

基于长期定位观测评估林分生长和气候干旱对杉木人工林集水区径流的影响机制

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摘要: 造林因其在固碳和木材生产中的作用以及对森林生态系统水文过程包括水量的影响而受到全球关注。然而, 长期观测资料不足以检验造林对水量的影响。此外, 全球变暖引起的干旱可能会改变径流生成过程, 使森林与水的关系成为热议的话题。本研究利用 1997 年至 2019 年对中国亚热带杉木人工林 22 年的长期观测数据(不包括 2017 年的缺失数据), 分析了造林后径流对干旱和林分生长的响应。干旱期平均径流量在月、季、年时间尺度上分别比非干旱期减少 41.2%、37.5%和 3.7%。当干旱事件持续 1.2 个月且干旱严重程度大于 1.5 个月时, 干旱对径流的影响显著。年径流量和径流异常在造林后的前 14 年随着林龄的增加而减少, 随后开始恢复。年径流量与林分生物量的关系也存在类似的变化规律。在不同的时间尺度上, 月径流主要受降雨和土壤水分的控制, 而不是由森林控制, 而年径流主要取决于林分生物量。研究林分发育过程中森林-水的长期关系以及干旱对径流的影响, 可为气候变化条件下植被恢复和森林可持续经营优化水分利用提供参考。

Long-term field observations of the impacts of drought and stand development on runoff in a forested watershed

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Abstract: Afforestation is gaining global attention for its role in carbon sequestration and timber production and affects hydrological processes in forest ecosystems, including water yield. However, long-term observation data is paucity to examine the effects of afforestation on water yield. Moreover, drought caused by global warming could change runoff generation process and makes the forest-water relationship being hotly debated. We used our 22-year data obtained from a long-time observation during the period from 1997 to 2019 (excluding missing data in 2017) in a Chinese fir plantation in subtropical China to analyze the response of runoff to drought and stand growth post afforestation. Average runoffs during drought declined by 41.2%, 37.5% and 3.7% lower than non-drought event at monthly, seasonal and yearly timescale, respectively. When a drought event lasted for 1.2 month and drought severity was larger than 1.5, the drought affected runoff significantly. Annual runoff and runoff anomaly decreased with stand age during the first 14 years after afforestation, and thereafter started to recover. Similar change pattern was found for the relationship between annual runoff and stand biomass. At different time

scales, monthly runoff was primarily controlled by rainfall and soil water rather than by forests, while annual runoff largely depended on stand biomass. The long-term forest-water relationship during stand development and effects of drought on runoff in subtropical plantation could provide insightful information for vegetation restoration and sustainable forest management to optimize water use under climate change.