J Ecosyst Ecography 2018, Volume 8
DOI: 10.4172/2157-7625-C1-033

World Conference on Ecology

March 19-20, 2018 | Berlin, Germany

Throughfall and its spatial variability beneath xerophytic shrub canopies within water-limited arid desert ecosystems

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Throughfall is known to be a critical component of the hydrological and biogeochemical cycles of forested ecosystems with inherently temporal and spatial variability. Yet little is understood concerning the throughfall variability of shrubs and the associated controlling factors in arid desert ecosystems. Here we systematically investigated the variability of throughfall of two morphological distinct xerophytic shrubs (Caragana korshinskii and Artemisia ordosica) within a re-vegetated arid desert ecosystem, and evaluated the effects of shrub structure and rainfall characteristics on throughfall based on heavily gauged throughfall measurements at the event scale. We found that morphological differences were not sufficient to generate significant difference ($P<0.05$) in throughfall between two studied shrub species under the same rainfall and meteorological conditions in our study area, with a throughfall percentage of 69.7% for C. korshinskii and 64.3% for A. ordosica. We also observed a highly variable patchy pattern of throughfall beneath individual shrub canopies, but the spatial patterns appeared to be stable among rainfall events based on time stability analysis. Throughfall linearly increased with the increasing distance from the shrub base for both shrubs, and radial direction beneath shrub canopies had a pronounced impact on throughfall. Throughfall variability, expressed as the coefficient of variation (CV) of throughfall, tended to decline with the increase in rainfall amount, intensity and duration, and stabilized passing a certain threshold. Our findings highlight the great variability of throughfall beneath the canopies of xerophytic shrubs and the time stability of throughfall pattern among rainfall events. The spatially heterogeneous and temporally stable throughfall is expected to generate a dynamic patchy distribution of soil moisture beneath shrub canopies within arid desert ecosystems.

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