The GLOFs Database

Vilímek V., Emmer A.

Department of Physical Geography and Geoecology, Charles University, Prague, Czech Republic

* Correspondence to: Vít Vilímek, Department of Physical Geography and Geoecology, Faculty of Science, Charles University in Prague
Albertov 6, 128 43, Prage 2, Czech Republic
Tel: +420221951361
Fax: +420221951367
E-mail: vit.vilimek@natur.cuni.cz

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1 Introduction

Glacial lake outburst flood (GLOF) is a term used for sudden release of water from any type of glacial lake, irrespective of its cause (e.g. Richardson and Reynolds, 2000). These are highly hazardous and significant landscaping processes, by which high mountainous environment evolves. It is thought, that threat of GLOF is generally increasing in these days of global climate change and related glacier retreat in major part of glacierized areas worldwide (Clague et al., 2012; Fig. 1). We need to realize, that threat of GLOF is highly complex question, which is closely tied with various types of natural hazards (especially with dynamic slope movements, earthquakes and heavy rainfalls; Emmer and Cochachin, 2013). For better understanding these processes, the GLOFs Database was established.

2 Reasons and object

GLOFs have been studied in various glacierized regions by national services e.g. in Hindu Kush - Himalaya region by ICIMOD (Ives et al. 2010), in Cordillera Blanca of Peru by ELECTROPERÚ / INRENA / ANA (Zapata, 2002), or by scientific departments of universities e.g. in Europe (glacierhards.ch; Huggel et al. 2004) or in North-American Cordillera (Clague and Evans, 2000; O'Connor et al. 2001). Nevertheless, no overall summary of these events has been done yet.

Our main aim is to create broadly available online database containing information about GLOFs, which appeared all over the world since the end of last significant glacier advance - the Little Ice Age (LIA). For this purpose, webpage www.glofs-database.com was established. The GLOFs Database project has been created under the International Programme on Landslides (IPL Project No. 179) in the frame of International Consortium on Landslides (ICL) and is designed for three years (2013-2015).

Collected information about particular GLOF are divided into the three groups of characteristics: (1) Glacial lake info, (2) Flood info, and (3) Socio-economic impacts (Table 1). Some of them are specific and other has given options. These are: dam type (bedrock-dammed, moraine-dammed, ice-dammed, or combined dam), probable trigger (ice or snow avalanche into the lake, rockfall / landslide into the lake, earthquake, intense rainfall / snowmelt, flood wave from a lake situated upstream, blocking of underground outfŸ:low channels, buried ice cores melting, or dam self-destruction), way of water release (dam breach or dam overflow) and affected sector(s) (homes, industry, agriculture, public infrastructure, others).

Table 1, Information summarised about particular GLOF in GLOFs database

Information	Example
Glacial lake info	
- name	Palcacocha
- coordinates	9°24'S; 77°23' W; 4 563 m a.s.l
- location	Cordillera Blanca, Peru
- dam type	moraine-dammed
Flood info	
- date of occurrence	13.12.1941
- probable trigger	Ice avalanche into the lake
- way of water release	dam breach
- flood volume	$1{,}85 - 10 \cdot 10^6$ m^3
- peak discharge	not known
- debris flow occurrence	yes
Socio-economic impacts	
- fatalities	about 6 000
- affected sector(s)	homes, agriculture, infrastructure
- material damages	not known
+ *Additional info*	lake still exists

Naturally, it is not possible to collect all characteristics of all groups for each GLOF, especially in case of historical GLOFs, but we would like to collect as much information as possible and thus provide relevant background for any analysis. Understanding to the causes and mechanisms of GLOFs, regionally specific aspects of their share and representation and spatial-temporal patterns of their occurrence is an important step in the regionally-focused GLOF hazard assessment, mitigation and risk management (Emmer and Vilímek, 2013).Fig. 1, An exampe of glacier retreat and lake No. 513 formation and development beneath the western slopes of Mt. Hualcán (6 125 m a.s.l.), central Cordillera Blanca, Peru. Please note clear downstream evidence of 2010 GLOF (visible on 2011

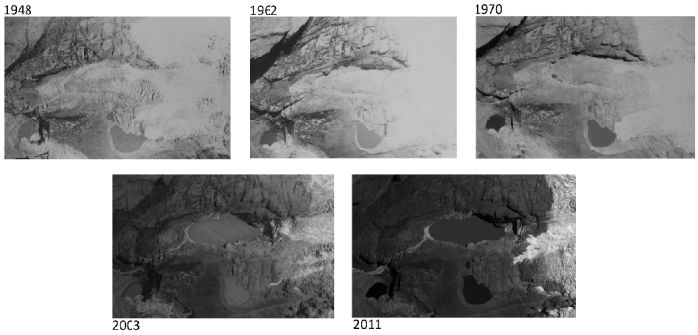

Fig 1. An exampe of glacier retreat and lake No. 513 formation and development beneath the western slopes of Mt. Hualcán (6 125 m a.s.l.), central Cordillera Blanca, Peru. Please note clear downstream evidence of 2010 GLOF (visible on 2011 image) following ice avalanche into the Lake No. 513. (Data sources: Authoridad Nacional del Agua archive, Huaráz, Peru (1948, 1962 and 1970 aerial photos) and Google Earth Digital Globe 2013 (2003 and 2011 images).

image) following ice avalanche into the Lake No. 513. (Data sources: Authoridad Nacional del Agua archive, Huaráz, Peru (1948, 1962 and 1970 aerial photos) and Google Earth Digital Globe 2013 (2003 and 2011 images).

3 The need of international cooperation

The GLOFs database fits into scientific cooperation – e.g. the International Programme on Landslides, namely the global network "Landslides in Cold Regions" (Emmer et al. 2013). The project is coordinated under the World Centre of Excellence (WCoE) dedicated to Charles University in Prague (see also Vilímek et al., 2010). First official presentation of the GLOFs database happened during the "Foro International Glaciares 2013 "between 1st and 4th July 2013, where several research teams which are used to work in Andes meet to prepare a common declaration "Declaración de Huaráz – Reunion de Expertos del Foro Internacional Glaciares". Future integrated research is expecting. This meeting enabled beginning of international cooperation between scientific institutions from South America (Bolivia, Peru), North America (USA) and Europa (Switzerland, Czech Republic).

4 Conclusions and future work

In cooperation with scientific departments worldwide, we collected information about more than five hundred of GLOFs, which happened all over the world since the end of Litle Ice Age and which will be added into the database (130 GLOFs from moraine-dammed lakes, 380 GLOFs from ice-dammed lakes and also few GLOFs originated from bedrock-dammed lakes or lakes with combinated dam).

First preliminary results showed differences between GLOFs from moraine-dammed lakes in three studied regions - Cordillera Blanca of Peru, North American Cordillera and Central Asia. Dynamic causes, such as slope movements into the lake, earthquakes and flood waves from a lake situated upstream, were four times more frequent than the long-term ones (buried ice melting, dam self-destruction). The most frequent cause of GLOFs in all studied regions was mass movements into lakes (about half of all events). Other causes were registered, too, nevertheless with varied frequency. Temporal distribution is regionally specific as well (Emmer and Cochachin, 2013).

The IPL GLOFs database project is in the fist year of running this year. Webpage www.glofs-database.com was established and first scientific departments joined to collaborate. Working plan for next year is primarily filling the database by collected data and database maintenance; also searching for new collaborating partners is an important aim.

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