



## **Outburst floods of glacial lakes in Patagonia: is there an increasing trend?**

Gino Casassa (1), Jens Wendt (1), Anja Wendt (1), Paulina López (1,2), Thomas Schuler (3), Hans-Gerd Maas (4), Jorge Carrasco (5,1), Andrés Rivera (1,6,7)

(1) Centro de Estudios Científicos, Valdivia, Chile (gc@cecs.cl), (2) UMR HydroSciences Montpellier, Montpellier, France, (3) Department of Geosciences, University of Oslo, Oslo, Norway, (4) Technische Universität Dresden, Dresden, Germany, (5) Dirección Meteorológica de Chile, Av. Portales 3450, Santiago, Chile, (6) Centro de Ingeniería de la Innovación del CECS, Av. Prat 514, Valdivia, Chile, (7) Departamento de Geografía, Universidad de Chile, Marcoleta 250, Santiago, Chile

Glaciers in Patagonia are temperate and many of them are receding at an accelerated rate, with a consequent enlargement of glacial lakes. We will review the occurrence of Glacial Lake Outburst Floods (GLOFs) recorded during the last century in Patagonia (Northern and Southern Patagonia icefields), and analyse them in view of the general warming of 0.5°C affecting the region during the last 40 years. Special attention will be devoted to Lake Cachet 2 (47°12' S, 73°15' W, 422 m a.s.l.) which has experienced 6 GLOF events during the last 2 years: April 6-7 2008, October 7-8 2008, 21-22 December 2008, 5 March 2009, 16 September 2009 and 5-6 January 2010. Lake Cachet 2 has an area of 4 km<sup>2</sup>, located on the eastern margin of the Northern Patagonia Icefield, being dammed on its southern margin by Colonia Glacier. Prior to the April 2008 event there had been no historical record of catastrophic flooding of this lake. Each event resulted in a flood wave of which travelled down Colonia River to the confluence with Baker River in a period of less than 48 hours, where it reached peak flows of approximately 2,000 m<sup>3</sup>/s. Here we present airborne and ground explorations carried out in the period 2008-2009 which confirm that the Lake Cachet 2 floods drain through an englacial tunnel under Colonia Glacier for a distance of 8 km, emerging at the front of the glacier. We propose that the lake started draining in 2008 as a result of the weakening of the ice dam produced by long-term thinning of Colonia Glacier. Measurements of the empty lake bed were performed with the CECS airborne laser scanner onboard a helicopter, which show that the maximum water volume of the lake is 200 x 10<sup>6</sup> m<sup>3</sup>. Modelling of the flood events has been carried out based on the subglacial flood model of Clarke (2003), showing that a semi-circular subglacial tunnel attaining a maximum dimension of 15 m can evacuate Lake Cachet 2 in approximately 48 hours, with peak flows on the order of 4000 m<sup>3</sup>/s. Preliminary results of morphological changes will be shown from lapse-rate photography of cameras installed in the summer season 2009/2010 at the Lake Cachet 2/Colonia Glacier outlet and at the Colonia Glacier front. We use our field data, airborne data, satellite imagery and hydrologic data collected by automatic sensors from Dirección General de Aguas (Chilean Water Cadastre) to describe the flood events and attempt to predict them.