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Hydrological interaction between glacier and páramos in the tropical Andes: implications for water resources availability

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Preliminary hydro glacier estimates indicate that glacier contribution to the average annual consumption (5.6 m3 s-1) of the city of Quito (Capital of Ecuador, ∼2'500.000 inhabitants, 2800 masl) represents only about 2%-4% of the total supply for human consumption. However, at the local level at the Antizana volcano (0°28'S, 78°09'W), the mass balance analysis of the system composed by the Humboldt catchment (area of 15.1 km2, 15% of glaciarized area, 5% of moraines area, 80% of the area is páramo-endemic ecosystem of the tropical Andes, range from 5670 masl to 4000 masl) and Los Crespos catchment (area of 2.4 km2, 67% glaciarized area, 27% moraines area, range from 5670 masl to 4500 masl), which is nested into the Humboldt catchment, allows us to identify that due to the presence of the glacier reservoirs there is an additional contribution of 24% to the annual volume at the Humboldt catchment and it helps to regulate the runoff during the dry season, where the daily additional glacier contribution from November to February in some cases could reach t 40%. The Humboldt catchment has similar physiographic characteristics than the sites where new diversions will be built in the future in order to satisfy the increasing demand of water for human consumption of the city of Quito and its surrounding populations.

Based on detail hydrological observations (every 15 minutes measurements) during 2005 to 2009 and sporadic environmental trace analysis during the same period, the annual percentage of glacier contribution from the Humboldt catchment could potentially be as high as 37% due in part to the glacier melt contribution that gets infiltrated over 4750 masl it is then delivered around 4100 masl through underground circulation. Some of the sites where the glacier contribution reaches de surface has been identified through field work and the glacier origin of this water have been confirmed using a conductivity measurement, which seems to be a good indicator in when there is low precipitation.

This additional contribution from glacier melt will reinforce the capacity to transform precipitation into runoff at the saturation zone of this high land catchment. As a consequence, the hydrologic behavior of these catchments could be negatively affected by disappearing glacier contribution under the climate change context predicted by the IPCC for this region. This could be also the case for catchments from other glacierized mountains located in the tropical Andes, where water supply for surrounding populations, high land ecosystems (locally known as páramos), and in some cases other economic activities such as agriculture will be in jeopardy.