INTERNATIONAL TSUNAMI INFORMATION CENTER
NEWSLETTER

2525 correa road, university of hawaii
honolulu, hawaii 96822 usa

NOVEMBER 1973

JANUARY-FEBRUARY 1974 NEW ZEALAND MEETING

Arrangements have been made for the IUGG and the IOC tsunami related meetings to be held in Wellington, New Zealand in late January and early February. Professor Soloviev's announcement on the subject is reproduced below. Abstracts should be submitted as soon as possible to the various conveners with copies to Professor Soloviev and Leonard Murphy. Notices of the meetings should be distributed as widely as possible to your colleagues interested in tsunami research problems.

THE INTERNATIONAL UNION OF GEODESY AND GEOPHYSICS TSUNAMI COMMITTEE

are to meet in Wellington, New Zealand from 29 January to 1 February 1974.

This notice is to call for contributed papers dealing with Tsunami Research within the general framework of:

Tsunami Generation

Tsunami Propagation

Tsunami Runup

Tsunami Instrumentation
and Experiments

Please send titles of papers before December 15, 1973 to:

L. M. Murphy
Secretary, IUGG Tsunami Committee
13528 Glen Mill Road
Rockville, Maryland, USA   20850

The plan of the symposium is as follows.

January 29 – a public popular scientific lecture "What is tsunami?"
(K. Iida, Japan) (by request of the New Zealand Organizing
Committee)

January 30 – tsunami generation (convener: K. Kajiura, Japan)

instrumentation and experiments (convener: G. Miller, USA)

January 31 – tsunami propagation (conveners: B. Zetler, USA and S. Voyt, USSR)

February 1 – tsunami run-up (convener: T. Murty, Canada)

discussion of tsunami vocabulary and miscellaneous
(chairman: W. Adams, USA)

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Sakhalin Complex Scientific
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С.Л.Соловьев
СахКНИИ ДВНЦ АН СССР
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Kinjiro Kajiura
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Hongo, Tokyo, Japan

Bernard Zetler
Scripps Institution
  of Oceanography
P. O. Box 109
La Jolla, CA, USA 92037

ABSTRACTS FOR 1974 NEW ZEALAND MEETING

A few new abstracts for the meetings to be held in New Zealand are
reproduced here for general information purposes.

EXISTENCE OF STEADY FLOWS

Lester Q. Spielvogel
Joint Tsunami Research Effort
National Oceanic and Atmopheric Administration
Honolulu, Hawaii

Abstract

The number of existence theorems for solutions to the exact irrotation
two-dimensional steady incompressible inviscid gravity wave problem is
rather small even when we consider that this is just a small but important
subset of the solutions to the Navier-Stokes equations. To the set of
existence theorems we add this which describes a countable infinite set of
semi-infinite flows over flat bottoms.

LONG WAVE RESPONSE OF A MULTIPLE ISLAND SYSTEM
MODELING THE HAWAIIAN ISLANDS

Eddie N. Bernard, Lt/NOAA Corps
Joint Tsunami Research Effort
National Oceanic and Atmospheric Administration
Honolulu, Hawaii

Abstract

The response of linearized long waves to the Hawaiian Islands
is investigated numerically using the actual topography of the islands.
A time-marching procedure is used to evalutate the wave field by the
linear, frictionless, incompressible, Eulerian equation of motion and
continuity in cylindrical coordinates. The condition of non-normal
flow is employed at the island shoreline, and a localized extrapolation
technique is used at the outer boundary to simulate a free-flow boundary.
A computerized system of the production of real topographic data is
described.

Verification of the numerical procedure is accomplished by agreement
with analytic solutions of steady state problems involving wave interactions
with geometric islands in both constant and variable-depth cases. Tests
being conducted show quantitative agreement with theory for both cases.
Following verification, elements of analysis include: A) choosing inputs
simulating tsunamis to generate wave records at the shorelines of each
island, B) time-series analysis of these wave records to calculate spectra
representing the response to incident waves for each island and C) repeating
(3) for various directional inputs which tsunamis have been known to approach
the Hawaiian chain. The response of each respective island acts as an
energy index and is compared for each directional input.

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DESCRIPTION OF A LOW COST, PORTABLE TSUNAMI WAVE RECORDER

Harold G. Loomis
Joint Tsunami Research Effort
National Oceanic and Atmospheric Administration
Honolulu, Hawaii

Abstract

The recent appearance on the market of an electronic solid-state pressure
transducer has made possible a very small and convenient portable tsunami wave
recorder. The entire unit could be packaged into the unused space inside a
Rustrak strip-chart recorder. However, that was not done in the recorder
described here as provisions for electronic filtering of long or short waves
were included. The unit can be used for recording tides, tsunamis, and/or
short period waves. The unit runs on 18 vdc provided by batteries or a power
supply.

NUMERICAL TSUNAMI SIMULATION

Charles L. Mader
Los Alamos Scientific Laboratory
University of California
Los Alamos, New Mexico 87544

Abstract

Two-dimensional, time-dependent, nonlinear, incompressible, viscous flow calculations of realistic models of tsunami waves interacting with continental slopes and shelves have been performed. Wave heights were observed to grow by a factor of 4 as they shoaled up a 1/15 continental slope. The second or third wave often exhibited the largest wave run-up. Comparisons with shallow water, long wave calculations showed similar results except for short wavelength tsunamis.

The damping action of submerged barriers on tsunami waves was investigated using numerical simulation of the flow. The effectiveness of the damping action of the submerged barriers on tsunami waves is similar to that observed experimentally for shallow water waves of much shorter wavelength.

The numerical simulation of tsunami waves can provide realistic descriptions of their propagation. Three-dimensional calculations of tsunami waves interacting with harbors, with multi-dimensional barriers, and with the ocean floor over the entire ocean are within the state-of-the-art.

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TSUNAMI PROPAGATION AND RESPONSE TO COASTAL AREAS

Michael H. T. Chen
Postdoctoral Research Associate
Joint Tsunami Research Effort
National Oceanic and Atmospheric Administration
Honolulu, Hawaii

Abstract

A suitable boundary condition which is equivalent to the matched impedance boundary condition in acoustic radiation is adapted to describe the open sea boundary where the wave is assumed to be totally transmitted. Applying the concept of open boundary, it is possible to carry out the investigation of wave response at a particular area without covering the entire ocean.

Expressing the governing equations of the linearized long-wave theory by the alternate-direction, explicit scheme, a numerical model is developed to study tsunami propagation across an ocean. The model is first used to solve

the time-harmonic steady-state problem such as a periodic long wave impinging upon a circular island with uniform water depth. The predicted and analytic solutions of the wave amplitude at the shoreline of the island are found to be in good agreement.

The destructive tsunami that resulted from the 1964 Alaska earthquake is simulated. In generat, the predicted first arrival time is approximately 30 min earlier than the recorded values. This discrepancy is due to the treatment for the shoaling area which is critical when the spatial grid is 1°×1° for the model. The wave build-up at Crescent City and Hilo is due to local amplifications, each of which should be examined separately. The predicted wave behavior for the selected station tends to agree with the recorded results.

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Atmospheric Acoustic and internal gravity waves and their relevance to tsunami prediction.

T.S. Murty,
Marine Sciences Directorate,
Department of the Environment,
Ottawa, Ontario, Canada.

AND

R.J. Polavarapu,
Atmospheric Environment Service,
Department of the Environment,
Toronto, Ontario, Canada.

ABSTRACT

The concept of earthquake magnitude developed by Richter in the 1930's proved to be useful in seismology and similar attempts were made in developing a tsunami magnitude scale. However, experience showed that such a tsunami magnitude scale did not work in practice due to the great influence to local topography of tsunami magnitude. At the I.U.G.G. tsunami symposium held at Moscow in August 1971 the consensus of opinion was to abandon the tsunami magnitude scale and develop a tsunami energy scale which might be universally adaptable. It is proposed here that one of the possible approaches to this concept of a tsunami engergy scale is to make use of the effects in the atmosphere caused by strong dip-slip earthquakes which are generally believed to be tsunami-genic owing to their predominant vertical faulting.

However, to understand the type of wave motions generated in the atmosphere by tsunami-genic earthquakes, one has to determine the atmospheric acoustic-internal gravity wave spectrun due to various energy sources in addition to earthquakes: meteorological disturbances, atmospheric nuclear explosions, volcanic explosions, solar eclipses, sonic booms, rocket launches etc. In this review paper, the spectrum due to these various perturbations was systematically examined; it appears that the atmospheric internal gravity waves in the ten to fifteen minute period range might be useful for tsunami energy estimation purposes.

ABSTRACTS FROM AUGUST 1973 LIMA, PERU IUGG MEETING

I.U.G.G. International Association of Seismology and Physics of the
    Earth Interior
Tsunami Committee XVII Meeting, Peru, Lima -- August 20, 31, 1973
Tsunami Symposium, Convener: S. L. Soloviev

ABSTRACTS OF PAPERS

K. IIDA, Nagoya University and Aichi Institute of Technology, Nagoya, Japan

Seismological Aspects of Chilean Tsunamis

A catalog of tsunamigenic earthquakes which occurred in the vicinity
of Chile has been compiled. Forty-six tsunamis were found during
the 410-year period from 1562 to 1972 and were classified according
to the magnitude. The tsunamigenic earthquakes were investigated in
connection with the generation of tsunamis.

Tsunami magnitude m was related to the earthquake magnitude
$m = 3.53M - 26.00$. The minimum magnitude of a tsunamigenic earthquake
associated with focal depth H(km) was found to be expressed as
$M = 6.7 + 0.0089H$. The percentages of earthquakes accompanied by
tsunamis classified by the earthquake magnitude were investigated.
The occurrence in the magnitude range of $7.6 > M > 7.8$ was 50% and
that in $7.9 > M$ was 100%. The frequency of tsunami occurrence
classified by the magnitude shows that the larger the tsunami magnitude,
the smaller the frequency. The generation of tsunamis in connection
with the focal mechanism of earthquakes was discussed.

V. SOUSA MOREIRA, Serviço Meteorologico Nacional, Lisboa, Portugal

Tsunamis, Extension of Faulting and Focal Mechanism

Correlations between tsunami magnitude and focal depth and between
tsunami magnitude and water depth at the epicentral area have been
established. The relationship between tsunamigenic and non-tsunamigenic
earthquakes with extension of faulting has been analysed.

Computations of tsunami energy of some tsunamis observed along the
Portuguese coast have been made, and correlations with tsunami magnitude
have been established.

A relationship between tsunamis observed in the European area and focal
mechanism is presented.

LI-SAN HWANG, H. LEE BUTLER, and DAVID J. DIVOKY, Tetra Tech, Inc.,
Pasadena, California, U.S.A.

Numerical Modeling of Chilean Tsunami of 1960

Numerical computations of generation and propagation of the Chilean
tsunami of 1960 were made. Reasons for the damage at Hilo Harbor,
Hawaii and the Japanese coast as a result of this tsunami will be given
in light of this computation. The phenomenon of tsunami directivity
and antipole convergence will be illustrated and discussed.

Permanent ground displacements (Plafker 1970) were used for determining
the tsunami generation, and the numerical model is based on hydro-
dynamic equations in a spherical coordinate system to account for the
spherical nature of the earth. The model provides a deterministic
approach to the description of tsunami waves and is verified by
hindcasting the wave behavior following the Alaskan earthquake of
1964. Results of the computation compared with field measurements
both in deep water (Wake Island) and inside a harbor (Hilo Harbor,
Hawaii) will also be presented.

G. PARARAS-CARAYANNIS, Coastal Engineering Research Center, Washington, D.C., U.S.A

The Source Mechamism of the Earthquake
and Tsunami of October 17, 1966 in Peru

An investigation of the source mechanism of the Peru earthquake and
tsunami of October 17, 1966 revealed that the tsunami was generated
by displacements of a crustal block having dimensions of approximately
150 km by 90 km and covering a total area of 13,000 sq km. The
tsunamigenic area lies on the continental shelf off the coast of Peru,
northwest of Lima, in the western part of an active seismic belt which
lies between the Andean mountain block and the Peru-Chile Trench. The
limits of the tectonic displacements which generated the tsunami were
determined by a reverse wave-refraction method, refracting waves from
Chimbote, Callao-Lima, San Juan, Arica, and Honolulu. The type of the
first water motions observed at some of these places nearer the epicenter
indicated that the crustal displacements were along a thrust fault
approximately paralleling the Peruvian coast and that the uplifted
portion was on the continental side of the rift. This is also supported
by the fact that seismic stations on the continental side of the rift
reported the initial motion on their seismographs as a compression.
The aftershock distribution and the strain release pattern are also
within the determined area and suggest that the earthquake fault was a
seaward extension of a fault system which has a pronounced surface
expression in the tertiary formations of the area near Ancon. This
area, although farther away from the epicenter, experienced effects
of maximum intensity, and it is considered to be one of three distinct
seismic zones in the Peruvian upper mantle, west of the Andean mountain
block.

T. S. MURTY, S. O. WIGEN, and R. ARORA, Marine Sciences Directorate, Department of the Environment, Ottawa, Canada

On Some Features of Tsunamis on the Pacific
Coast of South and North America

Some of the past tsunami records on the Pacific coast of South America were examined through simple analytical and numerical techniques with a view of deducing the characteristics of the tsunami forerunner, secondary undulations, and tsunami periodicities. That part of the Pacific coast of South America lying north of 40°S is relatively regular in topography and in this respect somewhat resembles the coasts of Washington, Oregon, and California while the coast of South America south of 40°S is inundated by complex inlets and resembles the coasts of Alaska and British Columbia. The periods of the fundamental longitudinal mode of several inlets on the coasts of Chile, Alaska, and British Columbia were computed to deduce possible resonance with tsunamis. Contrary to earlier findings by other authors that tsunami forerunners do not exist on the coast of South America, these were found in some locations. The Chilean, Alaskan, and British Columbian inlets are graded on a scale of secondary undulations to provide information on possible prolonged water level disturbances following the main tsunami.

S. L. SOLOVIEV, A. V. NEKRASOV, V. G. BUKHTEEV, and P. B. PYASKOVSKY, Sakhalin Complex Scientific Research Institute, Academy of Sciences and Leningrad Hydrometeorological Institute, U.S.S.R.

The Preliminary Results of Tsunami Zonation
of the Soviet Pacific Coast

The sources of strong Kurile-Kamchatka tsunami stretch along the Soviet Pacific coast. The longer the source is, the greater the water uplift, because of smaller scattering of wavefronts. The possibility of tsunamis occurring is nearly equal along the arc.

Calculations were carried out for a linear source, stretching along the arc at a distance of 70 km from it. Rays were drawn through 10 miles, being orthogonal to the source. Within each ray tube, water elevation was calculated by numerical integration of nonlinear one-dimensional equations of shallow water. Elevation within the source was taken in the form of half-sinusoid. The waves were calculated up to a depth of 10 m. Here and at the walls of ray tubes, the condition of complete wave reflection was adopted. The condition of free-going-off was adopted for the back contour of the source. The schemes of the coast division according to amplitudes and periods of tsunamis were built. It is shown that calculations according to Green's formula overestimate water uplift on the coast and give erroneous distribution along it. It was studied how remoteness, width, and orientation of the source influence the form of water elevation near the coast.

Two-dimensional integration of linear equations of shallow water was proposed for Kamchatka, allowing for study marginal wave formation and propagation.

L. M. MURPHY and M. SPAETH, National Oceanic and Atmospheric Adminiatration, Rockville, Maryland, U.S.A.

Pacific Tsunami Warning System and Possible Tsunami Protection Measures in South America

The Pacific Tsunami Warning System (in operation since 1948) is continually expanding in operational techniques and providing services to countries and certain islands in and around the Pacific Ocean basin. In order to further assist in the protection of life and property along the coasts of the Latin American countries an expanded network of tide and seismic stations is recommended which will essentially provide adequate local watch and warning information to these countries. In addition proposed techniques will be offered to reduce the deficiencies of local communications using satellite facilities and improved radio telemetry.

Suggestions will be offered in providing protective measures to coastal populations and industry, particularly to strategic harbors and lowlying coastal areas. Reference will be made to the work of the Japanese, the Canadians, and the United States as to how such efforts can assist in reducing the loss of life and property caused by nearby-generated tsunamis of the Latin American countries.

ABSTRACTS FROM AUGUST 1971 MOSCOW IUGG MEETING

Although the results from the last IUGG meeting held in Moscow in 1971 have not yet appeared in English, a comprehensive set of abstracts follows.

ABSTRACTS OF THE PAPERS

S. L. Solov'ev. EARTHQUAKE AND TSUNAMI RECURRENCE IN THE PACIFIC OCEAN. Tsunami energy evaluation formula is deduced. A correlation is made between tsunami duration and the earthquake magnitude, and water elevation in the focal zone. Existing scales of numerical evaluation of tsunami intensity are analysed. The Imamura-Iida scale is improved and further developed. Tsunami intensity i is defined as $\log_2 h + \frac{1}{2}$, where h is water elevation in metres averaged for the coast involved. Maximum tsunami intensity J corrected for inhomogeneity of energy emission from the focus is taken to be tsunami characteristic. J values have been estimated for all known Pacific tsunamis. Tsunami recurrence for 26 zones and the ocean as a whole has been found. A map-diagram of Pacific tsunami recurrence has been compiled. Recurence of earthquakes with magnitudes of $M \geq 6$ has been estimated in 6I zones of the Pacific Ocean from a special catalogue. Dependence of tsunami generation probability on seismotectonic peculiarities of a zone has been revealed. Tsunamigeneity parameter T equal to the ratio between the frequency of tsunamis and the frequency of earthquakes has been introduced. Tentative equations for calculation of probability of tsunami intensity J generation according to M and T have been derived. Effectiveness of the magnitude method of tsunami prediction has been estimated. A map-diagram of threshold magnitude values of Pacific earthquakes has been compiled for tsunami warning along the USSR coast.

L. M. Balakina. TSUNAMIS AND FOCAL MECHANISM OF EARTHQUAKES IN THE NORTH-WESTERN PART OF THE PACIFIC OCEAN. Peculiarities of focal processes in the north-western Pacific generating tsunami waves are revealed. Focal mecanisms of earthquakes considered are correlated with peculiarities of stress field in marginal zones of the Pacific Ocean.

S. S. Vo't, B. I. Sebekin. SOME PROBLEMS OF THE THEORY OF TSUNAMI WAVE PROPAGATION. Effects of propagation direction of unstabilized tsunami-type gravity waves caused by sea floor relief are treated. An analytical solution for a case of an uneven variation of basin depth is obtained and an asymptotic investigation of it is made. It is established that a depth discontinuity generates Kelvin-type waves, the spectrum of these waves is found, and the area of their propagation is determined.

V. M. Kaystrenko. INVERSE PROBLEM FOR TSUNAMI SOURCE DETER-MINATION. The paper deals with the inverse problem of the tsunami theory, i.e. determination of the sea floor shape deformation in a source from available records of sea level oscilla-tion at coast. An approximate boundary condition of the normal impedance type is used to register tsunami behaviour in a near-coastal zone, which simplifies the study of the problem consi-derably, the main features of the phenomenon being preserved. It is shown that the solution to the problem is nonunique in general, and peculiar sea floor deformations are possible which do not result in a sea level change in the coastal zone. An explicit quasi-solution for an instantaneous source in a round flat-floor ocean has been obtained. An expression for tsunami energy calculation from available records of sea level varia-tions at coast is given.

V. A. Bernstein. ON BOUNDARY EFFECTS IN REGIONS OF BOTTOM STEPS AT LONG GRAVITY WAVE PROPAGATION IN A ROTATING BASIN. A solution to the problem of long gravity wave propagation in a flat rotary basin with a vertical floor projection - from a point-like initial disturbance has been obtained. A disturbance part analoguous to Kelvin-Poincare waves has been distinguished for which an asymptotic expression for indefinitely increasing time has been derived by the method of the steepest discent. Attenuation character of these waves depending on coordinates and time has been investigated.

A. V. Nekrasov, R. V. Pyaskovsky, V. G. Buchteev. INVESTI-GATION OF PROPAGATION AND TRANSFORMATION OF TSUNAMI WAVES BY THE CALCULATION METHOD. Orthogonal approach to the shore and schelf of solitary waves is considered. The source is loca-ted in a deep part of the sea, on the slope, on the shelf. Numerical integration of shallow water equations is made. The form of level variations at coast and schelf edge for dif-ferent parameters of shelf and wave source is studied; and it is shown that a solitary wave transforms into a train of oscillations due to repeated reflection.

V. A. Makarov, V. G. Buchteev, G. E. Usankina. TSUNAMI WAVES
FROM INITIAL DISTURBANCES OF DIFFERENT FORM (INVESTIGATION ON
AN ELECTRICAL MODEL). An electrical model of the northern Japaneze
Sea with the 1964 Niigata tsunami focus has been compiled. De-
pendence of arrival times, periods, amplitudes and duration of
tsunamis upon focal disturbances is investigated. The best agre-
ement of experimental and actually observed rises of water is
obtained at the initial dome-like rise.

G. E. Kononkova, A. E. Reihrudel. MODEL INVESTIGATION OF
SOLITARY TSUNAMI WAVES RUN-UP ONTO THE COAST. Run-up of indivi-
dual tsunami-type waves onto a sloping coast was imitated in a
small shoot. Dependences of the height of water rise and the
width of the submerged zone on the basin depth, wave height,
inclination and mobility degree of the coast have been obtained.

V. A. Bernstein, V. Ya. Maramzin. CALCULATION OF TSUNAMI
RUN-UP AS FUNCTION OF INCLINATION AND ROUGHNESS OF THE BOTTOM.
Travelling of a tsunami wave through a band of nearcoastal
shallow water and its run-up onto the shore have been studied
by means of the theory of river-bed current. Potential E_{pot} and
kinetic E_{kin} energies of a tsunami wave have been calculated.
Correlation of these revealed that tsunami energy depends
essentially on the factor of roughness and inclination of the
floor, i.e. energy of a tsunami wave decreases with increase in
roughness of the soil and decrease in floor inclination.

A. E. Meerson. ON TAKING OCEAN BATHYMETRY INTO ACCOUNT
WHEN COMPUTING ARRIVAL TIMES AND AMPLITUDES OF TSUNAMI WAVES.
Technique of computation of maps of fronts and rays and geometri-
cal divergence of ray tubes of tsunami waves in deep sea is
described. The problem is confined to numerical solution of a
ray equation in an inhomogeneous medium. An algorythm of solu-
tion and its realization by an electronic computer are proposed.

V. A. Bernstein. TSUNAMI IN A SHELF ZONE. CHARACTERISTICS
AND REGISTRATION PROBLEM. Available theoretical and experimental
data on behaviour of a tsunami wave when it propagates on the
shelf are summarized. Special attention is paid to movemen of
water particles close to the floor due to the problem of tsunami
recording with bottom instruments. Hydrological conditions in a
shelf zone have been studies in detail, and different processes
that can interfere with tsunami wave recording have been consi-
dered. Optimum conditions for reliable recording of tsunami
waves with bottom instruments have been determined.

V. M. Zhak, A. M. Velikanov. I. N. Sapozhnikov. DISTANT
RECORDER OF SEA LEVEL. The paper deals with substantiation of
organization of remote measurement of near-bottom pressure of
different hydrophysical processes. Description of the transdu-
cers used, analysing and recording apparatuses, as well as of
a specially developed scheme to record insignificant relative
(0,17%) deviations of the frequency signal of the transducer is
given. Samples of records of pressure variations for wind oscil-
lations, swell, tidal and tsunami-like long waves are presented.
A conclusion is made about potentialities of the system and its
applicability in posts carried out to sea for operative warning
of a tsunami wave from hydrophysical data.

B. G. Pustovitenko. ANALYSIS OF INCLINOMETER OBSERVATIONS
ON SHIKOTAN ISLAND FOR YEARS 1967-1968. Annual cycle of earth
surface inclination observation by means of Ostrovsky instru-
ments at the Shikotan tsunami station is described. Relatively
weak effect of marine tides on inclinations is revealed. An
anomalous gradient of inclination before some earthquakes is
supposedly revealed.

B. G. Pustovitenko, A. N. Pustovitenko. ON POSSIBLE USE OF
PHOTOELECTRICAL INCLINOMETERS FOR RECORDING OF TSUNAMI WAVES.
5 to 20-minute-period oscillations of Shikotan Island which
correlate with seich oscillations of the water volumes adjacent
to the island have been recorded. A supposition is made about
a possibility of recording tsunamis approaching the island by
means of an inclination meter.

A. I. Ivashchenko. ON THE RECURRENCE OF STRONG TSUNAMIS IN
THE NORTH-WESTERN PART OF THE PACIFIC FOR THE RECENT 50 YEARS.
Sequence of earthquake-originated tsunamis with time in north-
western Pacific for the recent 50 years has been considered.
Strong tsunamis show a distinct tendency to group with time. The
groups cycle with a period of 5.6 $\pm$ 0.5 years, and recurrence
of events within groups is well described with Poisson"s Law.
A linear prediction of origination time of strong tsunamis in
future is given by means of the autocorrelation function of the
process.

K. I. Nepop. ON THE LONG-TIME TSUNAMI PREDICTION. Superlong-
period (a year and more in advance) tsunami prediction based on
consideration of process development inner regularities that
can partially be revealed by means of the linear theory of ran-
dom stationary functions is verified. Verification predictions
of annual suma of lgE, where E is tsunami energy, from observa-
tions since 1896 to 1968 are given a year in advance. Extrapo-
lation of the calculation curve was made up to 1974. The results
obtained are far from satisfactory.

F. D. Zhuk, S. L. Solov'ev. POSSIBILITY OF RECORDING OF
HYDROACOUSTICAL WAVES OF PACIFIC EARTHQUAKES ON SEISMIC STATIONS
OF THE USSR. Records of short-period seismographs installed
along the USSR Pacific coast within 1961 to 1967 have been exa-
mined. T phases have been found in great quantity only in re-
cords of the stations in the Shikotan and Bering islands and
at the Shipunsky Cape (Kamchatka). T phases of south-western
Pacific earthquakes are recorded best of all. Recordability of
hydroacoustic waves does not depend on the depth of an earthqua-
ke focus, but it is sensitive to the way a sloperadiater faces
a stations. Propagation velocity of submarine sound along the
axis of a channel along several paths is evaluated.

O. N. Solov'eva. MAGNITUDE DETERMINATION OF KURILE-KAMCHATKA
EARTHQUAKES FROM RECORDS OF MECHANICAL SEISMOGRAPHS. Records
of UEOFE and Wiechert mechanical seismographs in the Yuzno-
Sakhalinsk, Petropavlovsk-Kamchatsky, Kurilsk stations used
in the tsunami warning system have been processed. Calibration
curves have been built for the distance range of 0.5 to 10°
(0.5 to 2° most reliably) in order to determine earthquake
magnitudes from horizontal displacement of the Earth's surface
in longitudinal and transversal waves.

N. L. Leonidova. ON POSSIBILITIES FOR TSUNAMI WAVES TO BE
EXCITED BY TURBIDITY CURRENTS. Dense suspension currents resul-
ting in submarine canyons from earthquakes are believed to be a
possible cause of tsunami origination Parameters of waves gene-
rated depend on the mater depth, currents dimensions, floor
inclinations and other factors. It is shown that a similar me-
chanism of tsunami origination may have been present in the
Sagami Bay when the 1923 earthquake occured. Cases of earthqua-
kes that caused turbidity currents responsible for breakage of
cable lines, and which were followed by tsunami waves are listed.
Wave excitation within a zone of canyon development may account
for cases of tsunamis originated by land earthquakes with foci
considerably far from the coast, and for tsunamis related to
weak earthquakes.

Z. K. Grigorash. THE REVIEW OF SOME DISTANT TSUNAMI MAREO-
GRAMS IN THE BLACK SEA. The paper presents an analysis of tide
gauge records of three Black Sea tsunamis - those of June 26 and
September 11-12, 1927 and June 12, 1966 - for several points
located on the coasts of the Black Sea and the Sea of Asov.
Comparison of travel times, periods, amplitudes and other pa-
rameters of tsunami waves obtained from the mareograms with data
obtained earlier is made.

Ch. N. GO, N. L. Leonidova, N. N. Leonov. SOME DATA ON THE
AUGUST I, 1940, TSUNAMI IN THE JAPANESE SEA. Some data on tsunami
manifestation of August I, 1940, in the region of the Tietiukhe-
Pristan village are presented. The tsunami focus has been
constructed by means of the reverse refraction picture. Geologic-
geophysical preconditions of earthquake origination are analysed.

N. N. Leonov, L. S. Oskorbin, N. A. Shchetnikov, Ch.N.GO,
A. N. Boychuk, L. N. Poplavskaya. GREAT EARTHQUAKES AND TSUNAMIS
IN THE LITTLE KURILE ISLANDS ARC AREA, 1961-1969. Five strongest
earthquakes with $M \geqslant 6\frac{3}{4}$ that occured within the period from 1961
to 1969 and were felt in the main in southern Kuril islands and
northern Japan are considered. The strongest is the earthquake
of August II, 1969. Geological conditions of generation of
earthquakes and the macroseismic effect caused by these are
characterized and conclusions are made about dependence of tsu-
nami wave amplitudes on the magnitudes of earthquakes, the depth
and mechanism of foci.

S. S. Lapshin. TSUNAMIS AT THE PACIFIC COAST OF THE KURILE
ISLANDS IN 1968. In 1968, the tide gauges installed in Kurile
islands recorded two weak tsunamis that originated from earthquakes
of January 29, 1968, south-east of the Shikotan Island, and of
May 16, 1968, north-east of Honshu. The maximum height of the
tsunami waves was 0.25 m for the former, and 0.5 m for the
latter from tide gauge records in Burevestnik (isl. Iturupi) and
Yuzhno-Kurilsk (isl.Kunashir). Data on activity of the tsunami
warning service are presented.

EDUCATIONAL MATERIALS

At the last session of meetings it was determined that the ITIC should attempt to gather a complete set of educational materials as related to the Tsunami Warning System. These materials have been slow in coming, and various participating nations and agencies are urged to transmit any material available to the ITIC. Lists of the educational material may then be made available at the New Zealand meetings.

ENGINEERING STUDIES

The ITIC and the Joint Tsunami Research Effort are attempting to put together a complete bibliography of engineering studies which relate to tsunami problems for specific shoreline projects. For example, the construction of a harbor, breakwater, or electric generating plant at a shoreline susceptable to tsunami hazard usually requires that a study be made. The collection of these various studies (often only in commercial literature in the form of reports) would provide a valuable data bank for subsequent inquiries in the same or related regions. We would therefore like to urge that the various engineering companies and governmental agencies who have performed or had tsunami studies made for engineering purposes forward this information to the ITIC.

MISC. ARTICLE ON TSUNAMIS

TSUNAMIS [2]

Seven tsunamis were reported to the Environmental Research Laboratories (ERL) during 1970, including one that was recorded on a tide gage of NOAA's National Ocean Survey.

An earthquake in Mindanao, Philippine Islands, on January 10 (6.8° N., 126.7° E.) caused a minor tsunami that was recorded at the Malakal, Palau Island, Caroline Islands, tide station with an amplitude of 6 cm.

Following an earthquake on April 7 in Luzon, Philippine Islands (15.8° N., 121.7° E.), local wave activity was recorded at Dingalan Bay. Several huts along the shore were inundated. One witness reported the incoming waves were "taller than a man."

Press reports stated that on May 14, a series of shocks in the eastern Caucasus region of the USSR (43.0° N., 47.1° E.) caused a tsunami which submerged sand dunes along the Caspian seacoast.

Following the disastrous earthquake in Peru (9.2° S., 78.8° W.) on May 31, a minor tsunami was observed along the Peruvian coast. Waves of 76 cm. were recorded at Chimbote; La Punta tide station recorded 61-cm. waves.

An earthquake near Kyushu, Japan, on July 25 (32.2° N., 131.7° E.) caused a small tsunami which was recorded on Shikoku and Kyushu Islands. Maximum wave heights recorded were 52 cm. at Tosa-Shimizu, 42 cm. at Aburatsu, and 10 cm. at Murotomisaki.

Press reports indicated that a minor local tsunami was generated by the September 30 Philippine Islands earthquake (20.6° N., 122.0° E.).

An earthquake near the north coast of New Guinea (4.9° S., 145.5° E.) on October 31 generated a local tsunami which caused the only tsunami-related fatalities during 1970. Three people drowned when the waves upset their canoe. Maximum wave height reported from Madang was 1.2 meters.

CLASSIC CANAL THEORY

Although not exclusively in the realm of tsunami research, a recent report by Dr. Rudolph Preisendorfer of the Joint Tsunami Research Effort summarizes in a most thorough manner the analytic behavior of waves in interconnected channels and canals as indicated in the following abstract.

Abstract

The practical problems of linear surface-wave transport in nonuniform canals reduce principally to four main types: general responses to external and internal sources, seiches, resonances, and network problems. In each type of problem the geometry and physical parameters of the canals are given, and it is required to predict the time-dependent or steady-state (time-harmonic) wave amplitudes within the canals. In the present study these problems are reformulated for the time-harmonic case using the concepts and method of linear transport theory as they have recently been developed principally in the neighboring fields of geophysical radiative transfer theory and electric network theory. By applying the transport ideas of these two fields to classic canal theory (i.e., one-dimensional o-mode linear fluid motion), new mathematical and numerical procedures have been developed in each of the four main problem domains listed above. The mathematical procedures themselves fall into four classes: analytic, algebraic, product and quotient functionals, and interrelations among these classes. These applications are summarized and illustrated by means of a selected set of graphs. Detailed comparisons between the present approach and the classic approach are made in the bibliographic notes. The present work may be considered as a study of classic canal theory in which the theory is viewed either as an autonomous field of study (in its own right) or as the testing ground for possibly higher dimensional subsequent developments of the transport theory of linear hydrodynamics.

TSUNAMI PROPAGATION STUDIES

Dr. Michael Chen who has been visiting the Joint Tsunami Research Effort for the past year has just completed initial studies on Pacific wide tsunami propagation. An abstract of his report may be found under Abstracts for 1974 New Zealand IUGG Meeting. The figure which follows gives an indication of the type of output that is available from this large-scale tsunami propagation computer code. It is from this type of computation that we hope to be able to derive a relative susceptibility for all the tsunami-prone areas of the Pacific region. One limiting factor which immediately appears is the resolution of the Pacific depth data. The mean error in the Pacific depth data is believed to be about 200 m on the 1° grid data available. This becomes a serious limitation at shorter tsunami wavelengths as one numerically propagates the waves across the ocean. The relative phase may be incorrect by several minutes.

A second set of programs developed by Mr. Eddie Bernard is designed for smaller scale studies. The first application will be for wave propagation through the Hawaiian Island chain. Mr. Wellington Minoza of the Phillipine Republic is preparing a study of relative tsunami hazard susceptability for the Phillipine Islands. He has been visiting the ITIC during the month of October as a visiting UNESCO observer.
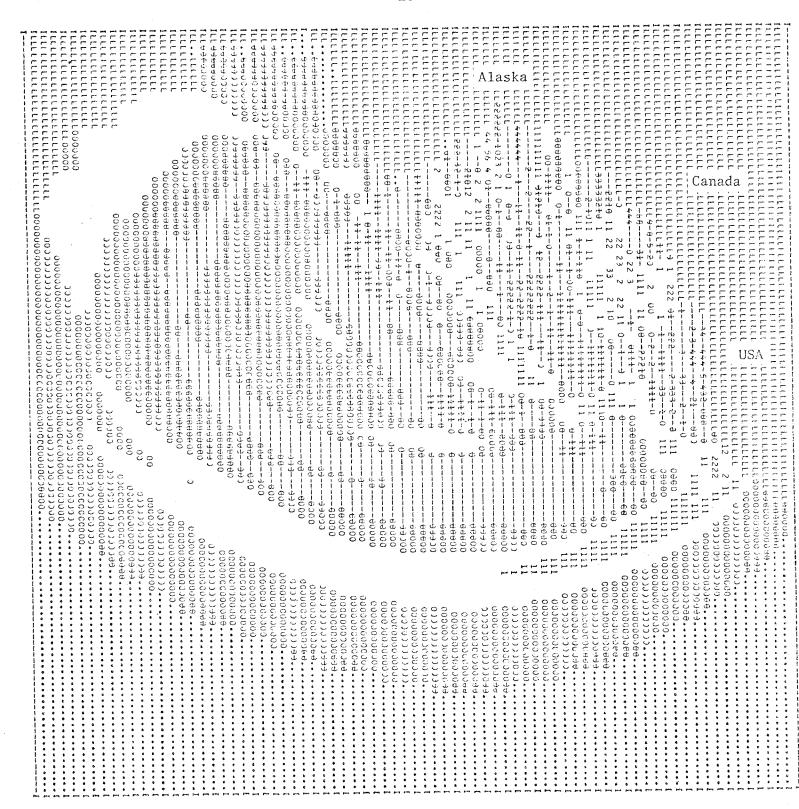
Fig. 1. Computer simulation of the tsunami produced by the 1964 Alaskan earthquake. The symbol L indicates land; the dots indicate undisturbed water. Relative contour intervals are shown by numbers; for example, at the lower right, minus zero (θ) indicates a slight depression in water level, and zero, a slight elevation. The blank space between zero and one is an elevation higher than zero but less than one. The initial condition was a stationary hump of water similar to the net ground deformation produced by the earthquake.