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湖南乌云界自然保护区典型生态系统的土壤持水性能

Soil water holding capacity under four typical ecosystems in Wuyunjie Nature Reserve of Hunan Province

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中文摘要:

土壤持水性能是决定生态系统水源涵养能力的关键,是自然保护区生态服务功能的重要方面。以湖南省乌云界自然保护区为研究区域,选取森林、灌丛、竹林和草地4个典型生态系统,采用野外调查采样和室内分析的方法研究了土壤的物理性质和持水性能。结果表明,乌云界4种典型植被下表层0-20cm土壤有机质含量普遍较高(>76 g/kg)、容重较低(<0.85 g/cm^3)、团聚体稳定性较强(>5mm水稳性团聚体达22.7%-52.3%),表明保护区土壤的结构发育总体上较好。森林和竹林土壤具有较多的大孔隙和较高的饱和导水率,有利于天然降水向地下水的转化,而灌丛和草地土壤毛管孔隙度则相对较高,其土壤中能够保持更多的有效水分。乌云界自然保护区4个典型生态系统0-40cm土层土壤重力水容量为:森林(83.5 mm)>竹林(79.2 mm)>灌丛(66.9 mm)>草地(43.8 mm),有效水容量为:草地(128.7 mm)>灌丛(111.6 mm)>森林(95.9 mm)>竹林(83.9 mm)。在明晰土壤总蓄水容量(>0 MPa)、重力水容量(0 - 0.01 MPa)、有效水容量(0.01-1.5 MPa)、无效水容量(>1.5 MPa)等概念的基础上,建议用重力水容量和土壤有效水容量两个指标来评价生态系统土壤的水源涵养功能,其中土壤重力水容量可以反映生态系统补充地下水和调控河川径流量的能力,而土壤有效水容量可以反映生态系统本身保蓄水分的潜力,这些指标均可以通过土壤水分特征曲线进行求算。乌云界自然保护区森林和竹林土壤对于补充地下水和调控河川径流量的能力较强,而灌丛和草地土壤保蓄水分的能力较强。

English Summary:

Soil water holding capacity is the key index of water conservation capacity of ecosystems and vital parameter of ecological service function in Nature Reserve. Four typical ecosystems including forest, shrub, bamboo, and grassland were selected in the study area of Wuyunjie Nature Reserve (WNR) of Hunan Province and soil physical properties and water holding capacity were studied through field investigation, soil sampling, and laboratory analysis. The results showed that the four typical vegetation-covered lands had greater soil organic matter content (>76 g/kg), lower bulk density (<0.85 g/cm^3), and higher soil aggregate stability (stable aggregate (>5 mm in diameter) contents ranging from 22.7% to 52.3%) in the surface soil layer (0-20cm) than the local farmland, suggesting that soil structural development was generally better in the reserve area. Soil macroporosity and saturated hydraulic conductivity (K_s) in forest and bamboo ecosystems were greater than those in shrub and grassland ecosystems, which were beneficial to the rainfall transfer to groundwater. However, soil capillary porosity in shrub and grassland ecosystems were higher, indicating that more soil available water could be reserved. The gravimetric soil water holding capacity (WHC_g) in the 0-40 cm soil layer under four typical ecosystems in WNR changed in the following order: forest (83.5 mm)> bamboo (79.2 mm)> shrub (66.9 mm)> grassland (43.8 mm). However, soil available water holding capacity (WHC_a) were the following: grassland (128.7 mm)> shrub (111.6 mm)> forest (95.9 mm)> bamboo (83.9 mm). On the basis of verifying the definition of total water capacity (>0 MPa), WHC_g (0-0.01 MPa), WHC_a (0.01-1.5 MPa), and unavailable water capacity (>1.5 MPa), we recommended that WHC_g and WHC_a could be used to measure soil water holding capacity of ecosystems. WHC_g could be used to assess the capability of recharging groundwater and adjusting river flow, while WHC_a could be used to assess the potential of soil water holding capability in the ecosystems. These indexes all could be measured through soil water characteristic curves. The close relationships between soil water holding capability and water storage capacity demonstrated that, vegetation type and soil structure were of importance in water sources reserve. Forest and bamboo ecosystems, characterized by the well-developed spatial structures, had stronger capability in recharging groundwater and adjusting river flows. However, shrub and grassland, which had relatively undeveloped spatial structure, could reserve more soil available water in the ecosystems. All these were associated with the changes in soil structures. Therefore, the conservation of diverse ecosystems has crucial ecological significance in the diversity conservation of habitats and eco-environments in the WNR.

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