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Soil Macropore Structure under Different Land Uses Characterized by X-ray Computed Tomography in the Qinghai Lake Watershed, NE Qinghai-Tibet Plateau

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ABSTRACT

Quantification of soil macropore is important to enhance our understanding of preferential pathways for water, air, and chemical movement in soils. However, the soil architecture of different land uses is not well understood elusive in Alpine region. The objective of this study was to quantify the architecture of soils beneath Alpine *Kobresia* meadow, Farmland, and Sand using computed tomography in the Qinghai Lake Watershed of northeastern Qinghai-Tibet Plateau. Nine soil cores (0–50 cm deep) were taken at three sites with three replicates. At each site, the three cores taken were scanned with a GE HISPEED FX/I Medical Scanner. The number of macropores, macroporosity, and macropore equivalent diameter within the 50-cm soil profile were interpreted from X-ray computed tomography, to analyze soil architecture. The analysis of variance indicated that land use significantly influenced macroporosity, the mean macropore equivalent diameter, and the number of soil macropore. The results indicated that soils under Alpine *Kobresia* meadow and Farmland had greater macroporosity, and developed deeper and longer macropores than that under Sand. For the Alpine *Kobresia* meadow, macropores were distributed mainly in the 0–100-mm soil layer, while they were distributed in the 0–200-mm soil layer for Farmland. The large number of macropores found in soil under Alpine *Kobresia* meadows and Farmland can be attributed to greater root development. The results from this study provide improved quantitative evaluation of a suite of soil macropore features that have significant implications for non-equilibrium flow prediction and chemical transport modeling in soils.

Key words: *Kobresia* meadow, Farmland, Sand, Soil architecture, Macropore, Root, Mattic epipedon

INTRODUCTION

Soil architecture, particularly soil pore space arrangement, can control important physical and biological processes in soil-plant microbial systems, where microbial population dynamics, nutrient cycling, diffusion, mass flow, and nutrient uptake by roots occur across many orders of magnitude in length (Young and Crawford, 2004). Water flow and contaminant transport are governed by the soil structure (i.e., the spatial arrangement of particles and pores)(Schwen et al., 2011; 2014; Yazdanpanah, 2016a; 2016b; Mazaheri and Mahmoodabadi, 2012). Macropores-earthworm burrows, root channels, fissures and interaggregate voids-represent only a small fraction of the total porosity in soil, but play a central role in many physical processes like fluid flow and solute transport (Katuwal et al., 2015). As emphasized by Jarvis (2007) and references therein, rapid flow and solute transport through macropores have been extensively explored by soil scientists during the last few decades. Macropores have been described through functional soil properties such as water retention, air permeability, gas diffusivity, and saturated and unsaturated hydraulic conductivity (Ball, 1981; Blackwell et al., 1990; Granovsky and McCoy, 1997; Mangalassery et al., 2013; Yazdanpanah et al., 2016), and by performing tracer experiments in the field or for soil cores in the lab (Deeks et al., 2008; Ersahin et al., 2002; Kjaergaard et al., 2004). At the pore or column scale, the pore network characteristics, especially pore size distribution and pore topology, are the most important factors controlling hydraulic behavior (Vogel and Roth, 1998). Macroporosity, the number of macropores, pore length, pore size distribution, continuity, tortuosity, and connectivity are considered significant characteristics that influence water flow and solute transport through macropores (Perret et al., 2007; Pierret et al., 2002; Bastardie et al., 2003; Peth et al., 2008; Luo et al., 2008). Different types of macropores have distinct geometrics and therefore function differently (Lin et al., 1996; Luo et al., 2008). Previous studies showed that soil type and land use were among the main factors influencing pore characteristics (e.g., Gantzer and Anderson, 2002; Zhou et al., 2008; Udawatta et al., 2008; Mooney and Morris, 2008). Luo et al. (2010) reported that soil type, land use, and their interaction, significantly influenced macroporosity, network density, surface area, length density, node density, and mean angle. Moreover, within the same soil type, soils