silt and clay along longitudinal soil Profiles

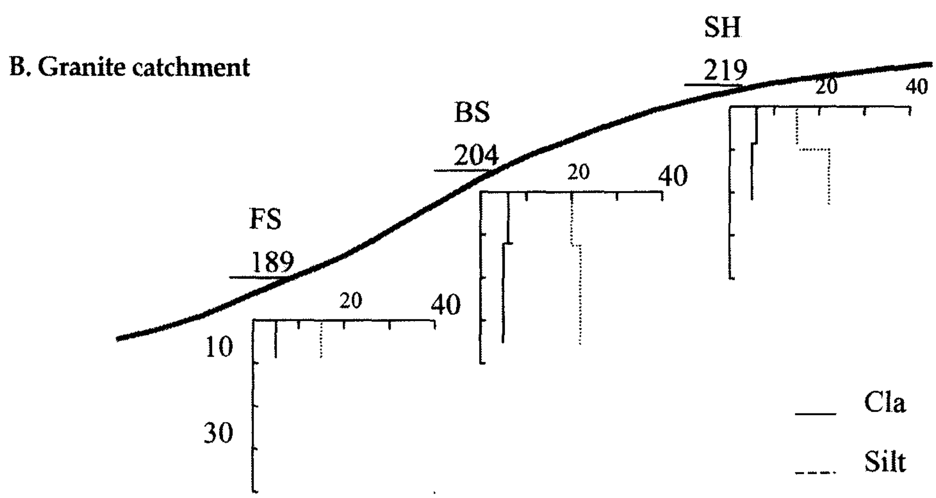

Fig. 4. Distribution of silt and clay along longitudinal soil Profiles

2. Granite catchment

The total precipitation shows 1648.8 mm with seasonal variation of rainfall. In general, it rains much in summer, but it rains little in winter (Fig. 1). The most amount of precipitation were 176.6 mm.day^{-1} and 73.8 mm.day^{-1} in Aug 24, 2003 and in Jul 17, 2004, respectively. The amount of total sediment in August, 2003 and July, 2004 were 10.5

kg and 9.91 kg, respectively. In Gr catchment, the sediments of coarse, medium silt and clay increased, whereas the fine sand and fine silts decreased comparing with sediments in Gn catchment.

The average saturated hydraulic conductivity (*Ks*) of soil is higher than that in Gn catchment. The maximum value of total hydraulic conductivity showed 8.1×10^{-2}cm/s in B horizon of 12-34cm in backslope. It means that this difference caused by the soil textures composed of fine gravel and coarse sand (Fig. 4). Soil textures in each horizon determines that sediments were deposited from shoulder and backslope in A horizon, and from shoulder slope in B horizon in this catchment.

IV. Conclusions

The result demonstrates that large amount of sediments are moveable caused by subsurface discharge or rainfall event. 1. The rainfall event appeared during rainy season in these catchments. The average amount of precipitation was 4.66mm.day^{-1} in gneiss basin and that was 5.59 mm.day^{-1} in Gr catchment. 2. The total sediment in Gn catchment are 8.2 and 4.6 times great than sediments in Gr catchment during 2003 and 2004, respectively. The sediments generated in Gn catchment in 2003 are 2 times great than sediments during rain in 2004, whereas that in 2003 are 1.1 times great comparing with sediments in 2004. 3. The maximum value of saturated hydraulic conductivity (*Ks*) appeared 8.1×10^{-2}cm/s in B horizon composed of sand and gravel in backslope in Gr catchment. Whereas, the minimum value of the Ks appeared 5.8×10^{-4}cm/s in B horizon composed of sand and silt of backslope slope in Gn catchment. 4. The observation demonstrated that sediments of sand and gravel were deposited from A horizon in shoulder and backslopes in Gr catchment, the sand and silt sediments were transported from A horizon in backslope and footslope in Gn catchment. Whereas, sand and silt were piled up from B horizon in shoulder slope in both of catchments.

References

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