Evaluation of soil quality index in forest ecosystems and its response to water flow connectivity

Zhiying Tang, Wenqi Zhang, Jinhong Chen, Yinghu Zhang*

Nanjing Forestry University

Abstract:

The soil quality index can effectively indicate the functions of ecosystems, which also reveal the vegetation and soil production. This index can directly reflect the conditions of water flow conditions within the soils. The strength of water flow connectivity in the soil profiles indicates the convenience of material and energy transportation, which can help us understand the spatial distribution patterns of nutrients or other solutes within the soils. However, few studies have linked soil quality index to water flow connectivity. In order to better reflect the changes in soil quality index, water flow connectivity was assessed in subtropical forest ecosystems. In our study, three forest stands (oak, pine, and bamboo forest) were studied in Jurong Xiashu Forest Research Base, China. Soil physical and chemical properties measurement each soil depth (0-10, 10-20, 20-30, 30-40, and 40-50 cm) and 9 dye-tracing experiments were conducted. The minimum data set (MDS), component analysis, and Pearson analysis were used to construct the soil quality indes (SQI) of different soil depths. We obtained the water flow connectivity index (WFCI) of different soil depths based on the dye coverage and fractal dimension of the dye-staining images. The results showed that: Soil quality index decreased gradually with increasing soil depth. For the topsoil (0-10 cm), the soil quality index was the decreasing order pine forest > oak forest > bamboo forest. However, with respect to 10-30 and 40-50 cm, the soil quality index was the decreasing order pine forest > bamboo forest > oak forest. In final, for 30-40 cm, the soil quality index in the bamboo forest was the highest, followed by pine forest, while it was the smallest in the oak forest. Soil profile scale water flow connectivity index decreased with increasing soil depth. For the soils (0-20 cm), the bamboo forest had the best water flow connectivity, followed by the pine forest, while the oak forest has the worst connectivity. For the soils (20-40 cm), the water flow connectivity index was the decreasing order bamboo forest > oak forest > bamboo forest. For 40-50 cm, water flow connectivity index was the decreasing order oak forest > bamboo forest > pine forest. The soil quality index and water flow connectivity index showed significantly positive correlations, with Pearson's correlation coefficients of 0.977, 0.928, and 0.913, respectively. The study provides new insights for the assessment of soil quality. In particular, the water flow connectivity index could effectively indicate the changes of soil quality to some degree.

Keywords: Soil quality, Water flow connectivity, Forest ecosystems, Soil properties