Contribution of Mountain Glacier Melting to Sea-Level Changes: Recent Past and Future

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Declaration

The work presented in this thesis was carried out while I was a full-time student at the Research School of Earth Sciences, at the Australian National University, between December 2004 and May 2008. The research described here is my own to the best of my knowledge and believe, except where mentioned in the text. No part of this thesis has been submitted to any other university or similar institution.

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Abstract

Observations of sea-level changes in the 20^{th} century show a rise of 1 to 2 mm year^{-1}, with accelerating rates in recent decades (IPCC, 2001, 2007b). Contributions to these changes include thermal expansion, recent melting of ice masses (Antarctica, Greenland, and mountain glaciers), and changes in terrestrial water storage. To quantify the contribution from recent mountain deglaciation, a global numerical model based on climate parameters is developed, incorporating seasonal variations in ice volume of 100 glaciated regions. The estimated melt-water from mountain glaciers contributed between 0.25 and 0.43 mm year^{-1} to global sea-level rise over the period 1961-1990, and between 0.47 and 0.58 mm year^{-1} over 1991-2000. This is consistent with directly observed ice-volume changes. Thus, confident predictions for future changes can be made using the same numerical model. It is predicted that mountain glaciers will contribute $\sim$1.5 mm year^{-1} on average over the remainder of this century. As well as the volumetric effect of the melt-water, local sea level is affected by the deflection of the crust and geoid in response to the change in surface load. Relative sea-level is predicted to rise on most of the worlds coastlines, but at sites located close to the melting glaciers sea-level is predicted to fall at a rate that reaches several times the average value, and estimates of geodetic signals are therefore strongly dependent on the region under investigation. The distinctive geographical pattern of the changes due to mountain deglaciation is dependent on a number of other factors which have also been addressed in this study. These include both the total and regional ice-volume loss of glaciers, the spatial representation of the glaciated areas, and the Earth models used. As the predicted geodetic signals at sites located close to large-scale glacier systems are of a magnitude that can be observed with geodetic techniques, these methods can provide additional constraints on the ice-volume loss of mountain glaciers.

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