Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

HDS04-01 Room:102B Time:May 20 09:00-09:15

Deep-seated catastrophic landslides induced by typhoon 12 and their precursory gravitational slope deformation

CHIGIRA, Masahiro[1*], Tsou Ching-Ying[1], MATSUSHI, Yuki[1], HIRAISHI, Narumi[2], Makoto Matsuzawa[1]

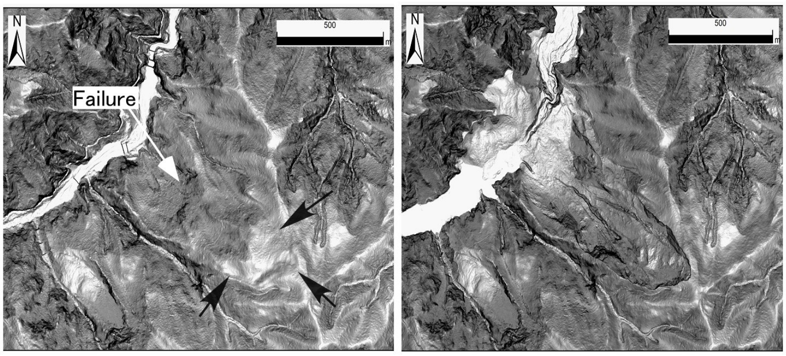
[1]Disaster Prevention Research Institute, Kyoto University, [2]Fukada Geological Institute

Typhoon 1112 crossed the Japanese Islands from 2 to 5 September in 2011, inducing more than 50 deep-seated catastrophic landslides of Jurassic to Palaeogene sedimentary rocks. These landslides hit houses, made landslide dams, or induced Tsunami by rushing into swollen rivers. The areas of landslides ranged from 36,000 m2 to 54,900 m2 and the maximum volume is estimated to be 15 million m3. Nine landslides have been surveyed by Lidar before the events as well as after the events, which clearly showed that eight of the 9 landslides had small scarplets near their future crowns beforehand as precursory topographic features. These scarplets are made by gravitational slope deformation that preceded the catastrophic landslides. The strains accompanying the deformation are estimated to be from 5 to 21 %, which suggests that these landslides were under the critical condition just before failure. Fourteen landslides we surveyed in the field had sliding surfaces along faults made during accretion or along bedding.

Lower photographs are slope images of Akatani landslide, one of the largest landslides induced by the typhoon. Comparing these images, we clearly identify scarplets along the future crown, which is indicated by black arrows. The landslide slope had a failure at the lower part beforehand, destabilizing the upper portion of slopes. Similar scarplets have been identified in most landslides before the events.

We acknowledge that the Kinki Regional Development Bureau of the Ministry of Land, Infrastructure, and Transport and Nara Prefectural Government to provide invaluable DEM data.

Keywords: deep-seated landslide, typhoon 12, slope development, geology, mass rock creep, gravitational slope deformation



Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

HDS04-02 Room:102B Time:May 20 09:15-09:30

Rainfall, slope instability, and deep-seated landslides in Kii Mountains Japan

MATSUSHI, Yuki[1*], YAMADA, Masumi[1], CHIGIRA, Masahiro[1]

[1]Disaster Prevention Research Institute, Kyoto University

Prediction of deep-seated landslides by heavy rainfall needs combination of two complementary approaches that focus on geological and geomorphological predisposition of hillslopes, and hydrological triggering of final slope destabilization. Analyses of topography and rainfall history will provide a clue to understand processes leading to deep-seated landslides in mountainous landscape. This study reports the case of deep-seated landslides caused by typhoon 12 in 2011, in Kii Mountains, Japan. A GIS-based topographic analysis revealed the distribution of potential hillslope instability in the terrain, and hence offered an interpretation for location of the landslides. Timing and motion of several landslides are reconstructed by seismic-wave records. We examined relationships between preceding rainfall and volume or speed of sliding mass to evaluate threshold conditions leading to landslides.

Keywords: deep-seated landslide, rainfall history, landscape evolution, hazard zoning

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

HDS04-03 Room:102B Time:May 20 09:30-09:45

Seismic recordings of the Landslides caused by Typhoon Talas

YAMADA, Masumi[1*], MATSUSHI, Yuki[1], CHIGIRA, Masahiro[1]

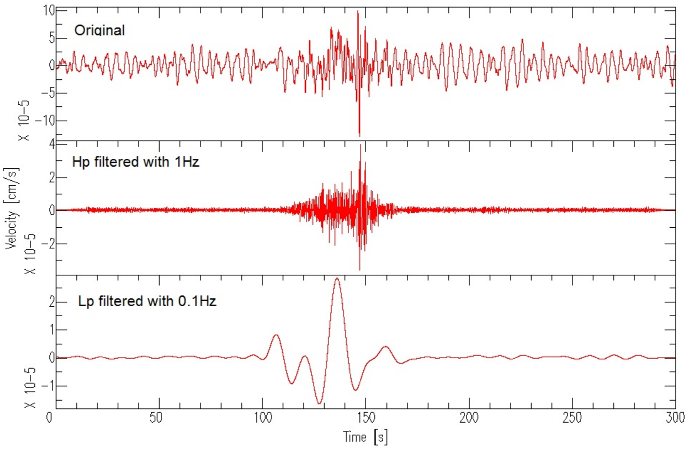
[1]DPRI, Kyoto University

Typhoon Talas passed Japan Island on September 3-4, 2011 and brought substantial rainfall in western part of Japan. Total rainfall by this typhoon exceeds 2000mm in Kii peninsula, which caused many landslides in Nara, Wakayama, and Mie prefectures. 73 people were killed and 19 were reported missing by this typhoon.

The seismic signals due to these landslides are recorded by dense seismic network in Japan. The long-period surface waves are recorded by broadband seismic network (F-net) all over Japan (NIED, 2011), and short-period ground motions are recorded by the high-sensitive seismic network (Hi-net) as much as a few hundred km away. The landslide signals are usually tens of seconds long and have smooth onset, thus it is easy to distinguish to records of small earthquakes with couple of seconds duration. The typical landslide recordings are shown in Fig. 1, We applied back-projection technique (Spudich and Cranswick, 1984) to the records and determined the timing and location of each landslide signal.

We successfully detected several landslides in the continuous seismic recordings, and large events with volume more than 1 million m3 were located by the back-projection method. The seismic waveforms are very characteristic, and composed of high-frequency ground motion (frequency $>$ 1Hz) and low-frequency ground motion (frequency $<$ 0.1Hz). This complicated waveforms reflects the actual mechanism of landslides, and helps to understand the mass movement in time series.

The sequence of the landslides caused by Typhoon Talas can be located by the conventional source relocation technique in seismology. The seismic signal can tell the snapshot of the process of the landslides, which is rarely observed in visual (Suwa et al, Socio et al.). This is one of the most well-recorded landslide sequences all over the world. This seismic network is originally designed for locating seismic activities, but continuous records are very important to understand the mechanisms of the natural phenomenon as shown in this presentation.



HDS04-04 Room:102B Time:May 20 09:45-10:00

Occurrence site of deep-seated landslides induced by typhoon 1112 in the Kii Mountains

HIRAISHI, Narumi[1*], CHIGIRA, Masahiro[2]

[1]Fukada Geological Institute, [2]DPRI, Kyoto University

Distribution of convex slope breaks and fluvial knickpoints which are regarded as "erosion front" and deep-seated landslides induced by typhoon 1112 have been investigated to reveal how landslides develop in the context of long-term slope development. We analyzed mountain topography by using 10-m mesh DEM, topographic maps and aerial photographs in the central Kii Mountains, southwest Japan. We found that convex slope break is widely distributed about 200m above the present riverbed in study area, and it divides the area into lower dissected area and upper palaeosurface. Dissected area is divided into lower and upper parts by at least one slope break. These slope breaks were formed by active incision, and the incision dissected palaeosurface and propagated main stream to tributaries and downstream to upstream. Deep-seated landslides tend to occur in slopes with these slope breaks, because undercut slopes are unstable and partly suffered gravitational deformation. Topographic analysis by erosion front has the potential to identify the landslide-susceptible region roughly but widely.

Keywords: deep-seated landslides, erosion front

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

HDS04-05 Room:102B Time:May 20 10:00-10:15

The geological characteristics of the Leye landslide near Alishan, Taiwan

FENG, Zheng-yi[1*], Kuo-Chin Chang[2], Hsiu-ying Lai[1], Zhen-zhang Ding[2]

[1]Department of Soil and Water Conservation, National Chung Hsing University, Taichung, Taiwan, [2]The Nantou Branch, Soil and Water Conservation Bureau, COA, Executive Yuan

Serious landslides occurred in Leye region near Alishan, Taiwan in 2009 during Typhoon Morakot struck. This study investigated the mechanism of the Leye landslides and the characteristic of the nearby geological characteristics in the landslide area. The fluvial processes of the Tsengwen River should influence the landform thereby also influence the development of the Leye landslides. The landslide is triggered by the intense rainfall of Typhoon Morakot. Also, in the sedimentary formation of Leye region, the geological structures, such as synclines, anticlines and dip slopes control the displacement of the landslides. The mitigation works maybe helpful to retard possible complex the hazards in recent coming years. Emergency evacuation could be a better solution to mitigate the hazards in the Leye landslide area.

Keywords: Landslide, dip slope, mechanism, mitigation

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

HDS04-06 Room:102B Time:May 20 10:15-10:30

Gravitational slope deformation induced by transient waves of incision in northern Taiwan

TSOU, Ching-Ying[1*], CHIGIRA Masahiro[1], MATSUSHI Yuki[1], CHEN Su-Chin[2]

[1]Disaster Preventation Research Institute, Kyoto University, [2]Dept. of Soil and Water Conservation, Chung-Hsing University

At least 11% of the upper Shihmen Reservoir catchment is affected by gravitational slope deformation in the northern part of the Hueshan Mountain Range, Taiwan, where is underlain by Oligocene and Miocene sedimentary rocks and metamorphic rocks. The gravitational slope deformation has occurred as a response to the propagation of new incision waves to palaeosurfaces. Therefore, landscape evolution must be accounted for to predict and to evaluate potential sites of catastrophic landslides, most of which are preceded by gravitational slope deformation. Geomorphic analyses combined with cosmogenic nuclide dating revealed that at least three phases of transient waves of incision have propagated into paleosurfaces with a minimum age of ~140 ka. Tectonically induced base-level fall triggered the first incision wave around ~120 to 140 ka, dissecting palaeosurfaces and inspiring gravitational slope deformation. The second incision wave probably driven by global sea-level lowering during last glacial age has reached to the catchment around ~13 to 15 ka with an enormously rapid incision rate of 20 mm a-1, inducing slope movements. Climate forcing such as increasing monsoonal precipitation during the last glacial-to-interglacial transition may have been another cause of the rapid incision. The third incision wave is apparently associated with a local base level change. The trigger and its initiation are as yet unknown This younger incision made steeper slopes (avg. 39.8 degree), over several tens to a few hundred meters above current river bed. These are small landslide-prone slopes since numerous numbers of smaller landslides are concentrated on the lowest steep part of the river-side hillslopes.

Surface exposure dating on slip surface of an ancient landslide on a dip slope reveals the occurrence of the landslide in the late Holocene epoch, suggesting the development of the deep-seated slope deformation creates suitable conditions in a long-term (in the order of millions of years) for the subsequent landslide activities since the paleosurface has been dissected by the first incision wave. Recent catastrophic landslides had been preceded by gravitational slope deformation of rocks with adverse geological structures, suggesting that major-landslide prone slopes are dip-slopes of alternating beds of sandstone and mudstone at the margins of the paleosurface.

Keywords: gravitational slope deformation, transient waves of incision, paleosurface, cosmogenic nuclide dating

HDS04-07 Room:102B Time:May 20 10:45-11:00

In-situ self potential measurement for monitoring of landslide process

YABE, Shuhei[1*], HATTORI, Katsumi[1], OTSUBO, Hiroshi[1], Edy Gaffer[2], Adrin Tohari[2], Kohri Sugianti[2], Boko Nurdiyanto[3], Iwan Maulana[3], Noor Effendi[3], Pri Harjadi[3], Suhardjono[3], Budi Waluyo[3], Byung-Gon Chae[4], HUANG, Qinghua[5]

[1]Graduate school of science, Chiba University, [2]LIPI, Indonesia, [3]BMKG, Indonesia, [4]Korea Institute of Geoscience and Mineral Resources, [5]Peking University

Recently, rainfall-induced landslides occur frequently. In order to mitigate landslide disasters, understanding of the landslide process and developing of early warning is important. In this study, self-potential (SP) approach has been attempted to develop an early warning system for rainfall-induced landslides. The laboratory experiments of landslides under the controlled artificial precipitation and a sandbox have been performed. Their results show the capability to monitor the subsurface water condition using the self-potential method. However, laboratory experiments have limitations in scale and soil layers. Therefore, it is necessary to verify the obtained results by a field (in-situ) experiment and we selected landslide site in Pelabuhan Ratu, Indonesia as a field experiment site.

In August 2010, we installed 39 non-polarizing (Pb-PbCl2) electrodes at 13 points. At each point, we buried the electrodes at a depth of 1.0m, 2.5m and 4.0m. And in order to check the relationship between self potential and water or soil displacements, 25 tensiometers, two borehole to measure tilt and a rain-gauge have been installed.

From the observed data, there is linear relationship between SP and pore water pressure. And electrokinetic coupling coefficient was yielded about -2.0 mV/m using this linear relationship.

It's recognized that SP changes in association with rainfall have been recorded at the site. We consider that these changes are caused as the result of groundwater flow. In order to check the groundwater flow, we calculate the electrical potential differences between neighboring two electrodes. The groundwater flow almost vertical direction in low rainfall day. In heavy rainfall day, the lateral flow dominates in the slope profile. And we calculate the hydraulic gradient using SP data and electrokinetic coupling coefficient. The hydraulic gradient of lateral direction tends to increase associated with heavy rainfall. From the indoor landslide experiment, the groundwater flow changes from vertical direction to lateral direction 20 min before the main collapse. Therefore, it indicates that the capture lateral flow might be connected with landslide process. The details will be provided our presentation.

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

HDS04-08 Room:102B Time:May 20 11:00-11:15

Statistical emulation of a landslide-generated tsunami model

GUILLAS, Serge[1*], Andria Sarri[1], Frederic Dias[2]

[1]University College London, [2]University College Dublin

Due to the catastrophic consequences of tsunamis, early warnings need to be issued quickly in order to mitigate the hazard. Additionally, there is a need to represent the uncertainty in the predictions of tsunamis' characteristics corresponding to the uncertain trigger features (e.g. either position, shape and speed of a landslide, or sea floor deformation associated with an earthquake). Unfortunately, computer models are expensive to run. This leads to significant delays in predictions and makes the uncertainty quantification impractical. Statistical emulators run almost instantaneously and may represent well the outputs of the computer model. In this paper, we employ the Outer Product Emulator to build a fast statistical surrogate of a landslide-generated tsunami computer model. This Bayesian framework enables us to build the emulator by combining prior knowledge of the computer model properties with a few carefully chosen model evaluations. The good performance of the emulator is validated using the Leave-One-Out method.

Keywords: landlslide, tsunami, statistical emulation, hazard assessment

HDS04-09 Room:102B Time:May 20 11:15-11:30

TSUNAMI GENERATION BY GRANULAR LANDSLIDES IN VARIOUS SCENARIOS

Brian C. McFall[1], Fahad Mohammed[1], FRITZ, Hermann[1*]

[1]Civil and Environmental Engineering, Georgia Institute of Technology, Savannah, GA 31407, USA

Tsunamis generated by landslides and volcanic island collapses account for some of the most catastrophic events. Major tsunamis caused by landslides or volcanic island collapse were recorded at Unzen in 1792, Krakatoa in 1883, Grand Banks, Newfoundland in 1929, Lituya Bay, Alaska in 1958, Papua New Guinea in 1998, and Java in 2006.

Source and runup scenarios based on real world events are physically modeled in the three dimensional NEES tsunami wave basin (TWB) at Oregon State University (OSU). A novel pneumatic landslide tsunami generator (LTG) was deployed to simulate landslides with varying geometry and kinematics. The LTG consists of a sliding box filled with up to 1,350 kg of naturally rounded river gravel which is accelerated by means of four pneumatic pistons down the 2H: 1V slope, launching the granular landslide towards the water at velocities of up to 5 m/s.

Topographical and bathymetric features can greatly affect wave characteristics and runup heights. Landslide tsunamis are studied in different topographic and bathymetric configurations: far field propagation and runup, a narrow fjord and curved headland configurations, and a conical island setting representing landslides off an island or a volcanic flank collapse.

Water surface elevations were measured using an array of resistance wave gauges. The granulate landslide width, thickness and front velocity were measured using above and underwater cameras. Landslide 3-dimensional surface reconstruction and surface velocity properties were measured using a stereo particle image velocimetry (PIV) setup. The speckled pattern on the surface of the granular landslide allows for cross-correlation based PIV analysis. Wave runup was measured with resistance wave gauges along the slope and verified with video image processing. The measured landslide and tsunami data serve to validate and advance 3-dimensional numerical landslide tsunami and prediction models.

Keywords: landslide, tsunami, volcano

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

HDS04-10 Room:102B Time:May 20 11:30-11:45

Debris flow hazards in Malaysia: The need for comprehensive mapping and risk assessment

KOMOO, Ibrahim[1*], LIM, Choun-Sian[1], Tajul Anuar Jamaluddin[1]

[1]Southeast Asia Disaster Prevention Research Institute (SEADPRI-UKM), Universiti Kebangsaan Malaysia

Debris flow is quite common in hilly and mountainous areas. In Malaysia, it is the life-threatening landslide disaster, the type of landslides that killed many lives compared to other landslide types. While many natural debris flows have occurred in areas without human settlement, there were at least 15 cases of killer debris flows since year 1994, at least 137 people were killed. Several major debris flows events in Malaysia were (1) a multiple-landslide cum debris flow flooded a major highway in Genting Sempah, Selangor killed 21 road users that were in their idling vehicles when the road was blocked by a small landslip. The debris flow started from landslides at the headwaters of the steep mountain flanking the highway; (2) a debris flow devastated a local village in Pos Dipang, Perak in 1996, 44 people died. The debris flow nucleated by several landslides in the upper valley scouring the valley, subsequently created temporary dams along the river before the village. The village was eventually swept away by overwhelmed debris flood when the temporary dams broke; (3) in Johor, Vamei-Typhoon storm with the strength that capable of uprooting trees and heavy rain attributed to several induced landslides then debris flow in Gunung Pulai in the year 2001. Four houses were swept away by the debris flood and 5 were killed, due to debris accumulated before a bridge across the river broke, and; (4) in 2002, 16 lives perished when debris flow buried their village in Ruan Changkul, Sarawak. It buried an 8-unit long house, the 20,000 cubic meter debris was initiated from a landslide on the agricultural land on top of the hill. More recently, in August 2011, a debris flow in Sungai Ruil, Cameron Highlands buried 4 houses at a foot slope, 7 killed while 2 injured; the houses were situated 150m away from the source of the landslide.

In Malaysia, the debris flow landslide is becoming an alarming disaster as development are encroaching the fringe of highlands and mountainous areas. The hazards from the adjacent slopes or upstream located far away has yet to be considered in many risk assessment. Only a limited mapping and identification of debris flow were carried out at very local scale while there are many places in Malaysian topography of mountainous and dissected hilly terrain are vulnerable to debris flow. Currently, research on debris flows in Malaysia is still very limited to post-disaster investigation within the areas of debris flow where disasters occurred, particularly if death is involved.

A nation-wide mapping is proposed to be carried out to delineate areas of potential and vulnerable to debris flows. The first level of national mapping will rely on topographical and geological data to identify elements that are susceptible to debris flow with emphasising on the basin geometry, geomorphology, modelling of run-out distance of a debris flow and at-risk cultural elements.

Keywords: debris flow, landslide, Malaysia, debris flood

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

HDS04-11 Room:102B Time:May 20 11:45-12:00

Monitoring of the rapid weathering in a badland of Plio-Pleistocene mudstone area, southwest Taiwan

HIGUCHI, Kohei[1*], CHIGIRA, Masahiro[1]

[1]Disaster Prevention Research Institute, Kyoto University

We monitored water contents and electric conductivities beneath a slope surface in a badland, southwest Taiwan, where highly incised topography is formed by rapid erosion of about 10 cm/year on Plio-Pleistocene mudstone. Badland is characterized by dissected bold landscape with gullies and ridges. It is widely distributed in arid to semi-arid areas in the world (ex. South Dakota in America, Loess area in China, south Italy and southeast Spain). Slope surface in badland of weak mudstone is markedly characterized by surface crusting and desiccation cracks, which reach 10 to 20 cm depths. Erosion in such badlands is assumed to be related to high saline contents. We set sensors for temperature, water content, and electric conductivity at 0 to 40 cm depths beneath a slope surface and measured them at 10 minutes intervals from 2009 to 2011. A rain gauge was set 1 m above the ground in front of the monitoring slope and hygro-thermo meters were set 10 cm above the slope surface and with the rain gauge. About 1900 mm of precipitation occurred during the monitoring interval and over 96% of the rainfall was in the rainy season from May to September. Air temperatures and relative humidities gradually increased to rainy seasons from dry season. Water contents near the slope surface were lowest in the dry season and increased by infrequent rainfall events, and became quite high in rainy seasons. Salinity, which is estimated from electric conductivities and water contents, near slope surface was lowest in dry seasons and increased in early rain seasons. The increased salinity was diluted by heavy rainfall events in rainy seasons and intensive erosion occurred by the grain dispersion by the dilution. Water penetration depths were 30 to 40 cm in dry seasons and became much shallower to a depth of about 10 cm in rainy seasons. The decrease in the water penetration depths may be attributable to the self sealing of cracks by rock expansion when wet.

Keywords: badland, Plio-Pleistocene mudstone, rapid erosion, weathering, salt movement, monitoring