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# Glacial retreat and hydrological response across the Rio Santa watershed, Peru

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Under conditions of continuous retreat, glaciers generate a temporary increase in glacial-melt derived stream runoff as they lose mass. Yet as the remaining glacier volume diminishes, the annual runoff reaches a peak and is followed by a persistent annual decrease. . Our previous research shows that the upper Rio Santa and some of its tributaries that drain the western slopes of the glacierized Cordillera Blanca have already passed peak water, the moment of maximum water availability, and now exhibit decreasing dry season discharge as a consequence of glacial retreat. We also showed that two different points along the same river exhibit two different situations vis-à-vis peak water. At La Balsa, situated at the outflow of the upper Rio Santa Watershed, peak water passed a few decades ago while La Recreta, a point situated close to the headwaters, is well passed peak water and further declines in glacier area will have a very limited impact.

Here we extend our exploration of the peak water situation by dividing the Rio Santa watershed into 26 sub catchments and analysing the impact of glaciers retreat on these sub catchments dry season hydrology. This was achieved by measuring discharge at 13 locations along the entire course of the Rio Santa using an ADCP (Acoustic Doppler Current Profiler).We also sampled water at 34 locations to analyze for major dissolved ions and the stable isotopes of water. We analyzed these data using a distributed hydrochemical watershed mapping tool called the Hydro-chemical Basin Characterization Method (Baraer et al., 2009). Glacier retreat simulations were then used to project future hydrological changes as a function of glacier mass loss and evaluate the downstream repercussions. Results indicate that the entire Rio Santa has passed peak water. An overall decline of the dry season discharge of 30% of the actual level is anticipated at Condorcerro, a discharge station situated just upstream of the first major coastal diversion project before the Rio Santa reaches the Pacific Ocean. Our discharge measurements show that approximately 80% of current lower Rio Santa dry-season flows are actually diverted in these projects to supply water for major cities and intensive agriculture situated along the hyper-arid coastal region. As the glaciers continue to retreat, the Rio Santa dry-season outflows will likely decrease to a level situated below the actual demand for coastal uses.