

GLOBAL CHANGE AND MOUNTAIN REGIONS



m r i
mountain research initiative

Affiliated Institutions



ADVANCES IN GLOBAL CHANGE RESEARCH

VOLUME 23

Editor-in-Chief

Martin Beniston, *Department of Geosciences, University of Fribourg, Switzerland*

Editorial Advisory Board

- B. Allen-Diaz, *Department ESPM-Ecosystem Sciences, University of California, Berkeley, CA, U.S.A.*
- R.S. Bradley, *Department of Geosciences, University of Massachusetts, Amherst, MA, U.S.A.*
- W. Cramer, *Department of Global Change and Natural Systems, Potsdam Institute for Climate Impact Research, Potsdam, Germany.*
- H.F. Diaz, *Climate Diagnostics Center, Oceanic and Atmospheric Research, NOAA, Boulder, CO, U.S.A.*
- S. Erkman, *Institute for Communication and Analysis of Science and Technology – ICAST, Geneva, Switzerland.*
- R. García Herrera, *Facultad de Fisicas, Universidad Complutense, Madrid, Spain*
- M. Lal, *Centre for Atmospheric Sciences, Indian Institute of Technology, New Delhi, India.*
- U. Luterbacher, *The Graduate Institute of International Studies, University of Geneva, Geneva, Switzerland.*
- I. Noble, *CRC for Greenhouse Accounting and Research School of Biological Sciences, Australian National University, Canberra, Australia.*
- L. Tessier, *Institut Méditerranéen d'Ecologie et Paléocécologie, Marseille, France.*
- F. Toth, *International Institute for Applied Systems Analysis, Laxenburg, Austria.*
- M.M. Verstraete, *Institute for Environment and Sustainability, EC Joint Research Centre, Ispra (VA), Italy.*

The titles published in this series are listed at the end of this volume.

GLOBAL CHANGE
AND MOUNTAIN REGIONS
An Overview of Current Knowledge

Edited by

Uli M. Huber

University of Bern, Switzerland

Harald K. M. Bugmann

*Swiss Federal Institute of Technology,
Zurich, Switzerland*

and

Mel A. Reasoner

*The Mountain Research Initiative,
Bern, Switzerland*

 Springer

A C.I.P. Catalogue record for this book is available from the Library of Congress.

ISBN 978-1-4020-3507-4 ISBN 978-1-4020-3508-1 (eBook)
DOI 10.1007/978-1-4020-3508-1

Published by Springer,
P.O. Box 17, 3300 AA Dordrecht, The Netherlands.

www.springeronline.com

Printed on acid-free paper

All Rights Reserved
© 2005 Springer
Softcover reprint of the hardcover 1st edition 2005

No part of this work may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, microfilming, recording or otherwise, without written permission from the Publisher, with the exception of any material supplied specifically for the purpose of being entered and executed on a computer system, for exclusive use by the purchaser of the work.

TABLE OF CONTENTS

INTRODUCTION

T. Hofer

The International Year of Mountains: Challenge and opportunity for mountain research

1

PART I: PALEOENVIRONMENTAL CHANGES

K. Alverson, C. Kull, G. W. K. Moore and P. Ginot

A dynamical perspective on high altitude paleoclimate proxy timeseries

11

S. L. Shafer, P. J. Bartlein and C. Whitelock

Understanding the spatial heterogeneity of global environmental change in mountain regions

21

L. G. Thompson, M. E. Davis, P.-N. Lin, E. Mosley-Thompson and H. H. Brecher

Ice cores from tropical mountain glaciers as archives of climate change

31

J. C. Gosse

The contribution of cosmogenic nuclides to unraveling alpine paleoclimate histories

39

A. Nesje, S. O. Dahl, Ø. Lie and J. Bakke

Holocene glacier fluctuations and winter precipitation variations in southern Norway

51

O. N. Solomina

Glacier and climate variability in the mountains of the former Soviet Union during the last 1000 years

61

H. Kerschner

Glacier-climate models as palaeoclimatic information sources: Examples from the Alpine Younger Dryas Period

73

J. Overpeck, K. B. Liu, C. Morrill, J. Cole, C. Shen, D. Anderson and L. Tang

Holocene environmental change in the Himalayan-Tibetan Plateau region: Lake sediments and the future

83

<i>M. Grosjean and H. Veit</i> Water resources in the arid mountains of the Atacama Desert: Past climate changes and modern conflicts	93
<i>A. F. Lotter</i> Palaeolimnological investigations in the Alps: The long-term development of mountain lakes	105
<i>R. W. Battarbee, S. Patrick, M. Kernan, R. Psenner, H. Thies, J. Grimalt, B. O. Rosseland, B. Wathne, J. Catalan, R. Mosello, A. Lami, D. Livingston, E. Stuchlik, V. Straskrabova and G. Raddum</i> High mountain lakes and atmospherically transported pollutants	113
<i>N. L. Rose, H. Yang, P. Fernández and J. O. Grimalt</i> Trace metals, fly-ash particles and persistent organic pollutants in European remote mountain lakes	123
<i>W. Tinner and B. Ammann</i> Long-term responses of mountain ecosystems to environmental changes: Resilience, adjustment, and vulnerability	133
<i>A. Lara, A. Wolodarsky-Franke, J. C. Aravena, R. Villalba, M. E. Solari, L. Pezoa, A. Rivera and C. Le Quesne</i> Climate fluctuations derived from tree-rings and other proxy-records in the Chilean Andes: State of the art and future prospects	145
<i>R. Villalba, M. H. Masiokas, T. Kitzberger and J. A. Boninsegna</i> Biogeographical consequences of recent climate changes in the southern Andes of Argentina	157

PART II: CRYOSPHERIC CHANGES

<i>W. Haeberli</i> Mountain glaciers in global climate-related observing systems	169
<i>M. B. Dyurgerov</i> Mountain glaciers are at risk of extinction	177
<i>G. Kaser, Ch. Georges, I. Juen and T. Mölg</i> Low latitude glaciers: Unique global climate indicators and essential contributors to regional fresh water supply. A conceptual approach	185
<i>B. Francou, P. Ribstein, P. Wagnon, E. Ramirez and B. Pouyaud</i> Glaciers of the tropical Andes: Indicators of global climate variability	197

<i>B. G. Mark and G. O. Seltzer</i> Glacier recession in the Peruvian Andes: Climatic forcing, hydrologic impact and comparative rates over time	205
<i>C. Harris</i> Climate change, mountain permafrost degradation and geotechnical hazard	215
<i>A. Kääb, J. M. Reynolds and W. Haeberli</i> Glacier and permafrost hazards in high mountains	225
<i>E. Martin and P. Etchevers</i> Impact of climatic changes on snow cover and snow hydrology in the French Alps	235
<i>R. Hock, P. Jansson and L. N. Braun</i> Modelling the response of mountain glacier discharge to climate warming	243
PART III: HYDROLOGICAL CHANGES	
<i>C. Schär and C. Frei</i> Orographic precipitation and climate change	255
<i>H. F. Diaz</i> Monitoring climate variability and change in the western United States	267
<i>L. Menzel and H. Lang</i> Spatial heterogeneity of snow conditions and evapotranspiration in the Swiss Alps	275
<i>A. Becker</i> Runoff processes in mountain headwater catchments: Recent understanding and research challenges	283
<i>S. Uhlenbrook, J. Didszun and C. Leibundgut</i> Runoff generation processes on hillslopes and their susceptibility to Global Change	297
<i>R. Kirnbauer, G. Blöschl, P. Haas, G. Müller and B. Merz</i> Identifying space-time patterns of runoff generation: A case study from the Löhnersbach catchment, Austrian Alps	309

<i>J. M. García-Ruiz, T. Lasanta, B. Valero, C. Martí, S. Beguería, J. I. López-Moreno, D. Regüés and N. Lana-Renault</i> Soil erosion and runoff generation related to land use changes in the Pyrenees	321
<i>B. L. McGlynn</i> The role of riparian zones in steep mountain watersheds	331
<i>J. Gurtz, H. Lang, M. Verbunt and M. Zappa</i> The use of hydrological models for the simulation of climate change impacts on mountain hydrology	343
<i>L. R. Leung</i> Effects of climate variability and change on mountain water resources in the Western US	355
PART IV: ECOLOGICAL CHANGES	
<i>Ch. Körner</i> The green cover of mountains in a changing environment	367
<i>W. D. Bowman</i> The response of alpine plants to environmental change: Feedbacks to ecosystem function	377
<i>H. Pauli, M. Gottfried, D. Hohenwallner, K. Reiter and G. Grabherr</i> Ecological climate impact research in high mountain environments: GLORIA (Global Observation Research Initiative in Alpine Environments) – its roots, its purpose and the long-term perspectives	383
<i>E. M. Spehn and Ch. Körner</i> A global assessment of mountain biodiversity and its function	393
<i>R. J. Williams and C-H. Wahren</i> Potential impacts of global change on vegetation in Australian Alpine landscapes: Climate change, landuse, vegetation dynamics and biodiversity conservation	401
<i>E. Tasser, U. Tappeiner and A. Cernusca</i> Ecological effects of land-use changes in the European Alps	409
<i>J. Harte</i> Climate interactions in montane meadow ecosystems	421

<i>J. S. Baron, K. R. Nydick, H. M. Rueth, B. Moraska Lafrançois and A. P. Wolfe</i>	
High elevation ecosystem responses to atmospheric deposition of Nitrogen in the Colorado Rocky Mountains, USA	429
<i>R. D. Vinebrooke and P. R. Leavitt</i>	
Mountain lakes as indicators of the cumulative impacts of ultraviolet radiation and other environmental stressors	437
<i>D. Schimel and B. H. Braswell</i>	
The role of mid-latitude mountains in the carbon cycle: Global perspective and a Western US case study	449
<i>H. H. Shugart</i>	
Remote sensing detection of high elevation vegetation change	457
<i>A. Guisan and J.-P. Theurillat</i>	
Monitoring networks for testing model-based scenarios of climate change impact on mountain plant distribution	467
<i>H. Bugmann, B. Zierl and S. Schumacher</i>	
Projecting the impacts of climate change on mountain forests and landscapes	477
<i>D. Fagre, S. W. Running, R. E. Keane and D. L. Peterson</i>	
Assessing climate change effects on mountain ecosystems using integrated models: A case study	489
<i>L. J. Graumlich, L. A. Waggoner and A. G. Bunn</i>	
Detecting global change at Alpine treeline: Coupling paleoecology with contemporary studies	501

PART V: HUMAN DIMENSIONS

<i>M. Beniston</i>	
The risks associated with climatic change in mountain regions	511
<i>M. F. Price</i>	
Forests in sustainable mountain development	521
<i>L. Lebel</i>	
Institutional dynamics and interplay: Critical processes for forest governance and sustainability in the mountain regions of Northern Thailand	531

<i>X. Jianchu and A. Wilke</i> State simplifications of land-use and biodiversity in the Uplands of Yunnan, Eastern Himalayan Region	541
<i>P. S. Ramakrishnan</i> Mountain biodiversity, land use dynamics and traditional ecological knowledge	551
<i>A. J. Hansen and R. S. DeFreis</i> Land use intensification around nature reserves in mountains: Implications for biodiversity	563
<i>D. I. McCracken and S. Huband</i> Nature conservation value of European mountain farming systems	573
<i>N. S. Jodha</i> Economic globalization and its repercussions for fragile mountains and communities in the Himalayas	583
<i>H. Hurni, H. P. Liniger and U. Wiesmann</i> Research partnerships for mitigating syndromes of global change in mountain regions	593
<i>L. MacMillan and H. P. Liniger</i> Monitoring and modelling for the sustainable management of water resources in Tropical mountain basins: The Mount Kenya example	605
<i>H. Schreier</i> Challenges in mountain watershed management	617
<i>M. R. v. Bieberstein Koch-Weser</i> Overcoming the vertical divide: Legal, economic, and compensation approaches for sustainable management of mountain watersheds	627
 SYNTHESIS	
<i>A. Björnsen, U. M. Huber, M. Reasoner, B. Messerli and H. Bugmann</i> Future research directions	637