



Claudio Margottini
Paolo Canuti · Kyoji Sassa
Editors

Landslide Science and Practice

Volume 3
Spatial Analysis and Modelling



 Springer



Claudio Margottini
Paolo Canuti · Kyoji Sassa
Editors

Landslide Science and Practice

Volume 3
Spatial Analysis and Modelling



 Springer

Landslide Science and Practice

Claudio Margottini • Paolo Canuti • Kyoji Sassa
Editors

Landslide Science and Practice

Volume 3: Spatial Analysis and Modelling



Editors

Claudio Margottini
ISPRA - Italian Institute for
Environmental Protection and Research
Geological Survey of Italy
Rome, Italy

Paolo Canuti
ICL - International Consortium on Landslides
Florence, Italy

Kyoji Sassa
UNITWIN Headquarters Building
Kyoto University Uji Campus
Uji, Kyoto, Japan

Associate Editors

Filippo Catani
Department of Earth Sciences
University of Florence
Firenze, Italy

Alessandro Trigila
ISPRA - Italian Institute for
Environmental Protection and Research
Geological Survey of Italy
Rome, Italy

Additional material to Volume 1 can be downloaded from <http://extras.springer.com>

ISBN 978-3-642-31309-7 ISBN 978-3-642-31310-3 (eBook)
DOI 10.1007/978-3-642-31310-3
Springer Heidelberg New York Dordrecht London

Library of Congress Control Number: 2013932640

© Springer-Verlag Berlin Heidelberg 2013

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)

Preface

Landslide Science and Practice

Proceedings of the Second World Landslide Forum

The Second World Landslide Forum (**WLF**) was organized at the headquarters of the Food and Agriculture Organization of the United Nations (FAO), Rome, Italy, on 3–9 October 2011. WLF is a triennial mainstream conference of the International Programme on Landslides (**IPL**) which is jointly managed by the IPL Global Promotion Committee consisting of the International Consortium on Landslides (**ICL**), the United Nations Educational, Scientific and Cultural Organization (UNESCO), the World Meteorological Organization (WMO), the Food and Agriculture Organization of the United Nations (FAO), the United Nations International Strategy for Disaster Risk Reduction (UNISDR), the United Nations University (UNU), the International Council for Science (ICSU), and the World Federation of Engineering Organizations (WFEO).

Background to the World Landslide Forums

The International Consortium on Landslides (ICL) was established by the 2002 Kyoto Declaration “Establishment of an International Consortium on Landslides,” with the Statutes adopted in January 2002. The Statutes defined the **General Assembly** of ICL: In order to report and disseminate the activities and achievements of the consortium, a General Assembly shall be convened every 3 years by inviting Members of the International Consortium on Landslides, individual members within those organizations, and all levels of cooperating organizations and individual researchers, engineers, and administrators. The General Assembly will receive reports on Consortium activities and provide a forum for open discussion and new initiatives from all participants.

The First General Assembly 2005 to the First World Landslide Forum 2008

The First General Assembly was organized at the Keck Center of the National Academy of Sciences in Washington D.C., USA, on 12–14 October 2005. At this Assembly, the first full-color book reporting consortium activities for the initial 3 years, 2002–2005, was published as “Landslides-Risk analysis and sustainable disaster management” through Springer. The 2006 Tokyo Round-Table Discussion – “Strengthening Research and Learning on Earth System Risk Analysis and Sustainable Disaster Management within UN-ISDR as Regards Landslides” – toward a dynamic global network of the International Programme on Landslides (IPL) was held at the United Nations University, Tokyo, on 18–20 January 2006. **The 2006 Tokyo**

Action Plan – Strengthening research and learning on landslides and related earth system disasters for global risk preparedness – was adopted. The Tokyo Action Plan established a new global International Programme on Landslides (IPL) including holding World Landslide Forums. Accordingly, the Second General Assembly 2008 was replaced by the **First World Landslide Forum** and held at the United Nations University, Tokyo, Japan, on 18–21 November 2008.

Report of the Second World Landslide Forum

The Second World Landslide Forum – *Putting Science into Practice* – was organized at the Headquarters of the Food and Agriculture Organization of the United Nations (FAO) on 3–9 October 2011. It was jointly organized by the IPL Global Promotion Committee (ICL, UNESCO, WMO, FAO, UNISDR, UNU, ICSU, WFEO) and two ICL members in Italy: the Italian Institute for Environmental Protection and Research (ISPRA) and the Earth Science Department of the University of Florence with support from the Government of Italy and many Italian landslide-related organizations.

- 864 people from 63 countries participated. Attendance was larger than expected, and twice the attendance at the First World Landslide Forum 2008 in Tokyo (430 participants: 175 from Japan and 255 from abroad).
- 25 technical sessions were held, and 465 full papers were submitted. All accepted papers were edited in 7 volumes including this volume:
 1. Landslide Inventory and Susceptibility and Hazard Zoning
 2. Early Warning, Instrumentation and Monitoring
 3. **Spatial Analysis and Modeling – this volume**
 4. Global Environmental Change
 5. Complex Environment
 6. Risk Assessment, Management and Mitigation
 7. Social and Economic Impact and Policies

Requests of Cooperation for Further Development of ICL and IPL

ICL and IPL are global multidisciplinary and cross-sectoral initiatives to promote landslide science and capacity-development to reduce landslide disasters. The core activities of ICL and IPL are *Landslides: Journal of International Consortium on Landslides*, World Landslide Forum, and IPL projects. Thanks to worldwide support of the journal, the Impact Factor of *Landslides* was 2.216 for 2011 which is the highest within 30 ISI journals in category of Engineering, Geological. The journal will develop from a quarterly journal to a bimonthly journal from Vol. 10 in 2013. The Third World Landslide Forum – Landslide risk mitigation toward a safer geo-environment – at the China National Convention Center, Beijing, China, on 2–6 June (conference) and 7–11 June (Field Trip) 2014. The ICL entered into the second decade of its activities and organized a 10th anniversary Conference on 17–20 January 2012, in Kyoto, Japan. ICL adopted the ICL Strategic Plan 2012–2021, *To create a safer geo-environment-* as an outcome of this conference.

ICL is an international nongovernmental and nonprofit scientific organization promoting landslide research and capacity-building for the benefit of society and the environment, and is

the thematic landslides platform in the UNISDR Global Platform for Disaster Risk Reduction. ICL activities are supported by voluntary efforts of ICL members and supporting organizations. All people involving in landslide research and landslide disaster mitigation activities are requested to cooperate for the development of this initiative through its second decade 2012–2021. (<http://www.iplhq.org/> and <http://icl.iplhq.org/>).

We are deeply appreciative of all the Second World Landslide Forum participants and of the contributions from our UNESCO, WMO, FAO, UNISDR, UNU, ICSU, WFEO partners and all of our colleagues in ICL for the development of IPL up to now. Finally we address our sincere thanks to Filippo Catani and Alessandro Trigila (the associate editors) for their extensive efforts covering the technical sessions, and reviewing and editing the papers.

Claudio Margottini
Forum Chair



Paolo Canuti
President of ICL



Kyoji Sassa
Executive Director of ICL



ICL and IPL Secretariat

IPL office: UNITWIN headquarters Buildings, Kyoto University Uji Campus,
Uji, Kyoto 611-0011, Japan

ICL office: The Association for Disaster Prevention Research,
138-1 Tanaka Asukai-cho, Sakyo-ku, Kyoto 606-8226, Japan

Email: secretariat@iclhq.org

URL: <http://www.iplhq.org/> and <http://icl.iplhq.org/>

Organizational Structure of the Second World Landslide Forum

Organizers

IPL Global Promotion Committee including:

- International Consortium on Landslides (ICL) *
 - United Nations Educational, Scientific and Cultural Organization (UNESCO)
 - World Meteorological Organization (WMO)
 - Food and Agriculture Organization of the United Nations (FAO)
 - United Nations International Strategy for Disaster Risk Reduction (UNISDR)
 - United Nations University (UNU)
 - International Council for Science (ICSU)
 - World Federation of Engineering Organizations (WFEO)
 - Italian Institute for Environmental Protection and Research (ISPRA)
- (* Members are listed in the last page of this book)

Co-sponsors

- International Union of Geological Sciences (IUGS)
- International Union of Geodesy and Geophysics (IUGG)
- International Geographical Union (IGU)
- International Flood Initiative (IFI)

Under the Auspices of

- International Association for Engineering Geology and the Environment, Italian Section (IAEG)
- Italian Association of Engineering Geologists (AIGA)
- Italian Association of Geotechnique (AGI)
- Italian Association for Mining Engineers, Environment and Territory (ANIM)
- Italian Georesources and Environment Association (GEAM)

International Organizing Board

Honorary Chairpersons

- Irina BOKOVA (UNESCO Director-General)
- Catherine BRECHIGNAC (ICSU President)
- Jacques DIOUF (FAO Director-General)

- Michel JARRAUD (WMO Secretary-General)
- Maria P. LAFFARGUE (WFEO President)
- Konrad OSTERWALDER (UNU Rector)
- Bernardo DE BERNARDINIS (ISPRA President)
- UNISDR Director

Chairpersons

- Claudio MARGOTTINI (ISPRA, Forum Chair)
- Paolo CANUTI (ICL President)
- Kyoji SASSA (ICL Executive-Director)

Deputy Chairpersons

- Peter BOBROWSKY (IUGS Secretary General)
- Deliang CHEN (ICSU Executive Director)
- Peter LYTTLE (ICL Vice President, US Geological Survey)
- Eduardo ROJAS-BRIALES (Assistant Director General of FAO)
- Badaoui ROUHBAN (Director of UNESCO's Section for Disaster Reduction)
- Yueping YIN (ICL Vice President, China Geological Survey)

Scientific Advisory Board

Representing Organisation

- Irasema ALCANTARA-AYALA (Vice President of International Geographical Union - IGU)
- Walter AMMAN (President Davos Forum)
- Michael CROZIER (President of International Association of Geomorphologists - IAG)
- Carlos DELGADO (President of International Association of Engineering Geology - IAEG)
- Luca DEMICHELII (Secretary General of EuroGeoSurveys)
- John HARDING (United Nations Secretariat to International Strategy for Disaster Reduction - UNISDR)
- Srikantha HERATH (Senior Academic Programme Officer of the United Nations University - UNU)
- Thomas HOFER (Forestry officer, Food and Agriculture Organization of the United Nations - FAO)
- Yumio ISHII (Chair of the Committee on Disaster Risk Management of The World Federation of Engineering Organizations WFEO)
- Derek MARTIN (Vice President for North America of International Society for Rock Mechanics - ISRM)
- Howard MOORE (Senior Advisor, International Council for Science - ICSU)
- Pedro SECO E PINTO (Past President of International Society for Soil Mechanics and Geotechnical Engineering - ISSMGE)
- Luciano PICARELLI (Chairperson of the Joint Technical Committee on Landslides and Engineered slopes - JTC1 of ISSMGE, ISRM, IAEG)
- Kaoru TAKARA (Vice chairperson of the Intergovernmental Council of the International Hydrological Programme of UNESCO - IHP)
- Kuniyoshi TAKEUCHI (President of GeoRisk Commission of International Union of Geodesy and Geophysics - IUGG)

Landslide Experts

- Giovanni BARLA (Politecnico di Torino, Italy)
- R.K. BHANDARI (Consultant, India)
- Christophe BONNARD (Swiss Federal Institute of Technology, Lausanne, Switzerland)
- Nicola CASAGLI (University of Florence, Italy)
- Leonardo CASCINI (University of Salerno, Italy)
- Giovanni CROSTA (University of Milano Bicocca, Milano, Italy)
- Jordi COROMINAS (Technical University of Catalonia, Barcelona, Spain)
- Dave CRUDEN (University of Alberta, Edmonton, Alberta, Canada)
- Thomas GLADE (University of Vienna, Austria)
- Jerome DE GRAFF (United States Department of Agriculture , Fresno - Ca - USA)
- Michel HERMELIN (Universidad EAFIT, Medellin, Colombia)
- Ken HO (Hong Kong Geotechnical office, Hong Kong, China)
- Jurgen KROPP (Potsdam Institute for Climate Change - PIK, Potsdam, Germany)
- Richard M. IVERSON (United States Geological Survey - Vancouver, WA , USA)
- C. F. LEE (Hong Kong University, China)
- Jacques LOCAT (University of Laval, Canada)
- Paul MARINOS (University of Athens, Greece)
- Hideaki MARUI (Niigata University, Japan)
- Hormoz MODARESSI (BRGM, Orléans, France)
- Farrouk NADIM (Norwegian Geotechnical Institute - NGI, Oslo, Norway)
- Gabriele SCARASCIA MUGNOZZA (University of Rome, Italy)
- Wang SIJING (Tsinghua University, China)
- Vern SINGHROY (Canada Centre for Remote Sensing, Ottawa, Canada)
- Alexander STROM (Institute of Geospheres Dynamics, RAS, Moscow, Russia)
- Ikuo TOWHATA (University of Tokyo, Japan)
- Keith TURNER (Emeritus Professor, Colorado School of Mines, Denver, Colorado USA)
- Keizo UGAI (Gunma University, Kiryu, Gunma, Japan)
- Roger URGELES (Institut de Ciències del Mar - CSIC, Barcelona, Spain)
- Yasser el SHAYEB (Cairo University, Egypt)
- Sergio SEPULVEDA (University of Chile, Santiago)
- Mauro SOLDATI (University of Modena and Reggio Emilia, Italy)
- Pasquale VERSACE (Calabria University, Cosenza, Italy)
- Cees van WESTEN (ITC, Enschede, Netherlands)
- Kifle WOLDEAREGAY (University of Mekelle, Ethiopia)

Local Organizing Board

Forum Chairs

- Paolo CANUTI (ICL President - WLF2 Chairperson)
- Claudio MARGOTTINI (ISPRA - WLF2 Chairperson)
- Kyoji SASSA (ICL Secretary General - WLF2 Chairperson)

Scientific Programme Committee

- Luciano PICARELLI (Second University of Napoli)
- Marco AMANTI (ISPRA)
- Filippo CATANI (University of Firenze)
- Fausto GUZZETTI (CNR-IRPI)
- Javier HERVAS (JRC)

- Thomas HOFER (FAO)
- Carla IADANZA (ISPRA)
- Claudio MARGOTTINI (ISPRA - WLF2 Chairperson)
- Paolo TOMMASI (CNR-IGAG)
- Alessandro TRIGILA (ISPRA)

Editorial Committee

- Filippo CATANI (University of Firenze)
- Riccardo FANTI (University of Firenze)
- Fausto GUZZETTI (CNR-IRPI)
- Javier HERVAS (JRC)
- Irene RISCHIA (ISPRA)
- Gabriele SCARASCIA MUGNOZZA (Università di Roma "La Sapienza")
- Alessandro TRIGILA (ISPRA)

Logistic Committee

- Thomas HOFER (FAO)
- Claudio MARGOTTINI (ISPRA - WLF2 Chairperson)
- Orlando PANDOLFI (ECN)
- Luna GUBINELLI

Field Trips

- Gabriele SCARASCIA MUGNOZZA (University of Roma "La Sapienza")
- Giuseppe DELMONACO (ISPRA)
- Riccardo FANTI (University of Firenze)
- Irene RISCHIA (ISPRA)
- Daniele SPIZZICHINO (ISPRA)
- Paolo TOMMASI (CNR-IGAG)

Fund Raising and Exhibition

- Claudio MARGOTTINI (ISPRA - WLF2 Chairperson)
- Paolo FARINA (IDS SpA)
- Giorgio LOLLINO (CNR-IRPI)

Secretariat

ISPRA, Italian Institute for Environmental Protection and Research
Dept. Geological Survey of Italy, Via Vitaliano Brancati, 48-00144 Rome, Italy.

Logistics and Administration

Orlando PANDOLFI - ECN yourLIFE Foundation

Contents

Part I Advances in Slope Stability Modelling	
Introduction by Ken Ho, Filippo Catani, Giulio Iovine, and Alberto Ledesma	
Geomechanical Basis of Landslide Classification and Modelling of Triggering	3
Gianfrancesco Rocchi and Giovanni Vaciago	
Study of Shock Landslide-Type Geomechanical Model Test for Consequent Rock Slope	11
Xu Xiangning, Chen Yuliang, and Li Shengwen	
Landslide Processes in the Urbanized Moscow Area	17
Valentina Svalova	
Landslide Hazard Assessment Based on FS_{3D} Combined with an Infiltration Model	21
Aline Silva and Lázaro Zuquette	
Modelling the Motion of Mobile Debris Flows in Hong Kong	29
J.S.H. Kwan, T.H.H. Hui, and K.K.S. Ho	
Modeling Potential Shallow Landslides over Large Areas with SliDisp⁺	37
Daniel Tobler, Rachel Riner, and Robert Pfeifer	
Three Dimensional Stability Analysis of the Grohovo Landslide in Croatia	47
Chunxiang Wang, Željko Arbanas, Snježana Mihalić, and Hideaki Marui	
Mass Movement Classification Using Morphometric Parameters (Puebla, Mexico)	53
Veronica Ochoa-Tejeda, Parrot Jean-François, and Fort Monique	
The 2010 Muddy-Debris Flow of Anganguero (Mexico): Modelling and Simulation	61
Jean-François Parrot and Veronica Ochoa-Tejeda	
A Rock Fall Analysis Study in Parnassos Area, Central Greece	67
George Papathanassiou, Vasilis Marinos, Dimitris Vogiatzis, and Sotiris Valkaniotis	
<i>CM</i>SAKe: A Hydrological Model to Forecasting Landslide Activations	73
Oreste G. Terranova, Pasquale Iaquina, Stefano L. Gariano, Roberto Greco, and Giulio G.R. Iovine	
Shallow-Landslide Susceptibility in the Costa Viola Mountain Ridge (Italia)	81
Giulio G.R. Iovine, Roberto Greco, Stefano L. Gariano, Pasquale Iaquina, Annamaria Pellegrino, and Oreste G. Terranova	