The degradation processes of soil structure in unmanaged Japanese cypress plantations

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Soil degradation triggered by soil erosion in unmanaged Japanese cypress plantations has been thought to be one of major environmental problems in Japan. The decline in soil structure is increasingly seen as a form of soil degradation (Bronick and Lal, 2005). Tamura et al. (2007) found that soil structure in Japanese cypress plantations tends to be less developed than those in forests consist of other tree species. However, the relationship between soil erosion and the degradation of soil structure was not discussed sufficiently. Our objective is to elucidate the degradation process of soil structure in Japanese cypress stand. Thus, we observed sediment transport on soil surface and the response of sub-surface soil to rainfall and discussed the relationship between them.

The study was carried out in 36 and 21 year-old stands of Japanese cypress and broadleaf forest stand in Terasawayama station of Shinsyu University. Soil profile survey showed the less developed soil structure in 36 yr-old stand than other two stands. As the response of sub-surface soil to rainfall, soil CO_2 concentration at the depth of 5, 15, 25 cm were measured with gas detection device once in a day in all stands. Splash sediment and raindrop kinetic energy were measured in 36 and 21year-old stands. The observation was conducted during July to September in 2006.

Total splash detachment was 8192 g m^{-2} in 36 year-old stand and 5100 g m^{-2} in 21 year-old stand, respectively. Raindrop kinetic energy was 22.6 J m^{-2} mm^{-1} in 36 year-old stand and 18.6 J m^{-2} mm^{-1} in 21 year-old stand, respectively. These results suggested that soil erosion increased in 36 year-old stand due to the increase of raindrop energy. Soil CO_2 concentration was found to increase in 36 year-old stand after rainfall events. On the other hand, those in 21year-old stand and broadleaf forest stand showed relatively constant through the observation period. One possible explanation for this difference is that raindrop with high energy in 36 year-old stand contributed to the formation of soil crust on soil surface and the consequent decline of air permeability. Ohte et al. (1995) showed that the increase of soil CO_2 concentration lowered pH of soil water. Subsequently, it is probable that soil aggregate should be decomposed by added proton (H^+). From these results, the increase of soil CO_2 concentration due to decline of air permeability caused by raindrop impacts should be suggested as one of causes of soil structure degradation.