Geophysical Research Abstracts
Vol. 18, EGU2016-10824, 2016
EGU General Assembly 2016

Reconstruction of cryospheric changes in the Maipo and Juncal river basins, central Andes of Chile: an integrative geomorphological approach

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Water in the central Andes (32–38˚S), a semi-arid mountainous area with elevations over 6000 m asl., is of great importance and a critical resource especially in the dry summer months. Ice bodies, such as glaciers and rock glaciers (permafrost) in the high mountains, provide a substantial part of the fresh-water resources but also for intensive economical use for the lowlands including Santiago metropolitan region, Chile. However the evolution of these ice bodies since the last deglaciation (i.e., Holocene, last ∼12,000 years), and in particular during historical times, and their feedback with climate is fairly unknown. In view of projected climate change, this is striking because it is also unknown whether these natural resources could be used as sustainable fresh-water source in the future.

Within the presented project, we develop and apply an integrative geomorphologic approach to study glaciers and their long-term evolution in the central Andes of Chile. Apart from glaciers (with variable debris-coverage), rock glaciers have evolved over time as striking geomorphological landforms in this area. We combine geomorphologic mapping using remote-sensing and in-situ data with an innovative surface exposure dating technique to determine the ages of distinct moraine ridges at three study sites in watersheds of the Santiago region: Juncal Norte, Loma Larga and Nieves Negras glaciers. First results of the project are presented, including a detailed geomorphological mapping and first analysis of the landform dynamics.

At all three sites, we distinguished at least three moraine systems of a Holocene putative age. These prominent moraine belts show that glaciers were at least 5 km longer than at present. Deglaciation from these ice marginal positions was gradual and complex in response to the detrital cover on the glaciers. Differences in ice thickness of the main glaciers in the respective valleys amount to about 100 m. Due to the partial, extensive debris coverage, the glaciers diminished in thickness without significant retreat of the glacier front. Another geomorphological feature identified is the separation of ice facies, from dynamically flowing ice with an active ice front, to dead ice covered by debris. In parallel, paraglacial processes affect the morphology of the moraines.

The central Andes are a climatically very sensitive zone between the southern humid and northern arid Andes, embracing a key location for uncovering past migration of the southern westerlies, the main driver of local climate variability. Understanding ice variability in the semi-arid Andes of Chile during past centuries (i.e., pre-instrumental time) can provide the urgent climate background context before the 20^{th}/21^{st}-century global warming and from here to assess local atmosphere-cryosphere linkages. This multifarious, patrimonial natural heritage and geological archive in the central Andes is nowadays not only threatened by climatic change but also human activities (e.g., mining).