Estimating soil erosion rate and erosional history in Mongolia using environmental radionuclides

Tomoyuki Nishikawa[1]; Yuichi Onda[2]; Yukiya Tanaka[3]; Maki Tsujimura[4]; Hiroaki Kato[5]

[1] Environmental Sci., Tsukuba Univ.; [2] Inst. Geosci., Univ. of Tsukuba; [3] Department of Geography, Kyung Hee Univ.; [4] Inst. of Geosci., Univ. of Tsukuba; [5] Institute of Geoscience, Univ. of Tsukuba

1. Background and purpose

Recently desertification phenomenon becomes significant problems in the grazing land in Mongolia. This study is the first step to perform fundamental solution and preservation technology, the greatest purpose of this study is to evaluate present erosion processes in the area. We investigated two small watersheds that have different condition of the vegetation in order to estimate soil erosion rate and erosion processes and erosion history, using the environmental radionuclides.

2. Study area

The study area is located in the upper Kherlen river basin, in the eastern part of Mongolia. This area is semi-arid area and the mean annual precipitation is approximately 200 mm. At Baganuur area (BGN; underlain by granite, vegetation cover in rainy season is 70%) and Kherlenbayan-Ulaan area (KBU; underlain by sedimentary rocks, vegetation cover in rainy season is 30%), two small watersheds was selected. We investigated the characteristics of soil erosion by water and wind, using aeolian sand trap and Cs-137 and Pb-210ex measurement of soil cores. In addition, the plot area that consists of the protected area and unprotected area from livestocks was constructed in each area; we measured and compared the amount of soil runoff and overland flow.

The Cesium-137 is an artificial radionuclide, with a half-life of 30.2 years, which was introduced into the environment as a result of the testing of thermonuclear weapons primarily during the period extending from the 1950s to the 70s. The Pb-210 is a natural radionuclide, with a half-life of 22.2 years. Its dominant source is soils and rocks. They have been widely used as environmental tracers for studying erosion and sedimentary systems (He and Walling, 1997). In the undisturbed soils, most of the Cs-137 and Pb-210ex are concentrated near the surface and the depth distribution exhibits an exponential decline with depth. But, they differ in both their origin and the temporal pattern of their fallout. Using Cs-137 and Pb-210ex, we estimated the depth, rate, processes, and history of soil redistribution by comparing the reference value at the reference site.

3. Results and discussion

The soil erosion rate for the past 40 years using Profile-Distribution Model, was estimated as net erosion rate in BGN watershed is estimated as 0.4 t/ha/y, average soil erosion rate is estimated as 1.7 t/ha/y, the sediment delivery ratio is 20%. In contrast, in KBU watershed, the net erosion rate is estimated as 2.6 t/ha/y that is about seven times as large as BGN; average soil erosion rate is estimated as 3.3 t/ha/y, sediment delivery ratio is 80%. Therefore, it is suggested that the main soil erosion process is sheet erosion by Cs-137 and Pb-210ex activities ratio and aeolian sand trap. Moreover, using the different characteristics of Cs-137 and Pb-210ex, soil redistribution history of every sampling point was presumed. The BGN watershed is in the state that soil erosion is activating and accelerating in recent years, KBU watershed is in the state that soil movement is decreasing; most of erosion would have occurred about 30 to 40 years ago during Cs-137 fallout.

4. Conclusion

The significant differences for many phenomena in connection with soil erosion were found between watersheds with different vegetation cover. In the BGN area, a little soil loss has occurred, but would increase in the future. In contrast, in the KBU area, much soil loss would have occurred in the past. However, studies would be required to evaluate actual state of soil erosion processes and erosion history.