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Quantification of root architectures and soil macropore networks using X-ray CT in the Qinghai Lake Watershed, NE Qinghai–Tibet Plateau

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The interactions between soil structure and the plant root-which influences the water movement and solute transport in soil-deserves special interest. However, the relationship between the roots and soil macropores at the cold climate of high-altitude was unclear. The objectives of this study were to visualize and quantify soil macropore networks and root architectures in intact soil columns, and to investigate the influence of root on soil macropore network characteristics. Intact soil columns (110 mm in diameter and 400 mm in length) were taken from Alpine *Kobresia* meadow, interspace patches of *Potentilla fruticosa* shrub *Potentilla fruticosa* shrub patches and *Artemisia Sphaerocephala* shrub at the Qinghai Lake watershed on Qinghai-Tibet Plateau in northwestern China. A medical X-ray Computed Tomography (CT) with a voxel resolution of 0.146 mm $\times$ 0.146 mm $\times$ 0.312 mm was used to visualize and quantify simultaneously the soil macropore network and root architecture. Results showed that macropores and the taproots were concentrated at the top 0-150 mm. The macroporosity (0.0074 mm^3 mm^{-3}) and the root volume density (0.045 mm^3 mm^{-3}) of the soil under the *P. fruticosa* shrub patche were significantly greater than the soil under other sites. The macroporosity, number density, node density, branch density of the macropore in the *P. fruticosa* shrub patches were greater than that in the interspace patches of *P. fruticosa* shrub, which were greater than that in the *Alpine Kobresia* meadow. And the volume density, number density, node density, branch density of the root followed the same trend. A strong positive correlation between root volume density and macroporosity in slices was found, with the distribution of macropores in the rhizosphere of taproots. Preliminary analyses suggest that the spatial distribution of the macropore under the interspace patches of *P. fruticosa* shrub, the *P. fruticosa* shrub and the *Artemisia Sphaerocephala* shrub was influenced mainly by the roots, especially taproots. Furthermore, freezing and thawing contributed to the cracks in the Alpine *Kobresia* meadow, the interspace patches of *P. fruticosa* shrub and the *P. fruticosa* shrub patches. Our findings provide valuable insights in understanding soil macropores forming in cold and high-altitude climate zone.