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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Moraine-dammed lake failures in Patagonia and assessment of outburst susceptibility in the Baker Basin" *by* P. Iribarren Anacona et al.

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The comment was uploaded in the form of a supplement:
http://www.nat-hazards-earth-syst-sci-discuss.net/2/C2166/2014/nhessd-2-C2166-2014-supplement.pdf

Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., 2, 4765, 2014.

Author´s response

We would like to thank the referee for pointing out characteristics of Patagonian Lakes that require further discussion. Below are our responses to the referee's comments.

It is clear that lake size/area is not related to hydrostatic pressure. This is only concerned with water depth, and the authors have not made the case that water depth over moraines is a precursor for moraine failure.

-This point was also raised by another reviewer. We modified the text to clarify that larger lakes are generally deeper and may exert higher hydrostatic pressures over the dams. Larger lakes have also more surface exposed to ice-avalanche and mass movement impacts. The text now reads as follows.

"Furthermore, lakes with larger areas are generally deeper (see e.g. Diaz et al, 2007 database), and can exert higher hydrostatic pressures over the dams making them more susceptible to failure (Richardson and Reynolds, 2000). Larger lakes have also more surface area potentially exposed to mass movement and ice avalanche impacts, increasing their outburst susceptibility."

The moraine dams rise above the lake level and water depth decreases towards the moraine location so water depth is never high over most large moraines in Patagonia. This is a crucial point to address.

I would also have liked to see some more discussion on lake depth because this may be important. There are some data from Warren (1991); Warren et al (2001) Aniya (1999) and Harrison et al (2007) I think this should be reported. Increasing lake size may play a role in increasing the likelihood of a rock or ice fall into the lake, but it may also serve to damp down any impact. So it is not clear that lake size can uncritically be used to assess failure. More discussion of this point needs to be made.

-We now acknowledge these points in the discussion section:

"Only 2 lakes were completely emptied by outburst floods. This is because moraine dams generally impound only part of the lake´s water volume (the rest of the water occurs below the moraine base in over deepened valleys). Hence, in spite of the existence of lakes of hundreds of metres in depth in Patagonia (see e.g. Warren et al., 2001), complete lake drainage is unlikely."

Likely failure is also affected by ice content in moraines, and as far as I know there are no ice-cored moraines in Northern Patagonia (there may be some near the SPI).

-Ice-cored moraines have been found for example by Worni et al., (2012) in Northern Patagonia. This is discussed in the original manuscript in the page 4782 lines 20-24. We now indicate that recently formed dams are more likely to contain ice. The text now reads as follows:

"The melting of ice-cored moraines also may be related to dam failures (through dam subsidence or the erosion of otherwise ice cemented debris; Richardson and Reynolds, 2000; MacKillop and Clague, 2007) since at least one of the failed moraine-dammed lakes in Patagonia had an ice-core (Worni et al., 2012). Other **recently formed dams, close to glacier fronts, may also contain buried ice. "**

Fig. 1.

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Interactive Comment