

HDS004-01

会場:103

時間:5月27日 10:45-11:00

ブータンの自然災害 Natural disaster in Bhutan

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Natural disasters intensively took place in Bhutan in 2009. For instance, unusual outflow from debris covered glacier, floods and natural damming of a river induced by a cyclone, watery mishap in the river recreation and earthquake struck the country as abrupt and unexpected events. Furthermore, slope failures interrupted the highway traffics, because of steep and geologically fragile slopes. These climatic and geo-hydrologic disasters revealed various risks and issues of the natural hazard in Bhutan.

The authors have been involved in the research project of glacial lake outburst floods (GLOFs) in JICA/JST program since 2009. On the basis of the project, over view of the disaster information and further advisement to the focal sections and persons are necessary.

As for the revealed issues, establishment of weather and seismographic observation network and its information spreading throughout the society are particularly required. Documentation and mapping of experienced various disasters in and around Bhutan are essential. It is also important to mention that technical development and awareness creation regarding hazard mitigation should be enhanced at the national and local governments and community level.

キーワード: 地すべり, サイクロン, 氷河災害, 地震災害, 河道閉塞, 災害管理

Keywords: landslide, cyclone, glacial disaster, earthquake, natural damming, disaster management

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ブータンヒマラヤの氷河湖決壊とその危険性 Glacial lake outburst and hazardous lakes in the Bhutan Himalaya

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In our country has been threatened by glacial hazard such as glacial lake outburst flood (GLOF) as well as the other high mountain region. In order to assess the possibility of GLOF hazard in the Bhutan Himalaya, we observed 27 lakes in the northern Bhutan under the JICA/JST project. In this presentation we will introduce the history of the GLOF hazard in Bhutan and summary of the preliminary result of the GLOF hazard assessment. The field surveys for the evaluation were carried out in/around the lakes in 2009 and 2010 by the authors and tenth other Japanese and Bhutanese researchers. Especially, bathymetric survey achieved to obtain more reliable information for assessing the stability of the moraine dam and flood analyses. Glacial lakes in the researched area show relatively stable at the moraine dam and surrounding slope. However, we need make plans continuous monitoring using satellite data and field observation in the future.

キーワード: 氷河湖決壊洪水, 減災, 危険度評価, 現地調査, 災害実績図
Keywords: GLOF, natural hazard mitigation, risk evaluation, field survey, disaster map

HDS004-03

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ESTIMATION OF SLIPRATE AND LOCKING DEPTH ON ACTIVE FAULT BASED ON GPS SURVEY IN ACEH PROVINE ESTIMATION OF SLIPRATE AND LOCKING DEPTH ON ACTIVE FAULT BASED ON GPS SURVEY IN ACEH PROVINE

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The potential seismic hazard along the Sumatran fault after the Great Sumatra Earthquake of 2004 was influenced by the factors such as: distribution of coseismic and postseismic activity following the 2004 earthquake, and the coulomb stress change caused by postseismic and coseismic displacement. These factors have increased the likelihood of an earthquake of magnitude more than 5 Mw occurring in the north segment of Sumatra Fault.

Campaign and Continuous GPS observations were made to monitor the crustal deformation caused by the 2004 Aceh earthquake. Data processing results show that the postseismic deformation activity is still ongoing in Aceh. Displacement due to postseismic deformation is 0.6 m in the EW direction at the point of ACEH. Estimation of slip rate for the Aceh segment of the Sumatra Dault is 2 mm / year, that of the Seulimum segment is 2 mm / year, and of the Tripa Segment is 3.5 mm/year, with about 10 km of locking depth

キーワード: Postseismic deformation, active fault, slip rate

Keywords: Postseismic deformation, active fault, slip rate

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Five Years Geodetic GPS observation in the West of Java Island Five Years Geodetic GPS observation in the West of Java Island

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West of Indonesia is region of the plate boundary between the Australia plate and Sunda plate is seismically highly active. Subduction of great tectonic plates continues further south and east/southeast along the great Sunda Trench. The normal subduction below Java is characterized by the development of typical fore-arc basins while oblique subduction beneath Sumatra results in partitioning of the convergent motion into thrust and strike-slip faulting. Along the arc, the age and thickness of the lithosphere increase considerably from west to east; from 49?96 Ma below Sumatra to the west to 96?134 Ma below Java. Subduction of great tectonic plates

The activity of local fault can be inferred from six time GPS campaign observation in West Java, 2006 (December), 2007 (August), 2008 (August), 2009 (June and August) and 2010 (August) as a sinistral motion of Cimandiri fault and dextral Lembang fault control the deformation pattern in West Java. Using simple elastic half-space model we estimate geodetic slip-rate of Cimandiri fault is 6mm/yr and 3mm/yr for Lembang fault. This result also suggest that the interplate coupling is very weak or if any it only extend at very shallow portion (less than 10 km) which is very difficult to be detected by inland GPS network that located 250 km away from the trench.

キーワード: Geodetic observation, West Java, Strain Accumulation

Keywords: Geodetic observation, West Java, Strain Accumulation

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A10絶対重力計によるインドネシアでの地盤沈下・地殻変動モニタリング (第2報) Application of A10 absolute gravimeter for monitoring land subsidence and crustal movement in Indonesia (the 2nd report)

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In many of the urbanized cities in Indonesia, one of the urgent problems is land subsidence mainly due to excess pumping of groundwater. In Jakarta, for instance, the recent GPS surveys conducted by ITB have revealed the significant subsidence along the northern coastal area with the rate of more than 10 cm/yr. It has been also reported that more than 10 cm/yr land subsidence is in progress in some areas in Bandung. In West Java, there are some active faults (e.g. Lembang fault) whose tectonic activities may cause crustal movements. These land movements can be measured by present-day space geodetic techniques, such as GPS and InSAR. In addition, precise gravity measurements can provide useful information to understand the mechanism of the movements, because they reflect the underground density changes or mass movements.

In order to detect the gravity changes associated with the land movements in West Java, we have been conducting gravity measurements with a field type absolute gravimeter, Micro-G LaCoste Inc. (MGL) A10 since 2008. The outline of the absolute gravity measurements and the survey areas have already been reported at the 2010 JpGU meeting. In this paper, we report the surveys conducted in 2010 and some results obtained so far.

The gravity measurements in 2010 have been conducted from July 15th to August 5th. Practically the measurements in Jakarta and Bandung have been carried out from July 22 to 25 and from July 31 to Aug 3, respectively. We employed both A10-07 and a Scintrex gravimeter for the measurements as same as before. In addition, we tried to occupy the same points as many times as possible to confirm the repeatability of the measurements. A note is that some of gravity points in Jakarta were lost mainly due to road construction. We therefore set up a couple of new points, in particular near the coastal area where large subsidence has been observed. The GPS measurements, on the other hand, have successfully been carried out by the ITB team from late June to the end of July.

During the survey before 2009, we experienced several technical problems on the absolute gravity measurements, particular on the field measurements in high temp and humid condition. We suspected these problems are mainly due to voltage drop of the DC batteries and thermal effects on the computer system for control and data acquisition. Therefore, this time, we directly used the car battery with the engine on during the measurements and tried to keep the computer cool with a PC cooling pad. All these efforts almost overcome the problems so far, and we could get the data as good as those obtained in normal condition. On the other hand, we found some offsets or drifts in the absolute gravity values obtained. This means that the absolute values need calibration, and we corrected the values afterwards by comparing the reference values measured in Japan.

The result of the GPS measurements in Jakarta show the same subsidence pattern as before, i.e., more than 10cm/yr subsidence along the northern coastal area. The gravity measurements show the same tendency, although the number of available gravity points are limited. The comparison between the height changes and the gravity changes shows more like the gradient of water density. However the uncertainty is still large and we need further data accumulation for more precise conclusions.

The gravity changes in Bandung also show the similar spatial pattern with the GPS data. However the quantitative comparison is still difficult. One of the reason is that many of the gravity points are not completely same points as the GPS points. This should be considered in the future surveys.

Keywords: absolute gravimeter, land subsidence, crustal movement, GPS, Indonesia

HDS004-06

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時間:5月27日 12:00-12:15

タラン火山の活動と周辺の構造性地震との関係 Relation of volcanic activity of Talang volcano with tectonic earthquakes

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Talang volcano is located in Solok district, West Sumatera, Indonesia. It consists of North and South craters and rises to 2597 m above sea level. Eruptions in 19th century were characterized by magmatic eruptions after the first historic record in 1833 with black ash plume and glowing lava emerging near Jantan peak. Magmatic eruptions repeated in 1843, 1845, and 1883. After dormant period in 20th century, eruption style of the volcano has changed to phreatic eruption in 21th century. The eruption occurred at Gabuo atas crater and formed hot spring pond. Phreatic eruption then repeated in 2003, 2005, and 2007. Relation of eruption of the volcano with large tectonic earthquakes was firstly recognized by a phreatic eruption on April 12, 2005 at the volcano. The eruption occurred 2 days after Mentawai earthquake (Mw 6.7) with epicenter distance about 147 km from the volcano. Increase in volcanic activity repeated after occurrence of large tectonic earthquakes in surrounding area of Talang Volcano, such as Padang earthquake (Mw 7.6) on September 30, 2009. Deep volcanic earthquake increased up to 79 events and shallow one increased up to 40 events. Interaction of large tectonic earthquake with volcanic activity at Talang volcano was shown by increasing seismicity or eruption. The hypocenters of the tectonic earthquakes were located near West Sumatera subduction zone or Great Sumatera fault. The increase in volcanic activity was triggered by tectonic earthquake with intensity more than III on MMI scale at the Talang volcano. Intensity of Talan's ground motion by Mentawai earthquake (Mw 6.7) 2 days prior to phreatic eruption on April 12, 2005 was V on MMI scale. Intensity of ground motion of Padang earthquake (Mw 7.6) on September 30, 2009 was VI on MMI scale at the volcano. In contrast, Talang volcano showed no increases in seismicity and eruptivity after the Mentawai Earthquake (Mw7.7) on October 25, 2010. The MMI scale at the volcano was only III. It was suggested that volcanic activity of Talang volcano was affected by large tectonic earthquake with intensity more than III on MMI scale.

Similarly to Talang volcano, Guntur volcano is located near active faults (Cimandiri, Lembang, and Baribis faults) and subduction zone. Subduction zone at southern part of Guntur volcano was a source of destructive earthquakes. On July 17 2006, Pangandaran earthquake (Mw 7.7) occurred and was felt at Guntur volcano with intensity III on MMI scale, however it was followed by increase in neither seismicity nor eruptivity. Similarly there was no change of seismicity when Tasikmalaya earthquake (Mw 7.0) struck south region of West Java with MMI III on September 2, 2009.

Talang volcano is more susceptible triggered by tectonic earthquakes than Guntur volcano. Active geothermal systems beneath the volcanoes become important factor for triggering phreatic eruption. However, magmatic systems of the volcanoes may still in normal stage. Intensity of the ground motion caused by the large tectonic earthquakes and previous condition of the volcanoes take important role in triggering increase in seismicity or eruption of volcano.

Keywords: Talang volcano, volcanic activity, tectonic earthquake, MMI

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The 2010-2011 Eruption of Bromo Volcano, East Java, Indonesia The 2010-2011 Eruption of Bromo Volcano, East Java, Indonesia

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As one of active volcanoes in East Java, Bromo volcano located at Tengger Caldera which administratively belongs to Probolinggo Regency. Based on the historical eruptions, the volcano was dominated by phreatic eruption. The eruptions were generally preceded by volcanic tremor as happened in 1995 and 2004. After the eruption in 2004, the volcanic activity was only showing gas emission from the crater.

The precursor changed when the volcanic activity of Bromo volcano started to increase in November 2010. Initially, the color of emission changed from thick whitish to grayish on November 8th. One hour later number of volcanic earthquakes gradually increased. The first phreatic eruption occurred on November 20th. On November 23rd, two eruptions took place which were also accompanied by tremor. The alert level of Bromo volcano was increased to level III (SIAGA) and 7.5 hours later the level was upgraded to the level IV (AWAS). The rapid upgrade was caused by enlarging in amplitude maximum of tremor from 5 mm until 30 mm. The intensity of the eruption gradually decreased and CVGHM decided to downgrade the status to the level III (SIAGA) on December 6.

The eruption is still ongoing until now. The seismograph has recorded tremor with the maximum amplitude varying between 5-40 mm. Until the middle of December, the crater ejected thick grey-brownish ashfall ranges from 400-2000 meter height. Late December, incandescent volcanic material that visually observed was emerged from the crater and pumice that was also ejected. That event indicates that the eruption of Bromo became magmatic. However, the alert level is still in level III (SIAGA). CVGHM has recommended not entering the danger zone with 2 km in radius from the crater.

キーワード: Bromo volcano, Phreatic Eruption, Magmatic, Volcanic earthquake, Tremor

Keywords: Bromo volcano, Phreatic Eruption, Magmatic, Volcanic earthquake, Tremor

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EVALUATION OF OF SINABUNG VOLCANO ERUPTION AUGUST- SEPTEMBER 2010 EVALUATION OF OF SINABUNG VOLCANO ERUPTION AUGUST- SEPTEMBER 2010

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Sinabung Volcano located at Karo District, Province of North Sumatera, geographically its summit lies at 03deg 10min North and 98deg 23,5min East. The peak has elevation of 2400 m.asl. The eruption history of Sinabung Volcano does not known well. On August 27, 2010, phreatic eruption occurred. It was a first eruption that continued by another eruption series on August 28, August 29, August 30, September 3 and September 7, 2010. The eruption produced volcanic ash and 1-5 km height of eruption column.

Some methods were conducted to monitor the volcanic activity of Sinabung Volcano such as seismic, geochemistry and deformation using EDM (Electronic Distance Measurement) and Tiltmeter. Seismic monitoring conducted continuously from 4 (four) seismic stations. Three stations use 1 component seismometer while other use 3 components.

The recorded seismic event consist of : Tectonic earthquakes, Local Tectonic earthquakes, Deep-Volcanic earthquakes, Shallow-Volcanic earthquakes, Emission earthquakes and Tremor earthquakes. Hypocenter distribution before eruption on September 7 separated below the crater and north part of Sinabung Volcano with depth of 1-6 km from the summit. After the eruption, it was concentrated precisely below the crater with 1-5 km depth. At the time when volcanic activity decreases (end of September ? October 2010), earthquakes accumulated at Northeast part with depth of 1-9 km. This indicated that the source of earthquakes not only from the volcano itself, but also possible influenced by local tectonic activity that occurred at Northeast highland of Sinabung Volcano.

Flux of SO₂ that was measured simultaneously with the eruption showed sizeable and high pressured volcanic degassing. Result of water chemistry analysis from some water samples around Sinabung Volcano showed high concentration of bicarbonate (HCO₃⁻), chloride (Cl), sulphate (SO₄), and natrium (Na). This indicated the presence of hydrothermal system below the conduit of Sinabung Volcano and also minor magmatic supply.

Tiltmeter measurement noted that there was no significant changes on both radial and tangential components during August-September 2010. It was assumed that pressure equilibrium changes gradually and as implication of this condition, the emission activity at the crater is still ongoing intensely.

Distance measurement with EDM showed slight correlation between slope distance changes and time. From this result, it was assumed that rate of energy release occurred gradually and will take a long time. Deformation at Sinabung Volcano not only as implication of internal energy release but also sensitive to regional tectonic activity, mostly for earthquake that has magnitude more than 5 Mw.

The activity of Sinabung Volcano is getting down this time. Visual observation, seismic activity and deformation monitoring show decreasing activity. However, phreatic eruption and lahar flow is still potentially occur. Some mitigation efforts conducted to anticipate the future eruption, such as establishment The Observatory Post of Sinabung Volcano that full equipped with monitoring equipment, construction of Geological map and Volcano Hazard map, distribution of information and coordination with Local Government.

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Urgent multi-disciplinary survey for the effects of tsunami from the Mentawai, Indonesia, earthquake on 25 October 2010

Urgent multi-disciplinary survey for the effects of tsunami from the Mentawai, Indonesia, earthquake on 25 October 2010

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We carried out field survey of tsunami from the 25 October Mentawai, Indonesia, earthquake in North and South Pagai Island. It was a multi-disciplinary survey supported by ongoing collaboration project between Indonesia and Japan, titled as Multi-disciplinary Natural Hazard Reduction from Earthquakes and Volcanoes in Indonesia. The main objectives of the survey were to measure physical aspects of tsunami, such as tsunami heights, inundation distances and characteristics of tsunami deposits, summarize human and property damage, and interview human and social reaction to the tsunami, i.e., if the tsunami warning messages reached to coastal community and how people reacted. The main findings of the survey was summarize as follows.

1. The tsunami heights were measured at eight localities on the west coast of North and South Pagai Islands. Thirty-eight measurements range from 2.5 to 9.3 m, but mostly 4 to 7 m. The tsunami inundation was more than 300 m at three locations.

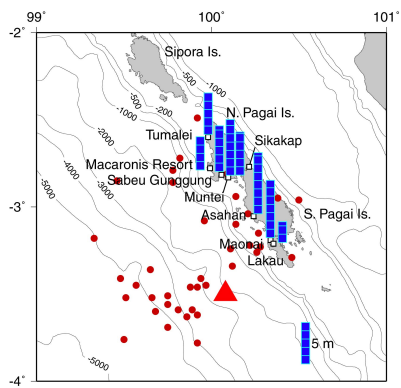
2. This earthquake was a tsunami earthquake, which produced weak shaking but large tsunamis. While initial magnitude was 7.2, analysis of long period seismic wave indicated the long duration and larger seismic moment (M_w 7.8), hence a possibility of large tsunamis. Such broadband seismic analysis of should be included in the tsunami warning system.

3. The tsunami deposits sampled at 4 to 6 sites along transects at three locations are described. The deposits are mostly coarse to medium sand, 5 to 26 cm thick, and composed of 2 to 5 units. Many units show normal grading and moderate sorting. The thickness is variable along profiles affected by local topography, but grain size generally shows finer landward.

4. Residents felt and many were awoken by earthquake, but they reported that the ground shaking was weaker than the 2007 Bengkulu or 2009 Padang earthquake. Because these earthquakes did not cause tsunami damage, many residents did not expect tsunami. Many people heard loud sound of tsunami, and escaped to inland.

5. The official tsunami warning from BMKG reached the Mentawai regency office, but did not reach coastal communities because of lack of communication tools. However, some coastal residents were watching TV and saw running text of tsunami warning (5 to 18 min after the earthquake, according to BMKG summary). Therefore, early warning message through television should be enhanced.

6. Numbers of casualties dramatically vary from place to place. Nearly a half of villagers lost their lives at some communities, but a few at other communities. Tsunami education, repeated drills, proximity to high ground, and a three-story tower seem to make the dramatic difference.



Keywords: Tsunami, field survey, Mentawai, tsunami earthquake, tsunami deposit, Indonesia

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Sedimentological Characteristics Of The October 25, 2010, Mentawai Tsunami Sedimentological Characteristics Of The October 25, 2010, Mentawai Tsunami

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On October 25, 2010, at 9:42 pm local time, an Mw7.7 earthquake occurred off Mentawai islands, about 120 miles W of Bengkulu, Indonesia. The earthquake generated tsunami and caused severe damage at the coasts of the islands, and killed more than 450 people. From November 6 to 9, we carried out a post-tsunami field survey, as a part of SATREPS project 'Multi-disciplinary natural hazard reduction from earthquakes and volcanoes in Indonesia' supported by JST and JICA. The survey team consisted of four Japanese and five Indonesian scientists, and was led by Prof. Kenji Satake. We visited nine sites located along the western coast of North and South Pagai Island, and revealed that the tsunami heights are mostly between 4 and 7 m there. Here, we report result of our sedimentological study of the tsunami deposits at four sites in Pagai Islands: Sabeu Gunggung, Muntei Barubaru, Macaronis resort, and Tumalei. At each site, the thickness and sedimentary characteristics of the tsunami deposit were measured and observed along transect and samples for laboratory analysis were collected. The tsunami deposits at Sabeu Gunggung, Macaronis resort and Tumalei are mainly composed by medium to coarse sand-sized fragments of corals, shells of mollusca and foraminifera. At Muntei Barubaru, the tsunami deposits are mostly composed by very coarse sand and gravel-sized deposits. Thickness of the tsunami deposits are ranging from 5 to 26 cm. The tsunami deposits consist of two to five units, and the units show both fining upward and coarsening upward trends, with fining upward dominating. Cross bedding structures are present at Tumalei transect. Mud clasts are found at the most landward points at Macaronis resort. Local topography noticeably affects the thickness, number of layers, and distribution of tsunami deposits along transect. The tsunami deposits do not show consistent landward decrease in thickness, but the grain size shows finer landward. Erosion features widely occurred at Sabeu Gunggung and Muntei Batubaru. At all sites, *Amphistegina lessonii* and *Neorotalia calcar* dominating the foraminifera content. These two species live at the shallow depths of less than 30 m. These two species indicate that the tsunami likely entrained most of the sediment in shallow depth. The foraminifera assemblage and diversity varies at each point, along transect and at each transect. Thus, the Mentawai tsunami deposits show complex characteristics. Understanding of these modern tsunami deposit characteristics will improve the clue to the recognition of paleotsunamis.

キーワード: sedimentology, tsunami deposits, grain size, foraminifera, Mentawai

Keywords: sedimentology, tsunami deposits, grain size, foraminifera, Mentawai

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南琉球列島の津波災害史の復元 -津波石ハマサンゴの放射年代測定によるアプローチ-

Reconstruction of past tsunami disasters: Evidence from radiometric dating of Porites coral boulders in Southern Ryukyus

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過去の津波災害がいつ・どの程度の規模で起こったか、またどの位の周期で襲来したのかを知ることは、現在の防災対策および将来予測を行う上で重要である。そこで本研究では、琉球列島の海岸に広範囲に分布している『津波石』と呼ばれる、過去の津波で打ち上げられた化石サンゴに注目した。サンゴは打ち上げられた際に死んで成長が止まるため、津波で打ち上げられた化石サンゴの新鮮な表面を採取し年代測定を行うことで、化石サンゴが打ち上げられた年代、つまり過去の津波イベントの年代を求めることができる。

いくつかの先行研究にて津波石の¹⁴C年代値が報告されているが、年代測定用のサンプル選定や¹⁴C年代値の暦年代への較正方法などに関して問題点が多かった。そのため、古文書記録に記載されている複数の浸水イベントのうちどの歴史津波で津波石が打ち上げられているかの推定は困難であった。本研究では津波石の中でも、同心円状に成長するため群体最上部が打ち上げられた時期に一致するハマサンゴ群体に着目した。また、津波石ハマサンゴに対して高精度かつ高確度な年代測定法を適用することで、正確にどの歴史的高波イベントで津波石が打ち上げられているかを決定した。

まず、現在サンゴ試料に対して最も精度の高い年代測定法であるU/Th年代測定法を、ハマサンゴ津波石という日本の津波堆積物に初めて適用した。その結果、1771年に発生した明和津波で津波石が打ち上げられていたことを実証するとともに、1625年に発生したとされる原因不明の高波イベントの痕跡を初めて科学的に発見した。

また、125個の津波石ハマサンゴ試料の¹⁴C年代測定を実施し、新たに求めた較正データを用いて正確な暦年代較正を行った。その結果、複数の巨大な津波石ハマサンゴが明和津波起源であることを明らかにした。この結果は、明和津波の水理量を推定するのに有用な巨礫移動モデルを適用するのに役立つ。さらに、様々な場所で新たに明和起源の津波石を発見した。これらの発見は、現在でも未解明な明和津波の波源や原因を解明する上で必要である、津波波源モデルに制約を与える事ができる新しい知見である。

77個の津波石ハマサンゴの¹⁴C年代測定結果から、1771年の明和津波や1625年の古津波イベントだけでなく、2000年以上前から様々な年代で打ち上げられていることがわかった。この¹⁴C年代値の確率分布の総和をとることで、古津波イベントがどのタイミングで起きているかを検証した。その結果、1771年や1625年以外にも複数の津波イベントが確認でき、南琉球列島において約150-400年の周期で津波石を打ち上げている高波イベントが発生していることがわかった。また、1460年代頃や1200年前後の津波イベントは古文書記録にも記載されていない地元の言い伝えによる伝説の津波と一致し、その他にも有史以前のピークも検出できた。今回の結果は、伝説の津波に関する初めての証拠である。

このように、津波石ハマサンゴに放射年代測定法を用いることで、歴史津波だけでなく、有史以前の津波も認定できることがわかった。また、過去の津波災害研究に対して津波石ハマサンゴを使うという有益な方法を開発することができた。

キーワード: 津波石, ハマサンゴ, U/Th年代測定法, ¹⁴C年代測定法, 古津波, 南琉球列島

Keywords: Tsunami boulders, Porites spp. coral, U/Th dating, Radiocarbon dating, Paleo-tsunamis, Southern Ryukyu Islands

HDS004-12

会場:103

時間:5月27日 15:00-15:15

Tsunamigenic Rate of the Pacific Ocean Earthquakes Tsunamigenic Rate of the Pacific Ocean Earthquakes

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Pacific Ocean is the location where three-fourth of the total number of tsunami had occurred. Countries surrounding this Pacific basin suffered from many tsunamis and killed great number of life. Problem occurs when earthquake information has issued, for example, what is a potential of a tsunami generation for such an earthquake magnitude or focal depth is known? This study proposed Tsunamigenic Rate (TR) which is defined as the ratio between the number of earthquake-generated tsunamis and the total number of earthquake occurred.

This study considers the NGDC database which contains earthquake event of 200 B.C. to present (from year -193 to 2010). The earthquake event excludes an event that the epicenter located longer 50 km from a shoreline. Total number of tsunami associated event is 743 and tsunami was not associated event is 735 leads to the total number of 1,478 events. Consequently, the Tsunamigenic Rate (TR) is calculated from earthquake event of the magnitude varies from 5.0 to 9.0, focal depth is as deep as 200 km and sea depth is as deep as 7,000 m. The Pacific Ocean is geographically divided into 9 regions namely, New Zealand-Tonga (NZZ), New Guinea-Solomon (NGS), Indonesia (IND), Philippines (PHI), Japan (JAP), Kuril-Kamchatka (K?K), Alaska-Aleutians (A?A), Central America (CAM) and South America (SAM).

Results support that greater earthquake magnitude and shallow focal depth has high potential to generate tsunami with high tsunami height. The average TR in Pacific Ocean is 0.50 where TR for each region varies from 0.35 (CAM) to 0.68 (NGS). TR for each region was calculated and shows the relationship with the three influence parameters namely, earthquake magnitude, focal depth and sea depth. The Tsunamigenic Rate will help ascertain one decision for a tsunami generation of each earthquake event based on a statistical basis of the historical data and decision support tool during an early tsunami warning stage.

キーワード: Earthquake, Tsunami, Pacific Ocean

Keywords: Earthquake, Tsunami, Pacific Ocean

HDS004-13

会場:103

時間:5月27日 15:15-15:30

チラチャップ（インドネシア）での想定巨大地震による津波数値計算と津波災害リスク評価

Tsunami simulations for expected great earthquakes and risk evaluation of tsunami disaster at Cilacap in Indonesia

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As a part of the JST-JICA project, "Multi-disciplinary Hazard Reduction from Earthquake and Volcanoes in Indonesia", tsunamis from expected great earthquakes are computed and a risk of disaster from those tsunamis at populated areas along the coast are planned to be evaluated.

Cilacap is one of the most populated towns in the Indian coast of Java. Recently, the 2006 West Java earthquake (Mw7.7) occurred as a tsunami earthquake and generated large tsunamis and caused the severe tsunami disasters at Pangandaran. Fortunately, the tsunami at the city of Cilacap was small, about 2m, because Nusa Kambangan Island protected the city of Cilacap from the large tsunami came from southwest. In this paper, the tsunami inundation heights and areas estimated at the city of Cilacap from several expected underthrust earthquake models along the Java subduction zone are presented.

For this research, available bathymetry data (such as ETOPO1, navigation charts and detailed survey data) and topography data (such as SRTM data and topography data from Bakosurtanal) were first collected for the detailed tsunami computation. To get more detailed bathymetry data and topography data, including building classification, near the populated areas at Pangandaran and Cilacap, the field surveys were conducted in 2010. The depths were continuously recorded by an echo sounder with GPS system installed in rented small boat. The navigation speed of boat was less than 10 km/h. At Pangandaran, we have collected the bathymetry data in the west coast area (3 km x 2 km) along almost 8 track lines. Each track line is about 2 km long and the direction is north-south perpendicular to the coast line. At Cilacap, we have collected the bathymetry data in the east coast area (4 km x 3 km) along 7 track lines. Each track line is about 4 km long and the direction is east-west perpendicular to the east coast.

The non-linear shallow water equations were numerically solved on a staggered grid system using a finite difference method applying a moving boundary condition. Nested grids were also used for the tsunami computation. To make a realistic source model, we first study tsunami generated by the 2006 West Java earthquake. We estimate the best source model which explains the inundation heights along the coast of Pangandaran Based on the source model of the 2006 West Java earthquake, several fault models off Cilacap along the Java subduction zone are assumed.

Preliminary tsunami numerical computation using the assumed fault model off Cilacap with a moment magnitude of 8.5 indicates that many houses in the city of Cilacap are flooded by the tsunami.

Keywords: Cilacap, Tsunami numerical simulation, Tsunami disaster, Large earthquake

Tsunami Risk Perception in Questionnaires and its use for the Modeling of Start Time Evacuation Behavior

Tsunami Risk Perception in Questionnaires and its use for the Modeling of Start Time Evacuation Behavior

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Questionnaires are a popular and fundamental tool for acquiring information on human behavior, public knowledge and perception of risk [2]. There is a lack of research in tsunami human behavior [1] specially on the start time decision for evacuation, even though a great improve on technology for early warning has been achieved, still some people decide not to evacuate from tsunami [4,5]. Most of survivals who did not evacuate give as a reason, the fact that the sea did not retreat, no information or warning confirmation came, or they considered themselves in a safe place already, etc. [3]. It is true that, if we do not consider cognitive aspects of the human being during the process of evacuation, the results provided by such models might be far from reality [6]. In this study, Risk Perception (RP) was the key for the construction of the model of start evacuation decision. RP is a subjective judgment of a risk, an idea of how risk could be the situation. It was treated as a dynamic level, from a moment of no threat through a decision stage in which an alteration of the environment is perceived and risk perception rises until the individual has to consider an action (e.g. evacuate or not), this, based on experience, social or external sources of influence and time pressure; and finally enters a last stage of risk recognition where the decision becomes a protective action. For this, a Tsunami Evacuation Behavior Questionnaire was conducted in La Punta, Peru. Risk perception level was calculated for each individual and a risk perception framework for evacuation decision was integrated into a model and verified with actual data from questionnaires. Reference Risk, Prospect Reference Theory, Subjective Judgment Matrices and Bayesian Learning were used as tools to construct this Risk Perception Framework for Tsunami Evacuation Decision. An improvement on predicted times for the sample group was obtained in comparison with traditional models [7]. The proposed risk perception model of decision shows consistency and a promising future in human behavior modeling for tsunami events.

Acknowledgments

We would like to express our deep appreciate to the Ministry of Education, Culture, Sports, Science and Technology (MEXT) and JST-JICA (Peru) for the Financial support throughout the study. Also our gratitude to La Punta municipality and residents, and Callao Regional Government through its Civil Defense Office and members.

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キーワード: human behavior, risk perception, tsunami evacuation, tsunami modeling
Keywords: human behavior, risk perception, tsunami evacuation, tsunami modeling

HDS004-15

会場:103

時間:5月27日 15:45-16:00

Improvement on tsunami casualty model and its application as the basic approach to design tsunami evacuation route

Improvement on tsunami casualty model and its application as the basic approach to design tsunami evacuation route

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An improvement of tsunami casualty model by utilizing better description of human body based on anthropometry data was conducted to obtain better understanding about human ? flow interaction that lead to tsunami casualty. The absence of the model verification from previous researches is now fulfilled. The proposed model is applied in Padang city, Indonesia, to assess the feasibility of roads that will be used for tsunami evacuation. The city is under threat of possible giant tsunami in the future due to the existing seismic gap in Mentawai fault zone. The term of Tsunami Casualty Index (TCI) is used to express the ratio of the time of tsunami inundation that lead to a dangerous situation to human, with the total time of the tsunami inundation. The roads with TCI more than 50% obtained from the model should be considered to be avoided during evacuation. In such areas, additional tsunami evacuation shelter may be needed by the community the possibility of tsunami casualty in the respective areas.

キーワード: Tsunami casualty model, evacuation, tsunami casualty index

Keywords: Tsunami casualty model, evacuation, tsunami casualty index

HDS004-16

会場:103

時間:5月27日 16:00-16:15

The Influence of Mentawai Tsunami to Public Policy on Tsunami Early Warning The Influence of Mentawai Tsunami to Public Policy on Tsunami Early Warning

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Tsunami hit Mentawai Islands on the night of October 25, 2011. All the affected are in Mentawai Municipality Administration which consists four main islands, Siberut, Sipora, Pagai Utara (North Pagai) dan Pagai Selatan (South Pagai). As the epicenter of the earthquake was south-west to the islands, the damaged areas concentrated on the west coast and became severe to the south.

From the prespective of tsunami warnings, on Mentawai event the requirements for an effective early warning were only partially fulfilled. In order for an early warning to save lifes, it should be (1) true and reliable, (2) timely and provide sufficient time evacuation, (3) able to reach every single individuals without exceptions, (4) clear and understandable, and (5) followed and obeyed. For Mentawai-case, first requirement was achieved. Some of the survivors even witnessed the running-text on television informing the potency of tsunami generating. Part of the second requirement was also effective, although due to geographical condition, time for evacuation were very limited. Unfortunately, the rest of warning requirements failed and live losses were more than 400 people.

There were two other important facts which confirmed by surveys carried out by experts shortly after the tragedy. Firstly, the earthquake was not felt very shaking, especially in comparison to nearby event on September 12, 2007 and November 30, 2009 where tsunamis were absent. This fact lead to the suprising existence of tsunami earthquake which was not recognised before in the west of Sumatera Island.

Secondly, it can also be seen in the event the absence of local wisdom in saving lifes. In the contrary to Aceh tsunami, December 2004 when local wisdom saved many lifes at Seumeulue Island, there is no such mechanism can be observed in Mentawai.

The facts above then provided important inputs for policy making process. The process was initiated by defining policy environment, its key actors and target groups and how all of these elements inter-related. Before it is formulated, the dynamics of the public policy was also considered to reduce the contradiction with the existing one. It is clear that root of the problems are the poverty in the areas which leads to high vulnerability. Therefore, government institutions are encouraged to set-up plans within their own mandates to overcome the problems should tsunami hit again in the future. A formal legal basis in the form of President's Instruction was then urgently needed to underline and emphasize the synergy among institutions to strengthened tsunami early warning in Indonesia.

HDS004-17

会場:103

時間:5月27日 16:30-16:45

メンタワイ津波地震で露呈したインドネシア社会の災害脆弱性について Disaster vulnerability revealed by the 2010 Mentawai tsunami earthquake in Indonesian society

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A tsunami earthquake occurred off the Mentawai Islands, Indonesia on 25 October 2010, and its tsunami claimed around 445 lives and devastated western coastal villages. The proximity of epicenter to Pagai Islands made a fast arrival of tsunami at a rainy night. According to BMKG (Meteorological Climatological and Geophysical Agency in Indonesia), seismic wave magnitude was M7.2. However, the tsunami heights were 4 to 7m, larger than that expected from the magnitude.

As an emergency response to the disaster, a group of researchers from Japan and Indonesia carried out a collaborative survey in Pagai Islands. The objectives of the survey include to measure physical characteristics of the tsunami, to interview government and United Nations (UN) personnel for emergency relief situation, and to interview local refugees and residents for their reactions. We interviewed approximately 120 persons and distributed about 50 questionnaire sheets at 10 coastal villages. The questionnaire consists of 17 questions, including location, earthquake shaking, people's action before the tsunami, casualties, their opinions for many casualties and on a safer future against tsunami. Other important information not listed in the questionnaire was also obtained during the survey.

The interviews revealed that the first aid was late because of remote area, bad weather and high waves immediately after the disaster, limited transportations, and late recognition of the damage situation. For the first seven days, the main relief center was in Padang, west Sumatra, where the resources were gathered. Because South Pagai Island does not have harbor, space for plane/ helicopter landing, nor appropriate road system on land, transportation of relief was done by ships in high waves. After seven days, the government moved the center to Sikakap in South Pagai Island. The government added helicopter distribution to support sea transportation. Because the Merapi volcano erupted in east Java Island on 26 Oct 2010, emergency relief aid had to be divided to two locations in Indonesia. The cluster approach system for disaster, which has been initiated by UN, was not effective for the weather condition and remote area in Mentawai islands. Small NGOs could not charter ships and helicopters. Logistics had to depend on big organizations, especially Indonesian Red Cross, Indonesian army and UN. Many volunteers and some small NGOs stayed in Sikakap and returned without doing any activity.

The 2010 Mentawai tsunami earthquake revealed Indonesia's vulnerability for natural hazards. Countermeasures of tsunami were not enough. Tsunami early warning system has been developed by international society after the 2004 Indian Ocean tsunami. The official warning from BMKG reached the Mentawai regency office, but did not reach local communities due to lack of communication tools. Some residents saw running text of tsunami early warning on TV. However, the communities speak local dialect and some of them especially women cannot read characters. It was doubtful all of them could read the text of tsunami early warning. Education to mothers is necessary to protect their children against natural disaster.

The lesson from this survey is that the Indonesia and international societies have to prepare for complex disaster in different places, as well as disaster at remote areas. Therefore, a main relief center for emergency response need to be established close to disaster area as soon as possible. It is also time to change tsunami early warning system, correct education and emergency relief assistance to seamlessly reach vulnerable people.

Acknowledgement: This survey was supported by SATREPS by JST, JICA, RISTEK and LIPI.

キーワード: 津波地震, 災害脆弱性, 防災教育, 早期警戒警報システム, 緊急救援, インドネシア

Keywords: tsunami earthquake, disaster vulnerability, education, early warning system, emergency relief, Indonesia

HDS004-18

会場:103

時間:5月27日 16:45-17:00

Earthquake Safer Housings and Buildings: Strength Evaluation of Existing Structures Earthquake Safer Housings and Buildings: Strength Evaluation of Existing Structures

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Important thing in seismic resistant structures is evaluating the seismic strength of existing structures. For important and expensive structures, structural health monitoring is applied by putting sensors capable of detecting any changes in the structures. Any changing in stiffness, mass, and damping of the structures is considered as symptoms. Fortunately, important structures are built with very strict supervising method so that the detail of the building is recorded in the as-built drawing.

For most developing countries, usually the drawing itself is not well kept. Even if it is kept in a safe place, the drawing and the actual building are usually not the same. Steel reinforcement inside the concrete makes it the source of in-appropriateness because it is hidden in the concrete. Building a structure that really follows the detailed engineering drawing is not usually the case for budget structures. For the sake of practicality, material availability, and rising cost, structures are usually built different from what it was stated in the engineering drawing.

Learning from that, it is important to apply a method that is capable of diagnosing the health of a structure. Methods for evaluating the strength of structure usually consist of two steps. First step is for obtaining data and second step is for making a numerical model based on the obtained data.

In this paper, experiences in carrying out strength evaluations of existing structures for seismic safety are shown and important findings are highlighted.

キーワード: existing structures, seismic resistant, strength evaluation, seismic code, structural analysis

Keywords: existing structures, seismic resistant, strength evaluation, seismic code, structural analysis

HDS004-19

会場:103

時間:5月27日 17:00-17:15

The Roles of Local Wisdom in Times of Post Disaster:Lessons Learned from the Bantul Earthquake

The Roles of Local Wisdom in Times of Post Disaster:Lessons Learned from the Bantul Earthquake

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The District of Bantul, Yogyakarta, is geologically and geographically vulnerable to earthquake, indicated by the 2006 earthquake that caused a significant socio economic impact to its people. The community experienced difficulty in providing their basic needs, especially during critical conditions, the first three days after the earthquakes, when relief from the government and other donors had not been received. An assessment using a qualitative approach informed that local wisdom played an important role for the community survival strategies. The communities looked for and prepared their needs, particularly food, health care and shelter by themselves with other members of neighborhoods (RT) and/or the community groups (hamlet/Dukuh). Their activities were strongly supported by the existence of local wisdom, such as community self helpfulness (tolong menolong) and cooperation (gotong royong), and sense of togetherness in facing disaster, care about each other, mutual response and endeavor. Their emergency responses were assisted by local institutions, both formal (RT, RW, hamlets and villages) and non formal (kinship and paguyuban). The government, particularly district and provincial government, with their relevant policies and programs and the leadership of the head of the district and Sultanate of Yogyakarta, also had a high contribution to the community recovering process, such as in the provision of their basic needs (food, health care and shelter).

キーワード: Local Wisdom, Community, Survival strategy, Local institutions, Earthquake, Disaster

Keywords: Local Wisdom, Community, Survival strategy, Local institutions, Earthquake, Disaster

HDS004-20

会場:103

時間:5月27日 17:15-17:30

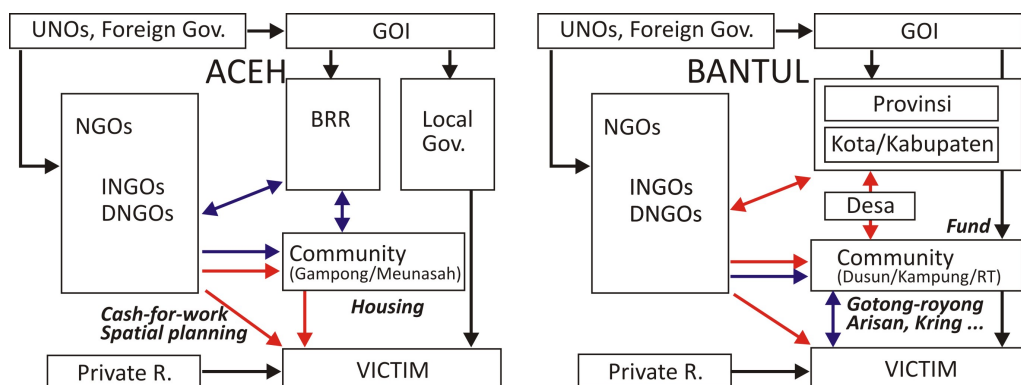
インドネシアのアチェおよびジョグジャカルタにおける災害復興に対するコミュニティ機能の比較検討

Comparing community functions for the post-disaster reconstruction in Aceh and Yogyakarta Regions of Indonesia

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この報告では、アチェおよびジョグジャカルタの事例の比較研究を通して、開発途上国、特にインドネシアの文脈において、災害復興に対してコミュニティがどのような役割をどのように演じるかということについて議論する。主なデータソースは、2010年8月にアチェ州バンダアチェおよびアチェベサールの200ガンボンと、2010年12月にジョグジャカルタ州パントールの161ドゥスンをそれぞれ対象に行った質問紙調査である。インドネシア政府は、それぞれ両地域における2004年インド洋大津波と2006年ジャワ島中部地震からの復興事業の完了を宣言した。しかし、長期復興過程においてどのような問題が生じ、各主体がどれにどのように対処してきたかということに関する議論はまだ十分ではない。例えば、私たちの住宅復興に関する予察的調査によれば、両地域間にはとりわけ援助の流れに大きな違いがあり(上図)、地域コミュニティの役割や政府との関係についても異なっている。多くの開発途上地域においては、災害対応、復旧、復興、備えの活動に際して、政府の機能に限界がある。それに代わって、コミュニティや親族などを基盤とした社会関係資本ないし社会的ネットワークがますます強調されるようになっており、そうした非公式のメカニズムを政府部門に適切に組み入れることがいよいよ重要である。ここでは、コミュニティに立脚した、あるいは草の根の災害対応にとってどのような社会的・地理的条件があるのかということについて、それらの両地域におけるハザードの種類や規模、地元の社会構造の相違に注目し、質問紙調査の結果を分析することによって議論する。



キーワード: コミュニティ機能, 災害復興, 草の根の災害対応, 社会関係資本, インド洋大津波, ジャワ島中部地震

Keywords: community function, post-disaster reconstruction, grassroots disaster management, social capital, Indian Ocean Tsunami, Java Earthquake

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インドネシアの教育システムにおける災害教育のメインストリーミング化 Mainstreaming Disaster Risk Reduction into Indonesian Education System: The Long and Winding Road to a Better Prepared S

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Mainstreaming Disaster Risk Reduction into Indonesian Education System:
The Long and Winding Road to a Better Prepared Schools

Irina Rafliana ? Indonesian Institute of Sciences (LIPI)

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Asep Koswara ? COMPRESS LIPI

Indonesian Disaster Education Consortium

Indonesia is one of the most disaster prone countries known all over the world. Many works had been done, in the area of preparedness and public education. The Indonesian Institute of Sciences had developed key parameters in measuring community preparedness, including for schools. It relates with the preparedness of individuals, as to teachers and students, and also preparedness of schools as an institution. In developing a better prepared school community, the government of Indonesia and also numbers of non government organizations were looking into pursuing integrating disaster education into curriculum. In turned out, that curriculum integration does not necessarily form a better schools policy in reducing their risks. This was verified using the assessment tools developed by LIPI. It needs more than increasing knowledge through curricula, to ensure reduced loss of lives during school time.

The Consortium for Disaster Education (CDE) was formed in 2005, and now already consisted of more than 50 organizations in Indonesia, working hand-in-hand with specific work on disaster education issues, including education policies. The consortium had facilitated and prepared a national strategy paper for mainstreaming disaster education in Indonesia, and supporting Indonesian Ministry of Education when it established the Ministerial Circular Letter to all provinces and districts prone to disasters. The consortium continued supporting this national movement with the extensive process needed, taking into account the critical parameters of what is meant by School-based Preparedness for all schools in Indonesia to build their schools safer and prepared. Indonesian Institute of Sciences together with Japan-ADRC and Tsunami Disaster and Mitigation Research Center-Syiahkuala University had studied 5 schools in Banda Aceh and observing ways and manners which schools might adapt to build their preparedness plan systematically, but moreover, at most easiest and relevant to schools condition and daily activities.

キーワード: 自然災害, 防災, 教育

Keywords: Natural Disaster, Mitigation, Education