Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

HDS027-01 Room:301A Time:May 25 08:30-08:45

Rainfall induced rockslides with landslide dam at the course of Miyagawa River, Mie Prefecture, Japan

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Heavy rainfall by the Typhoon Meari (No.0421) caused many landslides at the southern and central Mie Prefecture. Landslide dams were formed by large ones of them. Two cases of landslides and dams occurred at the Miyagawa Valley are described, and their characteristics are discussed.

Rockslide occurred at a tributary of Kasugadani has the volume of 330 million cubic meters. Thick chert lies on mudstone accompanied by felsic tuff and sandstone. The strata of the Chichibu Belt are gently tilted to the direction of the slope. The chert layer is loosened and becomes permeable, while the mudstone layer is less weathered and impermeable. It is inferred that such contrast of rock mass characteristics made the sliding surface at the geological boundary. The sliding mass flowed down 1.0 kilometer along the tributary and dammed the stream of Kasugadani. In the transportation area, hummocks with vegetation composed of large chert blocks are distributed. Thus the movement of the mass is inferred to be debris avalanche. The landslide dam has the dimension of 15 meters high and 75 meters wide.

Rockslide at Mochiyamadani has the volume of 300 million cubic meters. Here, porous limestone breccia promoted by weathering collapsed. Mudstone underlies, but it is uncertain whether the sliding surface exists along the geologic boundary or through the limestone breccia. The strata incline to the slope. The rotated sliding mass dammed the stream of Mochiyamadani with 40 meters high and 60 meters wide. Then a part of the sliding mass flowed to 0.5 kilometers with hummocks.

Mechanism of rockslide and movement of debris avalanche are common to the two cases. Also rapid sedimentation of upstream is common including the other cases of landslide dams formed by the rainfall, which implies that the landslides occurred right after the culmination in the state of rich sediment load. Rainfall induced landslides and dams both of the 1889 Totsugawa case and 1953 Aridagawa case were formed a half or two days after the peak of precipitation. The reason why such early collapses occurred in the 2004 Miyagawa case is uncertain. However, influence of antecedent precipitation and earthquake recorded intensity of 4 on JMA scale before 24 days is possible cause.

Keywords: rockslide, landslide dam, heavy rainfall, Typhoon Meari (No.0421), Miyagawa

Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

HDS027-02 Room:301A Time:May 25 08:45-09:00

An analysis of shallow landsliding at Shobara 2010 disaster using a rainfall infiltration-slope stability model

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This study examines hydrological processes for shallow landslide initiation at Shobara disaster caused by heavy rainfall on 16 Jul 2010, using a rainfall infiltration coupled slope stability analysis. Hydro-geotechnical properties of soils were measured by in-situ shear testing and laboratory permeability tests for undisturbed samples. Slip depths and slope angles were obtained from airborne laser scanning conducted just after landsliding. We simulated one-dimensional vertical pore-pressure propagation due to infiltration into a soil column resulting in rapid increase in pressure head and hence abrupt decrease in factor of safety at soil base. Records of 10 min-rainfall at both of landsliding and non-landsliding areas were used as input for the simulation. The results imply that short-lasting but high-intensity rainfall peak (44 mm/10 min on the record) at the end of the storm event triggers the shallow landslides. Several verbal evidences from residents and time of emergency call-ins coincide with the simulated timing of the landslide occurrence, which support the validity of our modeling.

Keywords: shallow landslide, rainfall infiltration, slope stability analysis, airborne laser scanning

Japan Geoscience Union Meeting 2011
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HDS027-03 Room:301A Time:May 25 09:00-09:15

Rainfall-induced Landslide Monitoring Using Self-potential Approach

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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 triggering. In China, Korea, and Japan, landslides frequently happen with heavy rainfall and make many losses of lives, houses, roads, railways, and lifelines such as power, gas, water, etc. In this proposal, basic study on early warning system for landslides will be investigated to understand landslide process through hydrological and electromagnetic changes. The final goal of the project is to develop a simple methodology for landslide monitoring/forecasting using self potential method in the frame work of joint research among China, Korea, and Japan.

The proposed project is developing a new scientific and technical methodology for prevention of natural soil disasters. The outline of the project is as follows; (1) basic understanding on the relationship between resistivity distribution and moisture in soil and their visualization of their dynamical changes in space and time using tomography technique, (2) laboratory experiments of rainfall induced landslides and sandbox for practical use of the basic understanding, (3) in-situ experiments in China, Korea, and Japan for evaluation. In consideration above, integration of geological, hydrological, geotechnical characteristics with electromagnetic one are essential. Furthermore, systematic procedure will be taken such as differences in soil and mean radii of soils. For the laboratory experiments of rainfall induced landslide, we use the equipment at Forest and Forestry Product Research Institute, Tsukuba, Japan.

Conventional methods to monitor landslides are based on geotechnical and hydrological approaches to measure pore pressures and displacement on the surface. In these methods, boreholes are required in general and may disturb the subsurface water system. Making boreholes causes a higher cost for monitoring and it is not so practical for field applications. On the other hand, self potential measurement to measure the surface potential difference using two electrodes is easy to set up and measure continuously. If the distribution of resistivity under the ground or soil moisture changes can be detected and can be visualized in space and time, we can have the remote sensing technique for monitoring the soil moisture or water content in the ground. The main purpose of this proposal is to establish a simple system for landslide monitoring/forecasting (early warning system) using electromagnetic approach through basic understanding on electromagnetic property based on hydrological, geotechnical, and geological changes.

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HDS027-04 Room:301A Time:May 25 09:15-09:30

Observing topographical displacement of the slope and distributing real-time hazard information in Ubayu hot spring

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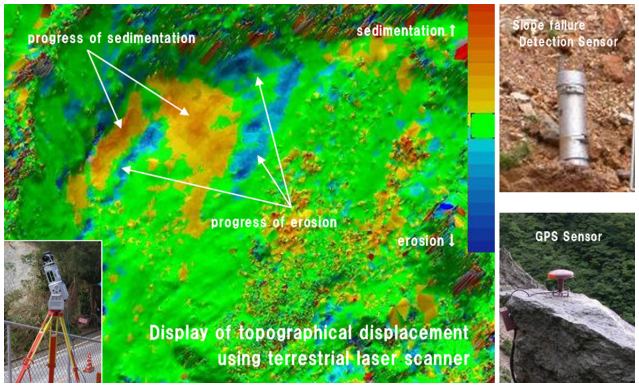
Ubayu hot spring area is located in the southeast of Yonezawa-city, Yamagata-prefecture. Bedrock is extremely weathered and alterated by hot spring alteration in this area. Instability of slopes caused by continuous rock fall and slope failure is going on. Because of these, recently, the large slope failure occurred two times. Also, Ubayu hot spring inn is possible to be isolated by sediment-related disasters, because of its location of deep mountainous region.

The objective of this examination is to detect displacement of the slope related to slope failure, just before or just after, and providing warning information for the people in order to let them make self decision regarding evacuation.

The following were examined:

1) Testing two times of highly precise survey measurements using terrestrial laser scanner. Visualizing the topographical changes for the past two years by analyzing the survey data.
2) Installing highly precise GPS sensor and observing topographical displacement of the slope continuously.
3) Installing real-time slope failure detection sensor and monitoring slope failure directly.
4) Installing the rain gauge and considering relations of topographical displacement and the rainfall.
5) Providing real-time hazard information of monitoring observation, and it was enabled to share information.



Keywords: Laser Scanning, Increment, GPS Sensor, Slope failure Detection Sensor

Japan Geoscience Union Meeting 2011
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HDS027-05 Room:301A Time:May 25 09:30-09:45

Effect of global warming on the hazard of sediment-related disasters in snowy regions of Japan

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The area along the Sea of Japan is known as one of the world's heavy snowfall regions, and is likely to be affected by global warming because of the low latitude of the Warm Temperate Zone. The changing snow environment is likely to affect the hazard of sediment-related disasters such as slush flows and meltwater-induced landslides. Therefore, we examined the effect of global warming on the hazard of sediment-related disasters in the snowy regions of Japan.

To clarify the mechanism of sediment-related disasters and evaluate their hazard, the water reaching the ground surface (MR) should be observed throughout the year. We conducted perennial field observation of MR using lysimeters, not only during the non-snow cover season but also during the snow cover season in a mid-land area where sediment-related disasters such as landslides occur frequently. The results of observations showed that the timing and intensity of MR vary depending on the large deviations in the seasonal snowpack environment.

In comparison with the heavy snow season and the light snow season, a high intensity of MR was observed at the beginning of snow cover and during the snow-melting period, and a large quantity of MR was recorded almost every day just before the snowpack disappeared. In the case of the light snow season, the snow accumulation was thin even in the coldest season of January or February. MR was observed intermittently throughout the snow-cover period and a large MR of 60?70 mmd^{-1} was recorded even in mid-winter.

Global warming will not bring a light snow environment but will lead to larger oscillations between heavy and light snow environments compared with at present. Therefore, in a heavy snow season, huge amounts of accumulated snow will remain till April and May when the air temperature and solar radiation increase rapidly, resulting in a higher hazard of sediment-related disasters with a longer time delay than usual. In a light snow season, MR will be observed in mid-winter in January and February due to the substitution of rainfall for snowfall and intense snowmelting, resulting in a high hazard of sediment-related disasters during this period. Therefore, the hazard of sediment-related disasters is likely to vary greatly as a result of global warming.

The regime of rain on snowpack and meltwater generated on the snow surface change during the infiltration processes of snow accumulation. If it rains with high intensity and short duration on snowpack, a regime of water from the bottom of the snowpack is transformed into low intensity and longer duration due to the buffering function of the snow. Therefore, the rainwater reaches the ground surface in a similar form of rainfall as when there is little snow accumulation.

The intensity and duration of MR affect the quantity of water infiltrating the ground. MR with moderate intensity but longer duration could infiltrate the deeper underground with larger amount of water and generate excess pore pressure resulting in deep-seated landslides. On the other hand, MR with short duration but high intensity may cause shallow landslides and debris flows. Therefore, the type and form of sediment-related disasters are expected to change since the precipitation and snow environment will fluctuate heavily as a result of global warming.

Keywords: global warming, snowy regions, sediment-related disasters, meltwater and/or rainfall

Japan Geoscience Union Meeting 2011
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HDS027-06 Room:301A Time:May 25 09:45-10:00

Debris avalanche deposits in historical-time found from the east side of Mount Ho-ou, the Akaishi Range, central Japan

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Some landforms-deposits reported from the Japanese Alps in central Honshu Island have been believed to be formed directly by glacial processes during the Pleistocene. However, recent reappraisal of these landforms-deposits indicates that these features had been produced and deformed by landslides in Holocene. This involves reevaluation of climatic geomorphology and Quaternary geology as well as paleoenvironmental reconstruction in mountain areas. Furthermore, this also causes a stir in disaster reduction and prevention related to the wide range of landslides. At this meeting, the author will describe the details of the debris avalanche deposits (DA) found from the east side of Mount Ho-ou, the Akaishi Range, central Japan. This DA has been considered to be formed by ice-mass collapse during the global Last Glacial Maximum (tied to MIS2), resulting in prominent river aggradation of the Komugawa River (the upper Fujigawa-Kamanashigawa River system). However, the following evidences and conclusions were obtained: 1) DA consists of a thick gravel layer with granitic rock clasts only although the present-day DA lies in a sedimentary bedrock area. 2) Rock clasts have characteristic auto-brecciated or jigsaw puzzle structure suggesting strong deformation by mass rock creeping and subsequent mobilization. 3) Humic soils with wood fragments are buried immediately beneath DA. 4) DA is covered by fluvial fine sand with wood fragments along the main river, probably introduced by natural-dam obstruction. 5) Wood fragments (total 5 samples including one sample by previous study) gave the ages ranging 770-990 cal AD and 670-890 cal AD. 6) Volumetric magnitude and H/L ratio of DA are estimated to be $1.8*10\hat{}7$ m$\hat{}$3 and 0.32, respectively. 7) The possible cause of DA was historical earthquakes (M$>$6.5) such as AD762 Mino-Hida-Izu Eq, AD841 Shinano Eq, AD841 Izu Eq and AD887 Goki-Shichido Eq. Either Mino-Hida-Izu Eq or Shinano Eq is believed to be the last event of the nearby Itoigawa-Shizuoka Tectonic Line active fault zone several kilometers east of Mount Ho-ou. Izu Eq could be attributable to the penultimate activity of the Tanna fault in Izu Peninsula, 120 km southeast. Goki-Shichido Eq. is considered to be caused by plate subduction along Suruga-Nankai Troughs, and it led to sector collapse and a natural-dammed lake in Yatsugatake Volcano 50 km north of the Mount Ho-ou.

Keywords: Debris avalanche, Pleistocene glaciation, Landslide, Historical earthquake, Paraglacial

Japan Geoscience Union Meeting 2011
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HDS027-07 Room:301A Time:May 25 10:00-10:15

Landslides in Hokkaido,2010

Jun Tajika[1*], Satoshi Ishimaru[1], Gentaro Kawakami[1], Noritoshi Okazaki[1], Makoto Tamura[1]

[1]Geological Survey of Hokkaido

Many disasters by slope failures and landslides, besides river floods, occurred in Hokkaido during a summer season in 2010 caused by frequent local heavy rains. Slope failures triggered by earthquake (December 2, Kiyota, Sapporo, MJ=4.6) also happened. We show some cases of these slope failures with their geologic background.

(1) August 13-14, Teshio and Enbetsu towns in northern Hokkaido: A lot of slope failures occurred at hillslopes and slopes in a low-relief mountainous area. Most of the slopes are consists of fine-grained sandstone and mudstone interbeds of the Pliocene Yuuchi Formation, and subsequently consists of diatomaceous mudstone of the Miocene Enbetsu Formation. The failures show transitional movement from surficial slide to debris flow. Some cases, at the slope consists of the Enbetsu Formation, show movement type of weathered-bedrock failure to debris flow (Ishimaru et al., 2011).

(2) August 22, Nokanan, Ashibetsu City in central Hokkaido: A landslide occurred at a slope consisting of mudstone and tuff of the Cretaceous Yezo Supergroup.

(3) From August to present, Kamikubonai, Sobetsu Town: A relatively small landslide, 250 m in width and 350 m in length, arose at a slope of the Toya pyroclastic deposits and underlying Neogen mudstone and tuff. Persistent displacement of 1 cm/day has been observed after a heavy rain in December 3.

(4) December 2, Kiyota, Sapporo City: Slope failures occurred in a golf course above the epicenter of the earthquake (MJ=4.6). The golf course was developed on a hill area consisting of the Shikotsu pyroclastic flow deposits. Two failures happened at artificial embankments built in the brook. One of slides show large displacement suggesting flow-type movement.

Keywords: landslide, geologic cause, heavy rain fall, earthquake

Japan Geoscience Union Meeting 2011
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HDS027-08 Room:301A Time:May 25 10:15-10:30

Landslides on artificial slope in city center of Naha

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Landslides in Shuri, Naha were caused by severe rain storm in 2004. The Landslides developed on artificial fill slope (embankment) after WW2. The mechanism of the landslides was discussed.

Keywords: landslide, embankment, interaction, Naha

Japan Geoscience Union Meeting 2011
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HDS027-09 Room:301A Time:May 25 10:45-11:00

Sagging geomorphology on ridges along the Fukui-Gifu prefecture boundary, central Japan

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We describe sagging geomorphology such as double ridges and uphill-facing scarps on the ridges along the Fukui-Gifu prefecture boundary, and discuss their relationship with the geologic structures of this area by using contour maps and 'Inyouzu' made from the DEM data with 1 m-mesh density; the data and maps were provided by the Etsumi Sankei Sabo Office, Chubu Regional Development Bureau, Ministry of Land, Infrastructure, Transport and Tourism. In the study area occur chert, melange and basalt of the Mino terrane, Neogene andesitic lava and volcaniclastic rocks of the Ito-o Formation, and Neogene Nogohaku-san granodiorite. Total distance of the ridge analyzed is 49.8 km, where 182 sites of sagging geomorphology with total length of 8.9 km are recognized. The distribution of the sagging geomorphology in the volcanic rocks and granodiorite area is dense, whereas in the chert and melange is sparse. Although most of the double ridges are parallel to the orientation of main ridge, some uphill-facing scarps are oblique or perpendicular to the ridge. Large-sclae uphill-facing scarps were formed in case that the attitude of bedding is parallel to the orientation of the main ridge. Carbonaceous materials and sediments have been accumulated in most of the linear depressions between the double ridges and between the uphill-facing scarp and the slope. Analyses of these sediments in future must reveal the development history of the sagging geomorphology in this area.

Keywords: sagging geomorphology, double ridge, uphill-facing scarp, Fukui, Gifu

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HDS027-10 Room:301A Time:May 25 11:00-11:15

Gravitational slope deformation and catastrophic landslide controlled by the incision of a paleosurface

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Huge landslides have been occurring in tectonically active mountains, where uprising and river incision form gravitationally unstable state in mountain slopes. In particular, when a paleosurface is incised, large volume instability is likely to be induced, because convex, projecting slopes are consequently made. We found large gravitational slope deformations induced by these processes in several locations, particularly in the upstream area of the Totsu River in the Kii Mountains in the outer belt of Southwest Japan, the Dahan River catchment, and the Chishan River in Taiwan. Our study includes chronological development history. Fluvial incision of a paleosurface makes a knick point, which recesses upstream, cuts the foot of side hillslopes of paleosurface, destabilizes the slopes, and then gravitational slope deformation starts on outfacing slopes.

We identified a paleosurface with an average slope of 33 degrees in elevations higher than about 650 m, which paleosurface is incised by a river to form inner valleys with a maximum height of 250 m of side slopes. This paleosurface is not a peneplain proposed by Davis but is steep with moderate relief. On the infacing slopes of inner valleys, convex slope breaks have been made, and on the outfacing slope, gravitational deformation has been induced by the undercut. Our reconnaissance study suggests that similar slope development occurred in the outer belt of Southwest Japan in Shikoku and Kyushu, where have similar tectonic background. Large landslides, which were induced by the 2005 rainstorm in the Mimi-River catchment in Kyushu, occurred in the inner valleys incised in the Shimanto terrain

We found paleosurfaces in higher elevations of the Neogene area in the Dahan River catchment. They are incised by rivers to form convex slope breaks and inner valleys. The distribution of gravitational slope deformations and landslides are closely related to the slope breaks, suggesting that they are controlled by the slope development as stated above. The Shiaolin landslide, which was induced along the Chishan River by the typhoon Morakot in 2009 in Taiwan, also occurred on the gravitationally deformed slope along the edge of a paleosurface.

Keywords: paleosurface, incision, gravitational slope deformation, landslide, slope failure

Japan Geoscience Union Meeting 2011
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HDS027-11 Room:301A Time:May 25 11:15-11:30

Slope destabilization induced by river rejuvenation in Shihmen reservoir watershed, northern Taiwan

Ching-Ying Tsou[1*], Masahiro Chigira[1], Yuki Matsushi[1], Su-Chin Chen[2]

[1]DPRI, Kyoto University, [2]SWC, National Chung Hsing University

Steep incised landscape of Shihmen reservoir watershed was sculpted by rapid uplift and erosion in a tectonically active setting in northern Taiwan, where geomorphic features such as knickpoints, terraces, slope breaks and paleosurfaces are developed. We conduct field investigation and analyses of a 12-m DEM to study the distribution of the geomorphic features and to integrate slope development, gravitational deformation, and landslide occurrence for the purpose of making hazard zonation map of landslides.

The Dahan River has three major tributaries, which have four or five major knickpoints each, and one knickpoint along one major tributary can be correlated to a knickpoint along another major tributary. This is indicative that knickpoints propagated upstream along the major tributaries. The minor tributaries of the major tributaries also have knickpoints, which could be correlated to each other and to the knickpoints along the major tributaries. This again supports an idea that knickpoints propagated upstream along these tributaries. Corresponding to these knickpoints, there are two groups of convex slope breaks, higher and lower slope breaks. The higher slope breaks bound a paleosurface, which is widely developed in higher elevations in the watershed; the formation and retreat of this group of slope breaks accompanied many large landslides, particularly on the outfacing slopes. The lower slope breaks appear to grade to the terraces traced several tens to a few hundred meters above trunk channels and major tributaries associated with the most recent base-level lowering; many shallow landslides have occurred below these lower slope breaks.

Keywords: river rejuvenation, slope destabilization

Japan Geoscience Union Meeting 2011
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HDS027-12 Room:301A Time:May 25 11:30-11:45

The role of mass rock creep on surface shape revealed by LiDAR.

Osamu Yokoyama[1*], Taro Uchida[1], youko nakano[1], ISHIZUKA Tadanori[1], KASAI Mio[2], Ryuji Suzuki[3]

[1]Public Works Research Institutes, [2]Hokkaido University, [3]Disaster Prevention and Mitigation Eng

Deep catastrophic landslide which bedrock failed might cause large-scale landslide dams and debris flows, and might afford the great deal of harm to around areas. In the study, term of deep catastrophic landslide means rapid landslides and excludes slow failures of a more chronic nature, such as deep-seated gravitational creep or rock flow. The prediction of location of deep catastrophic landslide is important to reduce such sediment disasters. Long-lasting, small-scale mass movements called gravitational mass rock creeps sometimes lead to deep catastrophic sliding. Therefore, it can be though that the spatial distribution of landforms related to long-lasting mass movements, such as rock creep slopes, downhill-facing scarps and so on, may provide an index for deep catastrophic landslide susceptibility.. To clarify spatial distribution of mass rock creep, interpretation of aerial photographs was often used. However, the interpretation of aerial photographs was affected by vegetation and the removals of vegetation effects were very difficult. Also this method needs a lot of skills. On the other hand, the LiDAR develops rapidly in recent years, and can understand detailed surface shapes in the mountainous district where the forest grows thickly. In this study, we used LiDAR data .to clarify the surface geometry of the mass rock creep slope and non-mass rock creep slope quantitatively,

The study area is Mt. Wanitsuka in the southern part of Kyushu. In this area, many deep catastrophic landslide occurred by heavy rain in September 2005, seven of which occurred at the slopes where could be found signatures of mass rock creep before occurrence of deep catastrophic landslide. We conducted detailed geological survey and interpretation of aerial photographs clarify spatial distribution of mass rock creep. We derived 2-m grid DEMs used the LiDAR data, and calculated the slope gradient and the eigenvalue ratio. The eigenvalue ratio is an index that expresses a degree the ruggedness on the surface. When the eigenvalue ratio is large, the slope surface is smoothly. In contrast, when the eigenvalue ratio becomes small, the slope surface is large ruggedness and undulate. Moreover, we calculated the slope gradient and the eigenvalue ratio using six additional grid cell sizes (4m, 10m, 20m, 30m, 50m, and 100m).

Slope gradient of mass rock creep was gentle, compared with non-mass rock creep, regardless of gird size. On the other hand, there was a difference in the distribution of the frequencies between mass rock creep slope and non-mass rock creep slope. When we used 2m as gird size for calculation, the difference in eigenvalue ratio between mass rock creep and non-mass rock creep was small. While we used 20-30m, these are large differences in eigenvalue ratio between mass rock creep and non-mass rock creep. However, we used 50-100 m as grid size, the difference became small. The change of the eigenvalue ratio distribution by the grid size indicates the different geometry between the valley and the ridge at the mass rock creep slope and non-mass rock creep slope. That is, the mass rock creep has shallow and rounded valley, and the non-mass rock creep has deep and steep valley. Thus, it can be thought that the mass rock creep slope can be extracted in quantitatively by using the LiDAR data.

Keywords: mass rock creep, deep catastrophic landslide, LiDAR data, eigenvalue ratio

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HDS027-13 Room:301A Time:May 25 11:45-12:00

Result of boring, electrical resistivity and some surveys in the landslide area detected by SAR interferometry

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Using Synthetic Aperture Radar (SAR), Une et al. (2008) revealed 2007 Noto Hanto earthquake (M6.9)-induced landslide that slightly moved east. The landslide covers 1.5km by 700m and lies on anti-dipping gentle hilly slope, and cracks and small landslide were found on the edge of and inside the initial landslide area. In the area we performed boring survey, observed outcrop, and measured electric resistivity on the slope, pH and electric conductivity along a stream. Boring core and measurement result of electric resistivity and pH did not show existence of clear slip surface; however, measurement result of electric conductivity suggested the location of lower end of the landslide area. These results infer that landslide blocks without clear slip surface moved east together at subtle deformation. And result of this study inferred characteristics of earthquake-induced landslide in the study area.

Reference
Une H, Sato HP, Yarai H, Tobita M, 2008, Analysis of surface deformation induced by the Noto Hanto and the Chuetsu-Oki Earthquakes in 2007 using synthetic aperture radar interferograms. Journal of the Japan Landslide Society, Vol.45, pp.125-131.

Keywords: earthquake, boring, electrical resistivity survey, electric conductivity, SAR

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HDS027-14 Room:301A Time:May 25 12:00-12:15

Deformation process estimate of a remobilized landslide based on IT Ground Tiltmeter observation and displacement vector

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Observing the movement of landslides using ground tiltmeters has been done at many landslide sites, but there are few cases where the rotation speed has been compared quantitatively along with displacement speed. This report introduces a case where the landslide mass deformation process was estimated at a remobilized landslide by using an IT Ground Tiltmeter System, by movable pile observations using an optical distance meter, and by interpreting aerial photographs and topographical maps.

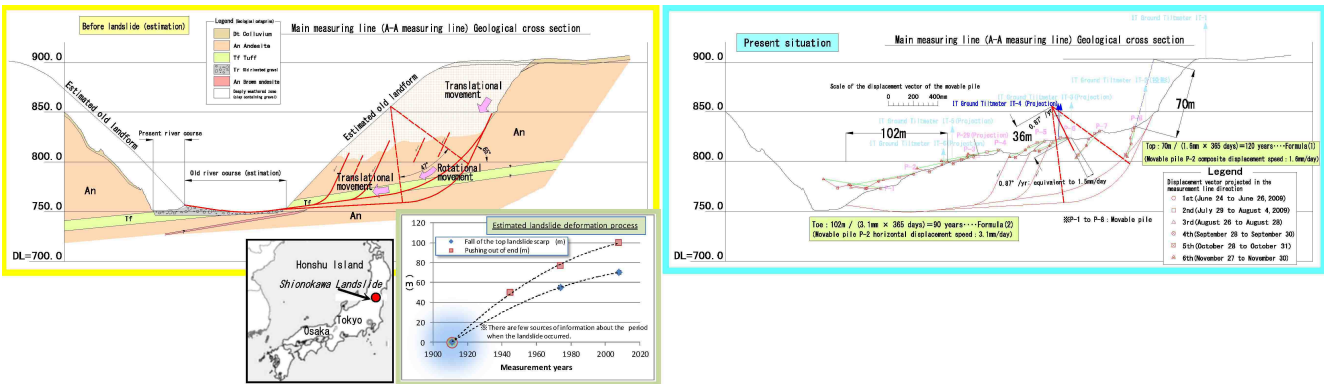
Shionokawa landslide is an active landslide with a clear landslide scarp with relative elevation up to about 70m. The foundation ground and landslide mass are Quaternary andesite, and it is assumed that a 7 to 11m thick tuff layer is, as a weak layer, associated with the formation of the landslide. A boring core found old river course sediments, confirming the past location of the river.

Monitoring using a ground extensometer began in May 2006, and movable pile observations were added in June 2009. Since then, observation data spanning up to 5 years have been accumulated. The ground extensometer in the top of the landslide scarp revealed an annual rate of change of 350mm (about 1.0mm/day), and while the rate of change varies during torrential rain or melting snow, it is almost constant from year to year. If a rough calculation is done based on movable pile observation results, it can be trial calculated that the present landslide topography formed in approximately 100 years: about 120 years at the top where the settlement displacement constituent dominates (formula (1) in the figure) and 90 years at the end where the horizontal displacement constituent dominates (formula (2) in the figure). However, the influence of river erosion at the end of the moving mass is not considered.

A 1:50,000 topographical map for 1911 shows neither river curves nor landslide topography. Aerial photographs taken by the U.S. military in 1945 found both landslide topography and river curves. From these information sources, we identified a river curve at the end and the fall of the landslide scarp of the landslide, and appended a graph prepared by estimating the change.

At the Shionokawa Landslide, *the Research Association for Development of Observation Devices used in Special Landslide Environmen* (revised name of the joint research) installed the IT Ground Tiltmeter System developed through joint research by the Public Works Research Institute and 4 private companies (PWRI et. al. 2009) at 6 locations from behind the main landslide scarp of the landslide to its bottom, and used them to perform observations at 1 hour intervals. Excluding one installed behind the main landslide scarp, all recorded tilt change, and both the backward rotation and forward rotation are confirmed by instruments. The largest tilt was recorded by IT-4, where the slide rotated backwards towards the landslide scarp side at a speed of 0.87degree per year (3,117seconds). As the figure shows, if it is assumed that it rotated on a circle with radius of 36m, the rotation is 543mm/year (1.5mm/day), which conforms closely with movement according to the actual movable pile observation (at movable pile P-6, 1.9mm/day).

The landslide mass deformation process from the time of occurrence of the Shionokawa Landslide until now was consistently estimated by combining the displacement vectors obtained by the IT Ground Tiltmeter System and the movable pile observations in this way. In sum, the authors suppose that at first, translation sliding and rotation sliding combined to leave the internal structure unchanged without conspicuous abrupt displacement, as gradual deformation occurred. Judging from change of the section shape, it may be assumed that the safety factor gradually rose and the displacement rate gradually slowed. The application of the IT Ground Tiltmeter System to a remobilized landslide is considered to be very effective in cases with a rotation constituent as at this survey location.



Keywords: landslide, IT Ground Tiltmeter System, rotational slide, displacement vector, deformation process

Japan Geoscience Union Meeting 2011
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HDS027-15 Room:301A Time:May 25 12:15-12:30

Numerical Analysis for Permeability of Clay on Natural Terrane

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A landslide on natural terrane is mainly occurred by rainfall, snowmelt, earthquakes and construction works. Especially, the role of rainfall or snowmelt in slope stability is very important because it causes decreased in shear strength by reducing the soil cohesion. As water content in soil increases, the shear strength in soil or other unconsolidated material usually decrease.

If clay exists in the weathered soil, the physical characteristics such as viscosity and permeability are generally different from the condition without the clay. In this case, changes of permeability or viscosity due to the rainfall or snowmelt are dependent on the content of clay in soil. In order to calculate the permeability variation according to the content of clay in soil, many researchers already investigated using laboratory experiments or in-situ tests in the field. However, it is difficult to determine the property of the clay such as a viscosity because of its poor crystalline property. In order to solve this problem and to calculate permeability of clay under various dry densities, we used molecular dynamic (MD) simulation to examine the viscosity of micro scale and homogenization analysis (HA) method to expand micro material property to macro scale. In this research, we determined the permeability of clay under various dry densities due to the rainfall or snowmelt conditions by using MD/HA method.

We determined the viscosity of micro scale material using the MD because the viscosity is heavily dependent on the amount of interlayer water and it cannot be calculated by the experimental method. And then, in order to calculate the macro scale permeability of clay under each dry density condition we made a unit model using the result of MD analysis as input data. Finally, macro scale permeability of clay was determined under various dry density conditions using the HA method. we also examined the applicability of the method to the natural terrane including clay.

Keywords: Molecular Dynamics, Homogenization Analysis, Viscosity, Permeability, Clay

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The influence of hydrogeological condition on earthquake-induced rapid and long runout landslides

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In recent decades, lots of landslides were triggered by earthquake and caused severe damages to the society. Earthquake-induced-landslides become a hot topic in natural disaster research field. For example, the 1995 Hyogoken-Nambu earthquake triggered Nikawa landslide and Takarazuka Golf-field landslide, 1999 Ji-Ji earthquake in Taiwan triggered Chaolin landslide and Jiufengershan landslide, 2003 Sanriku earthquake in Japan triggered Tukidate landslide, 2004 Sichuan earthquake in China triggered lots of landslides including Donghekou landslide in Qingchuan county, Wangjiayan landslide in Beichuan county, 2009 September Indonesia Sumatra earthquake triggered lots of flowslides including Tandikek slide and Malalak slide. From those cases, the hydrogeological condition shows strong influence on the initiation and motion of the landslides.

1) Rapid and long runout landslides triggered by 2008 Sichuan earthquake in China

The 2008 Wenchuan earthquake triggered lots of rapid and long runout landslides, which directly caused great loss of property and human lives and were responsible for a large percentage of total damages caused by the earthquake. It was found that groundwater and valley water played key roles in the rapid motion and long runout process of this landslide during the great earthquake. It was also observed that hazardous effects from the slowing of movement and/or a short runout, due to various geologic and hydrologic conditions of other landslides caused by the Wenchuan earthquake, contrasts with those which caused more deaths and damage due to rapid, long runout movement.

2) Tandikek and Malalak flowslides triggered by 2009.9.30 Sumatra earthquake in Indonesia

Earthquake activity is intense in southwestern Sumatra. Four major earthquakes occurred in the area between 2004 and 2009. The first and largest of these was the M9.3 earthquake that occurred on 26 December 2004. This earthquake caused a major tsunami disaster over a wide area, and 227,898 people lost their lives. A M8.6 earthquake occurred on 28 March 2005, followed by a M8.5 earthquake on 12 September 2007, and a M7.6 earthquake on 30 September 2009.

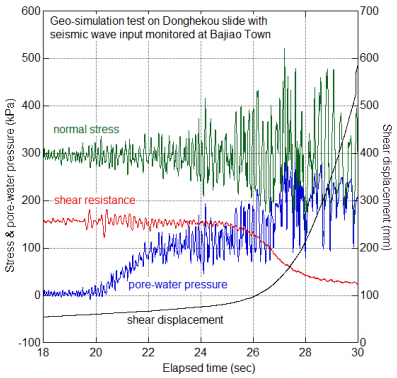
The 2009.9.30 M7.6 event was the smallest of these earthquakes, but it triggered many flowslides in the mountainous areas of Tandikek and Malalak. Those flowslides rapidly moved down slope, destroying villages at the fronts of the slopes, and killing many villagers. The distance from the epicenter is about 100 km. Padang is located almost midway between Cumanak and the epicenter. Among the landslides in the area, the Tandikek and Malalak flowslides caused most deaths. The common features of the two flowslides is that both occurred on steep source slopes of 30 to 40 degrees, movement was rapid, and villages located at the foot of the slopes were destroyed. This led to 132 and 32 fatalities at the Tandikek and Malalak flowslides, respectively.

Field investigation and ring shear tests indicate that, 1) Steep slope in the source area slope; 2) Continuous rainfall for three hours; 3) The strong seismic motion from the M7.6 earthquake; 4) The special structure, with the pumice layer overlying a stiff clay layer formed worst combination for flowslides.

3) Conclusions

Case study on Donghekou landslide triggered by 2008 Sichuan earthquake indicates the importance of hydrogeological condition on landslide initiation and motion. While case study on Tandikek flowslide and Malalak flowslide triggered by the 2009.9.30 M7.6 Sumatra Earthquake during rainfall shows that the worst combination of the following factors is the main reason for the flowslide occurrence and their rapid motion.

Through this study, we aim to call attention to similar slopes elsewhere. It is crucial to recognize the potential danger in those slopes, and locate the local residents in safe places.



Keywords: earthquake, landslide, hydrogeological condition, case study