Local and global Activity to contribute the Sendai Framework for Disaster Risk Reduction

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The Sendai Framework for Disaster Risk Reduction (SFDRR) 2015-2030, the successor instrument to the Hyogo Framework for Action (HFA) 2005-2015: Building the Resilience of Nations and Communities to Disasters, was adopted at the Third UN World Conference on Disaster Risk Reduction in Sendai, Japan, on March 18, 2015. The SFDRR outlines seven clear targets and four priorities for action to prevent new and reduce existing disaster risks: (i) Understanding disaster risk; (ii) Strengthening disaster risk governance to manage disaster risk; (iii) Investing in disaster reduction for resilience and; (iv) Enhancing disaster preparedness for effective response, and to "Build Back Better" in recovery, rehabilitation and reconstruction. They aim to achieve the substantial reduction of disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries over the next 15 years. The substantial reduction of disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries.
The group of rounding table for DRR in Miyagi was started in April 2015 just after the UN world conference for DRR to enhance the collaboration among, members of academia, government, private, citizen and mass media and to share the information of each activity once a month. International Research Institute of Disaster Science (IRIDeS), Tohoku University and the office of Sendai city jointly organize the series of lectures in 2016 to understand what is the SFDRR and how we can contribute for it for students, people including workshop for future activities. And statistics. The Global Centre for Disaster Statistic (GGCDS) was established in April 2015. The GCDS creates a unique collaboration among United Nations organizations and other disaster risk reduction (DRR) related institutions, centering on collaboration with the United Nations Development Programme (UNDP). The purpose of the Centre is to support countries to manage disaster risks in their country and contribute to international process on DRR. The GCDS has developed a database on statistical data concerning the Great East Japan Earthquake and Tsunami, hoping that the lessons from the catastrophic disaster will be spread across the world.

Keywords: Disaster Risk Reduction, rounding table, awareness and public education, Disaster Statistic


ともに考える防災の未来
私たちの仙台防災枠組　講座シリーズ
第一回　市民のための仙台防災
枠組を学ぶ
東北大学災害科学国際研究所
泉貴子
TOHOKU
IRIDeS

NIED Observation Network for Earthquake, Tsunami and Volcano and Contribution to Disaster Resilience

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The Sendai Framework for Disaster Risk Reduction 2015-2030 was adopted at the Third World Conference on Disaster Risk Reduction held in March 2015. In the framework, priorities for action were addressed to reduce disaster risk and loss for next 15 years. Understanding disaster risk is written as the first priority with the following sentence: To achieve this, it is important for the national and local levels to promote the collection, analysis, management and use of relevant data and practical information. Considering the above action, this presentation will introduce the NIED observation network for earthquake, tsunami, and volcano that is integrally expanded to the land and offshore regions, and use and application of the data.
Based on the lessons learned from the 1995 Kobe earthquake and the 2011 Tohoku-Oki earthquake and tsunami, observation system is essential to obtain the accurate and rapid information for seismic intensity as well as tsunami height and inundation. As the preparedness for forthcoming earthquakes concerned in the Tokyo metropolitan area and along the Nankai Trough as well as volcanos, NIED established the nationwide observation network with more than 2000 stations that covers the land and offshore regions. This unique network consists of various measures to capture diversity of natural phenomena from damaging strong ground motions toward very small earthquake signals , and wave propagation from the other side of the Earth. Various measures are also seen in the observation wells reaching 3500 m in depth, sensors at the dead-end tunnels longer than 50 m, and seismometer and pressure gauge installed along the ocean bottom cable longer than 6000 km along the Japan Trench and the Nankai Trough. Most observation data are open to the worldwide users for disaster resilience and related research. As familiar examples, the data are provided in realtime to the Japan Meteorological Agency for utilization of earthquake early warning and tsunami warning. These observation data are also used for seismic and tsunami hazard assessment such as the National Seismic Hazard Maps in Japan at the national (e.g., the Cabinet Office and the Headquarter of Earthquake Research Promotion) and local government levels. Furthermore, the realtime observation data are used for rapid estimation of disaster. NIED developed and operates test runs J-RISQ (Japan Real-time Information System for earthQuake), in which the number of collapsed building with a resolution of 250 m mesh size were estimated in a few minutes after the 2016 Kumamoto earthquake. The observation data and analyzed information are applied for facilitating the disaster response, and NIED operates crisis response portal sites to disseminate disaster information via websites immediately after the disaster.
In last decades, according to the improvement of observation technology, nationwide dense observation network data are available in realtime with a delay of sub seconds. Utilizing the data are expected to improve seismic and tsunami hazard assessment, disaster risk estimation, managing disaster response and relief activities, and effective recovery from the damage.

Keywords: Observation Network for Earthquake, Tsunami and Volcano

Activities of Japanese Government Committees related to Earthquake Research

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After major devastating earthquakes, the Japanese government has set up committees to promote seismological research and to reduce future earthquake damage. I will review the activities of current government committees related to earthquake research. Two committees, Coordination Committee for Earthquake Prediction (CCEP) and Earthquake Assessment Committee (EAC) for Areas under Intensified Measures against Earthquake Disaster have made efforts to assess possible precursors for large earthquakes with particular emphasize in Tokai region, but such short-term deterministic prediction is now considered difficult in the seismological community. The Headquarters of Earthquake Research Promotion (HERP), established after the 1995 Kobe earthquake, promoted to expand the geophysical observation network, made long-term and probabilistic forecast of earthquakes on active faults and subductions zones, predicted strong ground motion from such earthquakes, and made national seismic hazard maps including probabilistic estimation of ground motion. Earthquake Research Committee (ERC) under HERP made long-term forecast and ground motion prediction for Futagawa/Hinagu faults before the 2016 Kumamoto earthquake, but the results were not fully utilized by local governments or general public to prepare for potential earthquake. Central Disaster Management Council (CDMC) under Cabinet Office has estimated the maximum possible earthquakes along the Nankai Trough and around the Tokyo metropolitan area, estimated the building, human and economic losses from such earthquakes, and made policies to reduce such damage.

Keywords: earthquake

Multilateral Perspective on an Interdisciplinary Framework for Flood Forecasting and Flood Risk Projection: A Comparative Pilot Study

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The Sendai Framework emphasizes the importance of “geospatial and space-based technologies and related services and maintaining and strengthening in-situ and remotely-sensed earth and climate observations” to support national measures for understanding disaster risk and successful disaster risk communication. Moreover, the creation of an improved intergovernmental platform and an interdisciplinary framework is an urgent priority for flood risk reduction in a large river basin. In line with these efforts, the International Centre for Water Hazard and Risk Management (ICHARM under the auspices of UNESCO) has been supporting to provide useful tools such as advanced remote sensing and hydrological model simulations.

In the beginning of a collaborative research project undertaken by Japan, Bangladesh and the Czech Republic, we addressed the necessity of collaboration in the mutual exchange of technical knowledge and skills, including evidence-based data sharing, focusing on disaster risk management and reduction. We also introduced the quantitative assessment of river flood risk with climate and socioeconomic scenarios, representative concentration pathways emissions and shared socioeconomic pathways. The main purpose of the multilateral research was to propose a new interdisciplinary and international framework with an improved forecasting model and a scenario-based projection procedure, including the use of local and global data, for enhancing disaster preparedness of two pilot countries, Bangladesh and the Czech Republic. This new framework was designed to reveal river flood risk through grid-based model simulation with any grid scale. It was applied to three standard operational forecasting schemes focused on respective thematic priorities: (1) The improvement of flood inundation maps (i.e., maps with discharge, depth, velocity) using the results from a rainfall runoff inundation model with in-situ data (rain-gauge and water level) after the validation of inundation with Earth Observation data, i.e., SAR and optical images; (2) advanced flood forecasting using radar- and satellite-observed rainfall currently used for nationwide hydrological observation and for evaluating the level of flood risk; (3) potential economic impact along with the effect of flood hazard and risk. The framework was also applied to three nationwide projection schemes on the same priorities.

With this comparative pilot study on the two representative countries, the preliminary empirical examinations showed the possibility of quantifying nationwide risk despite different complexities. Major risk factors and the magnitude of risk change can be estimated using the interdisciplinary approach and should be investigated to understand local flood risk due to strong regional variability and characteristics such as extreme rainfall and simulated inundation area of a 50-year return period flood.

Keywords: Interdisciplinary framework, Nationwide flood risk, Flood forecasting

A Modeling Framework for Inland Flood Risk Assessment in Japan

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Flooding has been the most frequent natural disaster that claims lives and imposes significant economic losses to human societies worldwide. Japan, with an annual rainfall of up to 4000 mm is extremely vulnerable to inland flooding with over ¥300bn average annual loss, 60% of which is from Tropical Cyclone(TC) flooding and 40% from non-TC flooding. The focus of this research is to develop: (i) a detailed flood hazard model for japan, (ii) a vulnerability module that captures damageability of Japan’s built environment to flooding, and (iii) an industry exposure data set that has Japan’s entire building stock modeled at a very granular resolution.

The flood hazard component consists of three building blocks: (a) a stochastic precipitation model that simulates TC and non-TC precipitation separately and blends the two model outputs in a 10K samples of continuous annual precipitation over Japan, (b) a hydrologic model that takes the precipitation as an input and produces a 10K catalog of extreme peak flows and runoffs and (c) a hydraulic model that transforms the river peak flows to flood depths for each event in the catalog. The hazard component is heavily validated with most of the available meteorological, hydrological and flood map data for Japan.

The vulnerability module consists of functional relationships, also referred to as damage functions that relate hazard intensity to damage in terms of the so called damage ratio - the ratio between loss and replacement value. Damage functions are built separately for building, content and business interruption related losses and for each building construction type, height, occupancy, etc. Once the entire family of damage functions is available, the magnitude of the hazard extracted from the stochastic catalog at each instant in time and at each specific location is linked to a loss estimated as the damage ratio times each building components’ replacement value. Finally, all losses in a portfolio are aggregated at different spatial and temporal scales to provide a complete view of risk to the portfolio. To better validate the risk at a country level, an industry exposure database is developed that ultimately represent all potentially affected properties and provides means for assessing the risk for the entire flood insurance industry. The view of risk at prefecture and country level is intensively validated with loss data from major insurance companies and all available government sources.

Keywords: flood risk assesment, property loss estimation

Improvment of Emergency Response Preparedness for Natural Disasters using Mobile Phone Application

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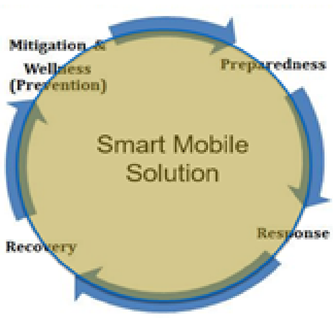
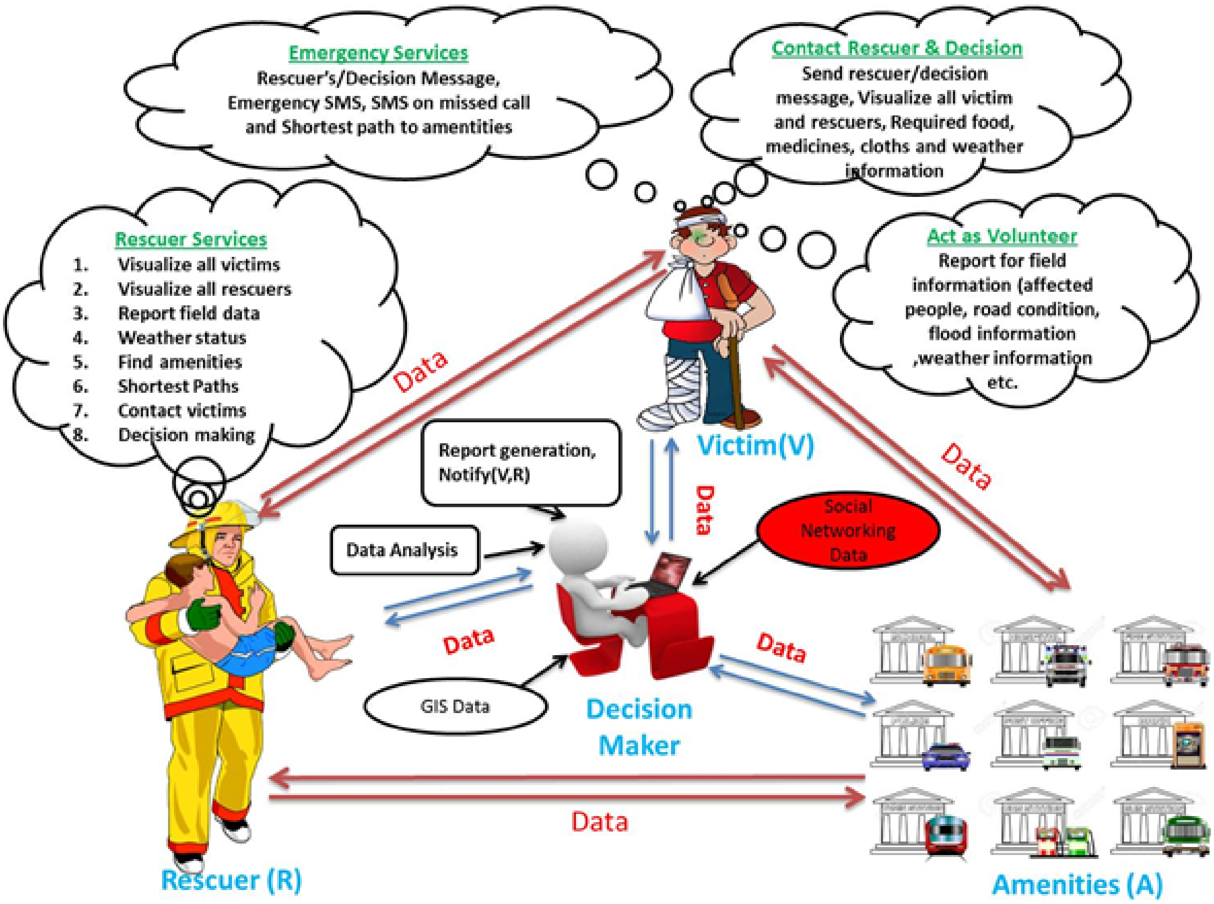
Rescue work during a disaster is highly affected due to lack of real time information available for rescuers, victims and decision makers. During rescue operations, availability of real-time information on a portable device would prove useful for collecting important data. In present research work, an application has been proposed which has been developed and tested as a GIS-based mobile application on the Android platform with disaster specific software modules. This mobile application is expected to be useful for disaster management teams during the rescue operations for better co-ordination and information exchange. A formal interview and discussions with officials from NDRF (National Disaster Response Force, Govt, of India) helped form an understanding, envisage requirements for the application.
The application titled "BhuNak" (Bhu: Sanskrit word meaning Earth; Nak short for *Naksha* meaning map) exhibits Emergency/Distress Call, Reporting System, Disaster Alerts and Geovisualization as its key features. The application allows field data reporting, sending geo-location SMS, viewing and retrieving weather and location information on the mobile device. The application has been tested for usability, time consumption and accuracy in different field and network availability conditions. BhuNak also has facilities of offline saving of dataset and sending it when communication links are available. Functionalities of the application are designed to successfully address all the phases of disaster. All the data shared between Victims and Rescuers are being saved in central server for data analysis. Decision maker can act as per the situation, can set the priorities and send real time messages and information to rescuers, victims and other agencies like hospitals, police NGOs etc.

Keywords: Disaster Management, Mobile Technology, GIS, Offline data sharing, Geovisualization

BhuNak Mobile Application





Fault slip distribution of the 2016 Fukushima earthquake estimated from tsunami waveforms

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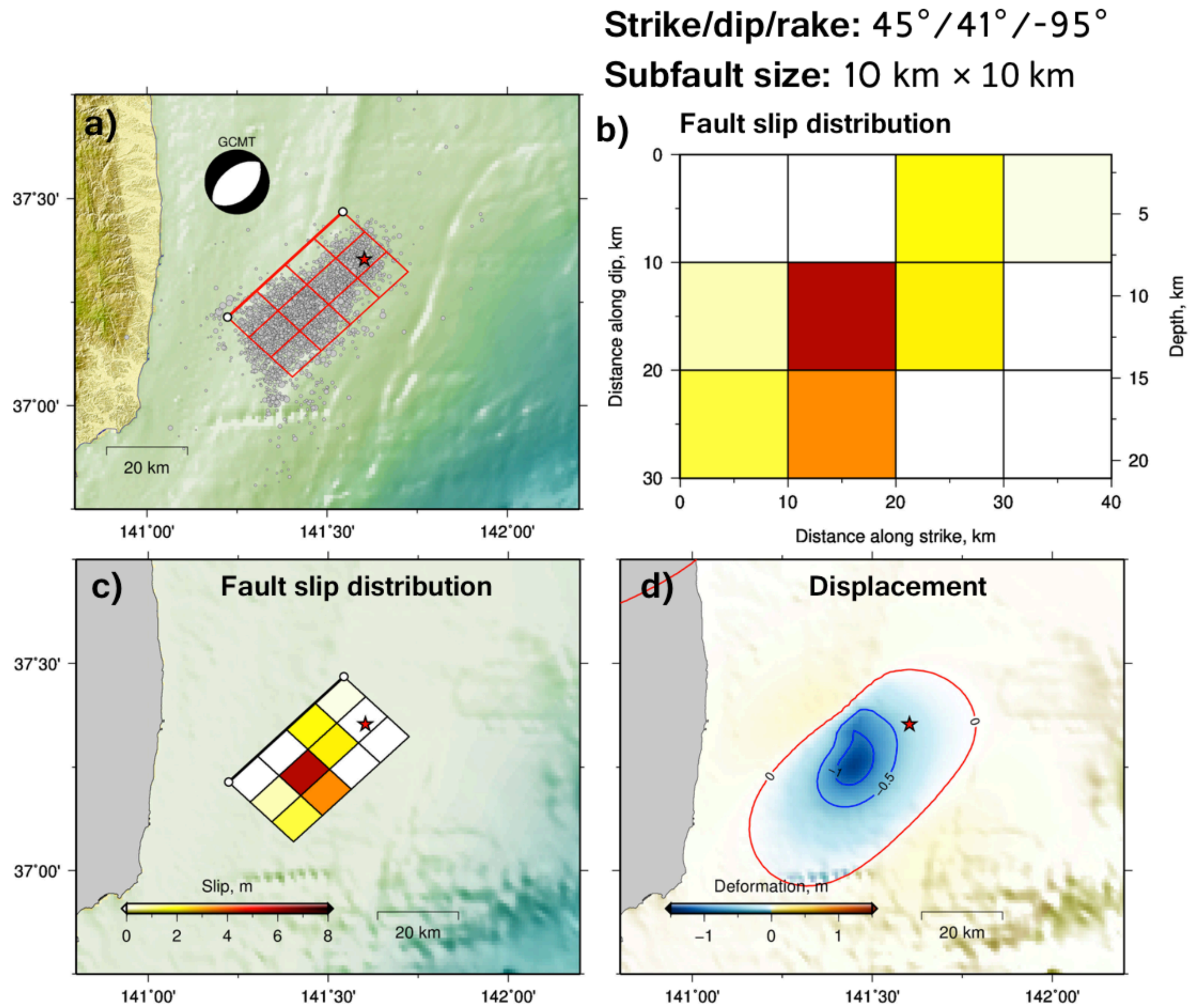
A large earthquake occurred on 21 November 2016 UTC offshore Fukushima prefecture approximately 40 km to the east from the dismantled Fukushima Daiichi nuclear power plant and 120 km to the southeast of Sendai city. Based on the JMA earthquake catalog, the hypocenter of the earthquake is located at 37.355° N, 141.604° E, and 25 km of depth and the magnitude (Mjma) is 7.4. There are four moment tensor solutions available for the event from Global CMT, JMA (two solutions), and USGS. All of these moment tensor solutions suggest that the earthquake is a normal faulting event and has a moment magnitude (Mw) of 6.9. The depths of the centroids are all at 12 km, which is shallower than the hypocenter depth provided in the JMA catalog. The earthquake generated a tsunami that was clearly recorded at tide gauges in Iwate, Miyagi, Fukushima, Ibaraki, and Chiba prefectures, and five cabled-pressure-gauges offshore Iwate (TM1, TM2, YTM1, YTM2, and YTM3).
The simulated tsunami waveforms from GCMT, JMA-CMT, JMA-WCMT, and USGS-WCMT solutions generally underestimate the observations. The tsunami waveform of USGS-WCMT northwest dipping (Normalized RMS error = 1.21) and GCMT southeast dipping (Normalized RMS error = 1.26) solutions better fit the observations compared to those from the other solutions. The centroid locations of JMA-CMT and JMA-WCMT are located on the edge of the aftershock region, that of USGS-WCMT is located outside and to the northwest of the aftershock region, and that of GCMT is located inside the aftershock area. Because the centroid and hypocenter depths are significantly different, we also run simulations with depths of 8, 12, 20, and 25 km. The results show that the simulated tsunami waveforms at offshore pressure gauges are more sensitive to the fault depth than those at tide gauges.
The fault geometry with the southeastward dipping of GCMT solution (strike = 45°, dip = 41°, rake = -95°) is chosen for tsunami waveform inversion because it gives small misfit to tsunami waveforms and the centroid is located within the aftershock area. We distributed 4 ×3 sub-faults with sub-fault-size of 10 km ×10 km, which cover the aftershock area. The estimated fault slip distribution has a large slip of 6 m at depth of 12 km (Figure 1). The seafloor displacement is estimated to be subsided by 1.3 m at the lowest point (Figure 1d). From the fault slip distribution, the calculated seismic moment by assuming a rigidity of 4×10^{10} N/m^2 is 2.21×10^{20} Nm or equivalent to Mw = 7.5, which is significantly larger than that from moment tensor solutions.
Using the estimated fault slip distribution, we run a numerical simulation to analyze the behavior of the tsunami propagation. The tsunami wave hit the coast of Fukushima and the coast reflected the wave back to the open ocean. The reflected wave is then refracted to the north direction and clearly observed in the later phase of tsunami waveform at Sendai port, TMs and YTMs stations. This propagation behavior is mainly due to the configuration of bathymetry off the east coast of Japan (from Chiba to Iwate prefecture). This effect of bathymetry is further confirmed by a numerical experiment of tsunami simulation using artificial bathymetry with seafloor deeper than 500 m as flat in which the reflected tsunami was spread in all directions in front of the coast without being refracted to a particular direction. Larger tsunami amplitudes in the later phases of tsunami waveform are observed and modeled at Sendai port, Ishinomaki, Ayukawa, and Ofunato. At Sendai port, the peak of the second arriving wave is larger (1.4 m) than the peak of first arriving wave (0.9 m). We also found that accurate and precise bathymetry around the ports is required in order to get a reliable coastal tsunami prediction.

Figure 1. Earthquake fault model estimated by tsunami waveform inversion. a) Focal mechanism, aftershock distribution, and subfault boundary. b) Cross-section of fault slip distribution along the dip. c) Map of fault slip distribution. d) Estimated seafloor displacement from the fault slip distribution.

Keywords: The 2016 Fukushima tsunami, tsunami waveform inversion, offshore pressure gauge, bathymetry effect, large tsunami later phase



Grouping the normal modes, a way to characterize tsunami sources in Japan Sea

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Satake and Shimazaki (1988) calculated the normal mode solutions of Japan Sea, qualitatively grouped the calculated modes into the whole Japan Sea modes and the regional modes, then discussed the properties of tsunami excitation of the 1963 Niigata earthquake and the 1983 Japan Sea earthquake.

We extended their method and obtained a high resolution normal mode solution of Japan Sea (Wu and Satake, 2015). We also characterized tsunami sources in Japan Sea, for the 60 potential submarine sources recently proposed by Japanese Ministry of Land, Infrastructure, Transport and Tourism.

In this study, we quantitatively grouped the normal mode solutions into basin-wide modes, regional modes and local modes, based on the eigenvectors, or water height distribution. We examined several statistical parameters, such as mean (first moment) or variance (second moment), and Kurtosis, which is the fourth moment divided by the square of the second moment. We finally selected Kurtosis to group the modes. We determined that the modes with Kurtosis < 35 as the basin-wide mode, those with Kurtosis $>$ 350 as local modes, and those between as regional modes. Out of 6000 modes that we have calculated, 622 modes are grouped as basin-wide mode, 4953 modes are regional modes and 425 modes are local modes.

We then calculated the excitation weights of the 60 potential submarine faults. The average excitation weight is larger if the moment magnitude is larger or the source is located at shallower water depth. In order to examine the contribution from the above 3 groups, we compared the average weights of largest 425 modes, and found that those from the regional modes are the largest. For the regional modes, the faults located at shallower water depth generally have larger excitation weights. This indicates that the regional modes excited by an earthquake at shallow water depth is most powerful.

Finally, eigenfunctions of these regional modes with large average weight for the 60 faults show that they have large amplitude in wide shore areas, where these faults are located. This is in agreement with the obtained results and also reminds us to pay special attentions to the regional modes excited by potential sources at relatively shallower water depth.

Global Centre for Disaster Statistics: Connecting UN, academia and policy makers to support the implementation of SFDRR

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The Global Centre for Disaster Statistics was established in 2015 to contribute to the implementation of Sendai Framework for Disaster Risk Reduction (Sendai Framework) and the 2030 Agenda for Sustainable Development (SDGs) through the following three objectives 1) Contribute to monitoring the progress of the Sendai Framework and the 2030 Agenda; 2) Provide scientific and technical advice on disaster loss and damage data in countries; and 3) Provide policy advice to build DRR capacities of national/local governments based on their needs.
To achieve the objectives, the centre has been developing a unique collaboration between UN organizations (UNDP, ESCAP, etc.), academia, and practitioners (national governments, regional DRR-related organizations and private sectors). The centre will focus on establishing a global database of disaster loss and damage by integrating data collected by countries to monitor and evaluate progress in the implementation of the Sendai Framework and SDGs. For the development of the global database, we have been working with six pilot countries to identify needs and develop a scheme for sharing data based on the cooperation with UNDP.
In addition, we have been developing research projects to apply scientific and technical analysis for generating disaster risk reduction policy. For that, it is essential to collect associated statistics such as population, socio-economic, and hazard data. The centre is looking forward to conducting research on tsunami hazard, macro-economic simulation, or health issue.
Eventually, the centre aims to play an important role in the international disaster risk reduction strategy by contributing to the monitoring of the Sendai Framework and SDGs. The centre could be a platform to provide innovative analysis and develop capacity of countries to achieve risk-informed development.

Keywords: disaster loss & damage database, Sendai Framework for Disaster Risk Reduction seven global targets, capacity building, risk-informed development

