Preface

Reports of extreme wave events in seas and oceans come about almost each week. Extreme water waves investigated in this book involve mainly rogue waves, but tsunami waves and storm waves are also considered. Several catalogues of extreme events like rogue waves observed in the World Ocean have been recently published.[1] For instance, during 2006–2010, 106 events can be classified as anomalous high short-lived waves. They occurred in deep and shallow waters, and also on the coast. Perhaps, one of the last events occurred on February 17, 2014 with ship "Marco Polo" on its route from the Azores to its home port in Tilbury, England, and it was carrying 735 passengers and 349 crew. A large wave hit the side of the ship between 1 and 2 p.m. local time at adverse sea conditions and killed one passenger and injured the second one.

There are a number of physical mechanisms that focus the water wave energy into a small area and produce the occurrence of extreme waves called freak or rogue waves. These events may be due to wave instability (modulational or Benjamin-Feir instability), chaotic behavior, dispersion (frequency modulation), refraction (presence of variable currents or bottom topography), soliton interactions, crossing seas, wind–wave interaction, etc. These giant waves are a real danger to ships and platforms, causing accidents with human losses. Tsunami waves are generally due to seismic motion of the sea bottom and less frequently due to underwater or subaerial landslides. Herein, the emphasis is put on tsunami waves generated by

[1] Liu, P.C. A chronology of freaque wave encounters. Geofizica, 2007, vol. 24, 57–70.

Didenkulova, I.I., Slunyaev, A.V., Pelinovsky, E.N., and Kharif, Ch. Freak waves in 2005. Natural Hazards Earth Syst. Sci. 2006, vol. 6, 1007–1015.

Nikolkina, I. and Didenkulova, I. Rogue waves in 2006–2010. Natural Hazards Earth Syst. Sci. 2011. vol. 11, 2913–2924.

Baschek, B., and Imai, J. 2011. Rogue wave observations off the US West Coast. Oceanography. 2011, vol. 24, 158–165.

Nikolkina, I. and Didenkulova, I. Catalogue of rogue waves reported in media in 2006–2010. Natural Hazards. 2012. vol. 61, 989–1006.

subaerial collapse of granular media. These waves may cause important damages in coastal areas and loss of life.

Extreme waves have been intensively studied during the past decades, and the European Geophysical Union organizes each year a special section "Extreme Waves." This book contains invited papers written mainly on the basis of works presented during the General Assembly of the European Geosciences Union in Vienna, plus five new invited papers which concern more recent researches on the present subject. In the paper "Rogue Waves in Higher Order Nonlinear Schrödinger Models" by C.M. Schober and A. Calini, it is demonstrated that a chaotic sea state appears to be an important mechanism for both generation and increased likelihood of rogue waves. In the paper "Freak-Waves: Compact Equation Versus Fully Nonlinear One" A.I. Dyachenko, D.I. Kachulin, and V.E. Zakharov derive an approximate equation which is compared to the fully nonlinear system. The compact equation is shown to describe correctly strongly nonlinear phenomena such as rogue waves due to modulational instability. L. Fernandez, M. Onorato, J. Monbaliu, and A. Toffoli in their paper "Occurrence of Extreme Waves in Finite Water Depth" discuss laboratory experiments in a large wave basin, numerical simulations with a truncated form of the potential Euler equations, and field experiments at the Lake George experimental site (Australia) to assess the role of third-order nonlinearity, namely the modulational instability, on water wave statistics. Existence of various shapes of rogue waves in shallow water is discussed in the paper "Modeling of Rogue Wave Shapes in Shallow Water" by T. Talipova, C. Kharif, and J.P. Giovanangeli. They pointed out that variable-polarity shape of a rogue wave is more probable than only one crest or one trough. The occurrence of extreme waves in shallow water is investigated in the paper "Non-Gaussian Properties of Shallow Water Waves in Crossing Seas" by A. Toffoli, M. Onorato, A.R. Osborne, and J. Monbaliu. They show that the interaction of two crossing wave trains generates steep and high amplitude peaks, thus enhancing the deviation of the surface elevation from the Gaussian statistics. The relation between observations and freak wave theories is examined in the paper "Searching for Factors that Limit Observed Extreme Maximum Wave Height Distributions in the North Sea" by G. Burgers, F. Koek, H. de Vries, and M. Stam. Observations indicate that steepness is a limiting factor for extreme wave height and at shallow water locations, extreme waves are not more frequently observed than at deep water locations. Average wave conditions, their variations, and extreme wave storms in the Baltic Sea are studied, based on long-term time series in the paper "Extremes and Decadal Variations in the Baltic Sea Wave Conditions" by T. Soomere. Significant wave heights, H_S, more than 4 m in the Baltic Sea occur with a probability of about 1 % and extreme wave conditions with $H_S > 7$ m approximately twice in a decade. The overall recorded maximum significant wave height is 8.2 m. The possibility of appearance of freak waves on a beach is analyzed in the paper "Runup of Long Irregular Waves on Plane Beach" by I. Didenkulova, E. Pelinovsky, and A. Sergeeva. It is shown that the average runup height of waves with a wide spectrum is higher than that of waves with a narrow spectrum. In the paper "Numerical Study for Run-Up of Breaking Waves of Different Polarities on a Sloping Beach" by A. Rodin, I. Didenkulova, and

E. Pelinovsky the transformation and run-up of breaking solitary waves propagating on a sloping bottom is investigated numerically within the framework of the nonlinear shallow water equations (St-Venant equations). For high wave amplitude they studied how the wave transforms into a bore (shock wave). In the paper "Tsunami Waves Generated by Cliff Collapse: Comparison Between Experiments and Triphasic Simulations" S. Viroulet, A. Sauret, O. Kimmoun, and C. Kharif investigate tsunami waves due to subaerial or submarine landslides both experimentally and numerically. They discuss recent experimental results on granular collapse in water and the influence of the physical parameters on the amplitude of the tsunami waves; such waves of landslide origin cannot be predicted. Waves of huge amplitudes can appear in the deepest layers of the ocean and the possible shapes of such waves in two-layer fluid is described in the paper "An Analytical Model of Large Amplitude Internal Solitary Waves" by N.I. Makarenko and J.L. Maltseva. Special analysis of nonlinear resonances between water waves is given in the paper "Symbolic Computation for Nonlinear Wave Resonances" by E. Tobisch (Kartashova), C. Raab, Ch. Feurer, G. Mayrhofer, and W. Schreiner. They argue the important role of nonlinear resonances in the wave dynamics that can be used to simplify the governing equations.

The book is written for specialists in the fields of fluid mechanics, applied mathematics, nonlinear physics, physical oceanography, and geophysics, and also for students learning these subjects.

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