

## Reviews

KASER, G. and H. OSMASTON. 2002. *Tropical glaciers*. Cambridge, etc., Cambridge University Press, xx + 207 pp. + map. (International Hydrology Series.) ISBN 0-521-63333-8, hardback, £75/US\$110.

To a glaciologist who has worked exclusively on the dynamics of large ice sheets, Kaser and Osmaston's book about those elusive and increasingly rare glaciers that populate the tropics came as something of a revelation. I wasn't ready for subtle peculiarities of climate to cause such fundamental differences in the behaviour of these glaciers. Having read the book, I am persuaded to reconsider tropical glaciers as not merely a glaciological oddity, but rather as sensitive indicators of climate change, a valuable resource in these rapidly developing regions, and a serious flood risk for the communities living below them.

The book begins with a prologue: a case history of lakes left during the recent retreat of glaciers in the Cordillera Blanca, Peru. These lakes formed behind ice-cored moraines that then proceeded to melt and allow outburst floods. Many of those floods have proved lethal to the towns many kilometres downstream. Kaser goes on to describe a surprisingly simple engineering solution that allowed some lake levels to be lowered to prevent catastrophic outburst.

Having thus whetted our appetite, Kaser steps back to discuss the basics, primarily what he means by "tropical glaciers". The most important characteristic of these glaciers is not that they lie between the tropics of Capricorn and Cancer, but that they experience "tropical climates". The fundamental feature of a tropical climate is that the annual variation in temperature is less than the diurnal variation. Thus annual cycles in accumulation and ablation are driven, not by temperature, but by changes in humidity, from the wet to the dry season. As a result, Kaser argues, tropical glaciers behave somewhat differently than their temperate relatives. For example, alpine glaciers that have the highest accumulation areas tend to be the ones that reach down to the lowest elevations, while the snouts of tropical glaciers in a particular area all tend to reach a similar elevation. Similarly, in alpine valleys the seasonality of runoff is increased by the presence of glaciers, whereas tropical glaciers act as buffers between wet and dry seasons and reduce the seasonality of runoff.

After this descriptive account, there follows an analysis of the sensitivity of tropical glaciers to various climate variables, in which Kaser concludes that glaciers in the wet tropics may be particularly sensitive to secular changes in temperature. This sensitivity is apparently demonstrated by the almost ubiquitous retreat of the glaciers over the last 100 years, which Kaser goes on to document. This section includes some spectacular photographs showing retreat of glaciers and snow cover in the Rwenzori, central Africa, and the Cordillera Blanca — a graphic reminder that many of these tropical glaciers could well disappear altogether in a matter of a few decades. There follows some discussion of

whether the observed retreat can be explained by changing climate, but sadly this discussion is ultimately unsatisfying, in the main because of a lack of good long-term climatic data from the areas of interest. Kaser appears to reach a tentative agreement with earlier authors who suggested that changes in humidity might have caused most of the changes in the 20th century, but that the most recent changes could be the result of warming.

At this point, the second author takes the stage, and the book goes through a substantial change of direction. Osmaston's account of reconstructions of tropical glaciers at the Last Glacial Maximum (LGM) is particularly detailed and I found myself lingering over a figure which summarized the changes in East African glaciers in a more digestible form than the text. This section ends with a plea that we understand that LGM tropical glaciers cannot be considered the same as modern subtropical ones, since at the LGM many aspects of the modern tropical climate still prevailed. In particular, the same lack of seasonality we see today was present.

The book is unusual in having been written in two parts, and in many respects the text fails to tie together their contrasting viewpoints. One could read either author's contribution without reference to the other. The accompanying 1:1000000 scale map sheet of the Rwenzori mountains was, however, a joint effort, and it is when one ponders over this map sheet that the link between the two contributions becomes undeniable. Those rapidly shrinking fragments of glaciers that survive atop the high mountains of the Rwenzori are the last remnants of substantial LGM glaciations, which left many marks on the lands below. Even to a glaciologist their existence is surprising, and this book highlights their fragility. The map sheet, which is available separately (£7 from stanfords.co.uk) stands alone, since it includes on its reverse an excellent summary of the parts of the book concerned with the Rwenzori glaciers.

*Tropical Glaciers* is a sober, academic account of the climatic control on tropical glaciers. The rigours and ordeals of the years of fieldwork that shaped the authors' expansive knowledge are mentioned only in passing in the preface — so cursorily, in fact, that one suspects that a popular version of this book may well be in the authors' minds, one that expands on the years of fieldwork hampered by civil wars, thin mountain air, hyperinflation and guerrilla activity. Sadly, the high price of the present edition will put it out of the range of many, but it would make an excellent acquisition for many departmental libraries.

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