

## ***Interactive comment on “Anthropogenic climate change and glacier lake outburst flood risk: local and global drivers and responsibilities for the case of Lake Palcacocha, Peru” by Christian Huggel et al.***

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General comments: The Lake Palcacocha was a source of the most destructive GLOF in human history which happened in 1941. Some mitigation measures to prevent lake outburst have been done. Growing volume of the lake due to glacier retreat is accompanying by growing population of Huaraz city located at the flow path. Thus any attempts to assess risk of GLOF from the Lake Palcacocha are highly relevant both at local and global scale. Authors used the Lake Palcacocha as a representative case for other glacier lakes and related risks around the world. The paper provides high-quality

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case study with significant conclusions, both locally and globally. It also provides nice synthesis of natural and social sciences which is important for comprehensive risk assessments. Novelty of results is quite clear. Structure of the paper is reasonable, Introduction is well-written, motivation and goals of the paper are fully clear. Authors provide brief but comprehensive description of the Lake Palcacocha evolution and engineering solutions to prevent dam failure. Currently lake growth potential is limited by topographic constraints, but outburst probability is high. Authors analyzed anthropogenic contribution to glacier retreat in Cordillera Blanca based on literature review and concluded that growth of lake Palcacocha has a clear anthropogenic signal. GLOF hazard in the absence of anthropogenic climate change the flood hazard would be much lower due to change of lake volume and increasing impact energy of ice/rock avalanches. Socio-economic drivers of risk are determined and analyzed basing on literature review and survey conducted in 2017. What is important, local residents showed little concern for the risk of flooding. The institutional instability generated only short-term, unsustainable measures to protect downstream populations. Authors note that combined effects of institutional and governance-related risk drivers have contributed to the increase of risk and provide interesting insight on cultural and emotional component of risk. Basing on analysis of risk drivers authors provide implications for responsibility and justice.

The manuscript is well written and free of technical errors, well structured, appropriate in length. All figures and the table are high-quality. Supplementary material is very useful for understanding of hazard assessment technology. The conclusions are clear and precise. The results obtained in this study are highly relevant to assess risk of future GLOFs not just in Huaraz but elsewhere. I definitely support publication of the manuscript.

Specific comments:

Authors noted that previous studies estimated about 40,000 people living in the inundation zone with a potential death toll of close to 20,000 (Somos-Valenzuela, 2014).

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Anywhere there is no assessment of current situation despite Fig.7 demonstrates significant growth of population in Huaraz. How many people live in zones with different hazard level (Fig.5) now? Is population density within hazardous area uniform or not? An addition of a figure where population density will be provided solely or overlaid to hazard zonation might be interesting for readers and useful for local communities and decision makers. Being fully agree with author's concept I will be happy to see what components of risk are major and what components are really minor. Furthermore, some recommendation how to minimize GLOF risk in Huaraz basing on risk driver analysis will increase practical and intellectual merit of this really great paper.

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