Environmental Science and Engineering

Environmental Science

Series Editors

Rod Allan
Ulrich Förstner
Wim Salomons

For further volumes:
http://www.springer.com/series/3234

Wei Shan · Ying Guo · Fawu Wang
Hideaki Marui · Alexander Strom
Editors

Landslides in Cold Regions in the Context of Climate Change

Springer

Editors
Wei Shan
Ying Guo
Institute of Engineering Geology
Northeast Forestry University
Harbin
People's Republic of China

Fawu Wang
Faculty of Science and Engineering
Shimane University
Matsue
Japan

Hideaki Marui
Research Institute for Natural Hazards
Niigata University
Niigata
Japan

Alexander Strom
Geodynamics Research Center
JSC Institute Hydroproject
Moscow
Russia

ISSN 1431-6250
ISBN 978-3-319-00866-0 ISBN 978-3-319-00867-7 (eBook)
DOI 10.1007/978-3-319-00867-7
Springer Cham Heidelberg New York Dordrecht London

Library of Congress Control Number: 2013948752

© Springer International Publishing Switzerland 2014
This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed. Exempted from this legal reservation are brief excerpts in connection with reviews or scholarly analysis or material supplied specifically for the purpose of being entered and executed on a computer system, for exclusive use by the purchaser of the work. Duplication of this publication or parts thereof is permitted only under the provisions of the Copyright Law of the Publisher's location, in its current version, and permission for use must always be obtained from Springer. Permissions for use may be obtained through RightsLink at the Copyright Clearance Center. Violations are liable to prosecution under the respective Copyright Law.
The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.
While the advice and information in this book are believed to be true and accurate at the date of publication, neither the authors nor the editors nor the publisher can accept any legal responsibility for any errors or omissions that may be made. The publisher makes no warranty, express or implied, with respect to the material contained herein.

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

Foreword

During the past 100 years, the global climate is changing and the geological disasters caused by it are growing. In the high-altitude permafrost regions, the degradation rate of glacier is accelerating, such as Qinghai-Tibet Plateau in China, the Alps in Europe and high mountain in Central Asia South America. On the other hand, in the high-latitude permafrost regions, such as Northern Canada, Alaska in USA, higher and lesser Khingan in Northeast of China, Siberia in Russia and the Nordic, the Southern boundary of permafrost is moving Northward gradually. Even in Kilimanjaro Mount in Africa which is located near the equator, also has been reported on permafrost degradation.

Many new geological problems are emerging with phenomena of permafrost degradation and extreme weather. Because repeated freeze-thaw cycle and the melting of surface and shallow slope, the geological disasters such as mountain collapse, mud-rock flow, and landslide are growing. All of above not only drastically changed the local geological and environmental conditions, but also caused huge losses to human lives and property, and threatened the security of local infrastructure.

In order to promote landslide research, as well as to contribute for the development of international community, environmental protection and capacity-building. On 21 January 2002, the International Consortium on Landslides (ICL) was established in Kyoto, Japan. ICL is a nonprofit and nongovernmental organization consisting (in 2012) of 51 member institutions from 32 countries; its International Program on Landslides (IPL) was jointly established by the United Nations Educational, Scientific, and Cultural Organization (UNESCO), World Meteorological Organization (WMO), Food and Agricultural Organization of the United Nations (FAO), United Nations International Strategy for Disaster Reduction (UNISDR), United Nations University (UNU), International Council for Science (ICSU), International Union of Geological Sciences (IUGS), and the World Federation of Engineering Organizations (WFEO).

In the ICL 10th Anniversary Conference (19 January 2012 in Kyoto, Japan), ICL decided to set up ICL Cold Regions Landslides Network (ICL-CRLN). The goal of it is, through exchanging and cooperation of the scientists coming from different countries and regions, as well as different professional field such as geography, geology, meteorology and so on, such problems as landslide mechanism, landforms distinguish, early warning and forecasting, disaster Assessment

were studied, which also could contribute to geological environment of the cold regions and safety of human life and property.

After legal procedures, ICL-CRLN announced its establishment in Harbin, China in July 2012. Currently, 15 scientists from Canada, Czech, China, Italy, Japan, Russia, and Switzerland joined ICL-CRLN. Wei Shan from Northeast Forestry University, China worked as the Network Coordinator, while Alexander Strom from Russia Geodynamic Research Center and Hideaki Marui from Niigata University, Japan served as the Deputy Coordinators.

At present, the study about landslides in cold region is not enough. However, this topic is likely to become concerns with the influence of climate changing on geological and environmental conditions in cold regions. This book we published now is a part of the study results of ICL-CRLN members, the content mainly is about landslides in cold region in the context of global climate changing. I appreciated their exploration spirit and their valuable research results, and also willing to recommend them to all the people interested in cold region landslide.

Florence, Italy, 15 June 2013

Paolo Canuti
President of International Consortium
on Landslides

Preface

As Prof. Canuti said, this book presents up-to-date research results of landslides in cold region. We define the cold region as the place where the monthly average temperature is less than −10 °C in the coldest month. In cold mountainous and hilly areas, the characteristics of mechanism, movement, and damage to environment of landslides are different with the landslides in noncold region. Moreover, these characteristics are closely related to climate change.

In order to strengthen the international cooperation and exchanges of landslide research in cold region, I proposed to launch the network of landslide research in cold region during the 10th council of the International Consortium on Landslides (ICL) in Rome in October 2011. This proposal was gotten the approval and support from Prof. Paolo Canuti (the president of the ICL), Prof. Sassa (the executive chairperson of the ICL), and the delegates participating in the council. In January 2012, the establishment of the network of landslide research in cold region was obtained by official approval of the ICL on 10th anniversary of the ICL in Kyoto University. After 6 months of preparation, the establishment of the network of landslide research in cold region of the ICL was proclaimed in Harbin, China on July 23, 2012. During the first meeting, we discussed and adopted the regulation and action plan of this network, published the declaration, and held the academic exchange of landslide research in cold region. Prof. Paolo Canuti, the president of the ICL, participated and delivered the congratulation. Dr. Alexander Strom who is the Researcher of the Geodynamic Research Centre (the branch of the JSC "Hydro-project Institute", Russia), Prof. Hideaki Marui who is the Director of the Research Institute for Natural Hazards and Disaster Recovery of Niigata University in Japan, Dr. Ying Guo from the Institute of Engineering Consulting and Design of Northeast Forestry University in China and other colleagues did fruitful work of developing the network of landslide research in cold region of the ICL. I really appreciate their supports and contributions.

At present, the members of the network of landslide research in cold region of the ICL and other colleagues from different countries and regions are using different research approaches to conduct comprehensive study on the landslides in cold region under climate change. This book is the summary of interim research results of colleagues and also a commemoration for the first anniversary of the network of landslide research in cold region of the ICL and the 3rd World Landslide Forum which will be hold in Beijing in June 2014.

Due to the differences from the regions and technical requirements, the topics, methods, and contents of colleagues' research are different. Dr. Filippo Catani, Prof. Paolo Canuti, and Prof. Nicola Casagli who are from the Department of Earth Sciences, University of Florence in Italy, and Dr. Chunjiao Wang and Prof. Wei Shan who are from the Northeast Forestry University in China studied the distribution of permafrost and slope movement before landslide using remote sensing. Their research results provide a scientific basis for early warning and prediction. Dr. Alexander Strom who is from the Geodynamic Research Centre (the branch of JSC "Hydroproject Institute", Russia) studied the process of landslide caused by the glacier of high-elevation mountain area in Central Asia from geological history. Prof. Hideaki Marui who is from the Niigata University and Prof. Fawu Wang who is from the Shimane University in Japan analyzed two landslides triggered by snowmelt in the North Central of Japan. Dr. Marten Geertsema and Dr. Menno van Hees who are from the Ministry of Forests, Lands and Natural Resource Operations in Canada, and Prof. Marta Chiarle who is from the Consiglio Nazionale delle Ricerche (Istituto di Ricerca per la Protezione Idrogeologica U.O.S. Torino, Italy) studied the debris flow triggered by snowmelt in the British Columbia of Canada. Italian scholars A. M. Ferrero, A. Godio, M. R. Migliazza, L. Sambuelli, A. Segalini, and A. Théodule et al., and Dr. Zhaoguang Hu who is from the Northeast Forestry University in China studied the geophysical characteristics of landslides in cold region. Prof. Adam Emmer and Prof. Vít Vilímek who are from the Charles University in Prague, Dr. Jan Klimeš who is from the Institute of Rock Structure and Mechanics, Academy of Sciences of the Czech Republic, Dr. Alejo Cochachin who is from the Unidad de Glaciologia y Recursos Hidricos in Peru, and Dr. Krivonogova and Dr. Stanislav Panov who are from the JSC Vedeneyev VNIIG in Russia studied the effect of landslides on reservoir safety in high-elevation mountain area in South America and the central Siberia permafrost in Russia. Marina Leibman who is the Chief Scientist of the Earth Cryosphere Institute SB RAS in Russia and her research team contributed four papers which presented the mechanism of permafrost landslides located in the northern Russia where is close to the Arctic Polar plains from geomorphology, vegetation and geochemistry. They also carried out the classification and risk assessment of landslides. Prof. Tonglu Li who is from Chang'an University in China and his team studied the mechanism of landslides in the permafrost of Qinghai-Tibet Plateau and the seasonal frozen region in the Northwest of China. Dr. Shiwei Shen and Prof. Lei Nie who are from the Jilin University presented a fast stability evaluation method of collapse in sliding type slopes. Prof. Wei Shan and Dr. Hua Jiang who are from the Northeast Forestry University studied the mechanism and movement characteristics of landslides located in the degraded areas of high-latitude permafrost in the Northeast China based on the data of climate change, geological survey, and monitoring. Dr. Ying Guo analyzed the effect of seasonal frozen-thaw process on the stability of soil slope according to the data of field monitoring and laboratory experiments.

In the occasion of completion of this edited book, I would like to thank all colleagues of the network of landslide research in cold region of the ICL.

Sincerely, I extend special thanks to my old friend, Prof. Fawu Wang who is one of the founders of the ICL. I appreciate his continued support and help for 10 years. Also, I would like to thank Agata Oelschläger, Kiruthika Poomalai, Fermine Shaly and Shine David of Springer. Without their excellent work, this book cannot be published on time and with high editing quality. Nonetheless, all errors and bias remain ours.

This book is the part of research results of my colleagues and me. Indeed, it is far from perfect. With the deepening of our research, more attention and more colleagues who plan to contribute to the landslide research in cold region, we will offer more high-quality research results, which will be the great contribution for global disaster mitigation.

Shan Wei

Harbin, China, 21 June 2013

Wei Shan
Coordinator of ICL Landslides
in Cold Regions Network,
Professor of Northeast Forestry University

Contents