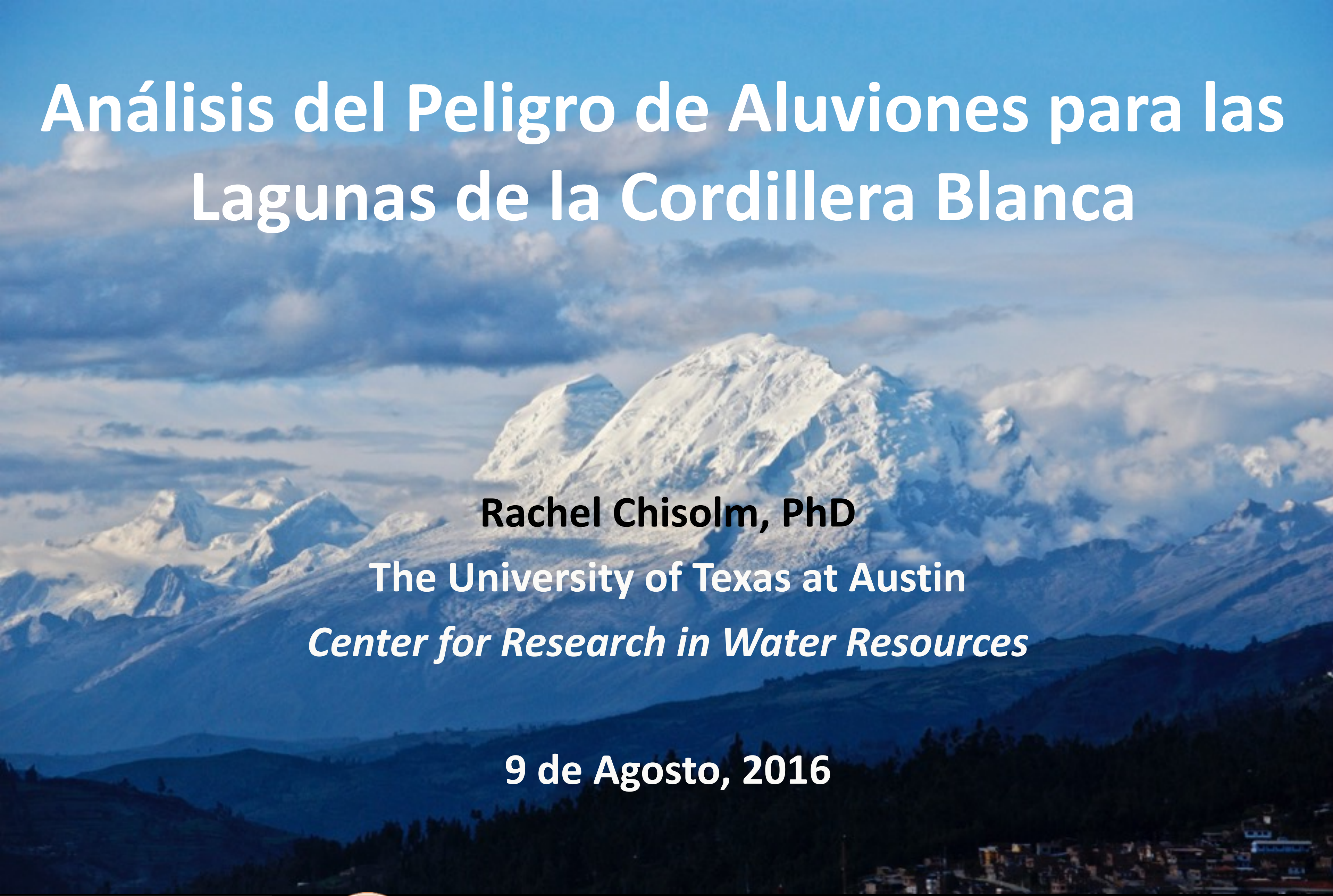
Análisis del Peligro de Aluviones para las Lagunas de la Cordillera Blanca



Rachel Chisolm, PhD

The University of Texas at Austin

Center for Research in Water Resources

9 de Agosto, 2016

High Mountains Adaptation Partnership

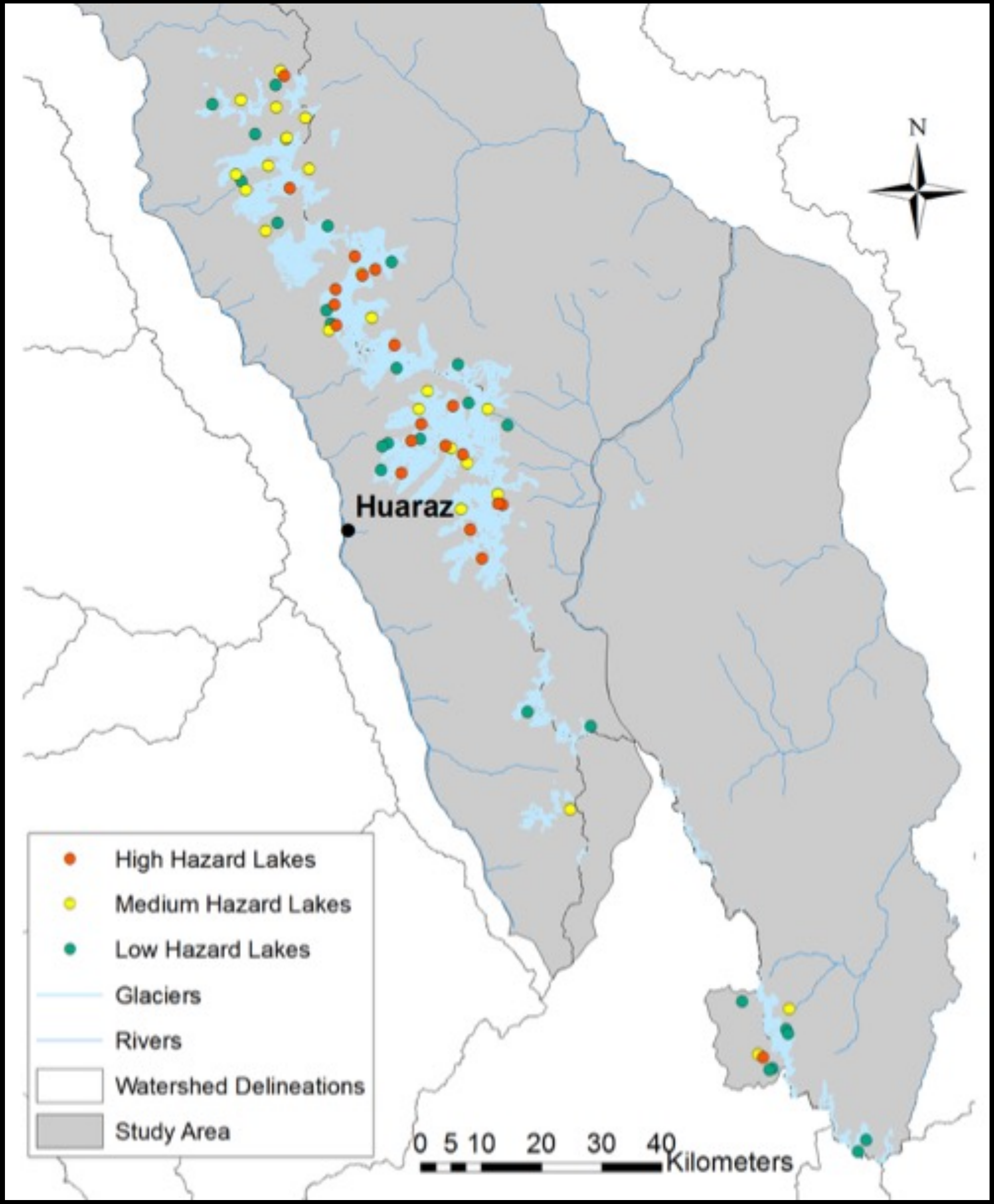
Climate Change Resilient Development

USAID

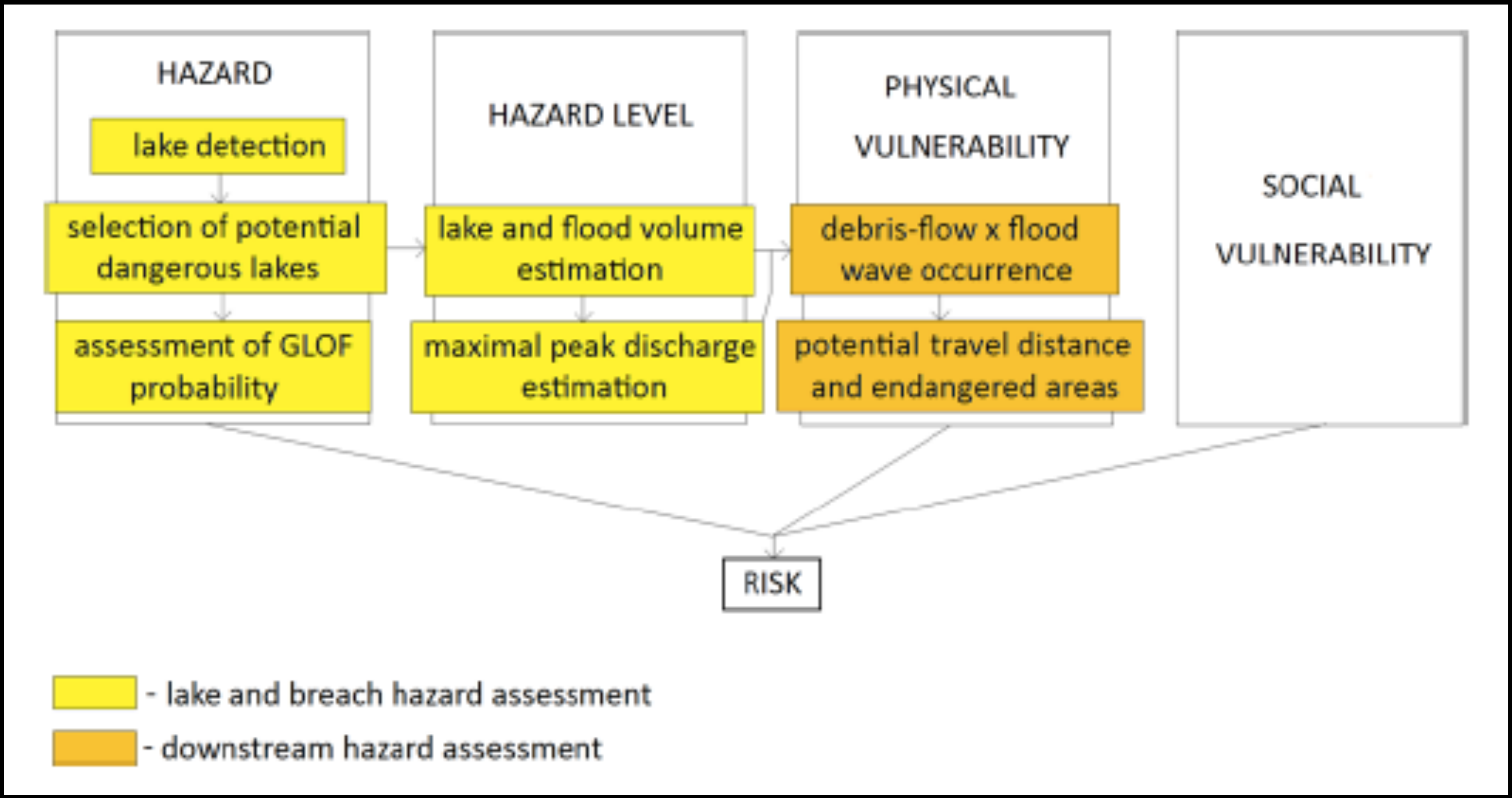
The Mountain Institute
Conservation. Culture. Community.

¿Por qué estudiar aluviones?

- 830 lagunas en la Cordillera Blanca de origen glaciar
- ~5.8 km^2 de área de superficie
- Aluviones pueden ser catastróficos

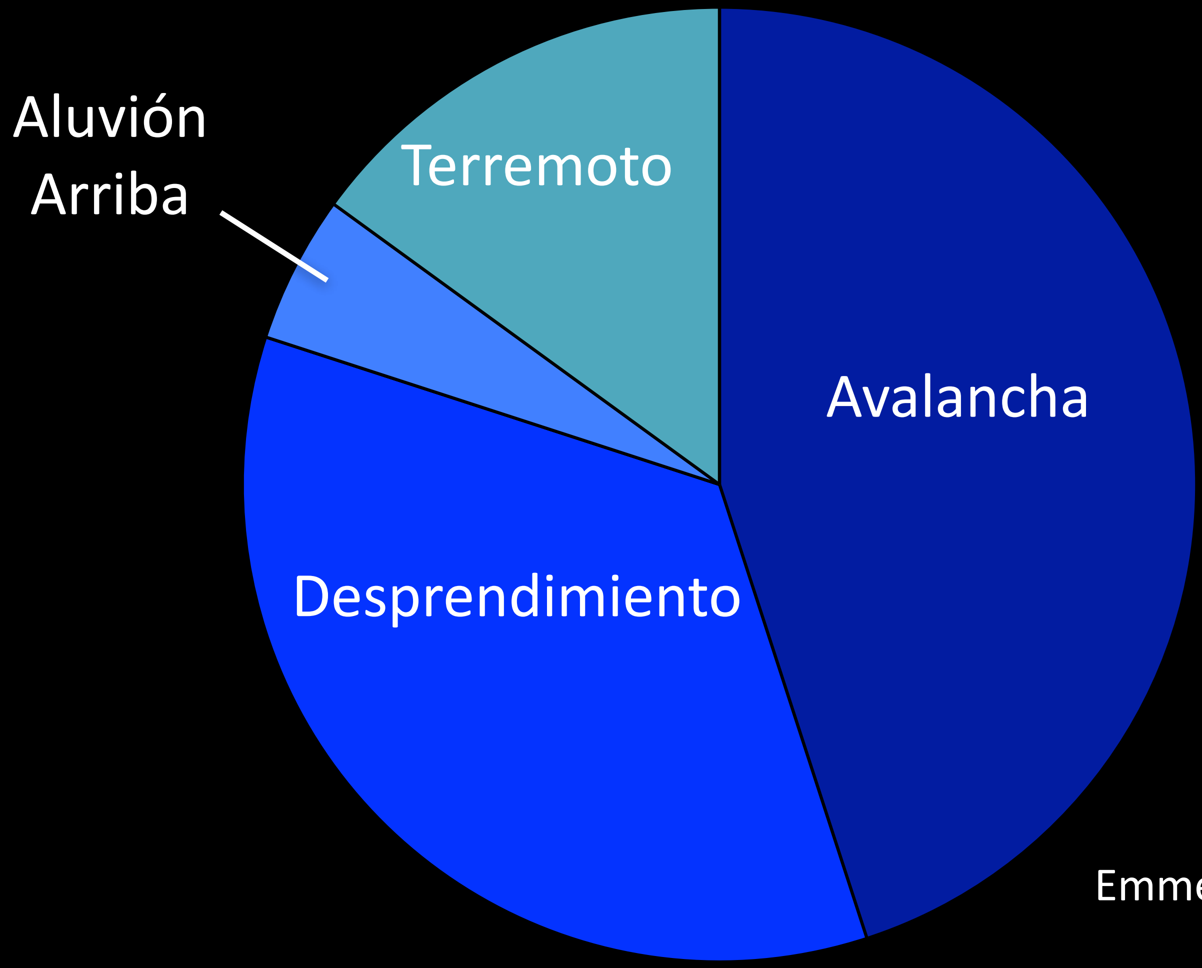


Análisis del Riesgo Glaciar



Emmer y Vilimek (2013)

Causas de Aluviones en la Cordillera Blanca



Emmer and Cochachin (2013)

Una avalancha es el detonante más común.

Emmer y Vilimek, 2014

- Scenario 1: dam overtopping from fast movement into lake
- Scenario 2: Overtopping from flood from lake upstream
- Scenario 3: Dam failure from fast slope movement into lake
- Scenario 4: Dam failure from flood wave from lake upstream
- Scenario 5: Dam failure from earthquake

Emmer y Vilimek, 2014

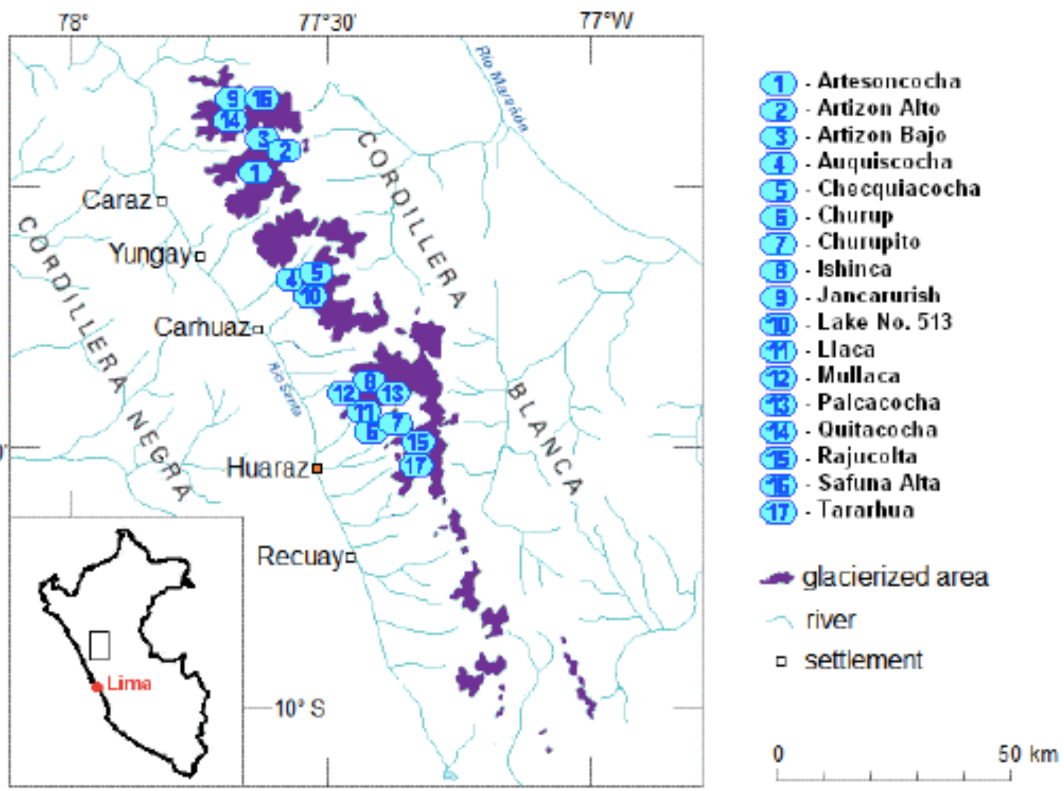


Figure 6. Localisation of studied lakes (base map modified according to USGS).

Emmer y Vilimek, 2014

Table 3. List of examined lakes (historical GLOFs).

Lake	Valley	Date of GLOF	Lake type	Probable scenario	Reference
Artesoncocha (7/1951)	Parón	16–17 July 1951	MDL	Dam failure following icefall into the lake	Ghiglino and Spann (1951); Lliboutry et al. (1977)
Artesoncocha (10/1951)	Parón	28 October 1951	MDL	Dam failure following icefall into the lake	Torres and Brottger (1951); Lliboutry et al. (1977)
Artizon Alto	Artizon/Santa Cruz	8 February 2012	BDL	Dam overtopping following a landslide of lateral moraine into the lake	Emmer et al. (2014)
Artizon Bajo	Artizon/Santa Cruz	8 February 2012	MDL	Dam failure following a flood wave from a lake situated upstream	Emmer et al. (2014)
Jancarurish	Los Cedros	20 October 1950	MDL	Dam failure following icefall into the lake	Lliboutry et al. (1977)
Lake no. 513	Chucchun	11 April 2010	BDL	Dam overtopping following ice/rock fall into the lake	Carey et al. (2012), Klimeš et al. (2014)
Palcacocha (1941)	Cojup	13 December 1941	MDL	Dam failure following icefall into the lake	Oppenheim (1946)
Palcacocha (2003)	Cojup	19 March 2003	MDL	Dam overtopping following a landslide of lateral moraine into the lake	Vilímek et al. (2005)
Safuna Alta (1970)	Tayapampa/Collota	31 May 1970	MDL	Dam failure caused by an earthquake	Lliboutry et al. (1977)
Safuna Alta (2002)	Tayapampa/Collota	22 April 2002	MDL	Dam overtopping following a rockslide/rockfall into the lake	Hubbard et al. (2005)

BDL: bedrock-dammed lake; MDL: moraine-dammed lake.

Emmer y Vilimek, 2014

Table 4. Pre-GLOF condition (susceptibility to outburst floods) of lakes assessed by the presented method (Bold – the highest potential for a particular lake; italicised – the actual cause).

Lake (condition)	Recorded GLOF trigger and mechanism	Potential for dam overtopping as a result of		Potential for dam failure as a result of		
		Fast slope movement into the lake (Scenario 1)	Flood wave from a lake situated upstream (Scenario 2)	Fast slope movement into the lake (Scenario 3)	Flood wave from a lake situated upstream (Scenario 4)	Strong earthquake (Scenario 5)
Artesoncocha (7/1951)	Dam failure following icefall into the lake	***1.000*** (calving)	0.000	***0.259***	0.000	0.025
Artesoncocha (10/1951)	Dam failure following icefall into the lake	***1.000*** (calving)	0.000	***0.225***	0.000	0.019
Artizon Alto	Landslide of moraine/dam overtopping	***0.996*** (landslide)	0.000	0.000	0.000	0.000
Artizon Bajo	Flood wave from a lake situated upstream/dam failure	0.985 (landslide)	***0.996***	0.205	***0.207***	0.026
Jancarurish	Icefall/dam failure	***0.983*** (calving)	0.000	***0.554***	0.000	0.135
Lake no. 513	Icefall/dam overtopping	***0.378*** (icefall)	0.000	0.000	0.000	0.000
Palcacocha (1941)	Icefall/dam failure	***1.000*** (calving)	0.000	***0.559***	0.000	0.217
Palcacocha (2003)	Landslide of moraine/dam overtopping	***0.961*** (calving)	0.000	0.000	0.000	0.026
Safuna Alta (1970)	Dam failure following strong earthquake	**0.604** (calving)	0.000	0.279	0.000	***0.231***
Safuna Alta (2002)	Landslide of moraine/dam overtopping	***0.589*** (landslide)	0.000	0.261	0.000	0.147

¿PREGUNTAS?

Metodologías de Modelamiento Rápido para los Peligros Glaciares

EL MODELO GLABTOP

El Modelo GlabTop para Estimar Espesores de Hielo

- Usa principios del los mecánicos glaciares y los DEM del superficie para aproximar el espesor de hielo
- Usos:
  - Espesores de hielo cuando no hay estudios del campo (mediciones in-situ)
  - Estudios del escala regional
  - Pronósticos de sitios para lagunas futuras

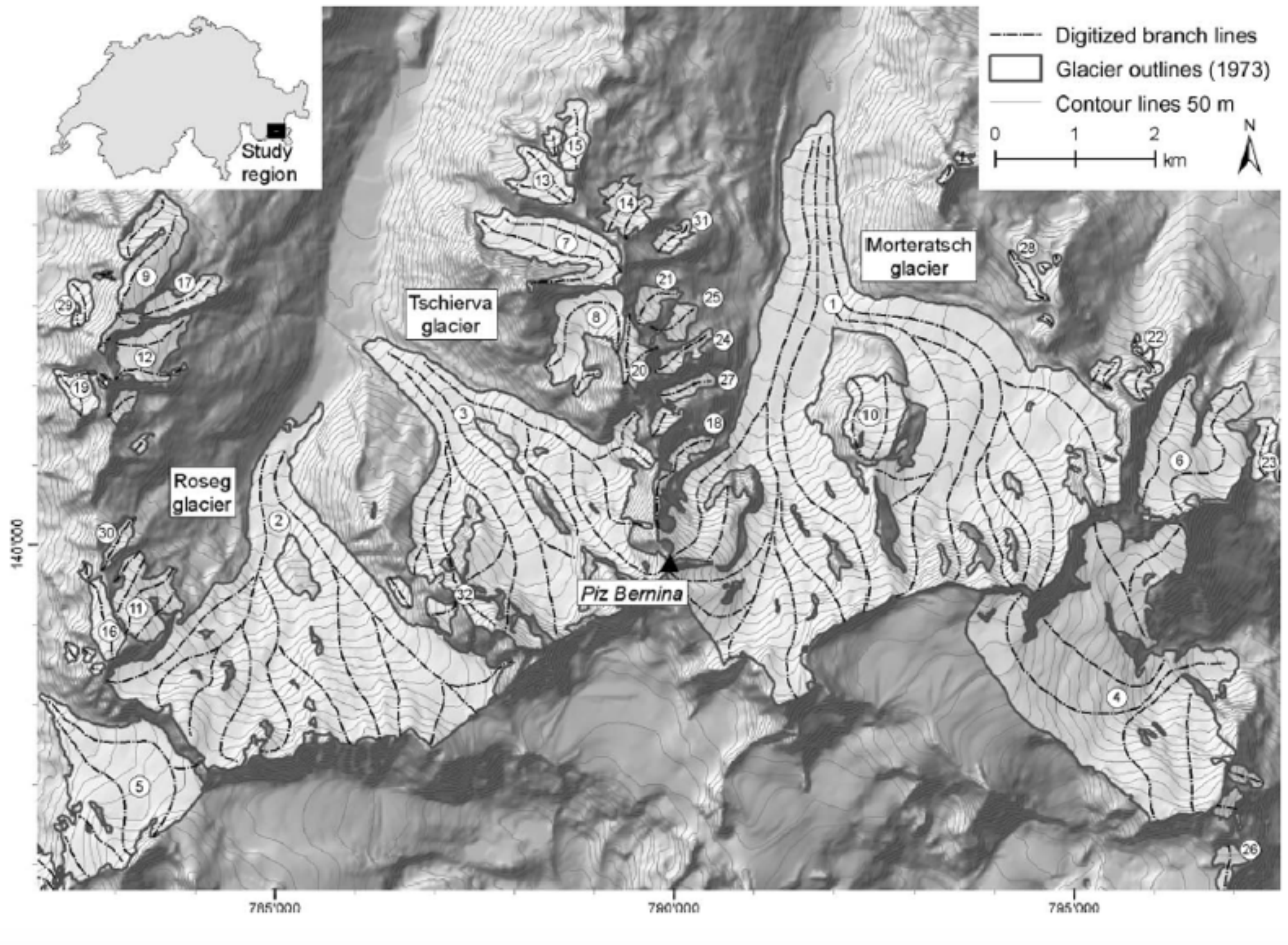
Referencias para el Modelo GlabTop

- Paul y Linsbauer, 2012
  - Paul, F., & Linsbauer, A. (2012). Modeling of glacier bed topography from glacier outlines, central branch lines, and a DEM. *International Journal of Geographical Information Science*, *26*(7), 1173-1190.
- Linsbauer et al., 2012
  - Linsbauer, A., Paul, F., & Haeberli, W. (2012). Modeling glacier thickness distribution and bed topography over entire mountain ranges with GlabTop: Application of a fast and robust approach. *Journal of Geophysical Research-Earth Surface*, 117(F03007).

Entradas al Modelo GlabTop

- Modelo topográfico (DEM)
- El contorno del glaciar
- Líneas de flujo del glaciar

Entradas al Modelo GlabTop



Paul y Linsbauer (2012)

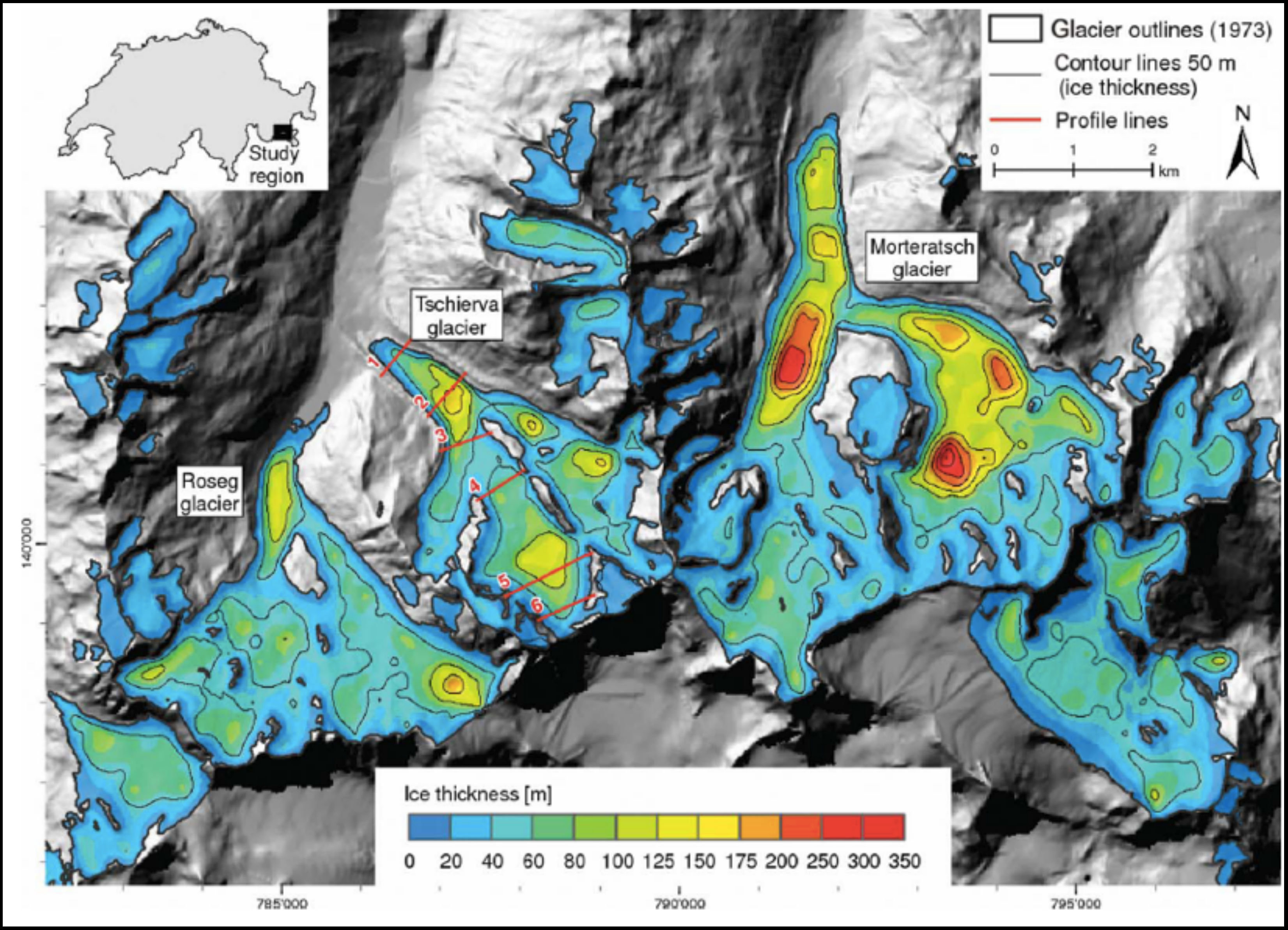
¿Como se calcula el espesor de hielo?

$$d = \frac{\tau}{(\rho g f \sin \alpha)}$$

$$\tau = 0.005 + 1.598\Delta h - 0.435\Delta h^2$$

d = espesor de hielo
τ = esfuerzo de corte basal
ρ = densidad del hielo
g – constante de gravedad
f = el factor de forma
α = la pendiente del glaciar

Resultados del Modelo GlabTop



Paul y Linsbauer (2012)

¿PREGUNTAS?