The Chilean Earthquake and Tsunami 2010

A Multidisciplinary Study of M_w8.8, Maule

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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

WIT Press
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: 978-1-84564-670-7
eISBN: 978-1-84564-671-4

Library of Congress Catalog Card Number: 2012940801

Printed by Print on Demand Worldwide, UK.

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Introduction

This book discusses the last Chilean earthquake which occurred on 27 February 2010. It happened at the end of summer vacations reaching a magnitude of 8.8 M_w with its epicentre in Cobquecura, in the BíoBío region. This phenomenon mainly affected the central Chile area which comprises of the regions of Araucanía, Biobio, Maule, General O'Higgins, Valparaíso and Metropolitan. At that date it was the fifth largest earthquake ever to have occurred on a worldwide scale. This book is organized in six chapters written by remarkable authors from different disciplines thus presenting a comprehensive view of the occurrence. The texts come from the fields of geophysics, hydromechanical engineering, telecommunication, geographic information systems, urban and design planning, building engineering, architecture and urbanism. Authors come from academia and the public and private sectors to give an idea of complementary approaches that range from theoretical descriptions to practice and emergency solutions.

In Chapter 1, Mora-Stock and Rabbel start with a geophysical description of recent 8.8 M_w earthquake located at the border of Maule region. In particular, it analyzes the subduction phenomena of the oceanic Nazca plate under the continental South American plate along the Pacific coast in Central Chile. It studies aftershock for an understanding of the subduction processes to improve the knowledge of earthquake-resistant construction. They state that Chile is one of the most seismically active countries in the world because it is located in the so-called "Ring of Fire" region which corresponds to the subduction zones along the coasts of the Pacific Ocean. This chapter also claims that the high magnitude was due to the release of energy accumulated in the Concepción–Constitución seismic gap contained since 1835. Interesting images clearly show the geographical scope of the earthquake in the Chilean territory.

In Chapter 2, Morales *et al*. discuss about tools. Tools such as remote sensing and geographical information systems provide a view of the surface of the Earth at different scales of observation whether spatial or temporal. This chapter studies damages caused by natural disasters such as earthquakes and tsunamis. Accurate analysis shows the spatial extent of damage from satellite observations before and after the event occurred on 27 February 2010. It starts with an overview of current remote sensing techniques applied for management of disasters and its implications on civic infrastructure, evacuation zones, buildings and settlements location. Impressive images are provided to compare multi-temporal scenes to detect changes

in a land surface and to generate maps to aid decision-making. Satellite images from cities such as Concepción, Santiago and Talca allow the discriminating damage areas at the level of local buildings, larger sites and whole sectors. Mapping through GIS provides an order of magnitude to calculate emergency housing and community subsidies to assist the victims.

In Chapter 3, Cisternas introduces a solid conceptual framework of tsunamis stating that they are part of the dynamics of the Earth just as they were in ancient times, and as they will continue to belong to our lives in the future. The author states that waves involving the whole depth of the ocean are mainly excited by earthquakes and may be estimated by W-phase method to give swift warning. He analyzes the three largest tsunamis in the last 50 years: 1960 in Valdivia Chile, 2004 in Sumatra Indonesia and 2011 in Tohoku Japan. He argues that tsunami measurements are necessary for quantitative modelling and for the establishment of regulations in the design of coastal cities and evacuation. Images of the concepts of tsunamis and complete equations to measure waves of tsunamis are provided. Amazing images of the displacement of ships, buildings, cars, and civic infrastructure are showed as well as locations on the waterfront risk area of public buildings and settlements. The author poses the challenge for new regulation measures.

In Chapter 4, Veas Brokering and Cárdenas start with historical reviews of earthquakes in Chile for the last 3/4 century to assert that this country is one of the most seismic in the world. The authors argue that seismic legislation has been built through a long national history of disaster and reconstruction learning. Issues such as urban planning, building structures, open spaces, heritage and architectural design are dealt with to show evidence of change after earthquakes. Adaptation measures from architecture and urbanism have been developed so as to be better prepared for the next natural disaster. Ordinances and rules related to those issues have been enshrined by law as a result of the learning experience which is detailed in this chapter. The recent tsunami provoked by the 2010 earthquake resulted in a change in the "Town Planning and Construction Ordinance" regulations, incorporating potential flooding areas by tsunamis. Impressive images of damages by the earthquake and tsunami are used to give an idea of its order of magnitude. In addition superb examples of Chilean seismic technology just applied to new building such as high-rise offices, shopping and health centres before the 8.8 M_w earthquake occurred on 27 February 2010 are presented. A positive experience is recorded as the new technology passed the test.

In Chapter 5, Cartes poses that the inconsistency of urban planning along the Chilean coastal cities is at fault because there is no law to protect areas with potential to be affected by natural disasters such as tsunamis. Despite Chile's long history of large earthquakes and the tsunamis provoked by them, Town Planning and Construction Ordinance has never considered them. One of the most devastating areas was the Biobio region both by earthquake and tsunami as these cities are closer to the epicentre, the impact is higher. The reconstruction process of coastal cities in the north of the region is exposed considering three principle elements: sustainability, participation and resilience. Trigger projects constituted poles of redevelopment inserted in master plans. All of them agreed on by the community and funded by

a variety of investment programmes guarantee safety and quality of life for people and heritage. An urban design scheme in the coastal city of Dichato is provided as a strategy in the planning process.

In Chapter 6, Ramiro *et al.* reveal an unexpected problem of telecommunication by Internet. An important percentage of the Chilean networks were unreachable from outside of Chile. In others words, Chilean Internet stopped working while the rest of the telecommunication services continued running. A study of this failure is presented with a discussion of the effects it had and some proposals to avoid a similar occurrence in the future. An important percentage of the prefixes disappeared from the global routing table for many hours. The authors discovered that 64% of the Chilean IP address space was not reachable from any of its 13 routers. Evidence of this unpublished discovery is shown in this chapter along with table, graphs and a testimony from an engineer involved in NIC Chile Research Labs.

Special acknowledgements are given to Athel and Mariluz for their support and patience in checking the English grammar.

Luz Alicia Cárdenas Jirón
Editor