

Contents

Preface	xi
Acknowledgements	xv
List of figures	xxi
List of tables	xxvii
List of symbols	xxix
List of abbreviations and acronyms	xxxiii
PART I Tsunami as a known hazard	1
1 Introduction	3
Introduction	3
Five stories	4
1 An Aboriginal legend.	4
2 The Kwenaitchechat Legend, Pacific Northwest.	5
3 Krakatau, August 27, 1883.	6
4 Burin Peninsula, Newfoundland, November 18, 1929	7
5 Papua New Guinea, July 17, 1998	9
Scientific fact or legends?	10
Causes of tsunami.	12
Distribution and fatalities	14
Mediterranean Sea.	15
Caribbean Sea	15

Contents

	Pacific Ocean Region (including Indonesia)	16
	New Zealand and Australia	22
	Bays, fjords, inland seas, and lakes	23
	Meteorological phenomena, freak waves, and storm surges	24
2	Tsunami dynamics	27
	Introduction	27
	Tsunami characteristics	27
	Tsunami wave theory	31
	Resonance	36
	Shallow-water, long-wave theory	37
	Run-up and inundation	40
	Run-up	40
	Inland penetration	45
	Depth and velocity at shore	46
	PART II Tsunami-formed landscapes	49
3	Signatures of tsunami in the coastal landscape	51
	Introduction	51
	Depositional signatures of tsunami	53
	Buried sand or anomalous sediment layers	53
	Foraminifera and diatoms	57
	Boulder floaters in sand	59
	Dump deposits	60
	Mounds and ridges	63
	Chevrons and dune bedforms	65
	Smear deposits	67
	Large boulders and piles of imbricated boulders	68
	Turbidites	75
	Erosional signatures of tsunami	77
	Small-scale features	77
	Large-scale features	83
	Flow dynamics	86
4	Coastal landscape evolution	91
	Introduction	91
	Catastrophism vs. uniformitarianism	91
	Tsunami vs. storms	94
	The nature of tsunami vs. storm deposits	95
	Movement of boulders	96

Types of coastal landscapes created by tsunami	98
Sandy barrier coasts.	98
Deltas and alluvial plains	101
Rocky coasts	103
Atolls	104
Examples of tsunami-generated landscapes: Australia	106
South coast of New South Wales	106
Cairns Coast, Northeast Queensland	109
Northwest West Australia	112
Other examples of tsunami-generated landscapes	115
Grand Cayman	115
Bahamas	117
Chilean coast	119
PART III Causes of tsunami	125
5 Earthquake-generated tsunami	127
Introduction	127
Seismic waves	127
Magnitude scales for earthquakes and tsunami	129
Earthquake magnitude scales	129
Tsunami earthquakes	130
Tsunami magnitude scales	132
Seismic gaps and tsunami occurrence	134
Relationships between earthquakes and tsunami	135
How earthquakes generate tsunami	135
Linking tsunami run-up to earthquake magnitude	139
Large historical tsunamigenic earthquakes	140
Lisbon, November 1, 1755	140
Chile, May 22, 1960.	143
Alaska, March 27, 1964	149
Events of the 1990s	154
Slow Nicaraguan tsunami earthquake of September 2, 1992.	156
Flores, December 12, 1992	158
The Hokkaido Nansei-Oki tsunami of July 12, 1993	160
Papua New Guinea, July 17, 1998	163
The Indian Ocean tsunami, December 26, 2004.	167
6 Great landslides.	179
Introduction.	179
Causes of submarine landslides	181

Contents

How submarine landslides generate tsunami	184
Historical tsunami attributable to landslides	186
The Lituya Bay landslide of July 9, 1958	187
Grand Banks tsunami, November 18, 1929	189
Geological events	193
Hawaiian landslides	193
The Canary Islands	196
The Storegga slide of 7950 BP	198
Bristol Channel, U.K., January 30, 1607	205
The risk in the world's oceans	213
Other volcanic islands	213
Other topography	215
7 Volcanic eruptions	217
Introduction	217
Causes of volcano-induced tsunami	217
Krakatau, August 26–27, 1883	222
Santorini, around 1470 BC	225
8 Comets and asteroids	231
Introduction	231
Near Earth objects (NEOs)	231
What are they?	231
How frequent have comet and asteroid impacts been?	234
How do extraterrestrial objects generate tsunami?	236
Mechanisms for generating tsunami	236
Size of tsunami	238
Geological events	245
Hypothesized frequency	245
Chicxulub, the Cretaceous–Tertiary (K/T) extinction event	247
Other events	251
<i>Deluge Comet</i> impact event 8,200 ± 200 years ago	251
The Mahuika Comet impact event and eastern Australia	253
Geological evidence for mega-tsunami	254
Maori legends supporting a cosmogenic event	257
Aboriginal legends supporting a cosmogenic event	258
Timing of Mahuika	260
Events in the Kimberley, Western Australia	263
Legends supporting cosmogenic tsunami	263
Field evidence	266

PART IV Modern risk of tsunami	271
9 Risk and avoidance	273
Introduction.	273
What locations along a coast are at risk from tsunami?	277
Warning systems.	280
The Pacific Tsunami Warning Center	280
Flaws in regional warning systems	285
Localized tsunami warning systems	286
How long have you got?	290
Where should you go if there is a tsunami warning?	291
What if it is an asteroid or comet?	294
Is it all that bad? The case of Sydney	295
10 Epilogue	299
Five stories	299
1 An unsuspected earthquake	299
2 An unassuming earthquake	302
3 A submarine landslide	303
4 A volcanic eruption	304
5 An asteroid impact with the ocean	305
Concluding comments	306
References	309
Index	325