Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

HDS06-01 Room:102B Time:May 23 09:00-09:15

On losses from landslides associated with large dams

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In 1963 the Vajont landslide in Northern Italy slid into a reservoir, generating a displacement wave that killed over 2500 people. Since then there has been a high level of awareness of landslide hazards amongst the engineers of large dams, such that there has been no repeat event on a similar scale. However, landslides continue to generate significant problems at large dam sites and on the banks of the associated reservoirs.

This paper examines the occurrence of landslides associated with dam projects over the last decade. It is demonstrated that reservoir bank failures continue to cause high levels of economic loss, although the loss of life in these events is reasonably low. The most notable case in recent year has occurred along the banks of the Three Gorges reservoir in China, where landslides have occurred at a higher than expected rate, resulting in the need to relocate large numbers of people. However, the data suggest that landslides are a very significant hazard during the construction of large dams. Since 2002 at least 550 lives have been lost in landslide events at or near to the construction sites of large dam projects. Most of these landslides, which have occurred in particular in East and South Asia, are the result of rainfall triggered rock slope collapses and debris flows, although some have occurred as a result of seismic triggering.

This paper examines the spatial and temporal occurrence of these losses and demonstrates that there appears to be an upward trend in the annual number of events. Over the next two decades a very large number of new dam projects are planned in high mountain area, particularly in Asia. This research suggests that a much higher level of attention needs to be paid to landslides during the construction of these large infrastructure projects if total losses over the this period are not to approach those of the original Vajont landslide.

Keywords: landslide, dam, reservoir, debris flow

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HDS06-02 Room:102B Time:May 23 09:15-09:30

Landslides of pumice fall deposits induced by the 2009 Padang earthquake and the formation of halloysite

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The 2009 Padang earthquake triggered nearly 1000 landslides which killed at least 600 people, a half of the death toll of the Padang earthquake. We made field investigation and laboratory analyses in order to clarify the mechanism of these landslides.

We investigated Tandikat area where the most destructive landslides with long run out had occurred. Tandikat area is widely covered by pumice fall deposits, which hereafter referred to as the Qhpt, underlain by paleosol. We found that landslide sites have common characteristic features: 1) Landslides occurred in area with Qhpt thicker than 4 m, 2) Sliding surfaces were made in a layer of mixed pumice and paleosol at the base of Qhpt.

From XRD analysis, we find that the pumice-paleosol mixed layer is rich in halloysite, while the underlying paleosol is rich in gibbsite and almost free from halloysite. Upper part of the Qhpt which had not been mixed with paleosol is free from halloysite. Cone penetration tests in the field showed that the pumice-paleosol mixed layer has the smallest resistance.

These evidences suggest that the halloysite rich pumice-paleosol mixed layer was one of the most important geological factors of the earthquake-induced landslides in this area. Halloysite in the paleosol of the mixed layers was probably made by the interaction between gibbsite and dissolved silica from pumice grains in the mixed layers and from percolating groundwater. Halloysite formation in the pumice grains of the mixed layers likely was promoted by the water accumulated on the essentially impervious paleosol.

Keywords: halloysite, the 2009 Padang earthquake, landslide, pumice fall deposits, geohazardz, landslide induced by earthquake

Japan Geoscience Union Meeting 2013
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HDS06-03 Room:102B Time:May 23 09:30-09:45

Landslide Investigation of Earthquake Induced Landslide during Rainfall in Tandikat, West Sumatra, Indonesia

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Indonesia is an archipelagic country which extends on one of the most active seismicity area in the world. In geological perspective, the west and south coast of the archipelago takes apart into Pacific Ring of Fire makes it numerously contains active volcanic mountains which extensively supplies loose volcanic material. The tropical climate brings consequence of high precipitation of the most area. These facts make Indonesia has high vulnerability against geo-disaster which induced by combination of earthquake and rainfall on volcanic areas.

One of the most devastating earthquakes in Indonesia struck West Sumatra Province on September 30, 2009, at 5:16 p.m. with MW 7.6 magnitudes, caused about more than 1000 deaths. The earthquake excited number of landslides which took more than 60% of total earthquake death toll. The most extensive landslides which occurred in Tandikat, Padang Pariaman Regency, buried hundreds of people and flattened some villages (Fig.1). These landslides occurred on loose pumice layered mountain during rainfall. The combination of intensive rainfall and strong earthquake is considered to decreases the slope stability dramatically. This study attempts to reveal contributory factors which involved on the event.

Integrated study of the landslide elaborating field investigation, laboratory work and numerical modelling were conducted. Geological investigation on the landslide area and laboratory investigation had been performed to examine geological features and mechanical properties of sliding material. The field investigation consisted of soil sampling, Standard Penetration Test (SPT), geological logging, in-situ permeability and density test. Further examination about mechanical properties of landslide deposit samples subsequently performed in laboratory. Several static and dynamic tests using cyclic triaxial apparatus had been conducted to study about stress-strain history of the soil under dynamic condition. The mechanical parameters of the material were then derived from both geological investigation and laboratory test by correlating SPT values and taking laboratory tests result. These parameters were then used into numerical model using finite element method software ABAQUS to analyze earthquake effect by considering time-historical acceleration from actual earthquake record.

Field investigation revealed that, particularly in the area, impermeable clay stratum is overlain by porous pumice layer. The difference of permeability may cause the saturation of lower part of the pumice layer when rainfall percolates. Both static and stress-controlled dynamic triaxial test showed the contractive behaviour of pumice deposit. This behaviour brought the consequence of excess pore water pressure increase at small strains. Immediate liquefaction occurred when specimen was conditioned as fully saturated and initial pore water pressure was given as to simulate ground water table after rainfall.

Finite element modelling using ABAQUS software indicated amplification phenomena of earthquake Finite element modelling using ABAQUS software indicated amplification phenomena of earthquake acceleration in the landslide area. The contributing factor of the amplification was the thick clay stratum and weathered andesitic sandstone layer below the pumice material deposit that was considered have low stiffness. Another possibility causing of amplification was the topographical aspect involving sloping surface. The numerical model and laboratory tests clarified that the amplification effect on the area caused the collapse of the pumice material. Immediate liquefaction was considered as the mechanism of the landslide due to the combination of earthquake amplification effect and soil saturation by rainfall during earthquake.

Keywords: Landslide, earthquake, rainfall, cyclic triaxial test, ABAQUS

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HDS06-04 Room:102B Time:May 23 09:45-10:00

Two Cases of Landslide Signal Mining from Massive Earthquake-Induced Landslides

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The short-time Fourier transform (STFT) is employed to identify two landslide- induced seismic signals in Chi-Chi earthquake. 7 seismic signals registered by strong ground motion station that contains the ground motion caused by two earthquake -induced landslide, Tsaoling rockslide and Jiufengershan landslide, are studied in the paper. Tsaoling rockslide involved a mass movement of 125 million cubic meters transported a 2 km long was triggered during 1999 Chi-Chi earthquake in central Taiwan. The seismic signal was recorded by the strong motion station about 700 m north of the landslide. 4 strong motion stations are close to landslide within 0.7 to 10 km. The Jiufengershan avalanche was the second largest landslide triggered by the Chi-Chi earthquake, mobilizing about 36 million cubic meters,of rock and soil from a dip slope. The Jiufengershan avalanche transported a 42?65 m thick, 1.5 km long, 3 strong motion stations are surround the landslide within 5 to 8 km.

The study shows that the earthquake signal began with a band of low frequency waves from 0.1 to 20 Hz, and rose up to 40 Hz during the main shock; then, the high frequency decreased progressively from 20 to 10 Hz. For the case of Tsaoling landslide, the landslide seismic signals show a high frequency band up to 60 Hz at the rock block cracking period. And dramatic excitation occurs during the 37.5th to the 41th sec, this period is estimated as the rock block sliding. At last, the high frequency of 30 Hz registered at the 76th sec. which is likely to correspond to the sliding mass impacting on the old debris dam. Next, for the case of Jiufengershan, the main shock appears the frequency spectrum for 0.1 to 40 Hz because of strong ground stations was located very near the faults. However, after main shock period the seismic signal demonstrated a 20 to 40 Hz high frequency band with difference pattern to the earthquake wave.

Results suggest the significant frequency of 20-40 Hz found as in rockmass sliding. It can be distinguished clearly from the after main shock waves which have frequencies of less than 20 Hz, typically ranging between 0.1 Hz and 10 Hz. The high frequency signal will be attenuated highly, especially in vertical direction signals, as the increasing distance from landslide location to seismic station.

Keywords: Landslide signal, seismic wave, earthquake-induced landslide, short-time Fourier transform

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HDS06-05 Room:102B Time:May 23 10:00-10:15

The internal structure and stability of a rockslide dam induced by the 2008 Wenchuan (Mw7.9) earthquake, China

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The internal structure of landslide dams plays a key role in their stability; however, it has not been much studied, probably due to the difficulty in obtaining information on internal structure in most cases. Here, we examined the shear-wave-velocity structure of a rockslide dam by a surface-wave technique called multichannel analysis of surface waves (MASW). During the 2008 Wenchuan earthquake (Mw7.9), more than 60,000 landslides were triggered and 800 landslide dams formed. Those dams with a high risk of collapse threatened rescue activities, and almost all of the large landslide dams were treated by digging a sluiceway immediately after the earthquake. Although the risk of collapse of many landslide dams was removed or lowered, not all of the countermeasures were based on well controlled methods. To analyze the internal of landslide dams to assist in carrying out reliable countermeasures, we made detailed investigations on some of the dams, and here describe one landslide dam that occurred in the Tianchi area. Grain-size analysis revealed that the displaced landslide materials experienced fragmentation and segregation during the long movement. The shear-wave-velocity profile of the dam revealed that the dam consisted of three facies (carapace, body and basal facies). The boundary between facies is distinct. The body facies had a greater shear-wave velocity (compared to those landside dams that had suffered collapse failure during the construction of a sluiceway), showing that the dam consisted of more densely deposited materials. This kind of dam body had a lower permeability, capable of retarding seepage that triggers collapse failure of the dam body due to piping. Big blocks on the surface also enabled the dam body to have greater resistance to overflow and thus reducing possible collapse failure in the immediate aftermath of overtopping.

Keywords: Landslide dam, 2008 Wenchuan earthquake, internal structure, stability of landslide dam, grain size distribution

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HDS06-06 Room:102B Time:May 23 10:15-10:30

Geological precursors of catastrophic landslides induced by earthquakes

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Recent earthquakes, the 2011 Tohoku earthquake, the 2009 Padang earthquake, the 2008 Wenchuan earthquake, the 2008 Iwate-Miyagi Inland earthquake, the 2005 northern Pakistan earthquake, and the 2005 Mid Niigata prefecture earthquake, gave us lessons about where and why large, catastrophic landslides are induced by earthquakes: those landslides had specific preparatory processes, mechanical or chemical, to be induced by earthquakes.

The 2011 Tohoku earthquake induced long run out catastrophic landslides in pyroclastic fall deposits with a sliding surface in halloysite-rich paleosol, which once was made by chemical weathering and has been resilified so that gibbsite changed to halloysite. Halloysite is very fragile against shaking and has been a major component of sliding surface materials of landslides during many earthquakes including the 2009 Padang earthquake. Dissolution of carbonate by groundwater was another chemical preparatory process of landslides induced by the 2008 Wenchuan earthquake.

Mechanical preparation for earthquake-induced large landslides is deep-seated gravitational slope deformation, which preceded many landslides involving the Daguanbao landslides by the Wenchuan earthquake and the Chiu-fen-erh-shan and the Tsaoling landslides during the Chi-Chi earthquake. Deep-seated gravitational slope deformation deteriorates rocks, which would become more susceptible to earthquake tremor. River erosion that undercut previous landslides, once collided to the opposite slope, is another important mechanical preparation for the landslides reactivated by earthquakes. There occurred many such catastrophic landslides during the Mid Niigata prefecture earthquake and the northern Pakistan earthquake.

Keywords: landslide, earthquake, pyroclastics, gravitational slope deformation, limestone

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Implementing Triple Helix Concept into DRR: Geospatial Information for Landslide Susceptibility Assestment in Lombok

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The Triple Helix Concept (THC) is an innovation of relationships between 3 elements: Government, Academics, and Business. Disaster Risk Reduction is the concept and practice of reducing disaster risks through systematic efforts to analyse and manage the causal factors of disasters, including through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events (UNISDR). DRR is a multifaceted issue requiring involvement from several sectors. Government and universities (academic) took part by establishing the policies, plans and programs, providing expertise in the tools and methodology. Private sector (business) is taking the lead in the term of investments and planning ahead to protect industry and society from disasters, economic disruptions while ensuring business continuity.

Most of the disaster related data are spatial in nature involve some geographic component. For planning, monitoring and decision making; there is typically a need for geospatial data. Therefore, geospatial information could play an important role in susceptibility assessment. The development in Lombok grows rapidly so that human activity will trigger more geological hazards. One of these hazards is landslide. To cope with these hazards impact, study about more detailed geological hazard map, information on the landslide prone areas, and identification of area susceptible to landslide is recommended. There have been many progress made in landslide susceptibility assessment (LSA) studies, whereby much of this progress is based on the extensive use of geospatial information by using GIS (geographical information system) and Remote Sensing technique. It can ease LSA and provides information for DRR missions. It also provides a high efficiency and optimizes time resources. The resulting landslide susceptibility map will be the base for DRR activities on Lombok Island.

Keywords: triple helix, disaster risk reduction, geospatial information, landslide susceptibility assessment, Lombok

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HDS06-08 Room:102B Time:May 23 11:00-11:15

Undrained shear behavior of saturated loess at different concentrations of sodium chlorate solution

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A series of ring-shear tests was conducted on saturated loess to investigate the effects of NaCl concentration in pore water and desalinization on the shear behavior under undrained conditions. The loess samples taken from a loess area with frequent occurrence of landslide in China were saturated by de-aired water with different concentrations of NaCl solution, and then were sheared undrained. After that, the samples were retrieved, remoulded, re-set into the shear box, and re-saturated by passing through de-aired distilled water (such that the samples were desalinized), and then were sheared undrained again. Through comparing the undrained shear behavior, the effects of NaCl concentration in the pore-water and desalinization on the undrained shear behavior of loess were examined. The results showed that the variation of NaCl concentration in pore water can strongly affect the shear behavior of saturated loess. Both the peak shear strength and steady-state strength increased with increase of NaCl concentration until a certain value, after which they decreased with further increase of NaCl concentration. Meanwhile, the peak shear strength and steady-state strength of the retrieved samples recovered to those of the original sample, namely the salinization of loess is recoverable. These findings may be of practical importance to better understanding the repeated occurrence of some irrigation-induced loess landslides in China.

Keywords: sodium chlorate solution, loess landslide, undrained shear behavior, irrigation

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HDS06-09 Room:102B Time:May 23 11:15-11:30

The Study on Landslide Disaster Mitigation and Management Using Numerical Analysis in Malaysia

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In Malaysia, recently, landslides happen occasionally and cause millions of losses every year. Government spends millions of Malaysian Ringgit on monitoring slope and slope failure measurement. NGO works together with local authority to monitor the slope to prevent casualty.

Setting site monitoring system in all slopes, with the extensometer, soil moisture probe, inclinometer and water gauge can monitor the movement of the soil in the slopes and predict the occurrence of slopes failure. However, installation monitoring system, in the whole country, to monitor and predict the failure of the slopes is very costly and almost impossible.

Here, we apply the numerical analysis on factor of safety F to predict the stability of the slope, which considers mechanism of resisting and driving forces in the slope. By comparing the observed data from monitoring site, history data and the result from the simulation using numerical analysis, a graph with a slope failure curve, by the rain data, can be determined. The increment of the accumulated rainfall data crossing the curve indicates the probability of the slope failure. Furthermore, the slope failure curve can also be diverted in the risk areas where have the almost same slope degree and soil properties.

Moreover, in our study, analyzing contour map, DEM data and history data by grading high, medium and low risk is proposed to determine the risk slope areas and narrow down surveying areas from the huge areas to the specified slope areas.

Data and information dissemination, by establishing quick response portal service, hazard map and providing training to the public, will alert the public on the risk of landslides. The awareness on the risk of slope failure among the public and installing the early warning system will minimize the loss due to slope failure.

Keywords: monitoring system, factor of safety, slope degree, soil properties, hazard map, public awareness

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HDS06-10 Room:102B Time:May 23 11:30-11:45

GEOLOGICAL ASSESSMENT AND POTENTIAL DEBRIS FLOW VOLUME ESTIMATION AT BUKIT CHENDERING, KUALA TERENGGANU, TERENGGANU, MAL

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Debris flow geohazard is not uncommon in hilly tropical terrain of Malaysia but received little attention from geoscientists and engineers mainly because their occurrences are difficult to predict. The development of the new Terengganu Palace in the northern flank of the Chendering Hill has been considered to be facing with threat of debris flow geohazards because the palace compound is partly surrounded by steep and rugged hill slopes which are dissected by narrow and steep hanging valleys. The potential for debris flow geohazards in this area has been identified from aerial photographs studies and field mapping, where some of the hanging valley flows are converging towards the site of the Public Ceremonial Building. Evidences for past debris flows have been identified in five hanging valleys. Geological assessments have been carried out in these valleys to search for evidence of past debris flow incidents and to characterise the nature of the past debris flows deposits. From the five hanging valleys, only two (i.e. Valley 2 and Valley 3) are considered very high risk and ought to be installed with suitable mitigating structures. Flexible debris flow barriers rather than rigid concrete structures have been opted for Valley 2 and Valley 3 because of site accessibility and construction feasibility. To facilitate the engineering design of the flexible debris flow barriers, potential debris flow volume for both valleys have to be estimated on the first place. The estimation of the potential debris flow is done empirically by estimating the area of the source and the thickness of the potential source (i.e. the combined thickness of loose sediments, colluvial deposits, and overburden soils). The estimate is done by subdividing the map of the potential source area into equal cells using a grid, estimate the proportion of each cell that is covered by the deposits, and then sum. Thickness (Tm) of the loose sediments at source were measured and estimated directly in the field from the exposed outcrops along the stream channel. With the given area and thickness, volume of the bulk debris flow source can be calculated by multiplying the total area with the measured source thickness (Tm). This formula gives dry volume of debris sources in the valley catchment. Under extreme rainfall event, it is very unlikely that the entire volume of the debris in the catchment will turn into debris flow. Past experiences indicate that the likely situation is that only 20 percent to 30 percent of the debris sources will be sliding down entering the valley channel and mixed up with water to form the likely debris flow volume. In most wet debris flow events of tropical country, the amount of water made up about 40percent of the entire flow volume. Therefore, by taking these factors into consideration, the predicted debris flow volumes for both Valleys 2 and 3 can be reliably estimated to facilitate the engineering design of the debris flow barriers.

Keywords: Debris Flow, Geohazard, Geological Assessment, Volume Estimation, Hilly Tropical Terrain

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HDS06-11 Room:102B Time:May 23 11:45-12:00

RAINFALL PHENOMENON TRIGGERING LANDSLIDE IN INDONESIA

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Landslides are common geological disasters in Indonesia, especially during rainy season. Geological conditions, climate, and human activities might cause landslide, however earthquake could trigger landslide but the most common landslide in Indonesia due to heavy rainfall.

Number of landslide commonly increases during rainy season, November - February, as recorded in 2005 to 2012. In 2010, rainfall was high since all the year long rained and the number of landslides higher than previous years. In 2010, landslides attained 199, higher than in 2009 (161), 2008 (139) and 2007 (101) as well as in 2011 (82) and 2012 (124).

A large landslide occurred in Dewata Tea Plantation on February, 23rd 2010, Bandung district, West Java province. It collapsed after high intensity rainfall which reached 675.9 mm during 15 days. Slope stability analysis in this area suggested that heavy rain could reduce the safety factor 22.75% of 1.257 (normal conditions) to be 0.971.

Keywords: landslide, rainfall, Dewata

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HDS06-12 Room:102B Time:May 23 12:00-12:15

The Development of self-potential tomography to estimate the ground water condition

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Landslides are one of the most severe natural disasters in the world and there are two types; rainfall induced landslides and landslides triggered by an earthquake. In this research, basic study on early warning system for landslides will be performed to understand rainfall-induced landslide process by hydrological and electromagnetic changes. The final goal of this research is to develop a simple technology for landslide monitoring/forecasting using self potential method. The advantages of this method are lower cost and easier to set up than the hydrological approaches using pore pressure sensors. The laboratory experiments show that the self-potential variation has relationship with the water and soil displacements. But, we can not estimate the ground water condition by self-potential yet. So, in this study, we developed self-potential tomography to estimate the ground water condition.

Measured self-potential value under the ground and charge distribution to estimate is given by the Coulomb's law. Therefore, this is inverse problem. To solve the inverse problem, we adapt Phillips-Tikhonov regularization with Generalized Cross Validation (GCV). To evaluate the reconstructed charge distribution and investigate the relationship with the ground water condition, computational simulations and applications to practical data by using the sandbox experiment has been examined.

It is found that the developed algorithm is effective through numerical simulations. Results of application to sandbox experiments show good performance but there are some problems to solve.

The details will be given in our presentation.

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HDS06-13 Room:102B Time:May 23 12:15-12:30

The initiation and positive regulation of the catastrophic Siaolin landslide

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The extremely high intensity rainfall of the 2009 Typhoon Morakot triggered numerous landslides in South Taiwan. The Siaolin landslide is the most notorious one where the down slope Siaolin village suffered heavy casualties. The geological characteristics of the Siaolin landslide and the sequence of this catastrophic event have been studied extensively. Even though the kinematics of the Siaolin landslide was depicted quantitatively via numerical simulation, the initiation and mechanisms associated with rapid moving of this landslide is poorly understood. A simplified rigid wedge model is accordingly used to study the initiation of the Siaolin landslide. The north plane of the wedge is assumed the bedding plane overlaid the matrix-supported colluviums whereas the south sliding surface is identified as a high angle fault. Besides, the crown of the Siaolin landslide is set as a tension crack on the eastern side of the wedge. The colluvium and fault gouge were collected from the Siaolin landslide site and a series of low- to high-velocity rotary shear tests was performed. The peak friction angle of the colluvium and the fault gouge are 22.8? and 18.3? under a velocity of 3.3 micron/sec. The factor of safety of the wedge can be calculated using a commercial wedge analysis tool. The result shows the wedge failure happened (FS$<$1) when the average water table attained 96% of the slope height. This result corresponds with the heavy rainfall triggered Siaolin case. Remarkably, the fault gouge, which composed of mainly angular and planar particles, tends to contract during shearing. It implies no normal stress increment provided during sliding and excess pore pressure could be generated. The shear behavior of the fault gouge contributes the positive regulation mechanism and the Siaolin wedge is apt to accelerate after the sliding initiated. Furthermore, the shear tests of the fault gouge and colluvium show the strength dropped substantially after peak under a high shear velocity (1.3 m/sec) condition. The steady state friction angles of the colluvium and fault gouge are 5.7? and 10.5?. With an increasing velocity after the initiation of landsliding triggered by the critical uplift water force, the rapid moving of the Siaolin catastrophic landslide is inevitable.

Keywords: Catastrophic landslide, Low- to high-velocity rotary shear, Friction coefficient, Wedge failure, Excess pore pressure

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HDS06-14 Room:102B Time:May 23 12:30-12:45

A catastrophic rockslide-debris avalanche at Zhaotong, Yunnan, China: description and dynamic analysis

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At about 6:00 p.m., on 23rd September 1991, a catastrophic rockslide-debris avalanche (volume:18 million cubic meters) occurred in the Touzhai valley approximately 30 km northeast of Zhaotong city in northeast Yunnan, China. The displaced mass travelled over 3.65 km down the valley in only a few minutes and finally part of the debris mass plunged into the Pan River. The landslide filled the valley with basalt debris to an average depth of 40 m. This paper introduces the general site conditions and then discusses the relevant site conditions favorable to form the rock avalanche. Based on field observations and witness interviews, the sequence of the rock avalanche was analyzed, and a detailed characterization from initiation to final deposition was presented. Finally, we use the DAN model to re-construct the dynamics of the rock avalanche.

Keywords: Rockslide, Debris avalanche, Runout behavior, Dynamic modeling

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HDS06-15 Room:102B Time:May 23 14:15-14:30

Movement of a long-runout landslide in deep snow: A case of the Kokugawa landslide in the Joetsu area, Niigata, Japan

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On 7 March 2012, a snowmelt-induced landslide (hereafter, the Kokugawa landslide) occurred on a gentle slope (10-20 degree) of Higashi-Kubiki Hill, adjacent to the Takada floodplain in the Joetsu area. The displaced mass of the Kokugawa landslide travelled 750 m from the scarp, destroying 11 houses in the process. The landslide occurred in the early snowmelt period, and the site was covered by a 2-m-thick snow layer when the landslide initiated. A major reason for the long runout may have been reduced friction at the snow interface at the base of the displaced mass. To examine this hypothesis, we describe the detailed movements and topographies of the landslide, based on field observations and aerial photography and LiDAR observations. We then discuss how the snow affected the behaviour of the landslide movements.

The site consists of Neogene marine mudstone and Early Pleistocene conglomerate, with the slope surface covered by loose materials (7-8 m thick) composed of old colluvial deposits and spoil materials from gravel extraction in the 1980s. The collapsed slope was 500 m long and 150 m wide, and the volume of the displaced mass was estimated to be 750,000 m3. The apparent friction angle was 9 degree (H/L = 0.15), as low as that of debris flows or extremely large landslides. Thus, the Kokugawa landslide had a significantly longer runout than landslides with an equivalent volume.

Although the outer part of the displaced mass spread out and deposited at the foot of hill, 350-500 m downward of the scarp, the main body of the mass continued to move rapidly (approximately 15 m/h) without spreading out after reaching a flat paddy field (1-3 degree). Snow on the paddy field was pushed by the mass and swelled up several meters above the snow surface level. The swelled snow formed a moraine-like snowpack of 5-20 m width around the mass. The mass including the snowpack reached houses 250 m from the foot of the hill on the morning of 10 March and stopped after destroying them. Repeated measurement of fixed points on the snowpack and the mass revealed that the mass, including the snowpack on the paddy field, gradually spread out over nine days after reaching the houses.

A lateral ridge developed for 180 m along the right side of the mass on the paddy field. At the boundary between the ridge and the snowpack, slickenlines were observed on the flank of the ridge. Neither snow nor mixed sediment/snow layers were found at the base of the ridge, and the ground surface beneath the ridge appeared undisturbed. In contrast, profiles from boring cores and a transverse trench at the centre of the mass showed that a clay layer about 1 m thick in the paddy field was eroded by the mass. Thus, the formation of the lateral ridge could be attributed to the following two mechanisms: lateral confinement by the compacted moraine-like snowpack that developed around the mass, and depression of the centre of the mass caused by the ground surface erosion.

We could not find any distinct evidence to support the hypothesis that reduced friction at the snow interface at the base of the displaced mass was the major reason for the long runout of the Kokugawa landslide. Rather, our results suggest that the long runout was a result of lateral confinement by the compacted moraine-like snowpack. The behaviour of the Kokugawa landslide indicates that snowpack confinement has a major effect on landslide movement. This effect should be taken into account for accurate prediction of landslide runout and related hazard mitigations in heavy snowfall regions.

Keywords: landslide, long-runout, deep snow condition, lateral ridge

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

HDS06-16 Room:102B Time:May 23 14:30-14:45

Using LiDAR Derived Digital Terrain Model to Identify Deep Seated Landslides in Mountainous Areas of Taiwan

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In August 2009, Typhoon Morakot triggered thousands of landslides and debris flows, and more than 600 people were dead or missing, and the economic loss was estimated at hundreds million of USD. Among these landslides, large deep seated landslides are critical and deserve attention, since they are evolve in destructive failures. For example, one deep seated landslide, the Hsiaolin landslide, with an area of about 250 ha, buried the entire village of Hsiaolin in Kaohsiung County causing 397 causalities, the disappearance of 53 others, and buried over 100 houses (Lin et al., 2011: Tsou2011). After the catastrophic Hsiaolin landslide, the recognition of areas where deep seated landslides may occur become a critical issue for landslide hazard mitigation for government and for peoples living in mountain area of Taiwan.

In 2010, Central Geology Survey of Taiwan initiates a project to establish 1 meter resolution LiDAR derived Digital Terrain Model through the island for helping recognition of potential geohazards in mountainous area. LiDAR capability to detect the bare ground elevation data also in forested areas, it was possible to recognize in detail landslide features also in remote regions difficult to access. In this paper we illustrate the high resolution LiDAR DEM is a very powerful tool to identify deep seated landslides in forest area comparing to the traditional interpretation technique by using stereo aerial photos.

According to landslide features such as arcuate crown escarpments, trenches, multiple ridges, down slope scarps, up slope scarps, transverse scarps, over hundreds of deep seated landslides with an area larger than 10 ha have been recognized in last two years by using inclination shading images and slope maps constructing from 1 m mesh Digital Elevation Model (DEM). Among these landslides, over 40 landslides were confirmed and investigated in the field. In this study, some of field examples are used to illustrate the efficiency of using LiDAR derived DEM in study of deep seated landslides in heavy forest areas.

Keywords: LiDAR, deep seated landslide, digital terrain model

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

HDS06-17 Room:102B Time:May 23 14:45-15:00

Large scale gravitational slope deformation related to fluvial dissection of a paleosurface

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Understanding the processes that lead to gravitational slope deformation and subsequent landslides can provide information about evolving landscapes. In order to shed lights on this topic, we conduct analyses of landscape by geological and geomorphological field investigations, DEM analysis, high-resolution satellite imagery interpretation in the upstream Dahan River and the Chishan River catchments in tectonically active mountain range in Taiwan. We completed inventory of gravitational slope deformation. Mapping was performed by visual interpretation of high-resolution images and/or field investigations and based on precursory topographic features. The precursory topographic features include scarplet or landslide scarp and hummocky surface. The distribution of the gravitational slope deformations shows that most of the gravitational slope deformations occur on slopes at or above the convex slope breaks bounding rims of low-relief paleosurface remnants in high altitudes. The analysis of longitudinal river profile shows knickpoint cluster at the edge of the low relief remnants, indicating the low-relief paleosurfaces have been eroded by retreating of knickpoints in relation to river rejuvenation in response to base-level lowering associated with tectonic uplift of the areas. Corresponding to the incision, the low-relief paleosurfaces can tend to gravitational unstable by undercutting and destabilizing the toes of adjacent hillslopes. Some of these unstable slopes led to catastrophic deep-seated landslides during heavy rainstorms with significant volume of landslide masses, shaping landscape relief. Mass rock creep structures within the source areas of the landslides evident the long-term slope development. Besides, these larger landslides are more effective in high altitudinal zone. This suggests that the larger landslide, which might be controlled by the local relief, is one of the major geomorphic processes for the long-term landscape evolution in tectonically active mountains. We include also chronological development of the landscape in the upstream Dahan River catchment. The results might be useful for future simulation of knickpoint propagation and its effects on paleosurface dissection and for quantitative assessment of landslide hazard disaster mitigation.

Keywords: gravitational slope deformation, fluvial dissection, paleosurface

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

HDS06-18 Room:102B Time:May 23 15:00-15:15

Formative conditions of incipient sliding zones in pelitic schist

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Large landslides frequently occur in pelitic schist areas, with the structure of the failing mass often being separated into smaller blocks. However, the reasons why landslides occur so readily in pelitic schist, and why their morphology separates into minor blocks, are not clear.

The texture of pelitic schist is strongly anisotropic, which means that it typically has low strength. In addition, landslides commonly occur on dip slopes in pelitic schist areas. These facts suggest that preferable conditions for landslide are related to schistosity within the pelitic schist.

In order to clarify the ways in which the mechanical behavior of pelitic schist controls landslide occurrence, we analyzed the microscopic texture and composition of pelitic schist, and then directly measured the shear behavior of analog materials of pelitic schist using a direct shear machine. Pelitic schist consists of alternating thin black layers, abundant in pyrite and graphite grains, and quartz-rich layers. The black layers are typically weaker than the quartz-rich layers, as has been tested using an Equotip rebound tester. Relatively thick, continuous black layers were found to have low hardness values. So unevenly distributed graphite layers are likely to determine the potential location of microscopic slip in a rock mass. To investigate the behavior of these systems we generated analog materials formed from layers made of artificial graphite sheets, to simulate the black layers, and plaster of Paris to simulate the quartz-rich layers. These systems were sheared parallel to the graphite layer at a constant rate in the direct shear machine at Durham University, allowing measurement of the shear strength. The results suggest that both the peak and the residual frictional strength between a graphite sheet and the plaster surface were about half of the strength of a joint within the plaster. Analog materials having continuous graphite sheets failed at a low shear strength. These results suggest that graphite layers likely reduce strength of the rock, and continuous graphite layers are likely important to determine slips in the rock mass.

Keywords: Landslide, Deep-Seated Gravitational Slope Deformations, Pelitic schist, Sliding zones of landslide, Graphite

Japan Geoscience Union Meeting 2013
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HDS06-P01 Room:Convention Hall Time:May 23 18:15-19:30

Analysis of landslide monitoring using an e-GPS system and multi-antenna GPS technology

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Based on GPS technology, this study monitored the movement of the landslide that impacted Taiwan's Formosa Freeway. Two monitoring systems and two data-processing software programs were employed. Auxiliary data were obtained from the GPS, raingauges, inclinometers, and water table meters for landslide analysis. The goal of multi-sensor monitoring was to construct an automatic early warning system for driver safety. Analytical results indicate that the landslide moved on average 1 cm/month in the southeast direction; that is, it moved slowly toward the Formosa Freeway, thereby posing a potential safety hazard for drivers. The positioning precision of the multi-antenna GPS (0.18, 0.25, and 0.57 cm in the north, east and vertical directions, respectively) was better than that of static relative positioning (0.29, 0.44 and 1.01 cm) and that of e-GPS technology (1.69, 1.35 and 2.45 cm).

Keywords: e-GPS, multi-antenna GPS, landslide, Taiwan

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

HDS06-P02 Room:Convention Hall Time:May 23 18:15-19:30

A Possible Slope Failure monitored by GPS Ranging in Tamagusuku Village, Southern Region of Okinawa Island

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According to the GEONET GPS baseline ranging operated by Geographical Survey Institute (GSI), the station in Tamagusuku Village, southern region of Okinawa Island, at which the operation was stopped in March 2012, was showing different movement from that at most of the other stations in Okinawa Island. The baseline between the Tamagusuku station and other stations in the central and northern areas on the island decreases gradually since around 2000. And then, according the GPS-based horizontal deformation record, the Tamagusuku GPS Station shifted NE relative to other stations in Okinawa Island. The ratio of NE-ward shift is not uniform and fluctuates from 2001. The fluctuation has good correlation with the amount of rainfall at the nearest AMeDAS (Automated Meteorological Data Acquisition System) Itokazu Station by Japan Meteorological Agency. The Tamagusuku station was located on the southward dipping slope surrounded by hills. A lot of cracks on the roads and walls on the buildings nearby are observed on these neighbouring hills. Since the basement rock in Tamagusuku Village is mudstone (Shimajiri Formation, 1.5-3Ma.), a slope failure may occur easily. Therefore, a possible reason of the shift and fluctuation of the GPS-based ranging record may be weakening of the mudstone basement (Shimajiri formation) at the Tamagusuku Station due to absorption of water after the heavy rainfalls. The GPS antenna of the Tamagusuku Station tends to lean towards northeast as the result of a possible slump. The geographical condition around the Station suggests a downslope focusing of soil, especially after a heavy rainfall. The large-scale slump which occurred in Shuri and in Nakagusuku in 2006 was the result at the final stage of the collapse due to the accumulation of weakening of the ground. On the other hand, the deformation observed around the Tamagusuku Station is regarded as the early stage of the slump. Considering that the amount of deformation is growing year by year, a sudden large-scale slump may take place at any time in Tamagusuku Village.

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

HDS06-P03 Room:Convention Hall Time:May 23 18:15-19:30

Fluctuations in pore-water pressures triggered by earthquakes at the Busuno landslide

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1. Introduction

Many strong earthquakes (EQs) of magnitude >6, such as the 2004 Mid Niigata prefecture EQ and the 2008 Iwate-Miyagi inland EQ above magnitude 6 have occurred over the past few decade. As dynamic stresses from EQs act upon the slope, pore-water pressure increases in soils with low permeability, which causes destabilization of the slope.

Okamoto et al. (2006) reported spike-like fluctuations in pore-water pressure in the landslide masses during the Mid Niigata prefecture EQ activity. However, they did not examine the relationship between fluctuations in pore-water pressure and seismic vibration characteristics. This study seeks to identify the fluctuations in pore-water pressure in the landslide masses that result from EQ seismic motion.

2. Methods of monitoring

We observed pore-water pressure and seismic motions at the Busuno landslide site in Joetsu City, Niigata Prefecture, Japan. We analyzed the seismic motions of five EQs, namely the 2004 Mid Niigata prefecture EQ of M6.8 (EQ1), its largest aftershock of M6.5 (EQ1'), the 2007 Niigataken Chuetsu-oki EQ of M6.8 (EQ2), the 2011 Naganoken Hokubu EQ of M6.6 (EQ3), and its largest aftershock of M6.6 (EQ3'). We installed a seismometer at the Busuno landslide in 2010. Analysis of strong motions that occurred before 2010 (EQ1-2) was conducted using data from the National Research Institute for Earth Science and Disaster Prevention (NIED) K-NET database Yasuzuka. To estimate the fluctuations in pore water pressure due to the EQs, we evaluated attenuation relationships for peak ground acceleration (PGA) and velocity, taking into consideration the effects of the fault type and site conditions (Si and Midorikawa, 1999).

We installed piezometers (pore water pressure gauges) in areas where large movements were observed in past years, and pore-water pressure was recorded every 10 min. Five piezometers (P21, P22, P23, P31, and P33) were installed in 2002, and pore-water pressure during EQ1, EQ1', and EQ2 was observed. These piezometers were crushed by heavy snow in 2006, and two new ones (P61 and P62) were installed and recorded the data during EQ3 and EQ3'. As the piezometers recorded measurements every 10 min, the peak pore-water pressure immediately following an EQ is not always recorded. We calculated a damping curve for the pore-water pressure data, and the peak of the curve was assumed from the decreasing trend of the data. The damping curve was applied to the positive pore-water pressure data.

3. Results and discussion

All piezometers showed fluctuations in pore-water pressures during the five EQs. The fluctuations in pore-water pressures increased with the Peak Ground Acceleration (PGA). EQ3 showed the highest PGA (NS 236 gal, EW 382 gal, and UD 108 gal) and the largest increase in pore-water pressure (14 kPa). Other EQs caused much lower fluctuations, of 2 kPa and less.

We believe the effects of a heavy snow pack on the slope were the cause of the largest increase of pore-water pressure. A layer of ˜3 m of snow covered the landslide area during EQ3 (March 12, 2011), thus subjecting the sliding surface to greater pressure.

The data from the five EQs showed correlations between PGA, Peak Ground Velocity, and the dominant frequency of up and down directional movement and fluctuations in the pore-water pressure before and after the EQ events.

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Keywords: seismic motions, excess pore water pressure, peak ground acceleration

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

HDS06-P04 Room:Convention Hall Time:May 23 18:15-19:30

Extremely rapid debris slide - debris flows induced by extreme rainfall on Aso volcano caldera slope in July 2012

Hiroshi Fukuoka[1*]

[1]Hiroshi FUKUOKA, [2]Yuki MATSUSHI, [3]Gen FURUYA, [4]Hiroshi SAITO

An extreme rainfall affected Kyusuh Island of western Japan in July and induced hundreds of fluidized landslides claiming tens of casualties. Especially on the Aso volcano caldera cliff, a number of extremely rapid debris slide ? debris flows were induced and affected the downslope communities. Measured trigger precipitation was recorded by the nearby ground-based station of the AMeDAS network (Automated Meteorological Data Acquisition System) as about 80 mm/h for consecutive 4 hours. Analysis of Radar Rain-gauge Analyzed Precipitation operated by the Japan Meteorological Agency showed landslide affected area almost coincided with the ones of heavier precipitation. Most of the landslides were initiated on the boundary of strongly weathered soils, which used to be new volcanic accretion materials. Outstanding features of these landslides are: (1) This area had been affected by similar heavy rainfall decades ago, however, again a number of landslides took place in the nearby past scars; (2) Many of the soil slide bodies are shallow less than 5 meters deep and possibly immediately transformed into debris flows or mud flows and traveled long distance to reach the downslope communities; (3) Visual observation of the sources showed the high possibility that some of the slides were apparently induced by liquefaction. Similar cases were reported of past 2 landslide disasters in Japan. This strongly suggests that excessive rainfall can trigger numerous mud flows of unexpected reach. We conducted close field study at a typical soil slide - mud flow site. It originally initiated as debris or soil slide on a thin steep bedding plane of about 34 degrees consisting of coarser accretion materials. Needle penetration test showed comparatively weaker strength in the layer. It is underlain by a layer of finer materials. Such a higher permeability contrast could contribute to higher susceptibility of excess pore pressure generation. We took soil samples from the vicinity of sliding surface and conducted pore-pressure-controlled ring shear test. We increased pore pressure at constant rate

until failure after applying normal/shear stresses of certain ratio representing the steepness of the sliding surface for the normally consolidated (of 100 kPa) specimen prepared by disturbed samples. Immediately after failure took place, we observed quick and large drop of shear resistance in a few seconds. Although the applied normal stress of this test is larger than the actual one, this implied strongly the occurrence of the sliding surface liquefaction. The resultant shear resistance was so small and it can explain the mechanism of those long run-out and low apparent friction angle of those landslides.

Keywords: extreme rainfall, landslide, debris flow, excess pore pressure, caldera cliff

Japan Geoscience Union Meeting 2013
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HDS06-P05 Room:Convention Hall Time:May 23 18:15-19:30

Investigation of landslides on inner slope of Mt.Aso caldera triggered by heavy rainfall in Northern Kyushu in July 2012

Hufeng Yang[1*], Fawu Wang[1], Tomokazu Sonoyama[1], Yasuhiro Mitani[1]

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Mt. Aso caldera is one of the largest calderas in the world. It is also known for typhoons and heavy rainfall during the rainy season. These relatively annual events have triggered shallow landslides and debris flows, which have caused severe casualties, destroyed properties and displaced local city dwellers. From July 11 to 14, 2012, an intensive rain fell on the Northern Kyushu during rainy season. a value higher than the highest local precipitation recorded in the last decade. This high precipitation triggered shallow landslides, especially around the rim of the caldera, which affected many villages and local settlers. Detailed field investigation was conducted to study the motion mechanism of shallow slope failures triggered by the heavy rainfall. A representative site, which is located in Ichinomiya, Aso-gun, Kumamoto Prefecture was selected for this study. Several field geotechnical tests were carried out in the landslide site. Portable cone penetration tests were conducted to evaluate the nature and degree of consolidation of the sediments which are mainly composed of tephra and pyroclastics; in-situ permeability tests were conducted with variations in depth of hand-drilled bore holes so as to measure rainfall infiltration rate. Representative soil samples were collected from different layers of the main scarp for particle size distribution analysis, shear strength tests, and other laboratory soil strength analyses. Results obtained from detailed field and laboratory investigations carried out in the area show that the main factors contributing to the occurrence of shallow landslides and debris flows are incessant rainfall, surficial drainage and runoffs, topography, geologic and soil strength properties. These factors are enhanced by the interplay between the steep wall of the caldera (over 30 degrees) and high precipitation coupled with high number of irregular cracks that acts as conduits for easy infiltration to subsurface drainage system. Another process that could have affected the slope stability could be from steady undercutting of the slope toe by strong surface floods, which overtime reduces the shear strength of the material leading to shallow sliding failure.

Keywords: Landslide, Rainfall, Mt.Aso caldera, Northern Kyushu

Japan Geoscience Union Meeting 2013
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HDS06-P06 Room:Convention Hall Time:May 23 18:15-19:30

Study on characteristics of ground vibration during times of flooding in mountainous rivers

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Large scale sediment movement phenomenon such as deep catastrophic landslide generates ground vibration. So previous studies showed, analytical results of the data based on high-sensitivity seismometer networks can have higher resolution in time and location of landslide.

On the other hand, it is confirmed that the amplitude vibration of seismometer during heavy rain or flooding is large in related to amplitude of vibration during without rain or flood. This phenomenon has influence on lowering of Signal-Noise ratio. It means, accuracy of detecting the large scale sediment movement phenomenon using these networks is reduced.

We examined microtremor in seismometer during heavy rain or flooding and compared the amplitude of microtremor with discharge of mountainous river. Also we estimated seismic wave by the sediment movement phenomenon during flooding. At a result, it was found that amplitude of microtremor and discharge before observing the peak discharge reveals correlation.

Keywords: Vibration sensor, Flood, Discharge, Amplitude of velocity, sediment movement phenomenon

Japan Geoscience Union Meeting 2013
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HDS06-P07 Room:Convention Hall Time:May 23 18:15-19:30

Simulations of seismic signals induced by landslides by numerical coupling of PFC and FLAC

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We developed a two-dimensional numerical coupling approach using the Particle Flow Code (PFC) and Fast Lagrangian Analysis of Continua (FLAC) code to simulate the flow process of landslides and rock avalanches. We used the Xiaolin rock avalanche as a case study. The sliding of the rock fragments was simulated by PFC. When the rock fragments impact on the top boundary of FLAC, forces and displacements of the boundary grids will be transmitted between the two codes. We assigned monitoring locations in the coupled numerical model to record the seismic signals induced by the simulated rock avalanche. The time-frequency spectrograms of the seismic signals were analyzed using Hilbert-Huang transform (HHT) for examining the seismic characteristics. The simulated results were compared with the seismic signals recorded during the landslide from a broadband seismic station, SGSB, which is 11.4 km away from the Xiaolin landslide site.

Keywords: PFC, FLAC, HHT, Xiaolin, landslide

Japan Geoscience Union Meeting 2013
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HDS06-P08 Room:Convention Hall Time:May 23 18:15-19:30

Variations of topographic feature of a Major Typhoon

Chih-Ming Tseng[1*], Ching-Weei Lin[2], Paolo Tarolli[3], Giancarlo Dalla Fontana[3]

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In August 2009, in Taiwan, Typhoon Morakot with a maximum rainfall of over 2,900 mm, induced over 23,000 landslides in mountainous area throughout southern Taiwan. One large scale deep-seated landslide, the Hsiaolin landslide, with an area of about 250 ha, buried the entire village causing 397 casualties, the disappearance of 53 people, and the destruction of over 100 houses (Lin et al., 2011; Tsou et al., 2011). The LiDAR-derived 2m resolution DEMs before and after Typhoon Morakot was utilized in this study to perform the relation between slope and contributing area. Montgomery and Foufoula-Georgiou (1993) suggested a partitioning of the landscape into drainage and slope regimes that include hillslopes (Region A), unchanneled valleys (Region B), debris flow-dominated channels (Region C), and alluvial channels (Region D). The comparison of slope-area relationship of Hsiaolin village before and after Typhoon Morakot indicates, no matter pre or post typhoon, the slope?area figure shows four regions with different scaling responses. However, there are remarkable for the significantly variation of scaling pattern in slope-area diagram after the deep-seated landslide. Sediment mass produced by deep-seated landslide with approximately 2.7x107 m3 (Wu et al., 2011) depleted from hillslope, nearly 90m deepest failure depth resulted in outward extend of upstream catchment boundary. Huge amount of sediment mass was transported downward also formed significant deposition in debris flow channel and alluvial channel, respectively. These phenomenon also reflects in slope-area graph, contributing area at parting between Region I and Region II migrate from 20 m2 to 50 m2, that means hillslope length become longer due to outward development of upstream catchment boundary. The local slope in debris flow channel (Region C) and alluvial channel (Region D) both become gentler after this catastrophic landslide. The analysis only after an intense event, really represent a strategic tool for a directly quantification of the processes that affected and significantly changed the earth surface.

Keywords: DTM, High resolution topography, LiDAR, Slope?area relation

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HDS06-P09 Room:Convention Hall Time:May 23 18:15-19:30

Visualization of precursory features of Typhoon-induced Shiaolin landslide by ALOS pan-sharpened stereoscopic imagery

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Precursory topographic features of gravitational slope deformation may provide a clue in predicting potential sites of catastrophic landslides. Visual photo-interpretation of high-resolution images such as optical satellite imagery and aerial photographs together with field survey remains the most used method to recognize the precursory topographic features and locate gravitational slope deformation. Here, we utilized ALOS pan-sharpened stereoscopic imagery of anaglyph to recognize the precursory topographic features before Typhoon Morakot-induced catastrophic Shiaolin landslide in southern Taiwan on 9 August 2009. Developed by the coauthors, Ryuzo Yokoyama and Michio Sirasawa, the ALOS pan-sharpened stereoscopic imagery is generated from the data of PRISM (a panchromatic stereo mapping sensor of 2.5 m resolution) and AVNIR-2 (a visible and near infrared sensor of 10 m resolution). We compared it with underlying geological structure that was exposed by the catastrophic landslide and was investigated after the event. The results indicate that the source area had the precursory topographic features: irregularly shaped bulges and depressions in many locations, suggesting the slope had been gravitational deformed beforehand. At least four of the locations were confirmed that the precursory topographic features were related to gravitationally deformed beds of alternating beds of sandstone and shale on a dip slope. The deformed beds were buckled and result in undulating beds or asymmetrical folds near the exposed ground surface. Consequently, the precursory topographic features might reflect the internal geological structures of the deformed slope. Besides, several slopes near the Shiaolin landslide site also appear as gravitational deformed slopes and can be characterized as potential sites of large and catastrophic landslides.

Keywords: ALOS pan-sharpened stereoscopic imagery, gravitational slope deformation, catastrophic landslide, precursory topographic feature

Japan Geoscience Union Meeting 2013
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HDS06-P10 Room:Convention Hall Time:May 23 18:15-19:30

Experimental examinations of the soil-water characteristics of a loess soil, China

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In Northwest of China, many loess landslides have occurred without obvious triggering factors (i.e., rainfall, earthquake, etc). These landslides have loess that is desiccated from the ground surface to a considerable depth, and pore-water pressure at shallow depths is generally negative with respect to atmospheric pressure. To understand and analyze the pore-water pressure distribution of these slopes and then provide evidence for their stability analysis subjected to matric suction, it is essential to study soil-water characteristics. Furthermore, the soil-water characteristic curve (SWCC), representing the relationship between volumetric water content and matric suction, has been developed to interpret and predict the mechanical behaviors of unsaturated slopes. In this study, A set of experimental trials were carried out to examine the influences of initial dry density, moulding water content and particle size fraction upon the soil-water characteristics of loess soil in Northwestern China. The experimental results were obtained by using a conventional volumetric pressure-plate extractor. The results indicated that volumetric water content had a monotone-decreasing nonlinear relationship with matric suction for all loess specimens. However, the dry density had considerable influence on soil-water characteristics. When the dry density increases, the air-entry value increases and rate of desorption decreases. Moreover, by comparing the soil-water characteristics of the specimens that have the same dry density but were compacted at different initial water contents, it was found that the initial moulding water content could affect soil structure (aggregation) significantly. Higher initial water content specimens had a higher air-entry value and a lower rate of desorption. The specimens with different particle size fractions appeared to exhibit distinct soil-water characteristics. A coarse-grained specimen had a lower air-entry value and higher rate of desorption compared with a fine-grained specimen.

Keywords: loess landslide, soil-water characteristic, dry density, water content, particle size fraction

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PROMPT REPORT OF NATURAL DAM FORMED IN THE WAY ELA RIVER, AMBON, INDONESIA

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On July 13, 2012, a huge natural dam was formed by the large scale landslide in the Way Ela River, Ambon, Maluku, Indonesia. Its height is about 150 meter. It still remains and its water level keeps high. In the downstream of the natural dam, there is a village with populations of 5,000, which is exposed to the catastrophe in case of the collapse of the natural dam. In order to prevent the damage from collapse of natural dam, Indonesian government has been promoting the countermeasures such as constructing a spillway, and establishing the early warning system. We have investigated the site of the Way Ela River three times and collected information about the natural dam. Here, we promptly report the interim results about the natural dam based on the information obtained so far.

Keywords: natural dam, Indonesia, landslide

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Rapid weathering and erosion mechanisms of mudstone in a badland under the humid, subtropical climate: A case study in a

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The badlands of Plio-Pleistocene mudstone in southwest Taiwan are characterized by sharp ridges and gullies and are located in humid subtropical area that experiences contrasting dry and rainy seasons. Erosion depths measured using erosion pins over a period of 4 years, averaged up to 9 cm/y. Mudstone sample cores recovered from slope surfaces in the dry season (April) and early rainy season (July), prior to the extensive erosion that occurs later in the rainy season, and monitoring dataset of salinity and water content near the slope surface through one and half year, suggested the following weathering and erosion mechanisms. Near surface layers (<10 cm depth) would become rich in salts with little change in physical properties of rock during dry season, and then decrease its bulk densities and increase its larger void ratios during the early rainy season. Thus deteriorated near surface layers are rapidly removed by slaking and erosion during intense precipitation in the main rainy season.

Keywords: Badlands, Mudstone, Weathering, Erosion, Slaking

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Model test of the submarine landslide impact forces acting on cables and the motion mechanism

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Communication cables, which cross the oceans between continents all over the world, are sometimes damaged due to the occurrence and motion of submarine landslides, causing interruption of data transmission, and even of international communications. When cable failure occurs, the economic loss is vast for cable restoration coupled with temporary or permanent breach in information transmission. Submarine landslides are usually triggered by many factors which include rapid sedimentation, retrogressive failure, earthquake and tectonic activity, gas hydrate dissociation and wave loading. These activities cause severe damage to transocean fibre optic cables. Direct observation of this phenomenon is still not enough because these events occur deep beneath the sea surface, and direct observation of submarine landslide would be extremely expensive and difficult because of its unpredictability. Many features of submarine landslides and the damage they cause to communication cables are unclear. The aim of this study is to use experimental approach to analyze and understand the motion mechanism of submarine landslides and its effect on communication cables. Our interest in submarine landslides lies in disaster mitigation of communication cables. An experimental apparatus to study submarine landslides was developed for this purpose. The apparatus consists of a wheel-shaped hollow disc of height 1.8m, an axle shaft at the center and a trough with a width of 0.4m at the inner circumference. Submarine landslides is simulated by using silica sand-water mixture in the lower part of the trough as the wheel rotates in a anticlockwise direction on the axle shaft with silica sand-water mixture in the same direction of motion, all controlled by a speedometer. Using this apparatus, with silica sand no.7-and no.8-water mixtures for these experiments, normal stress, shear stress, pore water pressure on the bottom of the apparatus and impact force on a communication cable model were measured using high definition transducers, sensors and data loggers. Experiments were carried out considering four factors: (1) the effect of motion velocity of submarine landslides; (2) the effect of submarine landslide volume; (3) Material composition of submarine landslides; and (4) the effect of different cable diameters. From data obtained from series of experiments, the friction angle of submarine landslides and impact force on a communication cable was obtained. In addition, small plastic balls which have specific gravity similar to silica sands were used as tracers to observe the characteristic bulk movement of soil masses during the experiments; results obtained were compared with the friction angle and impact force on a cable. Result obtained from the experiments show that four critical values of velocities and five stages of soil mass flow evolution conditions exist in these experiments. Impact force on the communication cable model is high for submarine landslides with low motion velocity, but decreases until the velocity gets to a critical value where liquefaction occurs, and subsequently increases in a linear fashion with velocity. On the other hand, friction coefficient is positively correlated with velocity of soil mass, but shows different tendency before and after the critical value of velocity. Also, large diameter cables are subjected to high impact forces. When the diameter of the cable is increased by 10%, the impact force also increases by 50%. The experiment with setting height of 20mm showed the high impact force. Conversely, experiments with higher setting height (40mm and 80mm) showed low impact force. This may be due to the influence of different relative densities of submarine landslide sediments. Although it is difficult to simulate the flow conditions which occur in deep water, we hope the test results provide some hints for communication cable design and cable positioning in the ocean.

Keywords: submarine landslide, motion mechanism, submarine cable, internal friction angle