

Preface to the Second Edition

In the first edition, we paid attention not only to tsunami waves, but to related phenomena, namely, seaquakes, as well, which to a significant extent reflected the interests of the authors at the time. The second edition is more “tsunami-oriented”: the chapter dedicated to seaquakes and the information on killer waves have been dropped.

A new chapter on the fundamental properties of coseismic bottom deformations at the tsunami source has been added in the second edition. The theoretical material expounded in the first edition has been supplemented with information on the hydrodynamic formulation of the problem both in the case of an incompressible ocean and when the compressibility of seawater is taken into account. The concrete problems concerning wave generation by dynamic deformations, dealt with within the framework of the theory of an incompressible liquid, are supplemented with two static problems: on calculation of the initial elevation at a tsunami source and on residual hydrodynamic fields that accompany tsunami generation by an earthquake in a rotating ocean. The chapter on hydroacoustic and nonlinear effects is supplemented with an analysis of new information on the manifestations of tsunamigenic earthquakes based on the data from deep-water stations. The chapter on the Propagation of a Tsunami in the Ocean and its Interaction with the Coast has also undergone essential revision: amendments mainly concern the section on numerical tsunami simulation, in which much new important information is added. The chapter on methods for tsunami registration is supplemented with a paragraph devoted to ionospheric manifestations of tsunamis. Besides the aforementioned amendments, numerous corrections were made in order to render the sounding of the text more modern; new important information was added together with references to new publications.

The tsunami problem is an outstanding example of an interdisciplinary problem. Researchers, who are specialists in different fields, work for implementing its resolution: oceanologists and seismologists, geophysicists and geologists, geographers and geomorphologists, hydroacousticians and engineers, computer scientists and mathematicians, marine biologists, and soil scientists and even sociologists.

Evidently, only joint efforts of the representatives of many scientific professions can result in essential progress toward resolving the problem, which we understand to involve lowering risks, the reduction of material damage, and, finally, most important, the elimination or reduction to a minimum of human casualties.

Although the authors acknowledge that the tsunami problem is an interdisciplinary problem, we do not claim to have created a comprehensive monograph reflecting all the achievements of modern “tsunami science”. The main scope of this edition—in accordance with its title—consists in reflection of the principal physical aspects of the tsunami problem. Nevertheless, the authors sincerely hope the book turns out to be useful to researchers and experts in any other professions having any whatever relationship to studying the tsunami phenomenon.

The authors are especially grateful to Dr. Tatiana Pinegina, who assumed the responsibility of totally revising Sect. 7.2, Dr. Ira Didenkulova for editing Sect. 6.3, Dr. Tatiana Ivelskaya for help in editing Sect. 1.4, Dr. Alexander Rozhnoi, Dr. Maria Solovieva, Prof. Vyacheslav Kunitsyn, and Dr. Artem Vorontsov for help in editing Sect. 7.4, Dr. Elena Sasorova for participating in the creation of Sect. 2.5 and Dr. Anna Bolshakova for preparing the illustrations to Sect. 2.3.

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Preface to the First Edition

Till the very end of the twentieth century tsunami waves (or “waves in a harbour”, translated from Japanese) were considered an extremely rare and exotic natural phenomenon, originating in the ocean and unexpectedly falling upon the seaside as gigantic waves. The 26th of December 2004, when tsunami waves wiped out, in a single day, more than 250 thousand human lives, mourned in many countries, turned out to be a tragic date for all mankind.

The authors of this book, who have studied tsunami waves for many years, intended it to be a systematic exposition of modern ideas concerning

- the mechanisms of tsunami wave generation,
- the peculiarities of tsunami wave propagation in the open ocean and of how waves runup beaches,
- the methods for tsunami wave registration and the operation of a tsunami warning system,
- the mechanisms of other catastrophic processes in the ocean related to the seismic activity of our planet.

The authors considered their main goal to be the creation of book presenting modern knowledge of tsunami waves and of other catastrophes in the ocean to scientific researchers and specialists in geophysics, oceanography, seismology, hydroacoustics, geology, geomorphology, civil and seaside engineering, post-graduate students and students of relevant professions. At present, in 2005, it has become clear that the demand for the information and scientific results presented in the book may be significantly broader and that they may be of interest to a large part of the population. Politicians, administrators, mass media, insurance companies, owners of seaside resorts and hotels, the civil fleet and the navy, oil-extracting companies, security services, space agencies, publishing houses, public education systems, such is a short list of possible users interested today in assimilating and spreading knowledge of the nature and manifestations of tsunami waves.

Waves, that regularly devastate the coasts of oceanic islands and are called tsunami in Japan, have been known for several centuries. The European civilization first encountered such catastrophic waves in 1755, when an exceptionally strong earthquake took place in the Atlantic ocean near the coast of Portugal and gave rise to a tsunami wave that immediately killed over 50 thousand people in the blooming city of Lisbon, which was about a quarter of the city's population. In the USSR, the Kamchatka tsunami of 1952 (2336 victims) resulted in creation of a State tsunami warning system. During the past 10 years (not counting the tragedy caused by the Indonesian tsunami in 2004) tsunami waves in the Pacific ocean took the lives of more than 10 thousand people.

According to UNESCO information, by the year 2010 residents of the coasts of oceans and seas will represent about 70 % of the total population of our planet. One should add persons visiting numerous seaside resorts, those who like to celebrate the New Year on exotic oceanic islands and, also, individuals seeking maritime adventures. All these people may happen to be within reach of one of the oceanic catastrophes, of which tsunami waves are the most dangerous.

Today, many states of the Pacific region,—Russia, Japan, the USA, Chile operate tsunami warning systems. The Russian system includes two tsunami Centers, situated in Yuzhno-Sakhalinsk and Petropavlovsk-Kamchatskii that are managed by the respective Board of the State Committee (Goskomitet) for hydrometeorology of Russia. The tsunami centers receive on-line information from seismic stations that carry out round-the-clock observation within the framework of the Geophysical Service of the Russian Academy of Sciences (RAS). In former times there were six such specialized seismic stations functioning along the Far-East coast of the USSR. At present only 3 stations (Yuzhno-Sakhalinsk, Petropavlovsk-Kamchatskii, SeveroKurul'sk) are in operation, and they all long need to be modernized and re-equipped.

The International Tsunami Information Center, the Pacific Tsunami Warning Center, the Alaska Tsunami Warning Center function successfully within the framework of the USA National Oceanic and Atmospheric Administration with participation of the UNESCO Intergovernmental Oceanic Commission (IOC/UNESCO). In Japan the duties of tsunami warning are performed by several hundred seismic and sea level stations united in a common information system managed by national agencies (JMA, JAMSTEC).

All national Tsunami warning services exchange on-line information via Internet, electronic mail and the specialized Tsunami Board Bulletin. Scientific studies of tsunami waves are coordinated by the International Tsunami Commission within the International Union for Geodesy and Geophysics (IUGG). During the period between 1977 and 1979 this commission was led by Academician S. L. Soloviev, who founded the Soviet Tsunami School. Another Russian scientist, Dr. V. K. Gusakov (Novosibirsk) occupied this position from 1995 up to 2003. In 2003, Professor K. Satake (Japan) was elected Chairman of the Commission. The Tsunami Commission and the International Group of the UNESCO Intergovernmental Oceanographic Commission (IOC/UNESCO) organize regular international scientific and practical conferences, devoted to the problem of tsunami

waves, in-situ inspections of coasts that were victims of tsunami waves, they publish reviews, information bulletins, national reports, general-education literature, and support the creation of databases.

In 1996, The European Geophysical Society (EGS) established the Sergei Soloviev medal to mark the recognition of S. L. Soloviev's scientific achievements. This medal is presented to scientists who have made essential contributions to the investigation of natural catastrophes.

The Russian school of tsunami researchers organized and led for many years by Academician S. L. Soloviev, is still considered a leading team in this scientific sector. A large contribution to the development of tsunami studies has been made by RAS Corresponding members S. S. Lappo and L. N. Rykunov; the Doctors of Sciences, who grew up in the Russian Tsunami School, A. V. Nekrasov, A. A. Dorfman (Leningrad), B. W. Levin, M. A. Nosov, A. B. Rabinovich, E. A. Kulikov, L. I. Lobkovsky (Moscow), E. N. Pelinovsky, V. E. Friedman, T. K. Talipova (Nizhny Novgorod), V. K. Gusakov, L. B. Chubarov, An. G. Marchuk (Novosibirsk), P. D. Kovalev, V. V. Ivanov (Yuzhno-Sakhalinsk), and their pupils have done much for successful development of the science of tsunami waves. Specialized tsunami laboratories and several scientific groups work in the M. V. Lomonosov Moscow State University (MSU) and in various RAS institutes: the Institute of Oceanology (Moscow), the Institute of Applied Physics (Nizhny Novgorod), the Institute of Computational Mathematics and Mathematical Geophysics of the RAS Siberian Branch (RAS SB) (Novosibirsk), the Institute of Maritime Geology and Geophysics of the RAS Far-East Branch (RAS FEB) (Yuzhno-Sakhalinsk), the Institute of Vulcanology and Seismology of RAS FEB (Petropavlovsk-Kamchatskii).

Many Russian specialists in tsunami waves, including the authors and the editor of this book, have acquired significant teaching experience not only in the universities of Russia (MSU, MSGU, NSU, NNSU, NSTU, SakhsU), but also in Universities of the USA, France, Guadeloupe, Australia, Columbia. Recently, owing to the development of new computer technologies and software, original models have appeared of rare phenomena in the ocean, that were hitherto beyond the reach of scientific analysis. The experience of elaborating original ideas accumulated by Russian scientists in the research of seaquakes, killer waves, temperature anomalies above underwater earthquakes, the formation of cavitation zones, plumes and surges of water require detailed exposition and physical analysis. The experience of collaboration with foreign colleagues, regular participation in international meetings, as well as experience in organizing international conferences in Russia (the Tsunami conferences of 1996, 2000, 2002) have revealed an increased demand in tsunami wave specialists and in systematization of the knowledge accumulated in this field.

At present, no proof is needed of the fact that the influence of tsunami waves on the coasts of continents and islands is of a global nature. This catastrophic phenomenon cares nothing about the borders of states and of the nationalities of individuals, who happen to be in the zone within reach of the catastrophe. In the nearest future the politicians of civilized countries will be compelled to start

resolving the issue of creating a global tsunami warning system, something similar to the World meteorological organization. This task will require scientists from all countries to make enormous efforts for systematization of the knowledge on tsunami waves, for the preparation of national experts, specialists and teachers in the problem of tsunami waves, for developing new methods and means of monitoring, for publishing series of textbooks, scientific and general-education literature.

The authors hope that this book will contribute to the formation of a general collection of knowledge on tsunami waves. The necessity of such a book has ultimately become evident.

Many of our colleagues have taken part in completing the book and preparing it for publication. Section 6.1 was in part prepared by the Director of the SakhUGMS Tsunami Center T. N. Ivek'skaia (Yuzhno-Sakhalinsk), section 6.2 was written by T. K. Pinegina (Petropavlovsk-Kamchatskii), a well-known specialist in palaeotsunami. The illustrations, used in the book and based on computer graphics, were prepared by the leading scientific researcher of the RAS Institute of Oceanology E.V. Sasorova (Moscow). The image of the word "tsunami" in the form of Japanese hieroglyphs was prepared for the book by Dr. H. Matsumoto (Japan, Tokyo). Certain material, put at our disposal by E. A. Kulikov (Moscow), V. K. Gusakov (Novosibirsk), V.V. Titov (Seattle, USA) and other colleagues of ours has been included in the book. The authors express their sincere gratitude to all of them.

We are grateful to our teachers S. L. Soloviev and L. N. Rykunov for the good school, and we revere their memory. We are grateful to our pupils and colleagues, whose friendly participation and help promoted the appearance of this book. We wish to express particular gratitude to the referee of this issue Prof. E. N. Pelinovsky. The support of the Russian Foundation for Basic Research and of the Russian Academy of Sciences was an enormous stimulus for the preparation and publication of this issue.

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