Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

HDS06-01 Room:101A Time:May 27 17:15-17:40

Rock slides, rock avalanches and deeps seated gravitational slope deformation at the orogeny scale: the case of European

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An orogen scale inventory of large landslides (mainly rockslides), rock avalanches and deep seated gravitational slope deformations (DSGSD) in the European Alps has been prepared by the authors (Crosta et al., 2013, 2014) and results of the analysis are presented in this contribution. The inventory includes: over 2000 large landslides, ranging in area between 0.1 and 17 km^2, about 300 rock avalanches, ranging between 0.09 and 15.5 km^2, and a total of 1033 DSGSDs, ranging in size between 0.03 and 108 km^2. The inventory covers an area of about 110,000 km^2 extending over the alpine territories of Italy, France, Switzerland, Austria and Slovenia, and was prepared by using available satellite imagery (multitemporal, Google Earth, Google, Inc.) and topographic data at different resolutions (DEMs from 1 m x 1m up to 20 m x 20 m for different areas). The inventory was validated against local and regional landslide inventories already available at different scales. Geometrical features and geomorphological parameters have been collected and related to the different phenomena and local settings in order to assess the control of local slope morphology on the occurrence and the geometry of these large instabilities. The frequency/area relationship for the different classes of mapped features is presented. The inventory shows that large landslides are widespread in the Alps with clustering in some sectors of the orogen. Their spatial distribution has been analysed through bivariate and multivariate analysis (mainly Principal Component Analysis and Discriminant Analysis) against a variety of factors, including: lithology, proximity to tectonic structures, seismicity, uplift and exhumation rates, position within the mountain belt and along main and tributary valleys, slope morphometry (e.g. relief, elevation, gradient), ice thickness of glaciers during LGM, and mean annual rainfall. The analysis allowed a preliminary assessment of conditions favourable to the onset and development of large landslides and DSGSD. The occurrence of foliated metamorphic rocks, LGM ice thickness, local relief (and related parameters), slope size, drainage density and river stream power are the local parameters most positively correlated to DSGSD occurrence. Finally, a comparison between the distributions of different phenomena is presented and discussed.

Keywords: landslides, deep seated gravitational slope deformation, rock avalanche, inventory, orogen, European Alps

Japan Geoscience Union Meeting 2015
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HDS06-02 Room:101A Time:May 28 12:00-12:15

Shallow Landslide Susceptibility Mapping Using High-resolution Topography for Areas Devastated by Super Typhoon Haiyan

RABONZA, Maricar[1*] ; FELIX, Raquel[1] ; LAGMAY, Alfredo mahar francisco[2] ; ECO, Rodrigo narod[2] ; ORTIZ, Iris jill[1] ; AQUINO, Dakila[2]

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Super Typhoon Haiyan, considered as one of the most powerful storms recorded in 2013, devastated the central Philippines region on 8 November 2013 with damage amounting to more than USD 2 billion. Hardest hit are the provinces of Leyte and Samar. Rehabilitation of the areas that were devastated requires detailed hazard maps as a basis for well-planned reconstruction. Along with severe wind, storm surge, and flood hazard maps, detailed landslide susceptibility maps for the cities and municipalities of Leyte (7,246.7 sq. km) and Samar (13,121 sq. km) provinces are necessary. In order to rapidly assess and delineate areas susceptible to rainfall-induced shallow landslides, Stability INdex MAPping (SINMAP) software was used over a 5-meter Interferometric Synthetic Aperture Radar (IFSAR)-derived digital terrain model (DTM) grid. Topographic, soil-strength and hydrologic parameters were used for each pixel of a given DTM grid to compute for the corresponding factor of safety. The landslide maps generated using SINMAP are highly consistent with the landslide inventory derived from high-resolution satellite imagery from 2003 to 2013. The methodology addresses the need for rapidly generated shallow landslide susceptibility maps and detailed landslide susceptibility classification which is useful to identify safe and unsafe areas for reconstruction and rehabilitation efforts. These shallow landslide susceptibility maps have been made freely available to different relief and rehabilitation agencies in Typhoon Haiyan ravaged areas. These maps complement the debris flow and structurally-controlled landslide hazard maps that are also being prepared for rebuilding Haiyan's devastated areas.

Keywords: Landslide, Natural Hazard, SINMAP, Susceptibility Map, Spatial Analyses, Philippines

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

HDS06-03 Room:101A Time:May 28 12:15-12:30

Triggering mechanism of shallow landslides in Izu-Ohshima Island, Japan.

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On October 16, 2013, Typhoon Wipha attached west slope of the Mt. Mihara in Izu-Ohsima Island, Japan, and induced shallow landslides with large areas. These landslides killed 36 people, and 3 people are still missing. Sliding surfaces of these landslides were located at the boundary between high permeable scoria (and tephra) layer and low permeable loess layer. Aerial photograph investigation in the period from 1945 to 2013 showed that only one rainfall event, Typhoon Ida in 1958, induced many landslides in the area before the Typhoon Wipha. Depth of the sliding surfaces during this Typhoon was similar to that during Typhoon Wipha. We derived spatial distribution of the pore water pressure in the two-dimensional slopes with multi-layer structures on the basis of the continuity equation and equation of motion for seepage flow. Our analyses elucidated that the pore water pressure does not agree with hydrostatic pressure if the lower end of the saturated zone is not locating on the impermeable layer. Our simulation of the seepage flow during the Typhoon Wipha and Typhoon Ida showed that the pore water pressure was highest at the boundary between tephra and loess layers on which sliding surfaces of the landslides were located. Pore water pressure during other large rainfall events without landslide was below that during Typhoon Wipha and Ida. Consequently, increasing in the pore water pressure at the boundary between tephra and loess is the important factor triggering landslides in the Izu-Ohshima Island.

Keywords: landslide, pore water pressure, Izu-Ohshima, multi-layer soil structure

Japan Geoscience Union Meeting 2015
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HDS06-04 Room:101A Time:May 28 12:30-12:45

Flowsliding in volcanic ash slope during heavy rainfall: A Case Study of 2013 Izu Oshima Landslides

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On Oct. 16, 2013, catastrophic shallow landslides were triggered on a wide area of the west-side hill slopes in Izu-Oshima Island, Japan, by the heavy rainfall accompanying Typhoon No.26 (Wipha). The displaced landslide material traveled long distance with rapid movement, resulting in 35 dead, 4 missing, and 46 buildings being completely destroyed on the downstream area of Motomachi area. To understand the initiation and movement mechanisms of these shallow landslides, we took sample from the source areas and examined their shear behavior under partially drained or undrained condition. We performed flume tests to trigger landslides by rainfall, and examined the variation of soil moisture, pore-water pressure and landslide movement. Test results showed that high pore-water pressure could be built up and maintained within the displaced landslide material, resulting in rapid flowsliding movement, irrespective of the nature of very shallow sliding mass. Results obtained from the simulation of landsliding shows that the high mobility resulted from liquefaction failure of displaced landslide materials. Field observation also revealed that wind load to the trees on steep slopes might have played key role on the triggering of the slope failure on wide areas.

Keywords: Flowslide, heavy rainfall, volcanic ash slope, wind load, trees

Japan Geoscience Union Meeting 2015
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HDS06-05 Room:101A Time:May 28 14:15-14:30

An Improved Method for Classifying Debris Flow Disaster Potential

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This study aims to clarifying torrents with debris flow disaster potential. A special debris flow occurred at Hualien County during typhoon Saola in 2012. A turning curve occurred and community which was not supposed to be under disaster potential damaged by debris flow. The previous study shows the main reasons of this event are continuous rainfall event, specific geological material and topographic conditions. The disaster represents the insufficiency of the current method to classify the debris flow potential. Therefore, this study follows the findings and intends to confirm if the similar torrents exist or not. The study cases were selected from the torrents with debris flow potential defined by the authority and 5 torrents were determined by their geological condition with metamorphic rock material. The debris flow simulations were carried out by Flo-2D numerical model with three continuous designed rainfall events. The simulation results show that turning curve occurred at some of the cases, but some did not. Authors analyzed their topographic conditions to check the differences of the simulation result. From the gradient of the flowing part and the topographic conditions of alluvial fan, the criteria of the debris flow resulting in turning curve could therefore be summarized, which could be the indexes to clarify the probable torrents with debris flow potential.

Keywords: Flo-2D, debris flow disaster potential, turing curve, topographic criteria, second debris flow disaster

Japan Geoscience Union Meeting 2015
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HDS06-06 Room:101A Time:May 28 14:30-14:45

Karangkobar landslide, Banjarnegara district central of Java Province Indonesia

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[1]Geological Agency, Ministry of Energy and Mineral Resources of Indonesia

In Indonesia has been 436 landslides during 2014 period. 115 of them occurred in the Central of Java Province. One of the landslide that evolve in to debris flow and cause great casualties and damages, have occured on December 12nd, 2014 in Jemblung, Sampang Village, Karangkobar, Banjarnegara Regency. Geographically it is located at 109○43 ’15.3912” E and 7○16’ 52.5828” S. This landslide causing more than 100 people died and property losses. Regionally disaster location composed by Jembangan volcanic rocks consisting of andesitic lava and volcanic rocks clastic.

The types of landslidesi is rotational sliding and the types of materials are debris. This landslide triggered by heavy rainfall. Climatological Agency of Banjarnegara data showed that rainfall accumulation reached 349 mm in eleven days before landslide, while at the time of the incident was recorded 101.8 mm.

This even is interesting because of the material dispersion mechanism happens to be a large of the distribution. Distance of debris flow up to large area and has caused damage along its flow track. Distribution of debris controlled by the viscosity of the material and topography.

Keywords: Jemblung, debris, rainfall, Banjarnegara, topography

Japan Geoscience Union Meeting 2015
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HDS06-07 Room:101A Time:May 28 14:45-15:00

Estimation of dynamic friction of the Akatani landslide based on the waveform inversion and numerical simulation

YAMADA, Masumi[1*] ; MATSUSHI, Yuki[1] ; MANGENEY, Anne[2]

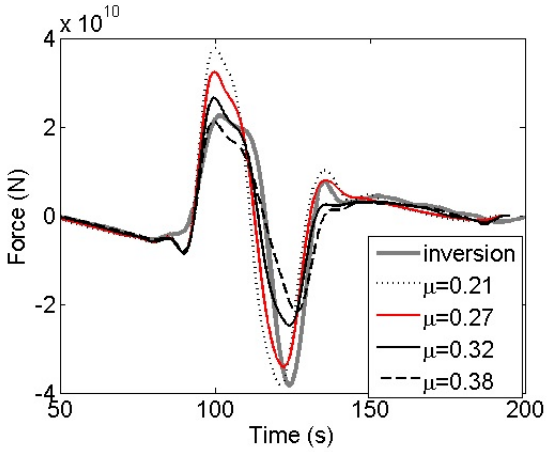
[1]DPRI Kyoto University, [2]IPGP

We performed numerical simulations of the 2011 deep-seated Akatani landslide in central Japan to understand the dynamic friction process of the landslide. By comparing the forces obtained from the numerical simulation and seismic waveform inversion, the most probable friction model was estimated.

Based on the numerical simulation, dynamic coefficient of friction was well constrained as 0.3 and a rapid increase of the velocity and the associated drop of the coefficient of friction were observed right after the onset of sliding.

The friction law that controls landslide dynamics is velocity-weakening with sudden drop after the initiation of sliding, which accelerates the deep-seated landslide. The friction model calibrated here using seismic data helps to understand the dynamics of the landslide and provide the basic property of the shearing resistance of the slip plane.

Keywords: deep-seated landslide, dynamic friction, seismic waveform, numerical simulation, granular material



Japan Geoscience Union Meeting 2015
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HDS06-08 Room:101A Time:May 28 15:00-15:15

Seismic observation in a large, incipient rockslide on an anaclinal slope

DOI, Issei[1*] ; WANG, Gonghui[1] ; KAMAI, Toshitaka[1] ; CHIGIRA, Masahiro[1]

[1]Disaster Prevention Research Institute, Kyoto University

Japan has experienced mega earthquakes and catastrophic coseismic landslides (e.g. the 2004 Niigata Chuetsu earthquake and the 2011 off the Pacific coast of Tohoku Earthquake). However, it is not well understood how the slopes behave under strong shaking because seismic observations on the slope are crucially insufficient.

In 2014, we started seismic observations in Kawashimo landslide, a large, incipient rockslide on an anaclinal (infacing) slope in Ehime Prefecture, southwest Japan. The length, the relative height and the width of the Kawashimo landslide are approximately 700 m, 450 m and 150 m, respectively. On the lower side of the landslide, rocks are highly fractured so that long cracks are densely observed. We installed two seismometers there, with the separation distance of 30 m. Ten earthquakes with high signal to noise (S/N) ratios were recorded from Oct. 30, 2014 to Jan. 7, 2015. We first calculated the spectra using the waveforms of ten seconds after the twice of S times because scattering waves are considered to be coming from all the directions in this time window. Then, we took the spectral ratios of two horizontal components to the vertical one for the purpose of cancellation of source spectra. The obtained spectral ratios are stable among ten earthquakes we analyzed, regardless of their back-azimuths. Horizontal components have a spectral peak around 7 Hz at both stations but the peak values of the spectral ratios are larger in NS components than in EW at one station, indicating that dip direction of the slope and/or shape of the landslide block may affect the characteristics of slope vibration. These results will provide basic information for considering the motion of the landslide materials on a slope during earthquakes.

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HDS06-09 Room:101A Time:May 28 15:15-15:30

Acoustic emissions preceding the stress drops in locally sheared granular materials

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For better understanding the mechanisms of rapid landsliding events, both the initial and long runout motion in which granular masses flow with extremely low friction is essential. Many studies had been performed to understand such kind of the unusual physical feature. However, the progressive maturation of these catastrophic landslides is still lack of enough scientific evidence. Importantly, acoustic emission (AE) technique provides the opportunity to study the grain-scale shear deformation of granular assemblies, and can be used to directly investigate the physical processes and failure mechanisms. Herewith, we employed a high frequency range of AE sensor to capture the elastic waves due to the abrupt perturbations of internal forces and release of strain energy, and the dependence of particle size and shear velocity on the AE characteristics has also been examined. We found that the dynamical drops of shear resistance and the amplitude of AE waveforms were larger with increase of the particle size. We also analyzed the relationship between AE rates (per second) and shear velocity, which indicated that the AE rates would increase with increase of the shear velocity. Ultimately, we examined the frequency contents and occurrence time of AE waveforms, and we found that the ultrasonic precursors occurred prior to the dynamic failures among granular materials.

Keywords: acoustic emission, stress drop, granular materials, particle size, shear velocity, rapid landslides

Japan Geoscience Union Meeting 2015
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HDS06-10 Room:101A Time:May 28 15:30-15:45

Debris avalanches of pyroclastic fall deposits induced by the 1949 Imaichi earthquake

CHIGIRA, Masahiro[1*] ; SUZUKI, Takehiko[2] ; WANG, Gonghui[1] ; TOBITA, Tetsuo[1]

[1]Disaster Prevention Research Institute, Kyoto University, [2]Tokyo Metropolitan University

Debris avalanches of pyroclastic fall deposits have been frequently induced by earthquakes in circum pacific countries, causing severe damage. Recent earthquakes that induced that type of landslides are 2011 Tohoku earthquake, 1984 Naganoken Seibu earthquake, 1978 Izu-Oshima-Kinkai earthquake, 1969 Tokachi-Oki earthquake, and 1949 Imaichi earthquake, in which landslides induced by the 1949 Imaichi have much less record than the others. Landslides induced by the 1949 Imaichi earthquake with a magnitude of 6.4 has been reported to have induced numerous numbers of landslides by Morimoto (1951) but their distribution has not been well plotted on a map and the slid materials are not well specified. We surveyed the affected area using high-resolution DEMs obtained by the airborne LiDAR and made field surveys. Comparison between the high-resolution DEMs and local landslide distribution maps showed that there are two types of landslide, one is a deep landslide with a sliding surface along the Kanuma Pumice Fall Deposot in a depth of 5-6 m and the other is a shallow landslide with a sliding surface probably along the base of the Imaichi Pumice Fall Deposit in a depth of 2-3 m. The deep landslides are rather easy to identify using high-resolution DEMs, and in addition to the 1949 landslides, we identified older deep landslides, which are assumed to have sliding surfaces in the same horizon with the 1949 landslides. Topographic features of shallow landslides may be erased fast, so we suppose older landslides cannot be identified on high-resolution DEM images.

Keywords: earthquake, landslide, tephra, pumice

Japan Geoscience Union Meeting 2015
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HDS06-11 Room:101A Time:May 28 15:45-16:00

Rapid Weathering and Salt Water Migration Processes near a Slope Surface in Plio-Pleistocene Mudstone Areas in Taiwan

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Badlands consisting of barren slope surfaces, sharp ridges, and v-shaped gullies are widely formed in Plio-Pleistocene mudstone in southwest Taiwan due to rapid weathering and erosion near the slope surface. The mudstone, which formed in the syn-collisional Plio-Pleistocene foreland sequence, has high density with a void ratio as low as 0.2 and has pore water chemistry similar to the seawater. In this area under the humid, subtropical climate with distinct dry and rainy seasons, since the mudstone slope surfaces are eroded as high as 9 cm/y in average in the rainy season, paved roads such as national express way are frequently damaged by slope failure hazards. To understand the mechanism of rapid erosion, we monitored water content and salinity near the slope surface and found that salt water migrates from the depth to the surface during the dry season, and salt precipitated on crack surfaces. After the dry season, rainfalls in the early rainy season dilutes the salinity, and closes desiccation cracks, consequently slowing the downward migration of water near the slope surface. The wetting of dry rocks and dilution of pore water near the slope surfaces deteriorates the rock and disperses rock-forming grains. The deteriorated surfaces are eroded during subsequent rain in the late rainy season. After the erosion, migration of salt water from the depths to the surfaces occurs again during the subsequent dry season.

Keywords: Plio-Pleistocene Mudstone, Rapid Weathering, Badlands, Monitoring, Salt Water Migration

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HDS06-P01 Room:Convention Hall Time:May 27 18:15-19:30

Landslides induced by the Nov. 22, 2014 Nagano Prefecture Kamishiro Fault Earthquake, Japan - a primary report

HAS, Baator[1*] ; MATSUDA, Masayuki[1] ; TAKAYAMA, Toko[1] ; FUNAKOSHI, Kazuya[1]

[1]Asia Air Survey, Co., Ltd.

To outline the characteristics of landslides induced by the strong earthquake (M6.7) occurred in northern Nagano Prefecture on Nov. 22, 2014 (Hereafter Nagano Prefecture Kamishiro fault earthquake), we interpreted landslide using aerial photos that taken just after the earthquake and partly conducted field survey. The earthquake was considered to be occurred on the Kamishiro fault, that dipping to east and is the northern part of the Itoigawa-Shizuoka tectonic line (The headquarters for Earthquake Research Promotion, 2014). The vertical and oblique photos taken by Asia Air Survey Co., Ltd on Nov. 24, 2014 were used for interpretation.

In the study area, about 58km2, a total of 104 landslides have been detected. Most of the landslides could be classified to shallow landslides. The most of the landslides occurred on terrace scarps, or around knick line of slopes. Meanwhile, many landslides occurred on slopes where previously occupied by old landslides.

In the study area, most of the landslides occurred within the distance of several km from the Kamishiro fault, in and around the Hakuba village and Otari village. However, landslides also have been confirmed in Nagano city where about 27 km distance from the source fault. In the study area, more than 70% of the landslides were located on the hanging wall of the source fault. This characteristic is coinciding with the features of landslides induced by reverse-fault earthquakes occurred in eastern Japan (e.g. Has et al., 2011). However, compare to the similar magnitude earthquakes, such as the Chuetsu earthquake in 2004 (Has et al., 2011) and Northern Nagano earthquake in 2011 (Has et al., 2012) occurred nearby the focal area of the Kamishiro fault earthquake, the number of landslides are much fewer and their dimension is much smaller. Future works are necessary for clarify these features how to related to the characteristics of strong motion, antecedent rainfall, topographical and geological conditions.

In this study, the interpretation of landslides was conducted in a very limited area, and also the field surveys were insufficient due to snow covering several days after the earthquake. For grapes the overall features of the landslides induced by the earthquake, detailed survey will be needed after snow melting.

Keywords: Earthquake, Landslide, Active fault, Nagano Prefecture

Japan Geoscience Union Meeting 2015
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HDS06-P02 Room:Convention Hall Time:May 27 18:15-19:30

A Study on the characteristics of the seismic signals produced by the man-made rockfall and debris flow

FENG, Zheng-yi[1*] ; LIN, Sheng-hao[1] ; XIE, Chang-hong[1]

[1]National Chung Hsiung University

In this study we performed a set of field tests on a 5-meter model slope to investigate the characteristics of seismic signals induced by signal rockfall (single rock rolling) and man-made dry 'debris flow' down a slope. We used a backhaul to release the 3 single rocks in 3 different sizes, and measure/compare the seismic signals they generated during rolling. Furthermore, we used a truck to dump a load of about 3 metric tons of coarse debris with the 3 rocks that used for signal rock rolling test and measure/compare the seismic signals generated by the dry 'debris flow'. The Hilbert-Huang Transform (HHT) was adopted to perform the mode decomposition and to analyze the time-frequency spectra for the seismic signals that we obtained in time domain. We expect that the seismic signals generated by the 3 large rocks in the 3 different sizes will produce distinguishable time-frequency characteristics in the seismic signals; that is, we can recognize that what frequency contents in the time-frequency spectra were produced by which size of the 3 test rocks. The results of this study may help us on interpretation of the seismic signals that we collect from seismic stations and broadband station for landslides.

Keywords: landslide, rockfall, debris flow, seismic signal, time-frequency analysis, HHT

Japan Geoscience Union Meeting 2015
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HDS06-P03 Room:Convention Hall Time:May 27 18:15-19:30

Rain-induced rock avalanches with sliding surfaces along low-angle-thrusts in accretionary prisms

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[1]Disaster Prevention Research Institute, Kyoto University

Recently, extreme weather related to global warming occurs frequently all over the world; there have been many record-setting rainfall events. Accordingly, potential of rain-induced rock avalanches increases. Examples of recent rain-induced rock avalanches with tens or more than a hundred of fatalities are a rock avalanche in Philippine Leyte in 2006, a rock avalanche in Shiaolin village, Taiwan by Typhoon Morakot (in 2009), and rock avalanches induced by typhoon Talas (in 2011) in Japan. However, the method to predict potential sites of rock avalanches is not established. Geological causes of rock avalanches are site specific and they must be clarified for each case.

Typhoon Talas induced more than 50 rock avalanches in the outer belt of the Southwest Japan, where is underlain by Cretaceous - lower Miocene accretionary complexes. We performed thorough geological mapping in the Akatani area, where two huge rock avalanches occurred with volumes of 2 million and 8 million m^3 respectively.

As a result, we found that these two rock avalanches had their sliding surfaces along a low-angle-thrust with dip 29 to 40 degrees extending more than 5 km, which fault we name the Kawarabi thrust. This thrust has a fracture zone of 1.5 m in the maximum width, composed of clayey fault breccia with a few layers of black gouges. These fault materials are very weak and impermeable, so the fracture zone is expected to prevent the groundwater filtration and build up the pore pressure. This thrust had been exposed along the riversides at the foot of the two rock avalanches, which suggest that the slopes on the thrust had been destabilized by the undercutting of long-term river incision. The destabilization induced gravitational slope deformation with small scarps before the catastrophic failure. In addition to the Kawarabi thrust, we found that the failed slope of the Akatani rock avalanche was cut by high-angle faults along both sides of the slope. Such a high-angle fault could be also assumed in the Akatani-E rock avalanche.

Our finding suggests that locating a large-scale low-angle thrust is essentially important to predict potential sites of rock avalanches as well as interpreting the internal structure of gravitationally deformed slopes. In addition, the combination of low-angle thrust faults and high-angle faults may be a common basic cause of gravitational slope deformation and catastrophic failure in mountains of accretionary complexes.

Keywords: rock avalanche, accretionary prism, thrust

Japan Geoscience Union Meeting 2015
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HDS06-P04 Room:Convention Hall Time:May 27 18:15-19:30

Fluvial incision history that controlled the distribution of landslides in the Central Range of Taiwan

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Hillslope processes, which are affected by long-term river incision, give rise to the risk of landsliding in active orogens. We studied the river incision history and the subsequent response of rock slopes in the upstream Dahan River catchment, north Taiwan, by analyzing river long profiles, hillslopes, and landslide scars. The results were combined with chronological data from several landform surfaces to reconstruct the history of landscape evolution. At the study area, the landscape comprises three levels of knickpoints and corresponding slope breaks. These knickpoints propagated upstream along trunk and tributary rivers, undercutting and destabilizing nearby slopes, of which the oldest is a paleosurface dated to ca. 150 kyr by cosmogenic nuclide dating. Consequently, three levels of V-shaped inner gorges (up to 600 m deep) are incised into the paleosurface. The inner slopes of the three levels of gorges have mean inclinations of 35.6 degrees , 37.7 degrees, and 39.8 degrees, and steepen from the higher to the lower inner gorges. These three series of knickpoints and corresponding slope breaks suggest the occurrence of three phases of river incision. Based on analyses of the steepness indices of the river long profiles, cosmogenic nuclide dating, and the regional tectonic and climatic history, the two earlier phases of incision are inferred to have been caused by prevailing tectonic uplifts during the middle to late Pleistocene, and the most recent phase by climate change in addition to uplift. The long-term history of river incision has controlled the distribution of deep-seated gravitational slope deformation and landslides. Many areas of deep-seated gravitational slope deformation and deep-seated rockslide-avalanches are aligned along the higher and middle slope breaks, and debris slide avalanches are concentrated along the middle and lower slope breaks.

Reference:

Tsou, C.-Y., Chigira, M., Matsushi, Y., Chen, S.-C., 2014. Fluvial incision history that controlled the distribution of landslides in the Central Range of Taiwan. Geomorphology 226, 175?192.

Keywords: landscape evolution, landslide, river incision, knickpoint, convex slope break, cosmogenic nuclides

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

HDS06-P05 Room:Convention Hall Time:May 27 18:15-19:30

Small-scale laboratory experiments of slope collapse under vertical shaking

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Slope collapse can be triggered by earthquake shaking. The collapse should depend on the parameters of shaking, i.e., acceleration, frequency and the duration. There have been many shaking experiments in the field of geotechnical engineering. In the recent years, experiments have also been conducted from the perspective of granular physics (Rubin et al., 2006, Katz and Aharonov, 2006). However there have been very few experiments in which the parameters mentioned above are varied by orders of magnitude. Here we report the results of experiments in which we vary the acceleration and frequency by 2 and 3 orders of magnitude, respectively. We study how the critical acceleration required for the collapse, the collapse velocity and its style depend on these parameters, to better understand the physics of slope collapse.

Experiments were conducted using a small acrylic cell to which a hopper is attached within so that a granular slope with a fixed slope angle forms. We place the cell on the shake table and shake it vertically under a specified acceleration and frequency for 60 seconds. We conduct experiments at frequencies of 10, 100, 1000 and 5000 Hz and acceleration (a) in the range of Gamma = a/g = 0.08-5 where g (m/sˆ2) is the gravitational acceleration. We record the collapse using a camera and analyze the digital images. The acceleration is measured using an accelerometer.

The initial slope angle was theta = 23.4 $\pm$ 0.5 which is close to the angle of repose (24 deg). From the experiments we find that the collapse style depends strongly not only on acceleration, but also on frequency. We defined 4 regimes : ”no collapse”, ”collapse”, ”convection” and ”jumping”. At 100 Hz, the collapse occurs and stops in a short time ($<$10 s) whereas at 1000 Hz the collapse continues throughout the 60 s. We constructed a regime diagram using the slope change rate during the time span of 0-5 s. We find that the critical acceleration for the slope collapse is minimum at around 100 Hz during 0-5 s, but shifts towards 1000 Hz as time elapses. We define two dimensionless numbers, the Shaking strength (S) and Jerk (Yasuda and Sumita, 2014). Here S=(Aˆ2 (2πf)ˆ2)／ gd ,J=(A(2πf)ˆ3)／ (g／ (2d／ g)ˆ(1／ 2)), where A (m) is the shaking amplitude, f (Hz) is the frequency, d (m) is the grain size. The minimum critical acceleration at 100 Hz can be explained by the combined condition of Gamma $>$0.3m, S $>$3.0x10ˆ-5 and J$>$0.3. We next consider the ”Jumping” regime. We calculate the height (z’) in which the particles jump up from the shake table and find that it becomes larger at high Gamma and low f. Comparing with the experiments, we find that the threshold for ”Jumping” regime can be explained by z’ $>$10 d.

To summarize, our experiments show that the slope collapse style and velocity depends strongly not only on acceleration but also on frequency and its duration. Characteristic frequency range of the earthquakes is 0.1 – 10 Hz. Our experiments suggest that the difference in the dominant frequency of the earthquakes may cause a variety of collapse styles.The ”Jumping” regime may correspond to the ”trampoline-effect” which has been proposed to explain the anomalous vertical ground motion in which the upward direction is larger compared to the downward direction (Aoi et al. 2008). In addition, our experiments suggest that there is a frequency band in which the critical acceleration becomes a minimum. This implies that if the dominant frequency of the earthquakes differs, it is possible that the resulting collapse can become larger even under a smaller shaking acceleration. Our experiments suggest that when assessing the possibility of slope collapse, one needs to consider all the possible frequency range caused by the earthquakes.

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Keywords: slope collapse, earthquakes, shaking experiments, granular matter, acceleration, frequency

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

HDS06-P06 Room:Convention Hall Time:May 27 18:15-19:30

XMP Radar application to optimize volcanic debris flow measurement in Merapi volcano

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Merapi is one of the world's most active volcano that is well known for its disastrous volcanic debris flow (*lahars*). Previously it has been understood that lahars at Merapi were triggered by rainfall with minimum intensity about 40 mm in 2 hour. However after its 2010 centennial eruption that deposited 10 times volume of pyroclastic materials of 1994 and 2006 eruptions, lahars at Merapi experiences different behavior as it is easily triggered by lower rainfall intensity at 14 mm in 1 hour and were also reported occurred in some areas that had never experienced lahars flow within 40 years. Since it is triggered by lower rainfall intensity now, it has been observed that lahars in Merapi occurred not only during rainy season but also in dry season.

Rainfall intensity in Merapi volcano plays important role not only on triggering and migrating sediment but also determining the level of damages. When rainfall intensity exceeds its threshold, the onset of generated lahars would happen within few hours. For Merapi volcano, it was suggested that rainfall intensity should be monitored for at least every 30 minutes duration. Variation of Merapi topography should also be considered when observing rainfall characteristic, since rainfall is also influenced by this small scaled climate factor. Hence using single raingauge is not recommended due to difficulties of installation, distribution and maintenance. Using raingauge would give limited spatial and temporal resolution.

A Radar system offers a way of measuring areal precipitation with both high spatial and temporal resolution and therefore currently offer the best solution to measure rainfall spatial variability in catchment area. The spatial resolution offered by ground based radar systems can range from ten of meter up to a kilometer, whereas the temporal resolution can range from seconds to an hour. This is an important factors for lahars measurement because in Merapi lahars generated at higher elevations and become more hazardous at 450-600 m elevation in each of the 13 rivers which drain the volcano.

X band dual polarimetric (XMP) radar has been installed at 110.4 E; -7.6 S or 14.3 km from Merapi's summit, Yogyakarta Regency, Indonesia. It has 6 s temporal resolution whereas spatial resolution ranging at 50-250 m mesh. This XMP radar has 9 GHz frecuency and 3.33 cm wavelength which gives far greater resolution than what can be achieved by raingauge network or typical operational C Band radar. Two rivers, Kali Boyong and Kali Gendol that mainly experience lahars every year were chosen to be observed. Both are still in range of 30 km radius of radar detection and flow in dense populated area.

Research objective is to estimate lahars in Kali Gendol and Kali Boyong using improved hyperKANAKO model. HyperKANAKO model is graphical user interface system that is able to predict 2 dimensional debris flow with considering sabo dams planning to reduce loss due to lahars occurrence. This system requires upstream hydrograph, landform information and sabo dam conditions to simulate flow depth, river bed variation, flow discharge and sediment discharge.

Landform information would be gained using geographic information system whereas sabo dam information would be collected based on secondary data. There are 56 and 22 sabo dams respectively at kali Boyong and kali Gendol. Mathematical model between rainfall intensity from XMP radar and discharge data would be used to modify upstream hydrograph. Thus hyperKANAKO model in this research would directly use rainfall information derived from XMP-radar. Output of hyperKANAKO model is expected to not only give information about lahars deposits but also on better management of sabo dam construction

Keywords: Merapi, Lahars, Hyperkanako model, XMP radar

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Detection of Landslide displacement by Geodetic techniques at the Noto Peninsula

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Natural disasters represented by earthquake, flood, and tsunami have occurred frequently in Japan. Landslides caused by earthquakes and/or heavy rains have caused great damages in many areas in Japan. Sliding of landslide moves slowly and continuously in general. Elucidation of the characteristic of spatio-temporal movement of landslide is important to understand the mechanism of landslide and to evaluate the assessment of its risk.

In this study, we estimated landslide displacements by geodetic techniques and analyzed the characteristic of landslide movement with ground surface observations at Wajima City, Ishikawa Prefecture, in the Noto Peninsula. We conducted GPS observations of the landslide during July 2014 to March 2015, and detected ground surface displacements from a change in the positions of the GPS sites. We also conducted SAR (synthetic aperture radar) analyses of InSAR (SAR interferometory) and PS-InSAR (persistent scatterer SAR interferometry) using 10 ALOS/PALSAR images acquired from December 2006 to October 2010. Furthermore, we used the ground data observation records of the borehole extensometers obtained by the Ishikawa Prefecture from 2008 to the present. We examined a landslide history of the analyzed area by tracking a topographic map published in 1970 and 5 m DEM released by GSI (Geospatial Information Authority of Japan) recently.

The InSAR analysis reveals landslide displacements of several tens cm/year in the area of 500 m x 500 m and horizontal displacements of 0.6-1.0 cm/year are estimated from GPS. The magnitudes and directions of the landslide displacements are coincident with the monitoring result of the borehole measurements and previous researches. We estimate the average rate of the landslide displacements of 0.5-0.8 m/year from the tracking topographical characteristics using the topographic data. These observations confirm that the landslides in the analyzed area have been active in recent years and suggest that active landslides in the past forms distinct scarp terrains and causes the past disasters written in historical materials.

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Keywords: Landslide displacement, geodetic techniques, GPS, InSAR, Noto Peninsula

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Observation of a gigantic Bhutan landslide caused by Cyclone Aila in 2009 using ALOS data

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The kingdom of Bhutan is located in the Himalayan Range in a mountainous area of weak geology. Landslide disasters occur every year, mainly induced by heavy rain. In 2009, the Mangde-chu River, one of the primary rivers in the country was blocked at 1,063 masl of its river bed by huge volumes of debris discharged from a tributary. Moreover, a National Highway connecting Bhutan with India was covered by the debris and closed to traffic. In spite of the significance of the event, no research was conducted on the debris transport process of the tributary.

Therefore, we conducted observations of the topographic condition of the tributary basin using satellite images produced by the Advanced Land Observing Satellite (ALOS, Daichi) of the Japan Aerospace Exploration Agency. Interpretation of the topography was done using a counter Digital Surface Model of ALOS PRISM data (5 m resolution). The ALOS data were observed just after Cyclone Aila. As a result, we detected the topography of a gigantic landslide with fresh scarps, at an upstream site of the tributary. The body of the landslide was 1.2 km wide and 1.1 km long; moreover, the landslide occurred in the vicinity of an older landslide.

We think that this landslide was induced by Cyclone Aila and became the source of the huge volume of debris that blocked the Mangde-chu River. The landslide is divided into blocks and is assumed to be unstable. It is important to conduct more detailed work and assessment in a timely manner because the government of Bhutan has constructed hydro-power facilities along the Mangde-chu River.

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Keywords: landslide, ALOS World 3D, geomorphic analysis, Cyclone Aila, Bhutan