

## **The High-mountain Cryosphere: Environmental Changes and Human Risks**

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## The High-mountain Cryosphere: Environmental Changes and Human Risks

Edited by Christian Huggel, Mark Carey, John J. Clague, and Andreas Käb. Cambridge, UK: Cambridge University Press, 2015. xii + 363 pp. Hardcover: US\$ 140.00, ISBN 978-1-107-06584-0. E-book: US\$ 112.00, ISBN 978-1-316-35515-2.

Recently, the cryosphere of the high mountains has been a focus of attention for scientists, educators, decision makers, practitioners, and the general public concerned about climate change because of its spectacular sensitivity to rising temperatures and the vulnerability of people populating mountain regions to the unprecedented transformations observed in recent decades. As our observational and modelling capabilities improve and interest soars, many papers and books have been produced, and many have been summarized in successive assessment reports by the Intergovernmental Panel on Climate Change (IPCC). However, as experts will know, despite the recent advances in cryospheric research, many questions still remain unanswered. Among these are complexities of interactions between the climate and cryosphere at different temporal and spatial scales—impacts of glaciers, snowpack, and permafrost wastage on water resources; risks associated with glacier retreat; and human perceptions of the cryosphere and its demise. On the other hand, those just beginning their research on the cryosphere may find the abundance of information, often spread across various disciplines, overwhelming.

Whether expert or beginner, the reader will find *The High-mountain Cryosphere* very useful indeed. This book attempts to fill the gaps in knowledge by summarizing the state of the art in research and focusing on

the less-known aspects of cryospheric changes and their impacts on both natural and human environments. At the same time, it serves as an excellent reference volume that highlights the most important issues, explains the interactions between various components of high-altitude environments in an easy-to-follow way, and with reference to numerous and often fascinating examples, addresses uncertainties, and provides extensive bibliographies at the end of every chapter. As an edited volume, it benefits from the expertise of leading researchers and, whether the reader is interested in permafrost, geomorphology, floods, the cultural value of glaciers, or societal conflicts resulting from rapid cryospheric changes, they are guaranteed a thoroughly informed opinion.

The book has 3 main sections. Part I—“Global Drivers”—focuses primarily on climatic forcings of cryospheric change acting at different scales. The first chapter examines impacts of atmospheric circulation and teleconnections on the mountains and glaciers of Europe and North America, the tropical Andes, the Tibetan Plateau, and Kilimanjaro, with reference to observations and climate models. The section proceeds with a chapter considering changes in temperature, precipitation, and related extremes. Although this focuses on the data-rich European Alps, it provides an excellent review of various global and regional data sets and methods of climatological analysis, which is most helpful in a teaching context. Next, a review of changes in snowpack and avalanche activity introduces the reader to one of the main themes of the book: hazards, risks, and risk management strategies. While such chapters are staples of any book on the cryosphere and are competent and useful, this volume goes beyond the standard, extending into the social aspects of cryospheric research. The chapter discussing interactions between extraction industries and glacier recession in the remote

mountains of Latin America, Kyrgyzstan, and Papua New Guinea is both unexpected and, frankly, disturbing. It is followed by a chapter on the cultural value of glaciers, which helps the reader to understand the development of identities and cultural values of communities populating high-altitude regions, as well as the depth of societal impacts of the observed cryospheric change.

Part II—“Processes”—focuses on a diverse range of processes operating in the high-mountain cryosphere and on the associated risks. The impacts of cryospheric changes—including glacier recession, permafrost degradation, and lake formation—on water resources and associated risks and hazards, including both severe water shortages and floods, are discussed with regard to different parts of the world and in the context of regional differences, both natural and socioeconomic. Water shortage is, perhaps, the main concern associated with glacier wastage. However, evaluating the contributions of glaciers to stream flow is complex science, and getting the projections right is paramount because of the costs of adaptation or the potential impacts of taking no action. The 7 chapters provide an excellent review of the complexities of glacier-related hydrological changes in the Andes, Swiss Alps, Himalayas, and North America. They demonstrate the diversity of hydrological responses to glacier change in the context of regional climatic conditions, assess potential negative socioeconomic impacts, and explore opportunities for adaptation in the regions where glacier contributions to runoff are significant. Risks and hazards are discussed with regard to permafrost degradation, increased melt and associated slope failures, rock and ice avalanches, debris-flow activity, and glacier lake outbursts. In each case, both natural processes and risk management and adaptation options are explored. Not only geomorphologists, hydrologists, and

those specializing in hazards, but also biogeographers will find this section of the book interesting. As glaciers and snowline retreat release land for plant growth and water availability alters, changes in ecosystems such as the formation of primary successions, migration of species, and changes in altitudinal zonation take place. In the last chapter of this section, these changes are discussed with regard to the tropical mountains, and important questions, such as whether there is a greater risk of extinction or a greater likelihood of the formation of new assemblages of species, are raised.

Part III—“Consequences and Responses”—explores the human dimension of the cryosphere and high-altitude environments. The values of snow and ice for the inhabitants of the Tibetan Plateau and the Himalayas are discussed, as well as their ability to cope with the harsh environments and hazards, the evolution of their coping strategies through time, and local knowledge of managing risks. Living on a volcano is always a risky business—and even

more so if its slopes are covered in ice. A chapter on ice-clad volcanoes provides a fascinating account of prehistoric, historical, and recent floods associated with volcanic activity, the impacts of which have by far exceeded those of glacier lake outbursts. This chapter takes the reader to the Andes, Iceland, Alaska, New Zealand, and Japan; it is, perhaps, the book’s most captivating chapter and will undoubtedly be very popular with students. My only criticism is that the authors have chosen not to include glaciers developing on the volcanoes of Kamchatka, where the positive mass balance and growth are surprisingly attributed to volcanic activity. Inevitably, rapid changes in harsh environments, where strong competition for resources exists, lead to conflicts, and many of these are related to water. The book concludes with an analysis of how water scarcity instigates conflicts because of the incompatible interests of different actors, such as different sectors of industry or different nations, and how these may be resolved.

To conclude, *The High-mountain Cryosphere* is a timely publication that successfully brings together various aspects of changing alpine environments. Its major achievement is the integration of the human dimension into cryospheric research, and this makes it stand out over all other works on snow and ice. The book will be equally invaluable to advanced researchers of the cryosphere and beginners, to academics and practitioners. It will most certainly be an excellent teaching aid, and no university library should be without it.

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