

RISK ANALYSIS IX



WITPRESS

Editor
C.A. Brebbia

Risk Analysis IX



WIT*PRESS*

WIT Press publishes leading books in Science and Technology.
Visit our website for the current list of titles.
www.witpress.com

WIT*eLibrary*

Home of the Transactions of the Wessex Institute.
Papers presented at Risk Analysis 2014
are archived in the WIT eLibrary in volume 47 of WIT Transactions on
Information and Communication Technologies (ISSN 1743-3517).
The WIT eLibrary provides the international scientific community with immediate and per-
manent access to individual papers presented at WIT conferences.
<http://library.witpress.com>

Editor:

C.A. Brebbia

Wessex Institute of Technology, UK

Published by

WIT Press

Ashurst Lodge, Ashurst, Southampton, SO40 7AA, UK

Tel: 44 (0) 238 029 3223; Fax: 44 (0) 238 029 2853

E-Mail: witpress@witpress.com

<http://www.witpress.com>

For USA, Canada and Mexico

Computational Mechanics Inc

25 Bridge Street, Billerica, MA 01821, USA

Tel: 978 667 5841; Fax: 978 667 7582

E-Mail: infousa@witpress.com

<http://www.witpress.com>

British Library Cataloguing-in-Publication Data

A Catalogue record for this book is available
from the British Library

ISBN: 978-1-84564-792-6

eISBN: 978-1-84564-793-3

ISSN (print): 1746-4463

ISSN (online): 1743-3517

The texts of the papers in this volume were set individually by the authors or under their supervision. Only minor corrections to the text may have been carried out by the publisher.

No responsibility is assumed by the Publisher, the Editors and Authors for any injury and/or damage to persons or property as a matter of products liability, negligence or otherwise, or from any use or operation of any methods, products, instructions or ideas contained in the material herein. The Publisher does not necessarily endorse the ideas held, or views expressed by the Editors or Authors of the material contained in its publications.

© WIT Press 2014

Printed in Great Britain by Lightning Source, UK

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of the Publisher.

NINTH INTERNATIONAL CONFERENCE ON RISK ANALYSIS
AND HAZARD MITIGATION

RISK ANALYSIS IX

CONFERENCE CHAIRMAN

C.A. Brebbia

Wessex Institute of Technology, UK

INTERNATIONAL SCIENTIFIC ADVISORY COMMITTEE

A. Duarte
M. Esmaeil Zaei
A. Fabbri
S. Fuchs
Z-G. Ji
J. Lisowski
M.M. Portela
E. Uspuras

Organised by

Wessex Institute of Technology, UK

Sponsored by

WIT Transactions on Information and Communication Technologies

International Journal of Safety and Security Engineering

WIT Transactions

Transactions Editor

Carlos Brebbia

Wessex Institute of Technology
Ashurst Lodge, Ashurst
Southampton SO40 7AA, UK

Editorial Board

- | | |
|--|---|
| B Abersek University of Maribor, Slovenia | G Belingardi Politecnico di Torino, Italy |
| Y N Abousleiman University of Oklahoma, USA | R Belmans Katholieke Universiteit Leuven, Belgium |
| K S Al Jabri Sultan Qaboos University, Oman | C D Bertram The University of New South Wales, Australia |
| E Alarcon Universidad Politecnica de Madrid, Spain | D E Beskos University of Patras, Greece |
| C Alessandri Universita di Ferrara, Italy | S K Bhattacharyya Indian Institute of Technology, India |
| D Almorza Gomar University of Cadiz, Spain | E Blums Latvian Academy of Sciences, Latvia |
| B Alzahabi Kettering University, USA | J Boarder Cartref Consulting Systems, UK |
| J A C Ambrosio IDMEC, Portugal | B Bobee Institut National de la Recherche Scientifique, Canada |
| A M Amer Cairo University, Egypt | H Boileau ESIGEC, France |
| S A Anagnostopoulos University of Patras, Greece | M Bonnet Ecole Polytechnique, France |
| M Andretta Montecatini, Italy | C A Borrego University of Aveiro, Portugal |
| E Angelino A.R.P.A. Lombardia, Italy | A R Bretones University of Granada, Spain |
| H Antes Technische Universitat Braunschweig, Germany | J A Bryant University of Exeter, UK |
| M A Atherton South Bank University, UK | F-G Buchholz Universitat Gesanthochschule Paderborn, Germany |
| A G Atkins University of Reading, UK | M B Bush The University of Western Australia, Australia |
| D Aubry Ecole Centrale de Paris, France | F Butera Politecnico di Milano, Italy |
| J Augutis Vytautas Magnus University, Lithuania | W Cantwell Liverpool University, UK |
| H Azegami Toyohashi University of Technology, Japan | D J Cartwright Bucknell University, USA |
| A F M Azevedo University of Porto, Portugal | P G Carydis National Technical University of Athens, Greece |
| J M Baldasano Universitat Politecnica de Catalunya, Spain | J J Casares Long Universidad de Santiago de Compostela, Spain |
| J G Bartzis Institute of Nuclear Technology, Greece | M A Celia Princeton University, USA |
| S Basbas Aristotle University of Thessaloniki, Greece | A Chakrabarti Indian Institute of Science, India |
| A Bejan Duke University, USA | |
| M P Bekakos Democritus University of Thrace, Greece | |

- J-T Chen** National Taiwan Ocean University, Taiwan
- A H-D Cheng** University of Mississippi, USA
- J Chilton** University of Lincoln, UK
- C-L Chiu** University of Pittsburgh, USA
- H Choi** Kangnung National University, Korea
- A Cieslak** Technical University of Lodz, Poland
- S Clement** Transport System Centre, Australia
- M W Collins** Brunel University, UK
- J J Connor** Massachusetts Institute of Technology, USA
- M C Constantinou** State University of New York at Buffalo, USA
- D E Cormack** University of Toronto, Canada
- D F Cutler** Royal Botanic Gardens, UK
- W Czyczula** Krakow University of Technology, Poland
- M da Conceicao Cunha** University of Coimbra, Portugal
- L Dávid** Károly Róbert College, Hungary
- A Davies** University of Hertfordshire, UK
- M Davis** Temple University, USA
- A B de Almeida** Instituto Superior Tecnico, Portugal
- E R de Arantes e Oliveira** Instituto Superior Tecnico, Portugal
- L De Biase** University of Milan, Italy
- R de Borst** Delft University of Technology, Netherlands
- G De Mey** University of Ghent, Belgium
- A De Montis** Università di Cagliari, Italy
- A De Naeyer** Universiteit Ghent, Belgium
- P De Wilde** Vrije Universiteit Brussel, Belgium
- D De Wrachien** State University of Milan, Italy
- L Debnath** University of Texas-Pan American, USA
- G Degrande** Katholieke Universiteit Leuven, Belgium
- S del Giudice** University of Udine, Italy
- G Deplano** Università di Cagliari, Italy
- I Doltsinis** University of Stuttgart, Germany
- M Domaszewski** Université de Technologie de Belfort-Montbéliard, France
- J Dominguez** University of Seville, Spain
- K Dorow** Pacific Northwest National Laboratory, USA
- W Dover** University College London, UK
- C Dowlen** South Bank University, UK
- J P du Plessis** University of Stellenbosch, South Africa
- R Duffell** University of Hertfordshire, UK
- N A Dumont** PUC-Rio, Brazil
- A Ebel** University of Cologne, Germany
- G K Egan** Monash University, Australia
- K M Elawadly** Alexandria University, Egypt
- K-H Elmer** Universität Hannover, Germany
- D Elms** University of Canterbury, New Zealand
- M E M El-Sayed** Kettering University, USA
- D M Elsom** Oxford Brookes University, UK
- F Erdogan** Lehigh University, USA
- D J Evans** Nottingham Trent University, UK
- J W Everett** Rowan University, USA
- M Faghri** University of Rhode Island, USA
- R A Falconer** Cardiff University, UK
- M N Fardis** University of Patras, Greece
- P Fedelinski** Silesian Technical University, Poland
- H J S Fernando** Arizona State University, USA
- S Finger** Carnegie Mellon University, USA
- E M M Fonseca** Instituto Politécnico de Bragança, Portugal
- J I Frankel** University of Tennessee, USA
- D M Fraser** University of Cape Town, South Africa
- M J Fritzler** University of Calgary, Canada
- T Futagami** Hiroshima Institute of Technology, Japan
- U Gabbert** Otto-von-Guericke Universität Magdeburg, Germany
- G Gambolati** Università di Padova, Italy
- C J Gantes** National Technical University of Athens, Greece
- L Gaul** Universität Stuttgart, Germany
- A Genco** University of Palermo, Italy
- N Georgantzis** Universität Jaume I, Spain
- P Giudici** Università di Pavia, Italy

- L M C Godinho** University of Coimbra, Portugal
- F Gomez** Universidad Politecnica de Valencia, Spain
- R Gomez** Martin University of Granada, Spain
- D Goulias** University of Maryland, USA
- K G Goulias** Pennsylvania State University, USA
- F Grandori** Politecnico di Milano, Italy
- W E Grant** Texas A & M University, USA
- S Grilli** University of Rhode Island, USA
- R H J Grimshaw** Loughborough University, UK
- D Gross** Technische Hochschule Darmstadt, Germany
- R Grundmann** Technische Universitat Dresden, Germany
- A Gualtierotti** IDHEAP, Switzerland
- O T Gudmestad** University of Stavanger, Norway
- R C Gupta** National University of Singapore, Singapore
- J M Hale** University of Newcastle, UK
- K Hameyer** Katholieke Universiteit Leuven, Belgium
- C Hanke** Danish Technical University, Denmark
- K Hayami** University of Tokyo, Japan
- Y Hayashi** Nagoya University, Japan
- L Haydock** Newage International Limited, UK
- A H Hendrickx** Free University of Brussels, Belgium
- C Herman** John Hopkins University, USA
- I Hideaki** Nagoya University, Japan
- D A Hills** University of Oxford, UK
- W F Huebner** Southwest Research Institute, USA
- J A C Humphrey** Bucknell University, USA
- M Y Hussaini** Florida State University, USA
- W Hutchinson** Edith Cowan University, Australia
- T H Hyde** University of Nottingham, UK
- M Iguchi** Science University of Tokyo, Japan
- D B Ingham** University of Leeds, UK
- L Int Panis** VITO Expertisecentrum IMS, Belgium
- N Ishikawa** National Defence Academy, Japan
- J Jaafar** UiTm, Malaysia
- W Jager** Technical University of Dresden, Germany
- Y Jaluria** Rutgers University, USA
- C M Jefferson** University of the West of England, UK
- P R Johnston** Griffith University, Australia
- D R H Jones** University of Cambridge, UK
- N Jones** University of Liverpool, UK
- N Jovanovic** CSIR, South Africa
- D Kaliampakos** National Technical University of Athens, Greece
- N Kamiya** Nagoya University, Japan
- D L Karabalis** University of Patras, Greece
- A Karageorghis** University of Cyprus
- M Karlsson** Linkoping University, Sweden
- T Katayama** Doshisha University, Japan
- K L Katsifarakis** Aristotle University of Thessaloniki, Greece
- J T Katsikadelis** National Technical University of Athens, Greece
- E Kausel** Massachusetts Institute of Technology, USA
- H Kawashima** The University of Tokyo, Japan
- B A Kazimee** Washington State University, USA
- S Kim** University of Wisconsin-Madison, USA
- D Kirkland** Nicholas Grimshaw & Partners Ltd, UK
- E Kita** Nagoya University, Japan
- A S Kobayashi** University of Washington, USA
- T Kobayashi** University of Tokyo, Japan
- D Koga** Saga University, Japan
- S Kotake** University of Tokyo, Japan
- A N Kounadis** National Technical University of Athens, Greece
- W B Kratzig** Ruhr Universitat Bochum, Germany
- T Krauthammer** Penn State University, USA
- C-H Lai** University of Greenwich, UK
- M Langseth** Norwegian University of Science and Technology, Norway
- B S Larsen** Technical University of Denmark, Denmark

- F Lattarulo** Politecnico di Bari, Italy
A Lebedev Moscow State University, Russia
L J Leon University of Montreal, Canada
D Lesnic University of Leeds, UK
D Lewis Mississippi State University, USA
S Ighobashi University of California Irvine, USA
K-C Lin University of New Brunswick, Canada
A A Liolios Democritus University of Thrace, Greece
S Lomov Katholieke Universiteit Leuven, Belgium
J W S Longhurst University of the West of England, UK
G Loo The University of Auckland, New Zealand
J Lourenco Universidade do Minho, Portugal
J E Luco University of California at San Diego, USA
H Lui State Seismological Bureau Harbin, China
C J Lumsden University of Toronto, Canada
L Lundqvist Division of Transport and Location Analysis, Sweden
T Lyons Murdoch University, Australia
Y-W Mai University of Sydney, Australia
M Majowiecki University of Bologna, Italy
D Malerba Università degli Studi di Bari, Italy
G Manara University of Pisa, Italy
S Mambretti Politecnico di Milano, Italy
B N Mandal Indian Statistical Institute, India
Ü Mander University of Tartu, Estonia
H A Mang Technische Universität Wien, Austria
G D Manolis Aristotle University of Thessaloniki, Greece
W J Mansur COPPE/UFRJ, Brazil
N Marchettini University of Siena, Italy
J D M Marsh Griffith University, Australia
J F Martin-Duque Universidad Complutense, Spain
T Matsui Nagoya University, Japan
G Mattrisch DaimlerChrysler AG, Germany
F M Mazzolani University of Naples "Federico II", Italy
K McManis University of New Orleans, USA
A C Mendes Universidade de Beira Interior, Portugal
R A Meric Research Institute for Basic Sciences, Turkey
J Mikielawicz Polish Academy of Sciences, Poland
N Milic-Frayling Microsoft Research Ltd, UK
R A W Mines University of Liverpool, UK
C A Mitchell University of Sydney, Australia
K Miura Kajima Corporation, Japan
A Miyamoto Yamaguchi University, Japan
T Miyoshi Kobe University, Japan
G Molinari University of Genoa, Italy
T B Moodie University of Alberta, Canada
D B Murray Trinity College Dublin, Ireland
G Nakhaeizadeh DaimlerChrysler AG, Germany
M B Neace Mercer University, USA
D Neculescu University of Ottawa, Canada
F Neumann University of Vienna, Austria
S-I Nishida Saga University, Japan
H Nisitani Kyushu Sangyo University, Japan
B Notaros University of Massachusetts, USA
P O'Donoghue University College Dublin, Ireland
R O O'Neill Oak Ridge National Laboratory, USA
M Ohkusu Kyushu University, Japan
G Oliveto Università di Catania, Italy
R Olsen Camp Dresser & McKee Inc., USA
E Oñate Universitat Politècnica de Catalunya, Spain
K Onishi Ibaraki University, Japan
P H Oosthuizen Queens University, Canada
E L Ortiz Imperial College London, UK
E Outa Waseda University, Japan
A S Papageorgiou Rensselaer Polytechnic Institute, USA
J Park Seoul National University, Korea
G Passerini Università delle Marche, Italy
F Patania University of Catania, Italy
B C Patten University of Georgia, USA

- G Pelosi** University of Florence, Italy
- G G Penelis** Aristotle University of Thessaloniki, Greece
- W Perrie** Bedford Institute of Oceanography, Canada
- R Pietrabissa** Politecnico di Milano, Italy
- H Pina** Instituto Superior Tecnico, Portugal
- M F Platzer** Naval Postgraduate School, USA
- D Poljak** University of Split, Croatia
- H Power** University of Nottingham, UK
- D Prandle** Proudman Oceanographic Laboratory, UK
- M Predeleanu** University Paris VI, France
- I S Putra** Institute of Technology Bandung, Indonesia
- Y A Pykh** Russian Academy of Sciences, Russia
- F Rachidi** EMC Group, Switzerland
- M Rahman** Dalhousie University, Canada
- K R Rajagopal** Texas A & M University, USA
- T Rang** Tallinn Technical University, Estonia
- J Rao** Case Western Reserve University, USA
- J Ravnik** University of Maribor, Slovenia
- A M Reinhorn** State University of New York at Buffalo, USA
- G Reniers** Universiteit Antwerpen, Belgium
- A D Rey** McGill University, Canada
- D N Riahi** University of Illinois at Urbana-Champaign, USA
- B Ribas** Spanish National Centre for Environmental Health, Spain
- K Richter** Graz University of Technology, Austria
- S Rinaldi** Politecnico di Milano, Italy
- F Robuste** Universitat Politecnica de Catalunya, Spain
- J Roddick** Flinders University, Australia
- A C Rodrigues** Universidade Nova de Lisboa, Portugal
- F Rodrigues** Poly Institute of Porto, Portugal
- G R Rodríguez** Universidad de Las Palmas de Gran Canaria, Spain
- C W Roeder** University of Washington, USA
- J M Roeset** Texas A & M University, USA
- W Roetzel** Universitaet der Bundeswehr Hamburg, Germany
- V Roje** University of Split, Croatia
- R Rosset** Laboratoire d'Aerologie, France
- J L Rubio** Centro de Investigaciones sobre Desertificacion, Spain
- T J Rudolphi** Iowa State University, USA
- S Russenckuck** Magnet Group, Switzerland
- H Ryssel** Fraunhofer Institut Integrierte Schaltungen, Germany
- S G Saad** American University in Cairo, Egypt
- M Saiidi** University of Nevada-Reno, USA
- R San Jose** Technical University of Madrid, Spain
- F J Sanchez-Sesma** Instituto Mexicano del Petroleo, Mexico
- B Sarler** Nova Gorica Polytechnic, Slovenia
- S A Savidis** Technische Universitat Berlin, Germany
- A Savini** Universita de Pavia, Italy
- G Schmid** Ruhr-Universitat Bochum, Germany
- R Schmidt** RWTH Aachen, Germany
- B Scholtes** Universitaet of Kassel, Germany
- W Schreiber** University of Alabama, USA
- A P S Selvadurai** McGill University, Canada
- J J Sendra** University of Seville, Spain
- J J Sharp** Memorial University of Newfoundland, Canada
- Q Shen** Massachusetts Institute of Technology, USA
- X Shixiong** Fudan University, China
- G C Sih** Lehigh University, USA
- L C Simoes** University of Coimbra, Portugal
- A C Singhal** Arizona State University, USA
- P Skerget** University of Maribor, Slovenia
- J Sladek** Slovak Academy of Sciences, Slovakia
- V Sladek** Slovak Academy of Sciences, Slovakia
- A C M Sousa** University of New Brunswick, Canada
- H Sozer** Illinois Institute of Technology, USA

D B Spalding CHAM, UK
P D Spanos Rice University, USA
T Speck Albert-Ludwigs-Universitaet
 Freiburg, Germany
C C Spyarakos National Technical
 University of Athens, Greece
I V Stangeeva St Petersburg University,
 Russia
J Stasiek Technical University of Gdansk,
 Poland
G E Swaters University of Alberta, Canada
S Syngellakis Wessex Institute of
 Technology, UK
J Szymd University of Mining and
 Metallurgy, Poland
S T Tadano Hokkaido University, Japan
H Takemiya Okayama University, Japan
I Takewaki Kyoto University, Japan
C-L Tan Carleton University, Canada
E Taniguchi Kyoto University, Japan
S Tanimura Aichi University of
 Technology, Japan
J L Tassoulas University of Texas at
 Austin, USA
M A P Taylor University of South
 Australia, Australia
A Terranova Politecnico di Milano, Italy
A G Tijhuis Technische Universiteit
 Eindhoven, Netherlands
T Tirabassi Institute FISBAT-CNR, Italy
S Tkachenko Otto-von-Guericke-
 University, Germany
N Tosaka Nihon University, Japan
T Tran-Cong University of Southern
 Queensland, Australia
R Tremblay Ecole Polytechnique, Canada
I Tsukrov University of New Hampshire,
 USA
R Turra CINECA Interuniversity Computing
 Centre, Italy
S G Tushinski Moscow State University,
 Russia
J-L Uso Universitat Jaume I, Spain
E Van den Bulck Katholieke Universiteit
 Leuven, Belgium
D Van den Poel Ghent University, Belgium
R van der Heijden Radboud University,
 Netherlands
R van Duin Delft University of
 Technology, Netherlands
P Vas University of Aberdeen, UK
R Verhoeven Ghent University, Belgium
A Viguri Universitat Jaume I, Spain
Y Villacampa Esteve Universidad de
 Alicante, Spain
F F V Vincent University of Bath, UK
S Walker Imperial College, UK
G Walters University of Exeter, UK
B Weiss University of Vienna, Austria
H Westphal University of Magdeburg,
 Germany
J R Whiteman Brunel University, UK
T W Wu University of Kentucky, USA
Z-Y Yan Peking University, China
S Yanniotis Agricultural University of
 Athens, Greece
A Yeh University of Hong Kong, China
B W Yeigh SUNY Institute of Technology,
 USA
J Yoon Old Dominion University, USA
K Yoshizato Hiroshima University, Japan
T X Yu Hong Kong University of Science
 & Technology, Hong Kong
M Zador Technical University of Budapest,
 Hungary
K Zakrzewski Politechnika Lodzka, Poland
M Zamir University of Western Ontario,
 Canada
G Zappalà CNR-IAMC, Italy
R Zarnic University of Ljubljana, Slovenia
G Zharkova Institute of Theoretical and
 Applied Mechanics, Russia
N Zhong Maebashi Institute of
 Technology, Japan
H G Zimmermann Siemens AG, Germany
R Zainal Abidin Infrastructure University
 Kuala Lumpur(IUKL), Malaysia

Risk Analysis IX

Editor

C.A. Brebbia

Wessex Institute of Technology, UK

WITPRESS Southampton, Boston



Preface

This book contains papers presented at the ninth International Conference on Computer Simulation in Risk Analysis and Hazard Mitigation (RISK 2014) held in the New Forest, UK, home of the Wessex Institute of Technology. The Meeting was organised by the Institute and sponsored by the International Journal of Safety and Security Engineering.

This series of conferences started in 1998 when the first meeting was held in Valencia (1998), to be continued in Bologna (2000), Sintra (2002), Rhodes (2004), Malta (2006), Cephalonia (2008), The Algarve (2010); and on the island of Brac in Croatia in 2012.

Risk 2014, as the previous conferences, covered all aspects of risk management and hazard mitigation, associated with both natural and anthropogenic hazards.

Current events help to emphasise the importance of the analysis and management of risk to planners and researchers around the world. Natural hazards such as floods, earthquakes, landslides, fires and others have always affected human societies. The more recent emergence of the importance of man-made hazards, is a consequence of the rapid technological advances made in the last few centuries. The interaction of natural and anthropogenic risks adds to the complexity of the problems.

The papers presented at the Conference covered a variety of topics related to risk analysis and hazard mitigation. They are published in this Volume 47 of Transactions of Information and Communications Technologies; which is widely disseminated around the world in both hard cover and digital formats. Furthermore all the papers are also archived in the WIT eLibrary (<http://library.witpress.com>) where they are immediately and permanently available to the international scientific community.

The Editor is indebted to the members of the International Scientific Advisory Committee and other colleagues who contributed to selecting the papers included in the Volume, as well as all authors for their contributions.

The Editor
The New Forest, UK 2014

Contents

Section 1: Risk analysis and assessment

On spatial uncertainty in hazard and risk assessment <i>A. G. Fabbri & C.-J. Chung</i>	3
Catastrophic oil spill analysis <i>Z.-G. Ji, W. Johnson & G. Wikel</i>	17
The acceptability of risks from natural disasters <i>D. J. Higson</i>	27
The principle of Defence-in-Depth in the perspective of Probabilistic Safety Analyses in the wake of Fukushima <i>J. Vitázková & E. Cazzoli</i>	35
Analysis of annual flood peak records in Mexico <i>C. Escalante-Sandoval & E. Garcia-Espinoza</i>	49
A preliminary flood-risk assessment of municipalities located in headwater basins of Slovakia based on the integrated approach <i>L. Solín, P. Skubínčan & M. Madajová</i>	61
Seismic risk assessment of reinforced concrete buildings <i>C. S. Dragomir & A. S. Tronac</i>	73
Seismic risk assessment of three types of exterior beam-column joints using fragility curves <i>N. H. Hamid & S. A. Anuar</i>	85
A low-cost instrumentation approach for seismic hazard assessment in urban areas <i>C. Z. Karakostas & V. K. Papanikolaou</i>	97

Innovative modeling methodology for mapping of radon potential based on local relationships between indoor radon measurements and environmental geology factors <i>S. De Novellis, A. Pasculli & S. Palermi</i>	109
A novel tool for risk assessment related to chemical attacks <i>Y. Malmén, H. Joki & J. S. Jensen</i>	121
Environmental risk assessment of cement dust on soils and vegetables in an urban city of South Western Nigeria <i>T. A. Laniyan, A. S. Olatunji & O. G. Fagade</i>	133
A game-theoretic approach to assess adversarial risks <i>S. Meng, M. Wiens & F. Schultmann</i>	141
Earthquake damage assessment: a theoretical framework and its application to Algerian buildings <i>M. Boukri, M. N. Farsi, A. Mébarki & M. Belazougui</i>	153
A kernel density smoothing method for determining an optimal number of clusters in continuous data <i>J. Bugrien, K. Mwitondi & F. Shuweihdi</i>	165
Fuzzy Consensus Qualitative Risk Analysis as a framework for the evaluation of risk events in real estate development projects <i>A. M. Aboushady & S. A. R. El-Sawy</i>	179
Fire risk analysis with a performance-based fire safety engineering approach and FDS models for underground facilities in Gran Sasso National Laboratories <i>M. Tobia, R. Tartaglia, A. Giampaoli, R. Perruzza & G. Farina</i>	193
Hydrogen sulphide mapping study for existing facilities <i>S. Al Rawahi & J. Al Harthi</i>	205

Section 2: Risk management

A methodology to compare risk management (RM) systems for the application and validation of specific threats in public transportation <i>C. Baumgarten, F. Brauner, C. Bentler, O. A. Mudimu & A. Lechleuthner</i>	219
--	-----

Assessing the economic impacts of crises: a decision-support approach to long-term strategic planning <i>M. Rääkkönen, K. Pilli-Sihvola, S. Kunttu, J. Yliaho, M. Jähi, G. Zuccaro & D. Del Cogliano</i>	229
--	-----

Estimating post- and pre-mitigation contingency in construction <i>A. Salah & O. Moselhi</i>	243
---	-----

Crew Resource Management and its possible role in nursing risk management <i>I. R. McAndrew & G. P. Wise</i>	251
--	-----

Decision structuring method for the selection of fixed firefighting systems: development and lessons learned from case studies <i>S. N. Bird, K. Ruikar, L. Bosher, J. Glockling & N. M. Bouchlaghem</i>	263
--	-----

Section 3: Hazard prevention, management and control

The roadmap towards a holistic safety culture based on an integrated environmental health and safety solution landscape <i>B. Freibott</i>	277
--	-----

A systematic approach to risk reduction measures in the Norwegian offshore oil and gas industry <i>A. Sevcik & O. T. Gudmestad</i>	287
--	-----

A review of collective protective measures for workers in contaminated sites <i>A. Ledda, S. Berardi & E. Bemporad</i>	307
--	-----

Section 4: Vulnerability assessment

A gas supply system criticality assessment <i>B. Jokšas, I. Žutautaitė & E. Ušpuras</i>	321
--	-----

The corrosion of stirrups and its effect on the seismic fragility of a corroded reinforced concrete (RC) column <i>Guanghui Zhang & Bing Li</i>	331
---	-----

Section 5: Disaster management

Assessment of the flood disaster management plans for the medical services in Tokyo and Fukuoka, Japan <i>M. Takezawa, H. Gotoh, K. Suzuki, Y. Takehi & T. Yamamoto</i>	345
---	-----

Tsunami flood risk prediction using a neural network <i>H. Gotoh & M. Takezawa</i>	357
---	-----

A disaster severity assessment decision support tool for reducing the risk of failure in response operations <i>S. Hasani, R. El-Haddadeh & E. Aktas</i>	369
--	-----

Actions, diagnosis and territorial management of the disaster in the city of Lorca after the earthquake of May 11, 2011 <i>S. G. Veintimilla & A. T. Espín</i>	381
--	-----

Creating common operational pictures for disaster response with collaborative work <i>T. Chen, G. Su & H. Yuan</i>	393
--	-----

A networking solution for disaster management to address liaison failures in emergency response <i>A. V. Singhal, A. Jha & A. Gairola</i>	401
---	-----

Section 6: Emergency management

Emergency management and an emergency plan for the Gran Sasso National Laboratories: underground laboratories and motorway tunnels <i>A. Giampaoli, R. Perruzza, M. Tobia & R. Tartaglia</i>	417
---	-----

Emergency preparedness of the Czech Red Cross <i>L. Balarinová, J. Dostál, D. Tučková & K. Ivanová</i>	429
---	-----

Section 7: Flood hazards

Case study: flood impact reduction <i>Y. Peddemors & B. Willemse</i>	441
Determination of the weighting factors of criteria influencing highway flooding using Multi Criteria Analysis based on an Analytic Hierarchy Process <i>S. Budhagooncharoen & B. Dhabhisara</i>	451

Section 8: Safety and security

The safety of marine navigation based on a game theory <i>J. Lisowski</i>	467
--	-----

Bridging the safety-security software gap
C. W. Axelrod 479

Just and safe housing for informal settlers in the developing world
J. Cuadra, M. Samples, R. Brower & J. Dilling 487

Safety assurance for a signalling system based on quality management
F. Yan 499

Circuit model of medical equipment for electrical safety purposes
E. Zennaro, C. Mazzetti, F. Fiamingo & G. L. Amicucci 507

Mitigating safety risk through confidential reporting
C. Langer 519

Author index 531