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Water budget of vegetation in montane cloud forests: a case-study in Santa Cruz Island, Galápagos

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Galápagos Islands, world famous volcanic archipelago for its pristine and endemic ecosystems faces an acute lack of freshwater. Yet, water is abundant in the highlands during five months of the year, the garúa season. During this period, an inversion phenomenon in the atmosphere forms a dense fog layer from ca. 400 m.a.s.l. to the summit. In these conditions, evaporation and transpiration are reduced and cloud water interception represents an additional input of water

In the frame of the Galápagos Islands Integrated Water Studies project, we conducted field investigations to better quantify the water budget of vegetation during the five months of the garúa season. Two experimental 6x6 m experimental plots have been selected for their constrasting configurations.
The first site of investigation, covered by middle size mixed forest is located at mid-elevation (ca. 400 m.a.s.l). It is most of the time below the fog layer, or at its lower fringe. At the second site (ca. 650 m.a.s.l.), fog occurrence is semi-permanent and vegetation is composed by moderately large homogeneous evergreen shrubs.

In addition to usual climatic variables (rainfall, air temperature and humidity, wind speed, solar radiation), we monitored on both sites all water fluxes over and within the vegetation: throughfall, stemflow, and sapflow. Throughfall measurements were performed with sets of 3 m long troughs dipping to automatic tipping bucket gauges. Stemflow has been collected with halves of rubber tubes placed around the trees of the experimental plots, and manually recorded. On the two sites, measurements of sapflow have been punctually performed with a Dynamax device during contrasting climatic conditions on the dominant tree species.

Comparing the two sites, we investigated the influence of the tree species and climatic conditions over the intensity of water fluxes. Interception by the canopy has been inferred from the wet canopy water budget, it is the consequence of both evaporation and fog interception processes. Besides, we computed evapotranpiration rates with the Penman-Monteith (PM) formulas, and confronted the temporal evolution of this estimated flux with the dynamic of the evapotranspiration rate inferred from field measurements.

These experimentations illustrate the limitation of widely used formulas. Field measurements provided a better understanding of the garúa season, which influences the water balance of all major Galápagos Islands.