SFB 552 "STORMA"
Stability of Rainforest Margins in Indonesia

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B4 Changes in the hydrological cycle along a gradient of forest use intensity

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Introduction

Management activities such as selective logging or conversion to agroforest alter the vegetation structure of many tropical forest landscapes. However, little is known about the hydrological impact of these more gradual changes in vegetation structure.

We studied a gradient from natural forest, over forest after small timber extraction and forest after large timber extraction to agroforest (Fig. 1) in order to assess the effects of the different management practices on above-ground hydrological processes.

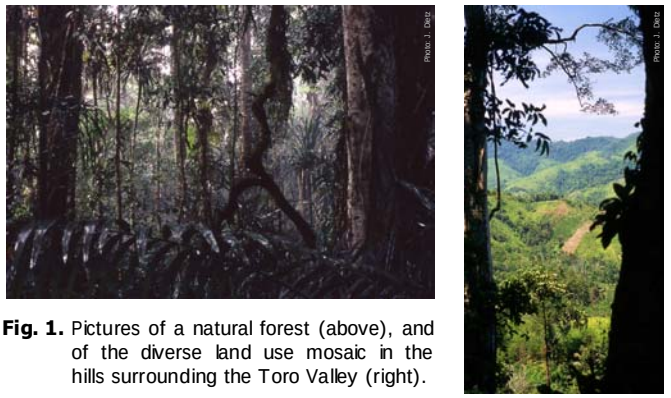

Fig. 1. Pictures of a natural forest (above), and of the diverse land use mosaic in the hills surrounding the Toro Valley (right).

Objectives

- To analyze stand structural characteristics presumed to be important for rainfall partitioning.
- To determine rainfall partitioning into throughfall, stemflow and interception.
- To identify stand characteristics that may control the partitioning by regression analyses.
- To investigate implications of leaf wetness duration on interception processes.

Methods

Twelve study plots in the surrounding of Toro (4 land use types with 3 replications) were equipped with 30 throughfall gauges and 10 stemflow collectors each. Gross precipitation was measured nearby each plot.

Thirty leaf wetness sensors were arranged as a profile through the canopy (1.5 - 33 m) along the meteo tower in Bariri and allowed continuous measurements (> 1 year) of leaf wetness and microclimate at different levels.

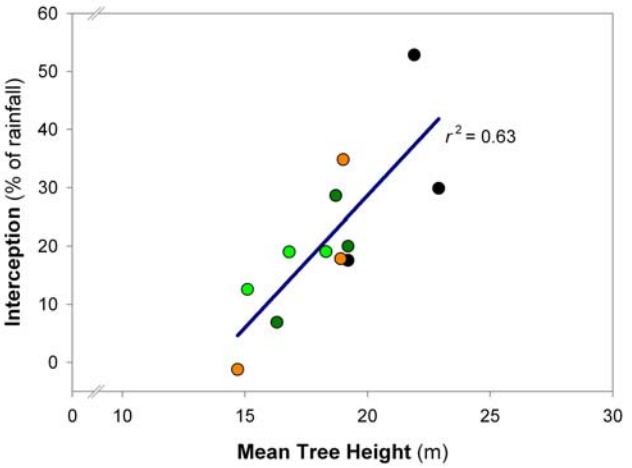

Fig. 2. Rainfall interception (in percent of gross precipitation) as a function of mean tree height (dbh ≥ 10 cm) in the 12 study plots: ● natural forest (A), ● forest after small timber extraction (B), ● forest after large timber extraction (C), and ● agroforest (D). Dietz et al. (submitted, *For. Ecol. Manage.*)

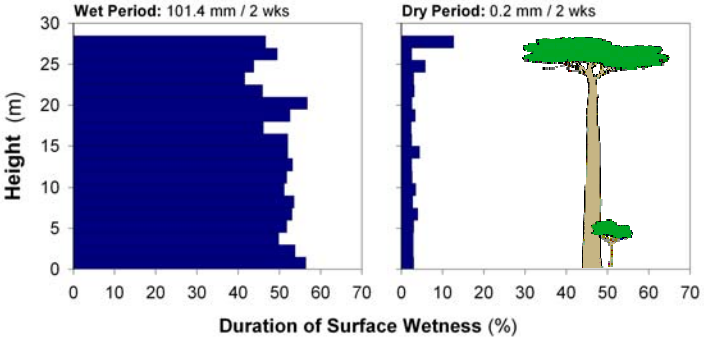

Fig. 3. Average duration of surface wetness (in percent of the time) in a vertical profile inside the Bariri forest in a wet 2-week period (June 1 - June 15, left panel), and a dry period (June 16 - June 40, right panel; with scheme of the principal extension of canopy and understorey). Dietz et al. (submitted, *Flora*)

Results

Highest interception was recorded in a natural forest plot while the lowest rate was found in an agroforest. Stemflow accounted for less than 1 % of gross precipitation in all plots. Stand height correlated strongly with interception (r^2 = 0.63; Fig. 2). In a multiple regression, tree height combined with leaf area index (LAI), improved the explained variation of interception (r^2 = 0.81).

The leaf wetness study revealed that the foliage of the entire canopy remained wet up to 50 % of the time during periods of frequent rainfall. Even during periods devoid of rainfall the canopy still experienced wetness for up to 5 % of the time (Fig. 3).

Conclusions

The forest use intensities strongly affected basal area and tree height. When considered separately, tree height, not LAI, showed the highest positive impact on interception. This suggests that turbulent energy exchange may provide more available canopy storage in higher stands since the leaves may dry off faster after each rainfall event than in shorter, more compact stands.

Outlook

PHASE II We showed that focusing on LAI as principal estimator and disregarding leaf wetness duration may lead to a substantial bias in applying current interception models to the study area. This shall be explored in greater detail in the near future.

PHASE III We will continue studying the hydrological cycle but focus on the drought response of the cacao agroforestry system and natural forest with respect to soil water resource use. Besides analyzing the rates and depths of soil water depletion we will investigate the water use and partitioning of shade trees and cacao plants in the agroforestry system and we will test whether hydraulic redistribution is an important mechanism to cope with drought in agroforest and forest.