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HDS27-P01 Room:Convention Hall Time:May 27 18:15-19:30

A proper method of Mercalli intensity-based evacuation from tsunami

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Three national organizations in Chile cooperate for tsunami early warning operations. National Seismology Center, University of Chile (CSN) operates real-time seismic analysis, Hydrographic and Oceanographic Service of the Chilean Navy (SHOA) evaluates the necessity of tsunami alerts or alarms by using CSN data, and National Office of Emergency of the Interior Ministry (ONEMI) is the only responsible in disseminating warnings and prompting residents to evacuate directly. For example, after the Iquique earthquake on April 1, 2014 (moment magnitude (M_w) 8.2 by CSN), a tsunami warning was issued for all coastlines of mainland Chile, because tsunami forecast areas have not been defined in Chile yet. Another example is the case of the earthquake on July 13, 2014 (at 4:56 p.m. local time; local magnitude (M) 5.6 by CSN); based on the MSI reports from the coastal cities, ONEMI issued precautionary evacuation of the coastal edges of Iquique, but it was soon canceled. It is found that this false alarm likely was caused by an inadequate standard procudure of Mercalli Scale Intensity (MSI)-based.

This paper shows that deriving an empirical relationship among MSI, epicentral distance (Δ), and M enable us to optimize the parameters of MSI-based precautionary evacuation, so that consistency between TFC-based warnings and MSI-based evacuation is assured.

The Japan Meteorological Agency (JMA) began operation of a quantitative tsunami warning system in 1999 (Kamigaichi, 2011); TFCs were used from 1977 to 1999. The version used from 1987 to 1999 has three curves relating Δ and M, which were used as the thresholds between four tsunami warning categories (major tsunami, tsunami, tsunami advisory, and no tsunami).

After compiling data of the earthquake catalog by CSN, tsunami observation data by SHOA, and some additional tsunami numerical calculation, we can apply TFC. Then, an empirical equation among MSI, M_w, and Δ (*e.g.*, MSI = $a\ M_w - b \log_{10}\Delta + c$, where a, b, and c are constants) can be derived from MSI data collected by ONEMI and an earthquake catalog by CSN. When the range of precautionary evacuation by MSI-based method is defined "within r(M) km from any coast city in which MSI is s or higher", parameters r(M) and degree s can be determined almost equivalent to the curves of thresholds used in the TFC method. If M and MSI at a coastal area in concern are available, MSI-based method can be applied just after the earthquake. Duration of strong shake or MSI at remote cites can substitute M.

This indicates that optimization of parameters of the MSI-based method for consistency to the TFC method is promising approach to improve the reliability of early tsunami warnings in Chile. This methodology could also be applicable to other countries. By the way, the issue of real-time measurement and acquisition of objective MSI can be solved by tsunami alarm equipment (Katsumata *et al*, in the same session).

Acknowledgements: This work is partly supported by SATREPS program by JICA and JST.

Keywords: Chile, early tsunami warning, instrumental Mercalli Scale Intensity, precautionary evacuation, tsunami forecast chart

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HDS27-P02 Room:Convention Hall Time:May 27 18:15-19:30

Prototype of standalone tsunami alarm equipment

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It is considered that one of the quickest ways of tsunami evacuation is movement to higher place soon after a strong and long ground shaking. Information from mass media could be helpless sometimes due to power failure. It would be helpful if there is a device which tells risk of coming tsunami.

Strong ground motion means that the source area of the event would be close to the current location, and long ground shake means that the event magnitude would be large. When the strong ground motion continues for more than thirty second, the magnitude of the event could be more than 7.5, and the duration more than sixty seconds could mean occurrence of an event of magnitude 8.5 or more. Whereas the accuracy of magnitude from strong-motion duration is very limited, it would be a valuable information when other information is not available due to power failure or other reasons. Ground velocity obtained by integrating the acceleration can be used for rough magnitude estimation also.

The MEMS (micro electro mechanical systems) sensors are currently available with low coast. Small computer systems are also available. We are developing a low-cost equipment using a MEMS sensor, one-chip microprocessor, and a small computer which could tell possible risk of tsunami with display and voice.

Instrumental seismic intensity could be one of outputs of the equipment. Seismic intensity is usually observed by human in the world. It is considered that rapid grasp of possible damaged area can be done if seismic intensities are reported through the network like as in Japan. Some methods have been proposed as instrumental modified Mercalli scale. It is easy to install those methods in the equipment. The seismic intensity itself could be a trigger of evacuation from tsunami (Hayashi et al., this meeting). In Chile, there is such an evacuation rule based on seismic intensity. Former tsunami alarm in Japan was also based on seismic intensity observed by human. Similar way could be used for the countries where enough seismic network is not deployed yet.

Acknowledgments

Web pages of ”ITAI NIKKI”, ”HAJIMETENO PIC”, and others were referred to to make up the measuring part. This study was partly supported by the SATREPS project of ”Enhancement of technology to develop tsunami-resilient community”.

Keywords: tsunami alarm, instrumental seismic intensity, magnitude, strong-motion duration

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HDS27-P03 Room:Convention Hall Time:May 27 18:15-19:30

Real time earthquake information and tsunami estimation system for Indonesia, Philippines and Chile regions

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Southeast Asia as well as South American regions are within the most active seismic regions in the world. To contribute to the understanding of source process of earthquakes and long term seismic activity, the National Research Institute for Earth Science and Disaster Prevention NIED maintains the international seismic Network (ISN) in the Asian-Pacific region. Continuous seismic waveforms from broadband seismic stations in Indonesia (148), Philippines (12), and Northern Chile (18) are currently received in real time at NIED, and used for automatic location of seismic events. Using these data we perform automatic as well as manual routine estimation of moment tensor of seismic events (Mw>4.5 in Indonesia and Philippines, and Mw>4.0 in Northern Chile) by using the SWIFT program developed at NIED (Nakano et al. 2008). Since January 2015 we started the real time calculation of local tsunamis in Indonesia, Philippines and Northern Chile using a tsunami simulation code and visualization system developed at NIED (Inazu et al. 2014), as well as earthquake source parameters estimated by SWIFT. The goals of the system are to provide a rapid and reliable earthquake and tsunami information in particular for large seismic events in the region, and produce an appropriate database of earthquake source parameters and tsunami simulations for research.

The system uses the preliminary hypocenter location and magnitude of earthquakes automatically determined at NIED by the SeisComP3 system (GFZ) from the continuous seismic waveforms in the region, to perform the automated calculation of moment tensors by SWIFT, and then carry out the automatic simulation and visualization of tsunami. The system generates maps of maximum tsunami heights within the target regions and along the coasts and display them along with the fault model parameters used for tsunami simulations. Tsunami calculations are performed for all events with available automatic SWIFT/CMT solutions. Tsunami calculations are re-computed using SWIFT manual solutions for events with Mw>5.5 and centroid depths shallower than 100 km. Revised maximum tsunami heights as well as animation of tsunami propagation are also calculated and displayed for the two double couple solutions by SWIFT. Detailed procedure for tsunami simulation is as follows;

1. Calculate two finite fault models based on seismic moment, fault mechanisms and centroid location by SWIFT, as well as by an empirical scaling relating seismic moment and fault dimensions. We use a large stress drop model by assuming, a fault length over fault width ratio of 2, and a fault average slip to fault length ratio of 5e-5 (Utsu 2001). These values approximately correspond to a fault average stress drop of 5MPa, implying larger values of simulated tsunami as compared to the values obtained from other scalings (i.e. Murotani et al 2008).

2. Compute the seafloor deformation using the dislocation theory (Okada 1985), for the source models obtained in step 1. In addition to the vertical seafloor deformation, we incorporate the contribution of horizontal seafloor deformation to the vertical component due to sea-floor gradient (Tanioka and Satake 1996 GRL).

3. Carry out the tsunami simulation based on a linear long-wave model and a long-wavelength filtering effect in the deep seas (Kajiura 1963).

4. Automatically publish the earthquake parameters and tsunami simulation results in the following web site:

http://www.isn.bosai.go.jp/en/index.html

Acknowledgments

Seismic data from Indonesia and Philippines is received at NIED under a cooperative research with BMKG (Indonesia), PHIVOLCS (Philippines), and GFZ (Germany). Data from Northern Chile is being provided by the IPOC (Integrated Plate Boundary Observatory of Chile) and Universidad de Chile.

Keywords: Indonesia, Philippines, Chile, Earthquake parameters, Tsunami forecast, Realtime

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HDS27-P04 Room:Convention Hall Time:May 27 18:15-19:30

Development of tsunami waveform database based on linear dispersive-wave theory for real-time tsunami forecasting

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Real-time tsunami forecasting based on source inversion of offshore tsunami data is effective for update of tsunami early warnings. To accomplish the real-time analysis in a short time, in advance of an earthquake we prepare a database of the tsunami Green's functions that are responses to the unitary displacement of a sea-surface element (unit source) at observing points. For the construction of our present database, linear long-wave (LLW) approximation was used in the numerical simulation. However, recent offshore tsunami observations have demonstrated that the LLW approximation is sometimes invalid and the linear dispersive effect should be taken into account in tsunami modeling. If the effect is neglected in our source inversion, the accuracy of the resultant tsunami predictions should be degraded. In this study, we develop a database of Green's functions based on the linear dispersive-wave (DSP) simulations to improve the forecasting accuracy. A difficulty to make the DSP database is very long computation time. The DSP simulation takes much longer time than LLW one. In addition, we have to perform the simulation more than 1000 times, corresponding to the number of the unit sources. To reduce the computation time, we used tsunami-simulation code JAGURS [Baba et al., 2015, PAGEOPH], which is optimized for the parallel computation in K computer (the Japanese supercomputer) by using OpenMP and MPI techniques. For more effective computation of many cases, we implemented a function that the tsunami simulations for more than 1000 source are performed in parallel once a user submits only one job. As the result of its application to the Nankai-trough region where there is 1059 sources, the whole calculation was finished in ˜20 hours by using 4236 nodes of the K computer.

This study is partly supported by the High Performance Computing Infrastructure program, MEXT. Numerical simulations in this study were performed by using K computer.

Keywords: real-time tsunami forecasting, database, linear dispersive-wave theory, K computer

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HDS27-P05 Room:Convention Hall Time:May 27 18:15-19:30

Possibilities of measuring great tsunamis using GNSS-based ship height positioning

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Offshore measurements of tsunamis are very useful for robust tsunami forecast and its source estimation. The measurements using ocean bottom pressure gauges and GPS buoys with good sensitivities have been established and installed in open oceans. Associated methods based on the on-line offshore data retrievals have been proposed and operated for real-time tsunami source estimation and forecast (e.g., Tang et al. 2012 JGR Oceans; Tsushima et al. 2012 JGR Solid Earth). In terms of extending the skills of the forecast and source estimation, it is useful to exploit further possibilities using other offshore measurements. In the present study we examined an offshore ship-borne GPS height record to evaluate noise level at frequency of the great tsunamis (10ˆ-2-10ˆ-1 cpm). The kinematic PPP (Precise Point Positioning) solution was expected to show possible detection of large amplitudes (>10ˆ-1 m) of offshore tsunami at the frequency. Such large-amplitude tsunamis seem to be hardly found in low-precision positioning solutions (DGPS (Differential GPS) and single point positioning) because of inherent background noise levels one order of magnitude larger than that in the PPP solution. The low-precision positioning GNSS equipments are, on the other hand, inexpensive and will be widely used as the AIS (Automatic Identification System) by a lot of ships including a larger number of small fishing vessels. The height information is not included in the current AIS data, but may be utilized in future. We are evaluating possibility of large tsunami detection by the low-precision GNSS height time-space series based on spatially-dense distribution from many ships.

Keywords: tsunami, GNSS, ship, height

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HDS27-P06 Room:Convention Hall Time:May 27 18:15-19:30

Relationship between tsunami heights at offshore and coastal points in the Sea of Japan

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Several large (M>7.5) earthquakes occurred along the eastern margin of the Sea of Japan and caused tsunami damage in Japan as well as on Korean peninsula in the last two centuries. They were the 1993 Southwest Hokkaido (Mjma 7.8), 1983 Japan Sea (Mjma 7.7), 1964 Niigata (Mjma 7.5), 1940 Shakotan-oki (Mjma 7.5), and 1833 Shonai-oki (M 7.5) earthquakes.

In order to assess possible future earthquakes and tsunamis, Ministry of Land, Infrastructure, Transport and Tourism (MLIT) of Japan recently identified 60 submarine active faults with lengths ranging from 24 to 162 km (corresponding moment magnitudes of 6.8 to 7.9).

Tsunami inundations in Aonae Bay, Okushiri Island, Japan on high-resolution bathymetry and topography data were simulated using the active fault models. For small tsunamis (coastal tsunami heights <4 m), the relationship between tsunami heights in the offshore (50 m depth) and at the coast follows a linear regression line, whereas for larger tsunami the linear relationship may not hold. The regression line gives an amplification factor of 3.5 to roughly estimate coastal tsunami height from a tsunami numerical simulation result on a coarse grid system.

We computed offshore and coastal tsunami heights along the Japanese coasts from these 60 faults and identified faults that may possibly cause tsunami damage (coastal tsunami heights >1 m) for 156 municipalities (cities and towns). Comparisons between offshore and coastal tsunami heights show that the ratios vary from place to place, and seem to be controlled by the bathymetric slope.

Keywords: Tsunami simulation, Tsunami inundation, Active faults, The Sea of Japan

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HDS27-P07 Room:Convention Hall Time:May 27 18:15-19:30

Estimation of tsunami propagation paths using the array analysis of tsunami simulation results

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Background
A maximum wave often arrives several hours after a first wave in case of a distant tsunami.
Therefore, it is considered to be important to prepare to monitor the maximum tsunami wave, knowing its propagation path.

Purpose
The purpose of this study is to show the tsunami propagation path in a single figure.

Methodology
Simulated tsunami waveform data are regarded as waveform data of an array observation.
An incoming wave direction for a reference point are determined, estimating semblance values (Neidell and Taner, 1971).
Going back toward the direction of the incoming wave from the reference point.
This process is done repeatedly until the ray reach the tsunami source.
It is a kind of a backward ray analysis.

Result
This methodology was applied to the 2010 Chile earthquake.
The various backward propagation paths from a NOAA DART station near Japan are displayed in a single figure.
It shows that the each wave in the observed waveform at a DART station is associated with the those propagation paths and the waveform is derived from them.

Keywords: tsunami simulation, backward ray analysis, maximum wave, array analysis, propagation path, distant tsunami

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HDS27-P08 Room:Convention Hall Time:May 27 18:15-19:30

An investigation of sea level fluctuation around the Tosashimizu Port by observed data

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1. introduction

When a long wave such as tsunamis invades the harbor and port, secondary undulation may occur depending on the topography condition and the period of the tsunami. Such a secondary undulation is observed in past tsunami events.

The study for a water level change caused by natural period is accomplished a lot with observation data and numerical computation.

Those studies were achieved dominant period of the natural period from the fluctuations of sea level of the harbor and the topography condition and discussion about amplification factor.

In this study target at Tosashimizu port, Kochi and observed sea level at inside and outside the port. This study research for secondary undulation at Tosashimizu port.

2. observation data

In this study, install 7 pressure gauge in the Tosashimizu Port and, during periods from September 10, 2014 to December 9, 2014, observed a sea level by 15 seconds sampling interval. We used High-frequency filter to remove sea level variations associated with synoptic atmospheric activity. We divided that data into 2 types : period containing weather disturbance and the other.

We performed spectrum analysis for the these data and considered the characteristic of the secondary undulation in the Tosashimizu Port

3. conclusion

In this study, We analyzed sea level data from September 10, 2014 to December 9, 2014 and examine characteristic of the secondary undulation in the Tosashimizu Port and got the following results.

3.1. From a result of the spectrum analysis of the not containing weather disturbance, the Tosashimizu port has strong peak around 20 minutes which are a natural period in the port. A peak begins to appear in around 40 minutes as approach the mouth of a port. On the other hand, out of the port has peaks seen around 40, 60 and 85 minutes.

3.2. From a result of the spectrum analysis of the containing weather disturbance, in the port, has strong peaks around 20 and 40 minutes. Out of the port has peaks around 30 and 75 minutes, on the other hand, not seen 40 minutes peak.

From the above results,

The period that spectrum peaks appears is different in inside and outside the port. In the Tosashimizu Port a state with different secondary undulation properties was confirmed in the inside and outside. In the containing weather disturbance period, the peak appear around 40 minutes is different from natural period and need to examination this peak generation factor.

Acknowledgments

This study received assistance to JSPS Grant in Aid for Scientific Research (B). I write it down here and express gratitude.

reference

1. Kuniaki ABE(2011): Seiche dominant periods of bays and ports determind from a repeated measurement (2) Pacific coast of Southwest Japan, Nippon Dental College bulletin, vol.40, pp.23-30

2. SusumuTAKAHASHI(1986):Tsunami and Secondary Undulation in the Ishikari Bay, Bulletin of the Faculy of Engineering Hokkaido University, vol.130, pp.17-32

3. Hitoshi MURAKAMI, Tomio SHIMADA(1979):Consideration about the characteristic of the Secondary Undulation based on field data and the actual survey (2), Journal of JSCE B2 (shore engineering), vol.26 pp.129-132

Keywords: secondary undulation, spectrum, Tosashimizu

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HDS27-P09 Room:Convention Hall Time:May 27 18:15-19:30

Seismic - Seiche generated at Lake Ashinoko

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The water level at Lake Ashinoko vibrated for some hours after the 2011 Off the Pacific Coast of Tohoku Earthquake (March 11, 2011, Mw9.0). We calculated the running spectrum for time series data of water level, and estimated natural periods (seiche) at Lake Ashinoko. We observed the seiche periods of 15.16 (T1), 6.58 (T2), 4.48 (T3), 3.88 (T4), 3.13 (T5), and 2.19 minutes (T6). T1, T2, T3, and T5 vibrated under a steady state, even before the earthquake. The amplitudes of T3, and T5 were activated after the earthquake. In addition to these periods, T4 and T6 were generated only after the earthquake. The seismic seiche excited by the earthquake continued at the maximum for about 20 hours. We discuss about the seismic seiche generated according to other earthquakes, and its mechanism.

Keywords: Seismic-Seiche, Lake Ashinoko, Spectrum Analysis, Natural Periods

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HDS27-P10 Room:Convention Hall Time:May 27 18:15-19:30

Resuspension of Marine Sediment in Osaka Bay by Tsunami

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The non-dimensional bed shear stress in Osaka Bay by the tsunami caused by Nankai Trough Earthquake was calculated. And the conditions which a resuspension of marine sediments occurs were clarified in every region of Osaka Bay. Resuspension not occur in the western part of Osaka Bay, where the predicted maximum flow velocity of tsunami is 1.8 m/s, under the present condition of the water depth and the moisture content. On the other hand, the resuspension occurs in the eastern part of Osaka Bay by the predicted tsunami. The occurrence and the scale of resuspension in the eastern part depend on the moisture content and the flow velocity of tsunami. Extremely strong resuspension will occur continuously throughout tsunami hitting in the estuary with over 72 % of moisture content. The scale of resuspension such a "Hot Spot" is decided by the moisture content. Marine sediments contain cysts and heavy metals especially in the estuary. We are afraid that resuspension of sediment lead red tide and water pollution over wide area to carried by advection after tsunami.

Keywords: Tsunami, Sediment, Resuspension, Osaka Bay, Nankai Trough, Shear stress

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HDS27-P11 Room:Convention Hall Time:May 27 18:15-19:30

Effects of the 17th century great Hokkaido tsunami on Tohoku regions

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Historically, great underthrust earthquakes occurred off east Hokkaido, Japan because the Pacific plate subducts beneath the Okhotsk plate. Also, tsunami deposits by prehistoric tsunami have been found off east Hokkaido on the coast of Pacific Ocean.

Previous study suggest that the 1611 Keicho tsunami earthquake is the 17th century great earthquake (Okamura and Namegaya, 2011). In this study, we examined effects of the 17th century great tsunami generated off east Hokkaido on the coast of Pacific Ocean in Tohoku region.

We estimated fault model of the 17th century great earthquake by using locations and elevations where tsunami deposits were found (Ioki and Tanioka, 2013). The result shows that tsunami inundation spread far inland were explained by a large rupture area at deep part of the plate interface. Surveyed tsunami heights near the coast were explained by very large slip amount at shallow part of the plate interface near the trench. The total seismic moment of the 17th century great earthquake was calculated to be 1.7×10^{22}Nm (M_w 8.8).

Tsunami heights and inundation were also calculated along the coast of Pacific Ocean in Tohoku region. Computed tsunami heights along the coast were almost less than 4 m and computed tsunami inundation area is very small at Yamada bay. Even if slip amount of estimated fault model is two or three times larger, computed tsunami inundation area in Tohoku region is small. Tsunami inundation area by the 1611 Keicho tsunami were not explained by our estimated fault model. By an effect of directivity, high tsunami was propagated toward east Hokkaido and low tsunami was propagated toward Tohoku.

Keywords: tsunami, great earthquake, Hokkaido, Kurile trench

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HDS27-P12 Room:Convention Hall Time:May 27 18:15-19:30

Tsunami simulation for the Korean Peninsula using a Nankai-Tonankai earthquake scenario

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[1]Pukyong National University, [2]Nat'l Res. Inst. Earth Sci. Disas. Prev.

There is a Korean historical document which records an observation of anomalous tidal waves at Jeju Island in 1707. The date corresponds to the occurrence of the great 1707 Hoei earthquake (M8.4) which occurred in the Nankai trough off southwestern Japan. This record suggests a possibility that the tsunami waves caused by the Hoei earthquake reached the Korean peninsula. In this study, we investigate whether the tsunami caused by an anticipated Nankai-Tonankai earthquake will affect to the Korean peninsula or not. We conducted a tsunami simulation based on the nonlinear longwave equations with a dynamic rupture scenario that breaks the whole Nankai-Tonankai area as a single event. We used the dynamic rupture scenario computed by Hok et al. (2011, JGR). The simulation shows tiny tsunami arrivals in Jeju Island about 4 hours after the start of tsunami propagation. At 12 points around the Jeju Island and 2 points between China and Jeju, tsunami heights are computed. We obtained larger tsunami heights (˜0.08 m) at the western side of the Jeju than the eastern side (˜0.05 m), and we observed the largest amplitude (˜0.17 m) at the southwestern coast. Also, we found that a larger tsunami wave reaches the eastern coast of China, in contrast to the Korean peninsula. Small tsunami amplitudes are observed at Jeju Island because the first tsunami wavefronts attenuated while turning around Kyusyu Island. This kind of simulation would be useful to understand how tsunamis originating at southwestern Japan propagate to Korea, which will serve for the mitigation of tsunami disasters in the Korean peninsula.

Keywords: Tidal waves record at Jeju Island, Nankai-Tonankai earthquake, Numerical simulation

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Relationships between heights and damage of the 1854 Ansei Nankai tsunami along west coast of Kochi prefecture, Japan

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Estimation of the historical tsunami heights is basically based on historical documents which record concrete marks of inundation heights and/or inundation limits. Some documents recorded only damage, for example, numbers of damaged buildings. In this case, it is no doubt about the tsunami inundation, but it is difficult to estimate the tsunami heights from only the damage records. Therefore, relationships between the tsunami heights and the damage are needed. The relationships are proposed as tsunami fragility (e.g. Koshimura et al., 2009, JDR), but it basically targets recent tsunamis. These relationships cannot be directly applied to the historical tsunamis, because resistance of buildings might be different between the present and the historical era. In this study, relationships between heights and damage ratio of the 1854 Ansei Nankai earthquake tsunami along west coast of Kochi prefecture, Japan, were obtained. A document “Kaei kinoe-tora doshi ojishin hikki recorded by Tatsusuke Tokunaga” documented in “Shinshu Nihon jishin shiryo 5 suppl. 5” was used. The document recorded numbers of buildings which were swept away, collapsed buildings, and slightly damage buildings. We calculated damage ratio (Hatori, 1964, BERI) as numbers of damaged buildings divided by those of total buildings for each hamlet. The numbers of the total buildings were used from “Kanpo gocho” . Tsunami heights have already been reported by previous studies (e.g. Tsuji et al., 1994, Historical Earthquake). Then, relationships between the damage ratio and the tsunami heights were obtained. The result shows that tsunami heights of 2 m corresponds to damage ratio of zero. The damage ratio drastically increases to more than 0.8, when the tsunami height exceeds 5 m.

Keywords: tsunami height, damage ratio, the 1854 Ansei Nankai earthquake tsunami, Kochi prefecture

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Tsunami source model of M7 earthquakes occurred in the Sea of Japan

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Eastern margin of the Sea of Japan has been considered as a nascent plate boundary between the Eurasian and North American plates but not a typical subduction zone, hence the maximum magnitude (M$<$8) of earthquakes is considered to be smaller than those in the Pacific Ocean. Nevertheless, several large earthquakes with M $>$7.5 in the last century caused seismic and tsunami damages, such as the 1993 Southwest off Hokkaido (Mjma 7.8), 1983 Japan Sea (Mjma 7.7), 1964 Niigata (Mjma 7.5), or 1940 Shakotan-oki (Mjma 7.5) earthquakes. Detailed studies of source process were performed for these earthquakes. There are many active faults along the eastern margin of the Sea of Japan. Smaller (M˜7) earthquakes also cause seismic and tsunami damages if their hypocenters are near the land. However, there are few analyses for earthquakes around M7. Therefore, we study the characteristics of the M˜7 earthquakes in the Sea of Japan using seismic waveform and tsunami waveform data.

We analyzed the 1983 West off Aomori (Mjma 7.1), 1971 West off Sakhalin (Mjma 6.9), and 1964 off Oga Peninsula (Mjma 6.9) earthquakes. We made teleseicmic waveform inversion using Kikuchi and Kanamori (1991, BSSA)'s code to obtain the heterogeneous slip distribution. We then computed tsunami waveforms using JAGURS code (Baba et al., 2015, PAGEOPH) at the tide gauge stations and compared with the observed tsunami waveforms. The tsunami waveforms were also computed from simpler rectangular faults with uniform slips. For the 1971 earthquake (Mw 6.8) and the 1983 earthquake (Mw 6.7), the amplitudes of tsunami waveforms calculated from the heterogeneous slip model did not reproduce the observed tsunami waveforms; to match with the observed tsunami amplitudes, larger seismic moment and average slips are required. Furthermore, for all the earthquakes, we have to examine the locations and parameters of each fault to reproduce the travel times and the agreements between observed and calculated waveforms.

Keywords: tsunami source model, fault parameter, tsunami waveform analysis, eastern margin of the Sea of Japan

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Multiple Tsunami Scenarios considering Large Slip Zone, Super Large Slip Zone, Hypocenter and Seismic Magnitude

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In the 2011 Tohoku Earthquake Tsunami Disaster, the actual tsunami heights had exceeded the estimated heights extremely and the underestimation caused serious damages in Japan. This tsunami shows a disaster beyond assumption increase damages greatly. Multiple scenarios might be effective in reducing the risk beyond assumption and they have been studied for the tsunami disaster mitigation (e.g. Takahashi et al., 1995 ; Kawata et al., 2003 ; Suzuka et al., 2004 ; Tomioka et al., 2005 ; Suzuki and Kawata, 2012). However, many researches have focused on the macroscopic fault parameters and the microscopic fault parameters have not been considered sufficiently.

After the Tohoku tsunami, Cabinet office government of Japan reported 'Large slip zone (LSZ) and Super large slip zone (SLSZ)' related with asperity and the assumed tsunami faults models (e.g. Cabinet office government of Japan, 2012). After that, some organizations consider a new assumption about fault model. However, the idea about a shape or location of LSZ and SLSZ is different. And the standard method has not been decided. Assumption of their shape or location could be different in the case of same hypocentral region, and the characteristic of occurred tsunami might be different. Therefore, the general model to assume LSZ and SLSZ is required.

Seto and Takahashi (2014) proposed a model to assume multiple tsunami scenarios considering uncertainly of LSZ and SLSZ, and the model was applied to the Nankai trough. The model consists of background rupture zone (BZ), LSZ and SLSZ. The main feature of this model is to enable to make the multiple tsunami scenarios systematically after determining some parameters such as the ratios of area and dislocation of LSZ to a tsunami fault. As a result, Seto and Takahashi (2014) showed 15 tsunami scenarios. However, it was indicated as the improvement that the model is not examined several LSZ and SLSZ, the uncertainly of hypocenter and seismic magnitude.

In this study, the improved general model considering more the above 3 points is proposed. Compared with the model of Seto and Takahashi (2014), the characteristic of this proposed model is as follows. (1) The uncertainly of seismic magnitude considered by a scaling law can be examined. (2) The two couples of LSZ and SLSZ can be examined. (3) The uncertainly of hypocenter can be examined. The proposed model was applied for the Nankai Trough to assume multiple tsunami scenarios and its detailed procedure was shown. As a result, several hundreds scenarios were assumed. By using these tsunami scenarios, tsunami propagation was simulated numerically and the maximum variation of water level observed within 24 hours on GPS buoys is examined comparing with the previous model.

Keywords: Tsunami fault, Uncertainly, Nankai trough, GPS buoy

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Effect of uncertainty in offshore tsunami heights on the probability inundation hazard assessment

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Application of the Probabilistic Tsunami Hazard Assessment (PTHA) to a tsunami inundation, which assumed occurrence of several types of earthquake, was discussed (Saito et al., 2014, JpGU). Estimations of tsunami inundation in PTHA is generally given by numerical simulations. The simulation results inlude uncertainties caused by tsunami source characteristics, propagation path characteristics or site characteristics. Therefore, there is variability in residual errors of tsunami heights at offshore. If one tsunami simulation results does not over a coastal levee, continental areas may not be inundated, but there is the potential that the tsunami clear a coastal levee due to an increase in offshore tsunami height by uncertainties.

We propose an approach of assessing inundation hazards considering the potential of overflow using a practical example of tsunami inundation hazard in Rikuzen Takata City, Iwate. First, we examine the correlation distribution of offshore tsunami heights and inundation height, and and calculate an approximate straight line. We assume the approximation line as a model for predicting tsunami inundations from offshore tsunami heights. Using the tsunami hazard curve calculated at the offshore site and the approximation line, we can estimate the tsunami inundation hazard curve for the potential of overflow. Comparing with the tsunami inundation hazard curve for the results which over coastal levee, we discuss the effect of uncertainty in offshore tsunami heights.

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Keywords: tsunami, inundation, hazard assessment, probability