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Thermal properties of differently-decomposed and variably-saturated peat soils in Japan

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Soil-temperature is one of the important factors to control the emissions of the greenhouse gases, especially methane, from the wetlands because methane formed by anaerobic bacteria activity which is highly affected by soil-temperature. Unique physical characteristics of peat soils such as high total porosity, high organic matter contents, and shrinkage characteristics may influence heat transport properties of peat soils. In this study, the thermal properties for differently-decomposed and variably-saturated peat soils were measured to investigate the effects of decomposition level and volume shrinkage on heat transport.

The study site was Bibai marsh, Hokkaido in Japan. Undisturbed peat samples were taken from three different sites in Hokkaido Bibai marsh at different depths using 100cm3 cylindrical cores. Peat 1 samples were sampled inside the marsh area, while Peat 2 samples were sampled from the area nearby a drainage ditch surrounding the marsh. Peat 3 samples were obtained from forested area located outside the wetland. Fiber contents showed that Peat 3 samples were the most decomposed followed by Peat 2 and Peat 1 samples.

The peat samples were initially saturated and subsequently drained using two different methods corresponding to the matric suction ranges. The thermal properties of the samples at different soil moisture suction levels were measured by using Decagon KD2-Pro probe.

All Peat samples gradually shrank with increasing pF, showing 50% to 85% of shrinkage during very dry conditions. Peat 1 at 20 cm depth and Peat 2 at 50 cm depth showed high volume shrinkage at pF 4 condition, while the volume shrinkage for Peat 1 at 10 cm was not significant as compared to that for other soils likely because a surface layer in Peat 1 is mainly composed of fresh Sphagnum mosses. In general, the thermal conductivity (TC) and heat capacity (HC) for all peat samples linearly increased with increasing volumetric water content (?). However, changes in the slope of the TC with ? under dry conditions, indicated shrinkage effects on the TC, giving the enhancement of TC due to the increased solid contents. The TC and HC of the deeper layers of Peat 3 samples were higher than surface layers and other Peat 1 and 2 samples. Since the Peat 3 samples, especially deeper samples, are more decomposed, higher solid contents and the difference in solid constituent might affect the TC and HC behaviors for deeper layers of Peat 3.

In perspective, with accumulations of TC and HC data for Peat soils including more decomposed deeper layers, micro-scale observations of pore structure e.g., using X-ray CT scanner and the effects of solid matter content on thermal properties should be further investigated and accurate predictive TC and HC models available for peat soils will be developed.

Keywords: Wetlands, Peat soil, Thermal Properties, solid content, Total Porosity, Volume Shrinkage