Canadian Journal of Forest Research

Article

Hydrological and nutrient regulation per occupation unit differ between structurally contrasting native and planted forests in the Northern Andes

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Abstract

Understanding ecohydrological dynamics that result from land-use conversions is fundamental in managing ecosystem services. One common forest transformation in the tropics is the establishment of monospecific plantations with exotic species for timber exploitation, replacing highly diverse natural forests. The impacts of establishing forest plantations in hydrological processes and biogeochemical dynamics have been highly controversial, with functions from structurally homogeneous plantations being sometimes assumed to be comparable to natural forests. To assess the effects of planting exotic conifer species versus natural forests on hydrological and biogeochemical functions, we measured incoming precipitation, throughfall, and stemflow. To compare between forest types, we propose the use of basal area for standardization of hydrochemical fluxes. While net precipitation was similar among forest types, the transmission of water to the forest floor per basal area unit was significantly higher in native forests. Yet, nutrient concentrations were similar among them. However, greater nutrient enrichment per unit basal area was observed for the native species. This more efficient nutrient cycling could be related to native forests being better adapted to oligotrophic soils. The re-establishment of native species rather than with exotic species can result in more efficient hydrochemical regulation, improving the capacity of these ecosystems to produce services.

Key words: canopy, ecosystem services, stemflow, throughfall, tropical mountain forests

Introduction

Tropical mountain ecosystems are key providers of environmental services (Briner et al. 2013), as a large proportion of the human population in the tropics lives and depends on these systems for their livelihoods. For instance, these areas support an important part in the agricultural production in the Central Andes of Colombia and are determinant on the maintenance of key ecosystem functions (Wasige et al. 2013; Suescún et al. 2017; García-Leoz et al. 2018). A large body of literature has highlighted the essential role of native tropical montane forests in hydrologic regulation and nutrient cycling, relevant for water supply, energy production, and the economy of the region (Locatelli et al. 2014; Labrière et al. 2015; Laterra et al. 2019). However, deforestation and land-use transformation in the neotropics, and particularly in Colombia, is fast and growing (Salazar et al. 2018; González-González et al. 2021), potentially affecting the capacity of these ecosystems to maintain their function, and consequently, the provision of ecosystem services (Li et al. 2009).

One common transformation in Andean forest ecosystems is the establishment of monospecific plantations with exotic tree species for timber exploitation. This transformation generally occurs after forests have been cleared and the land dedicated to other uses, including agriculture and pastures for cattle raising. Less frequently, natural forests are directly replaced by forest plantations. Some general impacts of forest plantations include the alteration of successional processes (D'Antonio and Meyerson 2002), reduction of biodiversity (Pawson et al. 2013), effects on water availability (Bonnesoeur et al. 2019), and nutrient cycling (Ramírez et al. 2014). These effects imply the potential alteration of water and soil quality related to ecosystem regulation functions (e.g., water and nutrient cycling functions).

Forest canopies modify water fluxes to soil through their effects on rainfall partitioning into throughfall, stemflow,