

## Lessons Learned from the 11 March 2011 Great East Japan Earthquake and Tsunami: Perspectives from Filipinos in Japan

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Three months after the 11 March 2011 Magnitude 9 earthquake that triggered one of the worst tsunami events ever experienced in Japanese history, a team of Filipino and Japanese scientists interviewed fifty (50) Filipinos who survived the event. The Filipino survivors were interviewed between June to August 2011. Most of the Filipinos interviewed have been residents of Japan for as short as 2 years to as long as 36 years. The purpose of the interviews was to gather first-hand survivors' and eyewitnesses accounts of the so that valuable lessons from this event in terms of awareness, preparedness and response can be highlighted.

The video-documented interviews aimed to gather from the field, technical information on the impacts of the earthquake and tsunami. The interviews specifically focused on determining what worked and did not seem to have worked on the existing warning and communication system on the national level as well as community level during the event. The interviews took into account an understanding of both the hardware system and message content during emergencies as practiced in Japan. One significant observation is that the content of pre-disaster earthquake and tsunami awareness campaigns did not have much information on scenario impacts, timing between the earthquake occurrence and arrival of tsunami, and lacked emphasis on intuitive observations of the natural signs for people to understand the phenomena and make proper individual response. Pre-disaster activities put too much emphasis on evacuation drills and procedures and this led to much dependence on public address systems and sirens (once siren is heard, go to identified evacuation site). The existence of seawalls in some areas also provided false sense of security. The constant triggering-off of the public sirens even during minor earthquake events and "no impacts" observed even after issuance of warnings for possible tsunamis through time, may have also contributed to the kind of response by some people at the crucial time when the big event finally occurred.

Although very tragic in its impacts, the event gave the opportunity to review existing procedure and systems in the Philippine setting. The lessons learned can be used in the current earthquake and tsunami awareness and preparedness program in the Philippines that emphasizes understanding and observations of the natural signs especially for locally-generated events, and encourages the establishment of community-based early warning system.

## Disaster Reduction Effort and Reconstruction after the 2011 Great East Japan Tsunami Disaster Reduction Effort and Reconstruction after the 2011 Great East Japan Tsunami

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The 2011 Great East Japan tsunami caused damage in a wide range and affected to various aspects of tsunami preparedness and mitigation. Some important topics to reduce human damage for such a large event are awareness and evacuation. This paper introduces some lessons learned and presents reconstruction status for such damage reduction.

Field surveys were conducted in tsunami affected areas to observe present reconstruction status around Sendai city. Recently, Sendai city provided new tsunami hazard map adding more evacuation shelter including a coastal adventure park that survived the 2011 tsunami. Disaster memorial was built near Arahama coast. Sendai airport which was reopened since April 2011 provides tsunami inundation mark of 3 m at the 1st floor of the terminal. Sendai airport access line was reopened since October 2011 and also provides some space for a display of tsunami damage pictures. Concrete stairs were built along the Tohoku express way because there were many people survived by climbing it. Namiwake shrine which is famous for their legend of a historical tsunami in 1611 put a sign giving information of the legend due to a large number of visitors after the 2011 event. For other areas, overturned buildings in Onagawa town, shrine in Yuriage village will become a symbol of tsunami disaster. Rikuzen-Takata city has a plan to plant Sakura tree along the tsunami inundation limit of the 2011 tsunami. Iwanuma city has a plan to construct escape hills with 10-15 m height using tsunami debris. All of these afford would help to transfer a story of tsunami disaster to a next generation and promote better evacuation.

Because return period of a great disaster is much longer than human life, the mentioned issues will encourage awareness and evacuation of residence. Many attempts were observed in present reconstruction such as memorial park, hazard map and evacuation route. These will help to reconstruct a disaster prevention town and be ready for the next tsunami.

キーワード: Tsunami Disaster, The 2011 Tohoku tsunami, Disaster Reduction, Disaster Education, Reconstruction  
Keywords: Tsunami Disaster, The 2011 Tohoku tsunami, Disaster Reduction, Disaster Education, Reconstruction

## Tsunami-deck: An introduction concept for a new type of tsunami evacuation shelter Tsunami-deck: An introduction concept for a new type of tsunami evacuation shelter

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The 2011 East Japan tsunami reveals many important lessons especially for the evacuation strategy. Limited available evacuation time request more distributed temporary evacuation place. For highly populated areas in addition to the flat topographic condition, Tsunami-deck is introduced as an option for vertical evacuation place. The basic idea was taken from real experience of 2011 tsunami where people used pedestrian bridge for evacuation. It is then enhanced by extended the space above the ground to accommodate more people without occupying land in the ground. We first examined the performance of pedestrian bridge along the tsunami affected areas in Hokkaido and Honshu. In total, 68 pedestrian bridges including the ones in train stations were analyzed. We found that pedestrian bridge will collapse if flow depth is higher than its height plus 2 m. In this sense, if pedestrian bridge will use for evacuation, than the height should be higher than at least the maximum predicted flow depth plus 2 meter. We then search the possibility to expand the space of bridges deck, and placed it at intersection. The rationale of this idea is to solve the congestion problem during evacuation by putting more evacuation place along the potential evacuation route. Limitations of Tsunami-Deck application is discussed from the result of numerical experiments of tsunami flow at intersection.

キーワード: 2011 Japan tsunami, tsunami evacuation, evacuation shelter

Keywords: 2011 Japan tsunami, tsunami evacuation, evacuation shelter

## Study on Tsunami Evacuation Building Demand through the Agent Based Simulation of Tsunami Evacuation in La Punta, Peru Study on Tsunami Evacuation Building Demand through the Agent Based Simulation of Tsunami Evacuation in La Punta, Peru

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La Punta in Peru is a peninsula in the western part of the Callao province and is almost entirely surrounded by the Pacific Ocean, except on its northeastern side, where it is bordered by downtown Callao. It is one of the smallest districts in Peru, however with nearly 5,000 inhabitants it is exposed to a high risk due to tsunami. La Punta is a long peninsula with a narrow neck connection to the inland area. this connection is the entrance and exit of the district, therefore the only way out of the inundation area. Based on this constraint, authorities encourage their population to decide for the vertical evacuation to high buildings in the area. This community has a high awareness of tsunami despite the lack of experience of real tsunami events in the last decades. Risk information and education by the local authorities had played an important role. Among the countermeasures available for tsunami evacuation process, Tsunami Evacuation Buildings (TEBs) were pointed out in the evacuation plans as the official structures for vertical evacuation in case of tsunami. The total capacity of TEBs reported in the evacuation plan (7,130), far exceeds the number of residents in the area (4,370). Apparently the demand of capacity for a future evacuation is fulfilled, however the spatial location of these TEBs might affect the distribution of preferences and individual demand at the moment of the tsunami event. Therefore, to understand this issue, we developed an integrated tsunami evacuation simulator at the micro scale level. A stochastic analysis of several numbers of different simulated scenarios of population spatial distribution were conducted. Evacuation on foot and car is considered. Agents were given simple rules of goal and route selection, while the start time of evacuation is based on a random assigned value out of several possible distributions of evacuation for the population. It was observed that 5% of residents who were supposed to evacuate to the closest TEB in the available 20 minutes of arrival time of tsunami, were trapped in the flow due to a late evacuation decision. Moreover, the average number of evacuees in each building at the end of simulations versus the real capacity, shows that almost half of the available TEBs present an over demand. More evacuees than the expected capacity will end up at this locations. However, the other half of TEBs remained with available space in a range of 11% to even 95% of its available capacity. Future measures to avoid the disparity of shelter demand must be taken to ensure that a safe evacuation and an optimal use of resources for the support in shelters are obtained.

キーワード: tsunami evacuation, tsunami evacuation building, evacuation model, Peru

Keywords: tsunami evacuation, tsunami evacuation building, evacuation model, Peru

## CONCEPTUAL DESIGN OF POLARIMETRIC SYNTHETIC APERTURE RADAR FOR NATURAL DISASTER MONITORING CONCEPTUAL DESIGN OF POLARIMETRIC SYNTHETIC APERTURE RADAR FOR NATURAL DISASTER MONITORING

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Synthetic aperture radar (SAR) is an important and efficient earth observing tool using microwave frequencies. Optical aerial and satellite images have been used long time for such applications. Unfortunately, weather conditions limit the use of optical data. These facts have led to the development of microwave sensors. The main thrust of such research activities is due to the fact that microwaves can penetrate through clouds and has all-weather capabilities. This paper discusses the conceptual design of a circular polarized Unmanned Aerial Vehicle (UAV) Synthetic Aperture Radar (SAR) in collaboration with Center for Environmental Remote Sensing of Chiba University, Japan. The proposed system is capable to obtain high-resolution image for natural disaster monitoring such as flood and landslide. The UAVSAR system operates at L-band, full circular polarization (right and left), with 1m by 1m spatial resolution. Its unique features include compact in size, light weight and low power. Firstly, the high level design of the system will be discussed and the system specifications are presented. It followed by radar electronics design, which outlined the details transmitter and receiver subsystem. Finally SAR embedded processor, data acquisition system and antenna system will be discussed. The developed UAVSAR system will be utilized in Malaysia to reduce the geo-hazard damage caused by landslide and flood.

キーワード: Synthetic aperture radar

Keywords: Synthetic aperture radar

## インドネシアの火山における噴火予測および災害評価手法に関する研究 Methods for eruption prediction and hazard evaluation at Indonesian volcanoes

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We report methods, based on geophysical observations and geological surveys, for the prediction of eruptions and the evaluation of the activity of 4 volcanoes in Indonesia. These are Semeru, Kelud, Guntur and Sinabung volcanoes. Minor increases in tilt were detected by borehole tiltmeters prior to eruptions at the Semeru volcano depending on the intensity of explosion earthquakes. The results show the possibility of prediction of the type and magnitude of eruption and the effectiveness of observation with a high signal-to-noise ratio. The establishment of background data is important for evaluating volcanic activity in long-term prediction. The cumulative volume of eruptive products is valuable for evaluating the potential for future eruption. The eruptive rate of the Kelud volcano is ca  $2 \times 10^6$  m<sup>3</sup>/y (DRE), but the volume of the 2007 eruption was only  $2 \times 10^7$  m<sup>3</sup>, suggesting a still high potential for eruption. Typical distributions of volcanic and local tectonic earthquakes were obtained around the Guntur volcano, where geodetic monitoring by continuous GPS observation is valuable. Based on geological surveys and dating, an eruption scenario is proposed for the activity of Mt. Sinabung, where phreatic eruptions occurred in 2010 after a historically long dormancy.

キーワード: 直前予測, 長期予測, 噴火シナリオ

Keywords: short-term prediction, long-term prediction, eruption scenario

## ブータンヒマラヤにおける氷河湖決壊の事例と発生頻度 The cases and frequency of glacier lake outburst in the Bhutan Himalayas

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In order to keep accurate preparedness for and attention on the GLOF hazard mitigation, explorations of past cases of outburst are necessary. The frequency of the GLOF occurrence is still unknown, because major outbursts which caused significant damage on downstream are rare and the recorded period is only several decades. We have to collect data on past outburst events as much as possible including unpublished and unknown incidents. As is obvious in the trace of the GLOF, the outburst event leaves typical topographical and sedimentological features, i.e. 1) v-shaped trench, 2) huge debris fan deposition and 3) subsequent devastated river bed. Hence, these features can be used as the proof of past outburst events. As for the most recent case of GLOF, the 2009 Tshojo flood was studied. The flood which was initiated by lake water leaking, and water splash to the surface via a en-/sub- glacier, shows the potentially dangerous hazard. Attention to such outburst events from invisible source will be required in the future.

As for the evaluation of the frequency of the GLOF incident, besides the reported 6 cases in the previous study, we revealed a total of 15 outburst cases in the Bhutan Himalayas using field survey data, and Corona KH-4A, Hxagon KH9-9, Landsat7/ETM+, and ALOS/PRISM satellite data and the images in Google Earth. These 21 cases were found in the Kuri Chu Tibetan branch, Chamkhar Chu, Pho Chu, Mo Chu and Soe Chu. Ten cases of them, the lake outburst on the foot of cliffs with a hanging glacier is the most frequent cases. Seventeen of 21 cases occurred before the 1970's, while 4 cases are counted during from the 1970's to 2010. Hence, the current frequency of outburst occurrences does not seem to have increased. In order to the Further research which covers the minor outburst events has to be broadened at least the Sikkim and Nepal Himalayas.

Keywords: Glacier hazards, Global warming, GLOF, Topographic feature, Satellite data, Occurrence prediction

## Study results of GLOF SATREPS Project in the Bhutan Himalayas Study results of GLOF SATREPS Project in the Bhutan Himalayas

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During the recent decades the melting of glaciers and rapid expansion of glacial lakes have caused series of disasters in the entire Himalayan region. Bhutan lies in the eastern part of the Himalayan range and is not an exception. Ever since the 1994 GLOF due to a partial outburst from Lugge lake which claimed lives, devastated infrastructures and agricultural lands in downstream valley of Punakha-Wangdue, urgent need to study glacier and glacial lakes in the upper streams of the water basins remained the priority. In line with other researches in those areas, the researches on glacier and glacial lakes through Science and Technology Research Partnership Project for Sustainable Development has filled up the gaps and updated the only inventory that existed.

Through this project, ground verifications for many lakes which were considered to be potentially dangerous have been carried out. Studies on water volume, bottom lake topography through bathymetry survey, existence of ice bodies in the damming moraines, tracking changes in those dams both through ground checks and Remote Sensing data analysis were engaged. In addition to one or two existing Automatic Weather Stations in the higher elevations, we have installed another one at an elevation of 5230 m asl. recording around nine parameters.

キーワード: glacial lake

Keywords: glacial lake



## Socio-Economic Factors Associated With Landslide Hazard: A case Study Socio-Economic Factors Associated With Landslide Hazard: A case Study

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Bukit Antarabangsa is one of the elite residential areas in Malaysia located in Ulu Klang, Selangor. The area has a high risk potential for landslide and several devastating landslide hazard occurred since 1993 caused a great concern for the safety of people and their properties. This study investigated on socio-economic aspects related to landslide. Data were collected from 64 randomly selected respondents using questionnaire and interview schedule. The results of the study reveal that high level of education, better job opportunities and higher income level caused most of the respondents to stay on highland area although they know that the area has a greater risk of landslide. It can therefore be concluded that most of the respondents were aware of the landslide but the attitude towards landslide risk is very low. The study also found that landslide tragedy in Malaysia has caused emotional and psychological trauma for residents who have survived.

キーワード: landslide hazard, trauma, socio-economy, awareness

Keywords: landslide hazard, trauma, socio-economy, awareness

## 斜面モニタリングによる警戒情報を用いた地域における地すべりリスクマネジメントの課題

### Issues of landslide risk management for local community by Warning information of slope monitoring

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So many Landslide and flood disasters occurred during rainfall season every year in Japan. To reduce the damage, the hazard or risk maps are one of the important tools of local community. On the other hand, it is not shown on maps that the intense distribution of rainfall vary with time. This means that hazard area dynamically changes with time. And therefore we have studied the WebGIS system evolved with dynamic information based on warning information.

In this paper, we are going to discuss issues of landslide risk management by warning information of slope monitoring.

Firstly, warning information of slope monitoring is explained below.

we have described that we conducted two large-scale model tests under different condition of groundwater using rainfall simulator at NIED. Surface displacement, ground inclination, moisture content and groundwater level are measured in this test. Then we discuss about the mechanism of unstable slope initiation during rainfall. In addition, we examine the method to define the criteria of rainfall-induced landslides initiation by slope monitoring.

Secondly, landslide risk management is expressed below.

GIS is an essential technology for supporting the various phases of risk management. Especially, WebGIS can integrate various disaster risk information on internet directly and it is easy way for people to access disaster risk information. "e-Community Map", which we have developed as open source software based on WebGIS technologies, integrates geospatial data provided through interoperable data interfaces of various distributors and bottom-up data inputted by local communities. The system delivers dynamic, geo-registered maps using standard international geospatial HTTP protocol services (Web Map Service (WMS), Web Feature Service (WFS), Web Coverage Service (WCS) and etc.) via an interoperable environment. The local communities input their legacy information and tabulated data using PCs, GPS-equipped phones, and other tools. The system outputs maps, including printed maps for off-line communication and field surveys.

In the phase of disaster preparedness, "e-Community Map" is effective for understanding local environment and discussing action for disaster preparation. Local residents can compare and overlay various geospatial data and understand hazards and risks corresponding with them. Then, they can check out points of interests and input various data, photos and memos. In discussion, they can examine the adequacy of preparation and build cooperation with stakeholders. Finally, they make their own maps and maintained them through the participation. And they use their maps for individuals, families and children and improve their preparedness and relationship.

Keywords: landslide, monitoring, warning information, Disaster Risk Management, local community, e-Community

## Large-scale watershed modeling in Kelantan, Malaysia Large-scale watershed modeling in Kelantan, Malaysia

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For the purpose of predicting and preventing inundations in the Kelantan watershed, Malaysia. We made a numerical watershed model by using the information about topography, vegetation, surface geology and human activities in the area. We present the results of the preliminary initialization phase simulation and some case studies.

キーワード: watershed, modeling, large-scale, Kelantan, Malaysia

Keywords: watershed, modeling, large-scale, Kelantan, Malaysia