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Volume 14

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Tsunamis and Earthquakes in Coastal Environments

Significance and Restoration

 Springer

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Foreword

Coastal zones are valuable areas where sea, land, and atmosphere meet. They are characterized by coastal topography and nearshore waves which drive various dynamic processes to interact with each other. The coastal topography serves as the basis of the environment, in which waves will break and produce turbulent mixing, dissipating wave energy and providing a wealthy coastal zone utilized by many ecosystems for various activities. In the coastal zone, vigorous sediment movement due to nearshore waves continuously changes the topography which protects land from flooding. Coastal environments based on coastal topography are therefore important in coastal hazard mitigation as well as sustainability of society. However, coastal environments are highly variable in broad timescales from minutes to decades, affected by natural and anthropogenic impacts from both the ocean and the land.

Coastal erosion is accelerating on many coasts all over the world. Water pollution and eutrophication are degrading coastal environments in semi-enclosed bays backed by megacities. Understanding the cumulative impact of these types of environmental degradation is difficult since the transport of sediment and nutrients is affected not only by waves, currents, and topography in the coastal zone but also by various inland natural and anthropogenic changes that lead to the increase and decrease of materials delivered to the coast. The impact is sometimes rapid urbanization far from the coastal zone. The response is sometimes delayed as long as several decades.

Large tsunamis and earthquakes are infrequent natural events capable of causing large-scale destruction along coastal areas by heavily altering their physical and environmental characteristics. Although coastlines are naturally highly dynamic systems, these events cause dramatic changes in estuaries, coastal lagoons, tidal flats, wetlands, and beaches resulting in large alterations in their morphology, sediment, depth, water quality, surface area, and flow, as well as inhibiting flora and fauna in a very short period of time. On occasion, the impact is so large that these coastal features even disappear completely.

History abounds with examples of devastating tsunamis that originated from different causes, most commonly from earthquakes. The first record of a Holocene

tsunami is related to the Storegga slide, a large submarine landslide in the North Sea around 6000 BC, which heavily impacted the coastline of Norway as sediment was found up to 20 m above sea level. In modern-day history, there are more than 50 records of large tsunamis and related earthquakes, including the most recent events in the Indian and Pacific Oceans (2004 Sumatra, 2010 Chile, and 2011 Japan).

In terms of human life, NOAA states that since 1850, about 420,000 lives have been lost due to tsunamis as local coastal communities and large villages, towns, and even cities have been impacted. Likewise, losses in infrastructure, the economy, and ecosystem services have amounted to trillions of dollars.

Tsunamis like the 2004 Indian Ocean Tsunami and the 2011 Tohoku Tsunami caused catastrophic damage to coastal areas. Many reconstruction processes are being introduced in the affected areas including structure-based countermeasures and nonstructure-based relocation and evacuation plans. In consideration of accelerating reconstruction processes, we need to pay deliberate attention to long-term treatment of coastal environments.

Restoration and reconstruction of damaged areas are the cause of large debates; on one side, arguments for the paramount importance of human protection at all costs, without proper consideration of the environment, have prevailed, while on the other, there are increased calls for a more balanced approach to harmonize measures of protection with the environment in order to allow coastal ecosystems to thrive. The restoration process and reconstruction measures in certain countries could be taken as an example of both, but unfortunately aesthetic and visual restoration is often mistaken for full environmental restoration.

This book deals with impacts of tsunamis and earthquakes on coastal environments. In addition to direct impact and response due to flooding and abrasion, the text covers physical, chemical, and biological responses in coastal morphology, water quality, and ecosystems. Comprehensive descriptions of multi-scale impacts of tsunami and earthquake events, both spatially and temporally, will help us to understand the complicated interactions developed in coastal zones and to achieve the sustainable resilient environment and society with smart post-event recovery. I believe this book will be beneficial to researchers and students in science and engineering as well as policy-makers, urban planning engineers, and coastal managers.

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Contents

1	Revisiting the 2001 Peruvian Earthquake and Tsunami Impact Along Camana Beach and the Coastline Using Numerical Modeling and Satellite Imaging	1
	Bruno Adriano, Erick Mas, Shunichi Koshimura, Yushiro Fujii, Hideaki Yanagisawa, and Miguel Estrada	
2	Imprints of the AD 1755 Tsunami in Algarve (South Portugal) Lowlands and Post-impact Recovery.....	17
	P.J.M. Costa, M.A. Oliveira, R. González-Villanueva, C. Andrade, and M.C. Freitas	
3	Ecosystem-Based Tsunami Disaster Risk Reduction in Indonesian Coastal Areas.....	31
	Eko Rudianto, Abdul Muhari, Kenji Harada, Hideo Matsutomi, Hendra Yusran Siry, Enggar Sadtopo, and Widjo Kongko	
4	Post-Tsunami Assessment of Coastal Vegetation, with the View to Protect Coastal Areas from Ocean Surges in Sri Lanka	47
	L.P. Jayatissa, K.A.S. Kodikara, N.P. Dissanayaka, and B. Satyanarayana	
5	Shoreline and Coastal Morphological Changes Induced by the 2004 Indian Ocean Tsunami in the Katchal Island, Andaman and Nicobar – A Study Using Archived Satellite Images	65
	Ali P. Yunus, Jie Dou, Ram Avtar, and A.C. Narayana	
6	Mud Volcanoes in an Active Fore-Arc Setting: A Case Study from the Makran Coastal Belt, SW Pakistan	79
	Iftikhar Ahmed Abbasi, Din Mohammed Kakar, Mohammed Asif Khan, and Ahmed Sana	

7	Response of Sheltered and Built-up Coasts in the Wake of Natural Hazards: The Aftermath of the December 2004 Tsunami, Tamil Nadu, India	97
	Jaya Kumar Seelam and Antonio Mascarenhas	
8	Characteristics of Shoreline Retreat Due to the 2011 Tohoku Earthquake and Tsunami and Its Recovery After Three Years	113
	Keiko Udo, Kaoru Tojo, Yuriko Takeda, Hitoshi Tanaka, and Akira Mano	
9	Investigating the 2011 Tsunami Impact on the Teizan Canal and the Old River Mouth in Sendai Coast. Miyagi Prefecture; Japan	125
	Mohammad Bagus Adityawan and Hitoshi Tanaka	
10	Morphological Characteristics of River Mouths After the 2011 Tohoku Tsunami in Miyagi Prefecture	137
	Min Roh, Yuta Mitobe, and Hitoshi Tanaka	
11	Post-Tsunami Lagoon Morphology Restoration Sendai; Japan	153
	Vo Cong Hoang, Hitoshi Tanaka, and Yuta Mitobe	
12	The Minato River in Miyagi Prefecture Reconstruction and Restoration – An Overview	167
	Vicente Santiago-Fandiño and Naoko Kimura	
13	Tsunami Impacts on Eelgrass Beds and Acute Deterioration of Coastal Water Quality Due to the Damage of Sewage Treatment Plant in Matsushima Bay, Japan	187
	Takashi Sakamaki, Youhei Sakurai, and Osamu Nishimura	
14	Effects of the Great East Japan Tsunami on Fish Populations and Ecosystem Recovery. The Natori River; Northeastern Japan	201
	Kinuko Ito, Ayu Katayama, Kazunori Shizuka, and Norihiro Monna	
	Index	217

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