Japan Geoscience Union Meeting 2015
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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

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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

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

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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

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

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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

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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

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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.

References :

Aoi et al. (2008). Science, 322, 727-730.
Katz and Aharonov (2006). Earth Planet. Sci. Lett. 247 280?294
Rubin et al. (2006). Phys. Rev. E 74, 051307
Yasuda and Sumita (2014). Prog. Earth Planet. Sci. 1:13.

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

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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