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Organic Carbon Accumulation in Andosols: (1) Unaccounted Andosols in Japanese Forest Soil

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Abstract

Andosols cover 17% of the national land in Japan and largely accumulate organic carbon, and therefore they could play an important role in the domestic carbon storage. Unfortunately, there are some Andosols which remain in an unaccounted state in Japanese forest soil. Brown Kuroboku soils, which would be correlated with unaccounted Andosols, were newly defined in the Unified Soil Classification System of Japan –2nd Approximation (2002). For an accurate estimate of the carbon storage in Japanese soil, a further study is necessary to demonstrate the distributional area of Brown Kuroboku soils in Japan.

Organic carbon accumulation in Andosols

Soils are major absorbers, depositories, and releasers of organic carbon (OC) on the earth's surface. The amount of OC in soils is more than four times that of carbon in terrestrial biota and three times that in the atmosphere. The OC content in soils significantly varies, from less than 1% by mass in some arid-zone soils to 50% or more in waterlogged organic soils (Hillel and Rosenzweig, 2009).

Andosols, which occur in volcanic regions all over the world, show the highest OC density aside from the organic soils according to the result of the OC mass estimation in soils around the world (Eswaran et al., 1993). Rapid weathering of porous volcanic ejecta or glasses results in the accumulation of stable organo-mineral complexes and/or short-range-order minerals, such as allophane, imogolite and ferrihydrite (Shoji et al., 1993). Due to the stability of organo-mineral complexes, Andosols largely accumulate OC. Andosols, whose area is estimated at about 975,000 km² or 0.8% of the world soils, contain approximate-

ly 1.8% of the global soil carbon (Hillel and Rosenzweig, 2009). Even though the Andosols contribution of the OC stock is not significant on a global level, it is relatively important in Japan. Andosols cover 17% of the national land in Japan (Committee for Soil Classification and Nomenclature, 2001) and therefore they do play an important role in the domestic carbon storage.

Other Andosols in Japanese forest soil

An Andosol with a thick dark-brown horizon called the fulvic horizon is classified as a Fulvic Andosol. Fulvic Andosols have been identified in Chile, Indonesia, Japan and New Zealand (Shoji et al., 1993). In Japan, Fulvic Andosols commonly form under forest ecosystems and often show a biosequential relationship with Melanic Andosols which have a thick black horizon called the melanic horizon. Fulvic horizons are rich in OC but their colors are lighter than the melanic ones, have andic properties, and 30 cm or more cumulative thickness, therefore Fulvic Andosols also significantly store OC like other Andosols.

Unfortunately, Fulvic Andosols in the Japanese forest soil remain in an unaccounted state. The forest soil covering 60% or more of the national land in Japan has been classified into 15 soil units by the Classification of Forest Soil in Japan (1975). In this classification, about 70% of the forest soils are occupied by Brown forest soils containing mostly Cambisols and some Andosols, while Black soils (Andosols) are the second largest group at 13% (Morisada et al., 2004). It is difficult to distinguish the area of Andosols from that of Cambisols within the area of Brown forest soils due to the lack of chemical analysis data for classifying Andosols. Since most Andosols included

in Brown forest soils will be potentially classified as Fulvic Andosols, they should be counted as superior OC accumulators.

Brown Kuroboku soils in Brown forest soils

Fig. 1 shows the distributions of Brown forest soils and Kuroboku soils in Japan. The gray-colored areas indicate the Brown forest soils and occupy 53% of the land surface in Japan. The black-colored areas denote the Kuroboku soils and occupy 17%. In this map, the Brown forest soils may include some Fulvic Andosols. Fulvic Andosols are not counted among the Andosols group in this soil map based on the traditional soil classification system.

Brown Kuroboku soils, which were correlated with Fulvic Andosols (WRB) or Fulvudands (Soil Taxonomy), were newly defined in the Unified Soil Classification System of Japan –2nd Approximation (2002)– (The Fourth Committee for Soil Classification and Nomenclature of the Japanese Society of Pedology, 2003). However, the distributed area of the Brown Kuroboku soils is almost still unaccounted for in Japanese forest soil. Since most of the Andosols

included in the Brown forest soils will be potentially classified as Brown Kuroboku soils, they should be counted as superior organic C accumulators. For an accurate estimate of the OC stock in Japanese soils, a further study is necessary to distinguish their area from that of the Brown forest soils and assign map units in the soil map of Japan (Kanno *et al.*, 2008).

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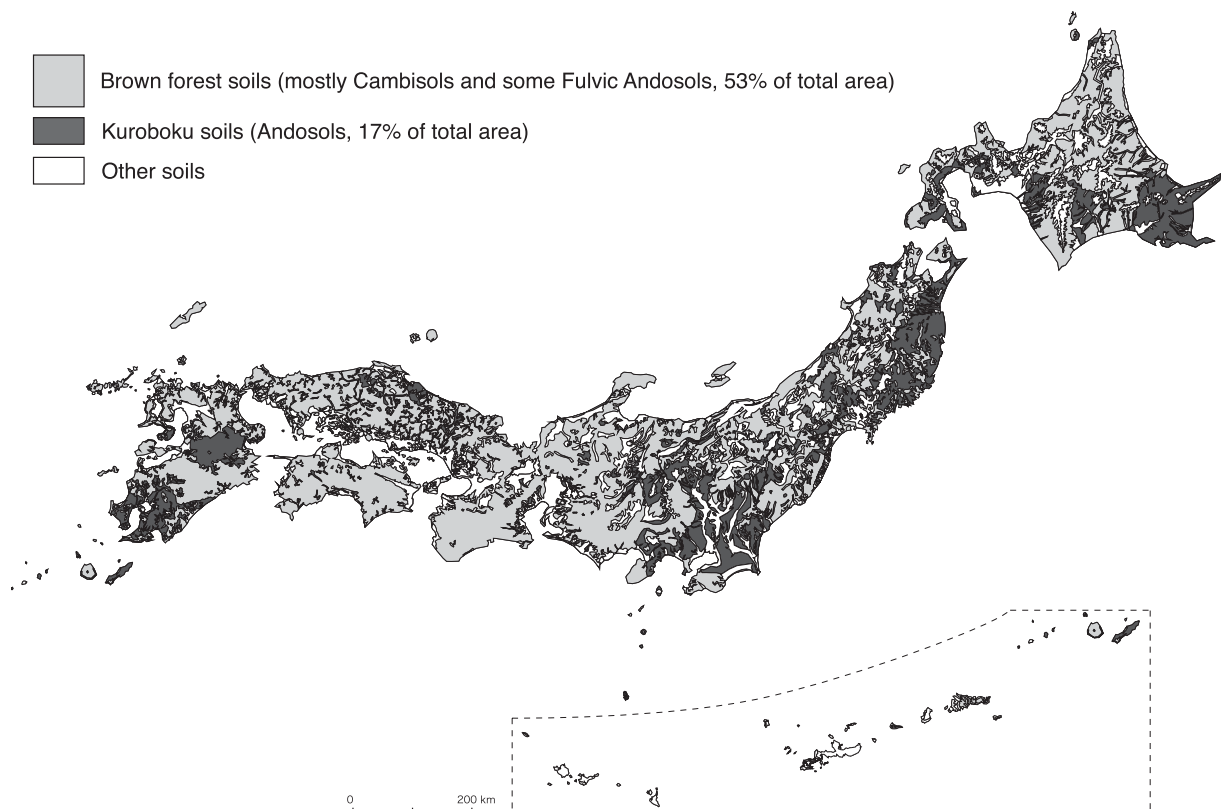


Fig. 1. Distributions of Brown forest soils and Kuroboku soils in Japan based on the soil regions map of Japan (Kanno *et al.*, 2008).

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