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Discussions

Interactive comment on "Towards quantifying the increase of rainfall interception during secondary forest succession" *by* B. Zimmermann et al.

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Thank you for your comments and the interest in our work.

In his short comment, F. Holwerda raises two issues. First, he challenges our assumption that stemflow is negligible at our research sites. Consequently, F. Holwerda suggests to rephrase the title of the manuscript and to focus on the change of throughfall during secondary succession only. Second, F. Holwerda encourages us to discuss our findings considering recent work from mature and secondary forest sites in Mexico (e.g. Holwerda et al., 2010; Muñoz-Villers et al., 2012).

As to the second point, we will carefully adopt the suggestion of F. Holwerda and relate our results to the recent findings from the Mexican sites.

The critique of F. Holwerda on the stemflow issue requires a more extensive reply. From our point of view, focusing our work on throughfall only would reduce the impact of the manuscript. For most researchers and decision makers the interest is in interception loss, which, of course, requires estimates of rainfall, throughfall and stemflow. In Panamanian young secondary, old secondary and plantation forests stemflow estimates vary between 0.4 % and 2.6 % of gross precipitation (Cavelier et al., 1997; Macinnis-Ng et al., 2012; Park and Cameron, 2008). Another study conducted in a palm-dominated forest stand located in Panama calculated a stemflow contribution of 3.2 % of gross precipitation (Niedzialek and Ogden, 2012). None of our forest plots was dominated by palms; hence, we may consider the range of 0.4 % – 2.6 % as a first rough estimate. Interestingly, these numbers are so low that they are within the range of ± 1 standard error of our throughfall estimates (cf. Table 1, Zimmermann et al., 2013). Moreover, three of the ten plots with forest regrowth younger than 10 years had interception values (based on rainfall and throughfall only) around 100 % (cf. Table 1, Zimmermann et al., 2013), which virtually precludes the occurrence of stemflow.

Although there was no evidence that stemflow plays a significant role at our research sites we conducted a small ancillary study and measured stemflow in a 1 ha plot that overlaps with 2 of our throughfall study sites (plot # 17 and # 18, cf. Table 1, Zimmermann et al., 2013). We conducted the stemflow measurements in the old-growth secondary forest on Barro Colorado Island because previous field observations indicated that some stemflow was produced by Oenocarpus mapora palms. We never observed stemflow in the young secondary forest plots in the Agua Salud area and hence did not consider measuring stemflow in these plots.

In our stemflow study we randomly selected six 10 m by 10 m plots and sampled stemflow of all trees > 5 cm diameter at breast height in these plots. In total we collected stemflow of 60 stems (7 of them belong to palms). The sampled stems comprise 25 species of varying size (minimum: 5.0 cm diameter at breast height (dbh), maximum: 113.5 cm dbh, mean: 13.1 cm dbh, 39 stems < 10 cm dbh, 21 stems $\geq$ 10 cm dbh).

During the 2 months sampling period we collected 26 rain events (minimum rainfall: 0.2 mm, maximum rainfall: 52.6 mm, mean rainfall: 6.5 mm). Our measurements indicate that rains < 5 mm produced negligible stemflow volumes (Fig. 1, this comment). However, even larger rainfalls produced only comparatively small amounts of stemflow (Fig. 1, this comment). Based on the accumulated rainfall data of event 1 – 26 (total: 167.8 mm) we estimated that total stemflow amounted to 0.98 % of rainfall. Of course, this number may vary depending on the frequency of large events during the observation period. Our stemflow estimates for events > 10 mm, however, indicate that even during periods dominated by larger rainfall events, the percentage of stemflow is likely to be small. Based on our measurements, our field observations, and the available data from the literature (Cavelier et al., 1997; Macinnis-Ng et al., 2012; Park and Cameron, 2008) which all suggest that stemflow volumes are low in Panamanian forests not dominated by palms we consider stemflow as negligible in our research areas. On these grounds, we wish to continue calculating interception loss using throughfall data only. Of course, one should always have in mind that we did not measure stemflow in all of the 20 study plots. To obtain stemflow measurements at all 20 forest sites, however, would have been logistically impossible. To make our approach more convincing we will present methodological details (information on the stemflow sampling design, a list of all species sampled, botanical data of the sampled tree and palm species) and results of our stemflow study (total stemflow data, and a figure that shows event-based stemflow as percentage of rainfall) as supplementary material attached to the revised version of our article.

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HESSD

10, C4846–C4850, 2013

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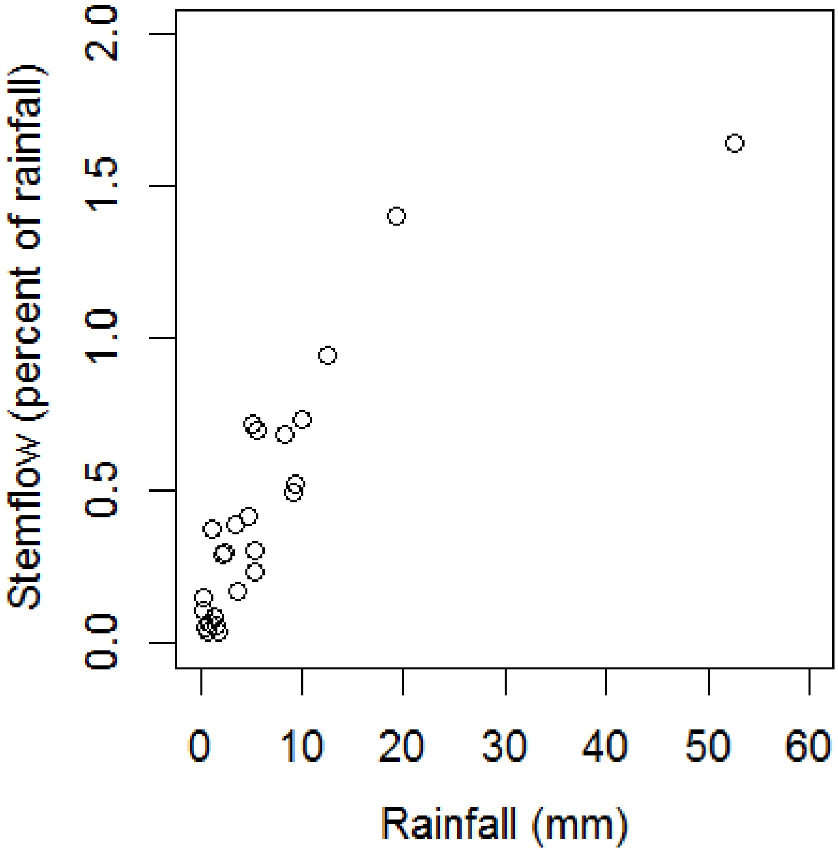

Fig. 1. Relationship between stemflow and rainfall (n = 26 events).

HESSD
10, C4846–C4850, 2013