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Atmospheric Water Inputs in a Cloud Forest Fragment in El Cañadón, Andes of Venezuela

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ABSTRACT

As part of an ecohydrological study in a cloud forest fragment in the Venezuelan Andes, we monitored the main water fluxes in El Cañadón (2200m), Capaz upper watershed,. During two years we recorded vertical precipitation (VP, rain) using a TE525 rain gage, net precipitation (NP) with 4 channel pluviometers (3x0,18m) and horizontal precipitation (HP) with a) Louvered Screen Fog Collector (LSFC) placed 6m high, b) Standard Fog Collector (SFC 6m) placed 6m high, and c) Standard Fog Collector (SFC 2m) placed 2m high. We also measured wind speed and direction. All measurements were recorded every 10min using a CR10X Campbell data logger. Our results show that El Cañadón received atmospheric mean water inputs 279 days during 2005-2006; 48% of this days, water income depended only on VP, 10% only on HP and 17% on both, VP+HP. Mean annual VP was 1241mm, with two maximums on May and August-October. The HP amounts depended on the collector type and height, but they were very low in general. Water intercepted by the LSFC corresponds to 0.3% of VP, for the SFC 6m this value was 0.2% and for the SFC 2m it was 0.5%. The annual HP pattern did not correspond to that of VP, with HP reaching the maximum values during the months with minimum rainfall (November to February). The rain events concentrated between 12-18h (42%) and 18-24h (34%), with only 26% occurring in the first 12 hours. The daily HP pattern obtained with the LSFC was similar to that obtained for VP, showing percentages of 51% between 12-18h, 23% between 18-24h and 26% occurring in the first 12 hours. The main direction of winds was NW to NE (45% of the HP events). For these same events, wind speed was 1.55 m s^{-1} in average. The forest canopy intercepted 51% of total water income, with 49% reaching the forest ground.

1. INTRODUCTION

The Venezuelan Andean cloud forest has suffered fragmentation processes caused by the elimination of part of the original forest and implantation of cultivated pastures. The actual landscape shows a pasture matrix with dispersed units of cloud forest which have different sizes and shapes. Rodríguez et al (2005) reported this kind of impact in the Capaz upper watershed, where 9000ha of cloud forest can still be found interdigitated with 5000ha of *Melinis minutiflora* and *Pennisetum clandestinum* pastures (figure 1).

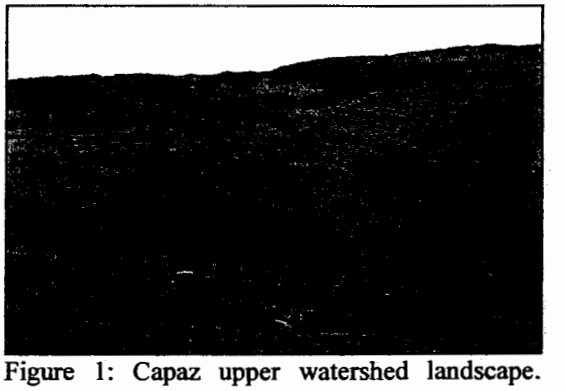

Figure 1: Capaz upper watershed landscape. Photo: M. Ataroff.

In 2005 we began a study with the goal of analyzing the hydrological characteristics of forest fragments and pastures, to generate basic data useful to valuate the impact of this management on the ecohydrology of the Capaz upper watershed. In this contribution, we present part of the results of water fluxes in a pilot fragment of cloud forest, including vertical, horizontal and net precipitation.

2. METHODS

Water fluxes were measured in a 9ha cloud forest fragment in El Cañadón (239561N 962642E) at

2200m, Capaz upper watershed, Mérida State, Venezuelan Andes. We measured the following fluxes over a two year period (2005-2006): vertical precipitation (VP) with a TE525 rain gage 2.5m high; horizontal precipitation (HP) with a) a Louvered Screen Fog Collector (LSFC, Juvik and Nullet 1995) 6m high, b) a Standard Fog Collector (SFC, Schemenauer and Cereceda 1994) 6m high and c) a SFC 2m high; net precipitation (NP) with 4 canal type pluviometers (3x0.18m). We also measured wind speed and direction with Young Wind Sentry Set 2.5m high. Data was registered every 10min by Campbell CR10X dataloggers.

3. RESULTS

El Cañadón received atmospheric water inputs over 279 day year^{-1} (2005-2006), of which 48% were only VP, 10% only HP and 17% with both inputs. The mean annual VP was 1241mm, with two peaks, one in May and the other in August-October (figure 2).

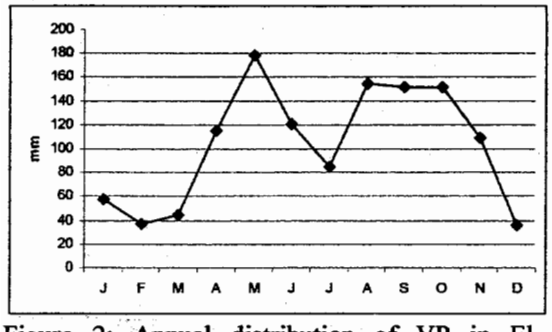

Figure 2: Annual distribution of VP in El Cañadón, Venezuelan Andes (2005-2006).

The HP amounts recorded depended on the collector type and height, but they were very low in general. Water intercepted by the LSFC corresponds to 0.3% of VP, while for the SFC 6m this value was 0.2% and for the SFC 2m it was 0.5%. During the months in which LSFC and SFC 6m were measuring simultaneously, comparisons were possible. The results show that LSFC measure higher HP inputs and recorded more events. The annual HP pattern did not correspond to that of VP, with HP reaching the maximum values during the months with minimum rainfall (November to February, figures 2 and 3).

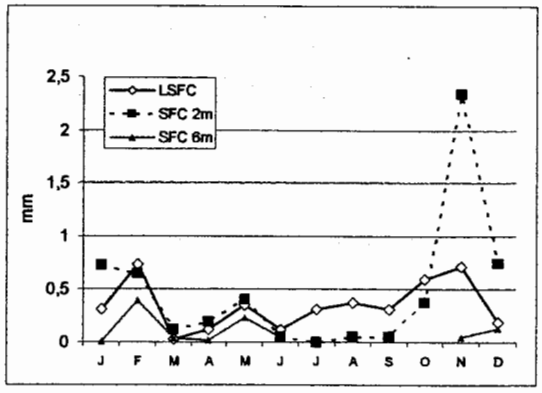

Figure 3: Annual distribution of HP in El Cañadón, Venezuelan Andes (2005-2006).

We recorded 440 mean annual rain events, distributed between 20 and 58 per month (February and October respectively). The maximum number of continuous rainy days was 15 in 2005 and 18 in 2006. Periods with up to 7 continuous rainy days corresponded to 86% and 81% of total days of 2005 and 2006, respectively. The maximum number of continuous dry days was 30 in 2005 and 14 in 2006; periods with up to 4 continuous days corresponded to 89% and 86% of total days of 2005 and 2006, respectively.

The HP showed different number of events depending on the collector type. During 2006, we recorded 31 events in LSFC and 87 in SFC 2m. Of them, the maximum number of continuous days with HP was 3 in LSFC and 6 for the SFC 2m; periods with up to 2 continuous days corresponded to 95% and 87% of total days of LSFC and SFC 2m, respectively. The maximum number of continuous days without HP was 45 in LSFC and 29 for the SFC 2m; periods with up to 23 continuous days corresponded to 81% and 93% of total days of LSFC and SFC 2m, respectively.

Rain events concentrated between 12-18h (42%) and 18-24h (34%), with only 26% occurring in the first 12 hours (mean of 2005-2006). The daily HP pattern obtained with the LSFC was similar to that obtained for VP, showing percentages of 51% between 12-18h, 23% between 18-24h and 26% occurring in the first 12 hours (mean of 2005-2006). On the other hand, SFC 2m showed a more balanced daily distribution with 32% at 12-18h and 29% at 00-06 h.

The orientations in which SFCs have its highest interception capacity are NW to NE and SW to SE. Wind behavior during HP events registered by SFC 2m (at the same high of Young Wind Sentry Set) showed that the main direction of winds was NW to NE (45% of the events). For these same events, wind speed was 1.55 m s^{-1} in average, with maximum absolute values of 5.47 and 6.32 m s^{-1} during 2005 and 2006, respectively.

The forest canopy intercepted 51% of total water input (1246mm), with 49% reaching the forest ground (mean of 2005-2006).

4. DISCUSION

The cloud forest fragment under study in El Cañadón, Venezuelan Andes, showed low values of VP (1246mm, mean of 2005-2006) in comparison with other Andean cloud forest in Mérida State; including La Mucuy 2025mm (between 1968-1978, at 2217m) and 3124mm (between 1996-1998); La Montaña 2339mm (at 2442m) and Valle Grande 1689mm (at 2400m). However it showed similar values to those reported for the station of San Eusebio-La Carbonera, located at 2300m in the same watershed: between 1415 and 1463 mm (years 1060-1067) and 1575mm between 1973 and 1974 (Ataroff y Rada 2000, Engwald 1999, GCH 1974, Steinhardt 1979, Veillon 1989). Despite this low VP values, La Carbonera cloud forest (of which El Cañadón is a fragment) is similar to the other Andean cloud forests mentioned is structurally, for the structural point of view (Vareschi 1992). However, the short duration of dry periods could partially compensate the low water input values. The low proportion of consecutive days without rain is similar of those recorded in La Mucuy, were 95% of this lapses are less or equal to 4 days (Walker and Ataroff 2005). On the other hand, the lapses of continuous days without HP were long in El Cañadón, in comparison to La Mucuy were the maximum lapse was 4 days without HP (Pacheco and Ataroff 2005).

The low HP values recorded with all the collector types are contrasts with those of La Mucuy (9% of total inputs, Ataroff and Rada 2000). A possible cause for this could be that the drop sizes were too small for the meshes used in this study. Low wind speeds could also influence these results.

The month and daily distribution of VP was very similar to that registered in La Mucuy, with two annual maximums (May and September-October) and the main number of events concentrated between 12 and 24 h (Pacheco and Ataroff 2005).

Our results show that, the forest fragment in El Cañadón intercepts a similar proportion of total water input than La Mucuy forest, despite large differences in absolute input values.

5. ACKNOWLEDGEMENTS

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