

Upscaling of geophysical measurements: A methodology for the estimation of the total ground ice content (and water equivalent) of two study sites in the dry Andes of Chile and Argentina

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With climate change and the associated continuing recession of glaciers, water security, especially in regions depending on the water supply from glaciers, is threatened. In this context, the understanding of permafrost distribution and its degradation is of increasing importance as ground ice can be considered as a significant water reservoir and as an alternative source of water that could potentially moderate water scarcity during dry seasons. Thus, there is a pressing need to better understand how much water is stored as ground ice in areas with extensive permafrost occurrence and how meltwater from permafrost may contribute to the runoff regime of a region (Rangecroft et al., 2016; Garcia et al., 2017).

Although permafrost and permafrost features in the Central Andes are considered to be abundant and well developed, the understanding of the Andean cryosphere, especially in areas devoid of rock glaciers, and thus, the potential water contribution of ground ice melt to areas downstream is scarce (Azocar and Brenning, 2010, Arenson and Jakob, 2010).

To contribute to a better knowledge, this study focuses on the permafrost distribution and the ground ice content and its water equivalent of two catchments in the semi-arid Andes of Chile and Argentina. Geophysical methods (Electrical Resistivity Tomography, ERT and Refraction Seismic Tomography, RST) were used to detect and quantify permafrost in the study regions in the framework of environmental impact assessments in mining areas. Where available, ERT and RST measurements were combined in order to estimate the volumetric ground ice content using the Four Phase Model (Hauck et al., 2011). This study then presents one of the first methodologies for the upscaling of these geophysical-based quantifications of the ground ice content to the entire catchments in order to obtain an estimate of the total ground ice volume in the study areas.

The aim of the study is to (i) develop an upscaling methodology that helps to estimate the total ground ice content (and water equivalent) of permafrost areas, (ii) to improve our understanding of the water stored as ice outside of rock glaciers, and (iii) to produce potential input data for runoff models in order to model the potential contribution of future permafrost melt water to runoff.

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