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

HDS27-01 Room:102B Time:May 24 09:00-09:15

Sector Collapse of Inagodake in Kita-yatsugatake Volcano and Landslide dams outburst disaters

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1. Introduction

Yatsugatake Volcano in Nagano Prefecture was violently shaken by an earthquake on 22 August, 887, which caused a large-scale sector collapse (Ishibashi, 2000, Inoue,2010). The collapse flowed down the Otsuki River in the form of a large-scale debris avalanche and blocked the Chikuma River upstream of the Shinano River, forming a gigantic landslide dam. In the area from Sakudaira to Nagano Basin along the Chikuma River, Ninna Flood sand covered rice paddies and houses.

2. Topographical feature of large-scale landslide dams

This disaster in mentioned in many historical materials, including records from the 887 earthquake and from the flood disasters of 888. These materials can be interpreted to show that on 22 August 887, in addition to the disaster caused by a violent earthquake (mega ocean-trench earthquake) that affected most of the main Japanese islands, a massive collapse occurred in the Yatsugatake Volcano, which blocked the Chikuma River and resulted in the formation of a huge landslide dam. Subsequently on 20 June, 888 (303 days later), the landslide dam collapsed, causing a heavy flood that washed away both houses, castles.

The altitude of the river bed at point of the river channel blockage was 1000 m above sea level. Debris including avalanche sediment present along the Otsuki River and there are many mudflow hill landforms and lakes including Lake Matsubara, resulting from the debris avalanche. Considering the existing of extrusive landforms such as mudflow hills near Lake Matsubara, I estimated to inundation height of 130 m and volume of 580 million m3, which would make it one of the largest landslide dams known to have occurred in Japan. This landslide dam formed along the Chikuma River and had an extremely large inundation volume, which gradually collected water for about ten months. The dam eventually became filled during torrential rainfall in the rain season. It suddenly failed 303 days later, caused a secondary debris avalanche. The water collapse behind the landslide dam flowed for over 100 km down the Chikuma River, which resulted in flooding and the deposit on the Ninna Flood sand (Kawasaki, 2010).

The landslide dam failure caused a secondary debris avalanche, which blocked the Aiki River near Koumi and formed Old Lake Aiki, which remained for over 600 years. Although Old Lake Chikuma 1 collapsed, Old Lake Cnikuma 2 (50 m height) existed for 123 years. Various place-names related to the lake; including Uminokuchi (enter the lake), Umijiri (exit the lake) and Koumi (small lake) still exist in the upper reaches of the Chikuma River. These names could be constructed as records of the landslide dam.

3. Secter collapse in the Kita-Yatsugatake and mega moved rock body in Inagodake

Kawachi (1983) suggested that the collapse of the eastern flank of Yatsugatake Volcano resulted in the formation of a horse-shaped caldera of 2.25 km in north-south length, 3.5 km in east-west length and 350 m in maximum relative height and estimated that the sediment from the Otsuki River debris avalanche amounted to 350 million m3. We later estimated the volume of the horseshoe-shaped caldera as over 1 billion m3 and postulate that this landform was a repeated debris avalanche as large as that which occurred in 887, along with volcanic activity.

Mt. Inagodake remains at the head of the caldera as a massive moved rock body, with an approximately 1000 m long axis, 200 m height, and 140 million m3 in estimated volume. This moved rock body may have been formed at the time of the sector collapse in 887. Alternatively moved rock mass may have exited earlier and the sector collapse may have occurred on a large scale that included is almost completely separated from the bedrock and may collapse significantly in the future as a result of earthquake activity, or post-volcanic activity. Consequently, we had to investigate the situation of mega moved rock body in Inogodake by GPS.

Keywords: Yatsugatake, Inagodake, sector collapse, landslide dam, debris avalanche

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HDS27-02 Room:102B Time:May 24 09:15-09:30

Late Pleistocene to Early Holocene large landslides in Takamaga-hara, Mount Suisho of Hida Mountains

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We describe the geologic and geomorphic features of large landslides (rock avalanches) in the uppermost Kurobe River in the northern Japanese Alps. The source area of these landslides was a steep amphitheater on the west face of Mount Suisho (2978 m a.s.l). The landslide deposits fill the valley of the Iwagoke-kodani River, which is a subsidiary stream of the Kurobe River, and cover an area of approximately 1.53 km^2. Moreover, hummocks and depressions have developed on the top surface of the landslide deposits. The landslide deposits consist of a thick (>70 m) gravel layer with brecciated rock clasts; the gravel layer has an estimated volume of 4.6 x 10^7 m^3. The lithology of the clasts in the gravel layer is the same as that observed on the rock slopes around the amphitheater at Mount Suisho. ^{14}C dating of seven wood fragments collected from the gravel layer provides age estimates of 10.187-9.631 cal ka. Meanwhile, sandstone fragments sampled from the amphitheater exhibit ages of 4.2-3.2 ^{10}Be ka, and a granodiorite specimen collected from a hummock surface produces ages of 68-40^{10}Be ka and 21-12^{10}Be ka. These ages, combined with the geographic separation of the sampling sites, suggest that multiple landslides occurred during the Last Glacial and the Late Glacial periods , as well as during the early Holocene epoch.

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HDS27-03 Room:102B Time:May 24 09:30-09:45

Debris flow involving landslide dam: a case of Mochiyamadani, Miyagawa area, Mie Prefecture in 2011

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Miyagawa area in Mie Prefecture was suffered by heavy rain of the Typhoon Talas in 2011, followed by 2004 rain. Many landslides were induced by both the rains. Pre-existed slow landslides reactivated, while incipient rapid deep seated landslides occurred isolated or at adjacent slope of pre-existed landslides.

In Mochiyamadani, tributary of Miyagawa River, enlargement of 2004 landslide and debris/rock slide at a neighboring slope were occurred at the uppermost course in 2011. The moving mass flowed down as a debris flow, eroded landslide dam which was formed by 2004 rockslide at the middle course, increased its volume, and reached the confluence of Miyagawa River. The debris flow destroyed a check dam and a bridge in the lower course, and flushed a house at the opposite bank of Miyagawa River. Miyagawa River was temporary dammed and raised up river water level.

Keywords: 2011 heavy rain, debris flow, landslide dam, Miyagawa River

Japan Geoscience Union Meeting 2013
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HDS27-04 Room:102B Time:May 24 09:45-10:00

Features and distribution of landslides triggered by heavy rainfall in the northern part of Kyushu in July 2012

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Many landslides occurred in the northern part of Kyushu island, following the heavy rainfall in July 2012. In this research, we aim to define the features and distribution of landslides triggered by the heavy rain. Moreover, we also contrived new application of the Landslide map published by NIED, by comparing features and distribution of landslides and the Landslide map.

Many landslide occurred in Aso area, Kumamoto Prefecture and Hoshino area, Fukuoka Prefecture which observed the total rainfall over 800 mm. Almost landslides occurred in Aso area were shallow landslide with less than 1m of thicknesses. On the other hand, in the Hoshino area, the landslide to which not less than 5 m in thickness and width exceed 100 m occurred although there is little number compared with Aso area. As a result of comparing the distribution and the features of landslide in both areas, it was revealed that the landslide occurred in both area differs in the scale and the morphology. The causes are considered to be geological units and the density of landslide topography. Therefore we can suppose the landslide susceptibility by combining the geological units and the Landslide map.

Keywords: Landslide, heavy rainfall in the northern part of Kyushu in July 2012, the Landslide map

Japan Geoscience Union Meeting 2013
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HDS27-05 Room:102B Time:May 24 10:00-10:15

Iwatoyama landslide and natural dam caused by the AD 1714 Shotoku-Otari Earthquake in central Japan

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The Iwatoyama landslide, which caused the loss of 30 lives, was induced by the Shotoku-Otari earthquake (*M* 6 1/4) on April 28 1714. This landslide is considered to be related to the Itoigawa-Shizuoka Tectonic Line active fault system located in northern Nagano Prefecture and believed to have created a natural dam obstructing the Himekawa River. However, little detailed information is known on the geologic and geomorphic features of the Iwatoyama landslide and its natural dam. We performed geologic and geomorphic investigation by air photo interpretation, geological exploration, and re-examination of historical documents as well as interviewing local residents. The principal results are: (1) the Iwatoyama landslide started on the western face of Mount Iwatoyama (1,356 m ASL), and the landslide mass directly moved down onto the Himekawa River, (2) the landslide mass obstructed the Himekawa River, resulting in formation of a dammed lake with an elongated water area extending 4 km upstream, (3) the height and width of the natural dam are estimated to be 80 m and 460 m, respectively, (4) the duration of the dammed lake was three days, and finally the dam collapsed causing a catastrophic flood, and (5) an integrated study of geology-geomorphology and historiography is beneficial for reconstructing landslides that occurred in historical times.

Keywords: Historical earthquake, Earthquake-induced landslides, Natural Dam

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HDS27-06 Room:102B Time:May 24 10:15-10:30

Effect of geological structure on the sediment supply rate and topography in a large landslide.

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Large-scale landslides continuously supply sediment into rivers after their initial formation by the erosion of exposed bed rock. We quantitatively examined characteristics of sediment supply processes in the Aka-kuzure, a large landslide in central Japan, based on the Airborn LiDAR data (2000, 2003, and 2007), and Terrestrial Laser Scanning data (2010 and 2011). By comparing these topographic data, two types of sediment supply processes were found in Aka-Kuzure: deeper landslides ($>$ 10 m in depth), and other erosion processes (erosion rate of $<$1 m yr^{-1}). In the areas underlined by alternate layer of sandstone and shale, erosion rate was different between the two geology; erosion rates in the sandstone and shale were about 1 m yr^{-1} and 0.2 m yr^{-1}, respectively. In these areas, steep cliffs of sandstone (slope gradient of 60-80 degrees) and gentler slopes of shale (slope gradient of about 40 degrees) forms step-like topography. This topography retreatedalong the dip direction by the erosion. Consequently, geological structure in the Aka-kuzure affects spatial distribution of erosion rate as well as topography in the landslide.

Keywords: deep-seated landslide, Aka-kuzure, sediment supply, Shimanto terrane

Japan Geoscience Union Meeting 2013
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HDS27-07 Room:102B Time:May 24 10:30-10:45

Relationship between rainfall condition and landslide magnitude-frequency in Japan

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Rainfall-induced landslides are important natural hazards that often inflict substantial damage to society. For assessing landslide hazards, a basic task is to understand the relation between historical landslide records and rainfall conditions. Although critical rainfall thresholds have been established in this context, little is known about the size characteristics of the resulting slope failures. This study examines potential correlations between landslide size distributions and total rainfall (mm), mean rainfall intensity (mm/h), maximum rainfall intensity (mm/h), or rainfall duration (h). We analyzed 4,848 rainfall-induced landslides that occurred throughout Japan during 2001 to 2011. We classified these landslides into two groups according to their estimated volume, and tested whether their size distribution is related to rainfall characteristics.

Results show that the frequency of small landslides surpasses that of large landslides at low values of total rainfall, mean rainfall intensity, and maximum rainfall intensity. In contrast, the frequency of large landslides increases with increases in these rainfall parameters. The cross-over values are the total rainfall of 200 - 270 mm, mean rainfall intensity of 3.5 - 3.8 mm/h, and the maximum rainfall intensity of 33 - 45 mm/h. With regard to the rainfall duration, the frequency distribution of large landslides is almost the same as that of small landslides. These results suggest that the total rainfall and the rainfall intensity affect landslide magnitude more than rainfall duration in the Japanese archipelago.

Keywords: landslide, magnitude-frequency, rainfall

Japan Geoscience Union Meeting 2013
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HDS27-08 Room:102B Time:May 24 11:00-11:15

Development history of sagging geomorphology: examples from Mt. Kanmuriyama, Gifu Pref. and Mt. Tsuenomine, Mie Pref.

Satoru Kojima[1*], NIWA, Ryota[1], KAYAMOTO, Koichiro[1], Heitaro Kaneda[2], Hidehisa Nagata[3], IKEDA, Akiko[4], Toshio Nakamura[4], Tomoyuki Ohtani[1]

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Recently sagging geomorphic features like double ridges and uphill-facing scarps attract attention as precursors of large-scale landslides. Many types of large- and small-scale sagging landforms have been ubiquitously found in the Japanese mountainous regions by the analyses of detailed topographic maps made by LiDAR survey. The development history and processes, however, are unclear. We report the results of field and coring surveys on sagging geomorphology in Mt. Kanmuriyama area, Etsumi Mountains of Gifu-Fukui prefecture boundary and Mt. Tsuenomine area in Mie Prefecture, Kii Penisula.

Chert and sandstone formations of the Jurassic accretionary complex of the Mino terrane are widely distributed in the Mt. Kanmuriyama area. Sediments accumulated in the ridge-top depression (altitude: 1,131 m) northwest of Mt. Kanmuriyama were drilled by hand auger equipments in order to characterize the deposits. The sediments are composed of 1) conglomeratic orange mud, 2) light-yellow mud, and 3) alternating beds of dark-gray mud and carbonaceous mud/leaf litter mixture, in ascending order. The thickness of the sediments, increasing from east to west and 3 m in maximum, suggests that the depression has been resulted from the eastward slumping of the ridge-top. On the basis of the Kikai-Akahoya tephra (K-Ah) of 7.3 ka and AMS-14C ages measured on the wood fragments embedded in the sediments and the sediment accumulation rate estimated by these ages, the depression was formed about 11,000 years ago, and has been constantly filled up with the sediments.

Miocene sandstone and mudstone with minor amounts of conglomerate occur in the Tsuenomine area. There are several types of deformation landforms such as double ridge on top, uphill-facing scarps, landslide dam and buried dammed lake. Sediments accumulated in the ridge-top depression about 9 m thick were drilled, and they are massive mud changing to the muddy conglomerate at the bottom. Although the sediments include no plant remains suitable for the AMS-14C age determination, three layers of tephra at 0.8, 4.3 and 7.8 m depths are sandwiched, which are correlated to the Aira Tn (AT, 28-30 ka), Kuju-Daiichi (KJ-P1, 50 ka) and Kikai-Kuzuhara (K-Tz, 95 ka) tephras, respectively. These ages indicate that it takes more than 60,000 years for the sedimentation of the massive mud about 7 m in thickness.

Keywords: sagging geomorphology, landslide, Mt. Kanmuriyama, Mt. Tsuenomine

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HDS27-09 Room:102B Time:May 24 11:15-11:30

Tectonic controls on gravitational deformation: a regional sagging mapping in the western Mino Mountains using LiDAR

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Many linear geomorphic features of gravitational origin, known as sagging or sackung, are recognized on and around high mountain ridges worldwide. A complete scanning and mapping of those sagging features in a given region, however, has ever been difficult because classic aerial-photograph examination does not allow detection of small geomorphic features under forest canopies. We here present the first complete distribution map of sagging features in a wide area using high-resolution airborne LiDAR and the elaborate DEM visualization that facilitates mapping and interpretation of small geomorphic features of various morphology and orientations. The target area is the western Mino Mountains, central Japan, where the ˜35-km-wide and ˜24-km-long area is characterized by relatively monotonous, moderate- to high-relief mountains of 1000-1600 m high and uneven active-fault distribution. The recently acquired 1-m-resolution LiDAR data of the Etsumi Sankei Sabo (Erosion Control) Office cover the entire western Mino Mountains, providing the rare opportunity to examine various controls on large-scale gravitational deformation and mass-wasting in a humid temperate tectonically active region. We produced stereo-paired Red Relief Image Maps to visualize DEMs and carefully mapped sagging features. Our mapping reveals that sagging feature prevails almost everywhere in the studied area, with a total number being as many as 10486 and a total length being as much as 716 km. The average line density is 0.68 km/km2. We also found a strong positive correlation between sagging-feature density and altitude, indicating that potential energy is a very important control for the formation of sagging features. The areas underlain by sedimentary rocks tend to show higher line density than those of igneous rocks. We also examined the impact of strong ground motions and static crustal strain associated with movement of active faults within the area and found that both parameters are positively related to sagging-feature density. In particular, the static strain has a stronger effect than strong ground motions, suggesting that we need to take into account static crustal strain associated with active faulting in accessing mass movement potential, in addition to strong ground motions.

Keywords: sagging, airborne LiDAR, active fault, Mino Mountains

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HDS27-10 Room:102B Time:May 24 11:30-11:45

Gravitational deformation and bedrock groundwater discharge in a hillslope underlain by accretionary sedimentary rocks

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Prediction of location and timing of deep-seated catastrophic landslides requires 1) detection of topographic signals formed by preceding gravitational deformation, 2) understanding of hydro-geological structure constrained by discontinuities in bedrock, and 3) revealing response of deep groundwater to rainfall infiltration. We curried out investigation of topography and geology, and hydrological observation in a high relief dip slope underlain by accretionary sedimentary rocks in Katsuragawa, Shiga Prefecture Japan. The observed hillslope has many scarplets and bedrock springs. Discharge from these springs shows a variety of response to rainfall, implying existence of multi system of groundwater aquifer in the bedrock.

Keywords: deep-seated catastrophic landslides, gravitational deformation, deep bedrock groundwater, bedrock spring, rainfall-runoff processes

Japan Geoscience Union Meeting 2013
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HDS27-11 Room:102B Time:May 24 11:45-12:00

Topographic criteria for susceptibility mapping of earthquake induced landslide

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Topographic features were studied from viewpoints of earthquake types, such as off-shore and inland-epicentral earthquakes, and landslide types, such as shallow surface slide, debris slide and deep seated slide. Topographic types that are prone to cause each type of landslide due to each type of earthquake are proposed. They are gravitational creeping slopes, steep slopes or cliffs along gorge, old landslide of which toe part are incised, buried valley with weathered pyroclastic deposits and end part of active faults with strike slip sense. They are effective criteria for susceptibility mapping of earthquake induced landslide, using AHP method combined with lithological and structural data by each earthquake type.

Keywords: susceptibility mapping, earthquake induced landslide, topographic criteria

Japan Geoscience Union Meeting 2013
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HDS27-12 Room:102B Time:May 24 12:00-12:15

Geomorphological settings of the slope movements in the Matsushima Bay area induced by the 2011 Off-the Pacific Coast of

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Slope movements such as rock failures and rock slides were concentrated in the hilly areas of Matsushima Bay in Miyagi Prefecture by the 2011 Off-the Pacific Coast of Tohoku Earthquake. Geomorphological settings of the slope movements have been studied by the GIS-based analysis and stereoscopic slope maps which was produced from the 2m-mesh DEM taken by the Geographical Survey Institute, Japan.

90% of the slope movements which has been detected by interpreting Google Earth images and field survey occurred on the slopes more than 40 degrees in slope gradient and 10m in relative height. Though the frequency of them increases in concordant with the gradient, it is highest in the class of 10-20m in relative height where the steep slopes of marine erosion both at recent and Holocene time have been formed. The time-sequential comparison of the settlement house numbers indicates that they have been increased near such steep slopes. Since the risk of landslide disasters induced by earthquakes has increased, further measures against the slope disasters are required.

Keywords: Landslides, Matsushima, the 2011 Off-the Pacific Coast of Tohoku Earthquake, stereoscopic slope map

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HDS27-13 Room:102B Time:May 24 12:15-12:30

The cases and their aspect of glacier lake outburst in the Himalayan range

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The risk evaluations by previous studies for glacial lake outburst flood (GLOF) have been conducted on shaky ground. ”Dangerous glacial lake” means many of different by various researchers and agencies. One glacial lake in Sagarmatha region, eastern Nepal is examples of that. Because the lake which has been considered as both side, very dangerous and not so dangerous. The former side, international donors and researchers spent presious time and money in recent for protection work. In order to give reliable evaluations, further detailed information and considerations are required.

The author had reported the past outburst events and occurrence tendency in the Bhutan Himalayas (an abstract paper in the JpGU 2012. Global Environmental Research, 16, 69˜80). Furthermore, I expand the area of observation into the Himalayan range. As the recent work, following results were obtained, 1) Most of outburst events had occurred till the 1970s in the Himalayan range. It means that glacial lake outburst is a part of transition phenomenon between from the Little Ice Age to the present climate, rather than just a recent global warning. 2) The location of outburst event is concentrated in the central and eastern Himalayas (Bhutan, Sikkim and Eastern˜central Nepal). 3) Flood records in the previous descripted data and local information is not always glacial lake outburst floods.

In this presentation, I will show the other condition and tendency of occurrence of outburst events which are related to the basement topography and so on.

Keywords: glacial lake outburst flood, glacial topography, climate change, case study, disaster prevention

Japan Geoscience Union Meeting 2013
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HDS27-14 Room:102B Time:May 24 12:30-12:45

Self-potential variation in the rainfall-induced landslide flume test with two-layered sands

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Recently, rainfall-induced landslides occur frequently with increase of heavy rain. In order to mitigate landslide disasters, understanding of the landslide process and developing of early warning system are important. In this study, self-potential (SP) approach has been attempted to develop an early warning system for rainfall-induced landslides. Self-potential approach is a passive method to measure potential difference under the ground by using the electrodes set under the ground. And, this approach is low cost and easy to set up.

To understand the relation between self-potential changes and landslide, laboratory experiments have been performed. The main results are as follows;

(1)Expansion of saturated area is corresponding to that of the low potential area.

(2)The water flow directions changes from vertical to parallel to the slope.

(3)The trend of self-potential variations in saturated areas is explained by hydraulic gradient, theoretically.

(4)The transient changes of self-potential variation appear below sliding segment a few ten minutes before the main collapsed, when the apparent sand displacement starts.

In the previous laboratory experiments, we had used the uniform soil layer. However, a practical field has a complex and multiple layered sands. Therefore, in this study, we tried to the laboratory experiment with two soil layers.

The details will be provided in the presentation.

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HDS27-P01 Room:Convention Hall Time:May 24 16:15-17:30

Relationship between slope failures and height and density of trees brought by LIDAR data

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Authors showed that tree height can be supposed from LIDAR data and number of trees and area of tree timber at breast height can be presumed in case of plantation of ceders by previous study in Izumozaki district, Niitaga prefecture. Authors analyzed relationship between form of trees and probability of slope failure occurrence. Less probability of slope failure occurrence is pointed in case of higher tree areas from study in Izumozaki district. Authors will show results of further analysis about the relationship.

Keywords: LIDAR Data, Height and Density of Trees, slope failures

Slope angle at each 30m x 30m cell (2004)

Maximum tree height at each 30m x 30m cell

	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-(m)	average
0-5 (m)	0.4%	7.8%	10.5%	-	-	-	-	-	-	-	2.1%
5-10	0.8%	7.6%	14.1%	19.0%	-	-	41.7%	-		-	8.2%
10-15	0.9%	1.7%	6.2%	16.2%	23.5%	33.8%	51.3%	26.3%	-	-	12.1%
15-20	2.1%	3.3%	4.6%	11.8%	13.0%	22.3%	24.7%	22.7%	31.0%	-	11.8%
20-25	2.2%	2.3%	4.8%	6.0%	10.6%	12.5%	18.0%	13.7%	15.6%	-	9.8%
25-30	0.0%	2.0%	3.6%	6.8%	8.9%	11.8%	14.3%	15.0%	8.3%	-	10.1%
30-35	-	0.0%	4.9%	6.3%	9.0%	12.1%	11.1%	16.3%	16.3%	-	10.3%
35-	-	-	12.5%	6.1%	12.1%	8.6%	16.3%	10.3%	-	-	11.2%

(%) : ratio of slope failure area in each cell

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HDS27-P02 Room:Convention Hall Time:May 24 16:15-17:30

Automated Delineation of Slope Unit using Airborne LiDAR derived Digital Elevation Models

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Digital elevation models can provide us with wide variety of information about the land surface using existing GIS softwares and programs. When analyzing the susceptibility of hillslopes to displacement as well as landsliding, stability is usually determined on a watershed basis. However, basic evaluation is conducted on individual hillslope bounded by ridges and streamlines with which combinations of slope units comprise a watershed. Here, watershed boundaries can be extracted by automated GIS programs. Nonetheless, hillslopes are often manually digitized from scanned contour maps which are then made into geographic data.

For an attempt to develop an objective method for automated delineating of slope unit, the authors applied Zhou's approach (2004) of reversed elevation model and extracted hillslopes through raster processing. The dataset used in this study was an airborne LiDAR derived elevation models collected in Hofu City, Yamaguchi Prefecture in 2009. Identified slopes were then combined with normally obtained watersheds to obtain slope units bounded by ridges as well as streamlines. For analyzing sensitivity of outcomes, five-different window size and three-repeat counts were tried to when calculating summit planes while five-different minimum contributing areas were tried when dividing watersheds.

Keywords: Airborne LiDAR, digital elevation model, slope unit, automated delineation, slope failure

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

HDS27-P03 Room:Convention Hall Time:May 24 16:15-17:30

Extracting small scarps to predict potential sites of deep-seated landslides

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Typhoon Talas 2011 induced many deep-seated landslides in the Kii Mountains. Ten landslides had been surveyed by airborne laser altimetry before the landslide events by the Ministry of Land, Infrastructure, Transportation, and Tourism and Nara prefectural government, which made it possible to analyze detailed topography. There were few landslides that had detailed topographic data beforehand. Topographic analysis clarified that these deep-seated landslides had been preceded by eyebrow-shaped small scarps along their future crowns, which suggests that such small scarps are the clues to predict potential landslide sites. Most of these scarps are too small to be easily identified on aerial photographs.

We made several types of images from high-resolution DEMs and compared their possibility to identify precursory small scarps for three landslides in Otoh in Gojo, Nara (Shimizu, Akatani, and Nagatono). The images were a slope image, a 3-D slope image, a 3-D red image, and a curvature image.

The precursory scarps were 35-43 degrees with a horizontal length of 7-57 m along slope lines. Horizonta length and vertical height are close because the slope angle is near 45 degrees. These scarps are identified by the change in slope angles, and are not easily recognized because of larger sizes. The Shimizu landslide had one small scarp and the Akatani and the Nagatono landslides had more than one scarps.

We found no big difference among the images we made to detect precursory scarps. The slope image and the 3-D red image could not tell us the slope direction in some cases. The 3-D slope image had no such troubles, but must be observed with stereoscopic glasses so could not be annotated on it. It could not be used with other images on GIS. Identifying precursory small scarps could not be made automatically, but could be made manually in a practical sense. Appropriate images help this process.

Keywords: Deep-seated landslide, Air-borne laser altimetry, Gravitational slope deformation

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Large landslide in the northwestern face of Mount Mitou, west Tokyo

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Rugged mountains consisting of inclined sedimentary rocks are present in the upper part of the Tama River, 70 km west of downtown Tokyo. It is generally assumed that these mountains are subjected to geologic and geomorphic conditions that are conducive to the occurrence of gravitational mass rock deformation and large landslides. Therefore, we clarified the geomorphic and geologic features of a large landslide on the northwestern face of Mount Mitou, which lies within this area. We found a thick angular gravel bed with a volume of approximately 2 x 10^6 m^3; this layer contained jigsaw brecciated rock clasts, and hummocks were present on the ground surface. This gravel bed originated from a large landslide, the material for which was likely supplied from the amphitheater located 1 km south of the area where the gravel bed is primarily distributed. This gravel bed filled and dammed the small valley of a tributary of the Tama River, resulting in the production of a small lake or floodplain. The age of primary landsliding is estimated to be 1292-1399 cal AD or older, based on the ^{14}C ages of lacustrine-floodplain deposits, although younger ages in the range 1469-1794 cal AD are obtained from the gravel bed itself. This suggests that at least two independent landslides occurred at the study site. Interview with the local residents clarified traditional literature describing the break of a small lake and the apparition of a great serpent on the northwestern face of Mount Mitou; such features could be a metaphor for collapse of the landslide lake and the subsequent debris flow.

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Relationships between sagging geomorphologies and geological structure of Nogo-hakusan Granodiorite along the Gifu-Fukui

Naoya Iwamoto[1*], Satoru Kojima[1], Heitaro Kaneda[2], Tomoyuki Ohtani[1]

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Many landslides have occurred in Japan with steep landform, and have damaged people and properties. Therefore, it is very important to understand the site characteristics and warning signs of the landslides. Sagging geomorphologies are considered to be one of the warning signs of landslides. However, relationships between development of sagging geomorphologies and landslides are unclear. This study aims to claarify the relationships between the formation process of sagging geomorphologies and landslides by to examine sagging geomorphologies and geological structures of igneous rock.

Many sagging geomorphologies occur in Nogo-hakusan Granodiorite distributed around Mt. Nogo-hakusan on the Gifu-Fukui prefecture boundary. The sagging geomorphologic features were extractred from the detailed contour maps based on DEM data offered by Etsumi Sankei Sabo Office and Fukui River and National Highway Office. Geological structures such as joint systems and faults of the granodiorite were studied in the field. As the result, 189 places of sagging geomorphologies were recognized, and their dominant directions are parallel to the dominant strikes of the joint system. When the strikes of joints are subvertical to the strikes of the ridges, the sagging geomorphologies are poorly developed. The sagging geomorphologies are developed on the flat surface or gentle slope on the top of the mountains and the ridges, and many of them are mainly located behind post-glacial dissection fronts. Repetition of the following process and close relationships between the sagging geomorphologies and landslides can be supposed by these observations: 1) unstabilization of the flat surface behind the dissection front by landslide, 2) formation of sagging geomorphologies by the unstabilization, and 3) occurrence of landslide at the sagging.

Keywords: sagging, Mt.Nogohakusan, landslide, joint

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Reconstruction of processes of gravitational slope deformation around Mt. Eboshi using terrestrial cosmogenic nuclide

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A number of linear depressions are widely distributed around Mt. Eboshi, Northern Japanese Alps. This study addressed the reconstruction of formation processes of gravitational slope deformation using terrestrial cosmogenic nuclide. The rock samples for exposure dating were taken from three scarp faces, which are estimated as slip planes related to gravitational slope deformation, corresponding to three linear depressions; two depressions are located at the upper part of the slope and the other is at the middle part of the slope. The concentration of cosmogenic nuclide (^{10}Be) at the two scarp faces at the upper slope was higher than that at the middle slope. Assuming that initial nuclide concentration is zero and no shielding by seasonal snow cover, we estimated minimum exposure ages of these scarp faces. The minimum exposure ages of upper two scarps were estimated as 2.9 ka and 1.2 ka, while it was calculated to be 0.9 ka for the middle one. These data suggest that slope deformation had advanced downward in Holocene.

Keywords: Terrestrial cosmogenic nuclide, Holocene, granitic rocks, Northern Japanese Alps

Japan Geoscience Union Meeting 2013
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HDS27-P07 Room:Convention Hall Time:May 24 16:15-17:30

Preparation of seamless landslide GIS data

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Since 1982, 1:50,000 landslide maps have been produced at the Japanese National Research Institute for Earth Science and Disaster Prevention. Since October 2000, the institute has been publishing a landslide GIS database and making these data available over the web. In 2012, we began a major project to revise these data. This project targeted three problems: 1) Division of landslides extending over the boundaries of the map into separate elements, 2) Inaccurate positions and shapes in landslide GIS data produced since 2005, and 3) Presence of obvious errors in the attribute data. To address these problems, we released an updated seamless landslide GIS database. The data are continuously maintained and updated once a month.

Keywords: Landslide GIS data, Seamless data, Major revise, Data release

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HDS27-P08 Room:Convention Hall Time:May 24 16:15-17:30

The research in regarding with electrical resistivity tomography at landslide area in Nishi-ikawa,Tokushima,Japan

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Landslide is one of the severe disasters triggered by rainfalls or earthquakes. Recently, landslides tend to increase by global-warming. This research pays an attention to the rainfall-induced landslide. So far, we are trying to develop the early warning system for the landslide using self-potential (SP) measurements. The previous our indoor experiments provide some important facts in landslide process for hydrological, geotechnical, and electromagnetic senses; (1) expansion of saturated area under the ground, (2) changes of underground water flow from vertical to lateral directions, (3) apparent soil displacement 2-30 minutes before the main landslide, (4) good agreement between saturated area and area with low SP value, and (5) appearance of transient signals 2-30 minutes before the main landslide. These facts should be validated in in-site measurements. In general, to monitor underground water condition, pore-pressure meters are used but they are likely to disturb hydraulic system underground due to drilling. On the other hand, electrodes for SP measurements do not disturb it because they are installed near the surface. So there is an advantage in SP approach to monitor actual slopes. In this study, we perform electrical resistivity tomography and core sampling by borehole drilling as preliminary tests.

The test area is the slope at Nishiikawa, Tokushima, Japan. The Disaster Prevention Research Institute Kyoto University installed sensors such as extention meters to monitor the slope. We perform electrical resistivity tomography for this slope. We set up 6 lines in this study. 2 lines set to lateral to the landslide segment, and 4 lines cross segment. The inter-electrode distance of the experiment are 1m and/or 2m for each line. Then we have drawn 2 dimensional resistivity map for cross-sections and a quasi-3 dimensional map from the observed data. The results show that there are low resistivity region at shallower depth ($<$ 3 m). In order to evaluate the resistivity tomographic results, we drilled 2 boreholes to investigate core sample and found an impermeable layer with lay material around 3m depth. This is the very consistent with the electrical resistivity tomographic results. Through these facts, it is safe to say that the estimation on slip surface of the landslide segment seems adequate. In next step, an in-situ test system for monitoring practical slope will be constructed at the slope. The details will be given at our presentation.

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HDS27-P09 Room:Convention Hall Time:May 24 16:15-17:30

Measurement of the anisotropic pore water diffusion in clay samples by NMR diffusometry

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[1]AIST

Clays are important minerals for the geohazards such as landslides. The platy grain structure of clays yields strong anisotropy in the transport properties of clay samples. Proton nuclear magnetic resonance (NMR) is a promising tool to measure the diffusion anisotropy of pore water in clay samples non-destructively and non-invasively. The applicability of NMR diffusometry to clay samples is discussed mainly in terms of the preliminary computer simulations (e.g., Fig. 1) using the random walk technique (Nakashima et al., 2008).

Ref: Nakashima et al. (2008) Water Resources Research, vol. 44. http://onlinelibrary.wiley.com/doi/10.1029/2008WR006853/pdf

Keywords: clay, nuclear magnetic resonance, computer simulation, pore structure, anisotropy, diffusion tensor

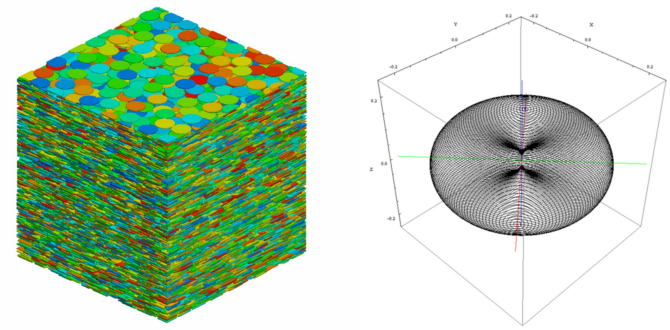

Fig. 1 Left: synthetic image of a sediment of completely parallel clay platelets (porosity 47 vol%). Right: corresponding direction-dependent normalized self-diffusivity of pore water as a wireframe shell having a constriction (not convex ellipsoid).

Japan Geoscience Union Meeting 2013
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HDS27-P10 Room:Convention Hall Time:May 24 16:15-17:30

Why does a landslide accelerate? - Estimation of dynamic friction process associated with the sliding -

Masumi Yamada[1*], Hiroyuki Kumagai[2], Yuki Matsushi[1], Takanori Matsuzawa[3]

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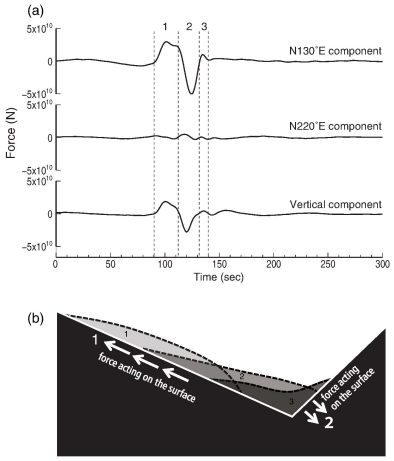
Assessing and managing the risks posed by deep-seated catastrophic landslides requires a quantitative understanding of the dynamics of sliding rock masses. Previously, landslide motion has been inferred qualitatively from topographic changes caused by the event, and occasionally from eyewitness reports. However, these conventional approaches are unable to evaluate source processes and dynamic parameters.

In this study, we apply a different approach for reconstructing the dynamic landslide processes using ground shaking data recorded away from the landslide. The deep-seated catastrophic landslide sequence induced by heavy rainfall in 2011 in the Kii Peninsula, Japan, was the first instance in which 1) seismic signals radiated by landslides were recorded by densely distributed near-source seismometers, and 2) the precise volume of the landslide material was able to be measured by comparing pre- and post-landslide topographic data obtained using airborne laser scanning. We performed a source inversion with the long-period seismic records of one of the largest events, and from this obtained a force history of the landslide.

Here we reveal the dynamic processes of the landslide: smooth initiation of sliding, acceleration accompanied by a substantial decrease in frictional force, and deceleration due to collision. Of particular importance is the determination of the dynamic friction during the landslide. The coefficient of friction is estimated to be 0.56 at the beginning of the event and drops to 0.38 for most of the sliding. The change in the frictional level on the sliding surface may be due to liquefaction or breaking of rough patches, and contributes to the extended propagation of the large landslide. The approach demonstrated here offers an innovative method for understanding the sliding processes associated with catastrophic landslides, enabling us to simulate the motion of such events.

Figure caption: Dynamic process of the Akatani landslide. (a) Estimated single-force source time functions for the two horizontal components (sliding direction and its perpendicular direction) and the vertical component. (b) Schematic diagram of the mass sliding model. The numbers correspond to the three stages indicated in (a).

Keywords: landslide, deep-seated landslide, seismic data, coefficient of dynamic friction



Japan Geoscience Union Meeting 2013
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HDS27-P11 Room:Convention Hall Time:May 24 16:15-17:30

The evaluation of denudation form in the mountain streams, use of the analyze shallow landslide susceptibility

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In this study, we applied the analyze shallow landslide susceptibility (called C-SLIDER) to Hofu city and we examined the validity of a C-SLIDER result and an actual shallow landslides area, and verified about the applicability of the C-SLIDER.

At result, does not progressed denudation areas which were soil layer is thick area were validity of the analysis result by the C-SLIDER and an actual shallow landslide area is high. In other words, the degree of risk shallow landslide by the C-SLIDER method is applicable. On the other hand, progressed denudation areas which were soil layer is thin were validity of the analysis result by the C-SLIDER and an actual shallow landslide area is low, in other words, the degree of risk shallow landslide by the C-SLIDER method is inapplicable.

Keywords: debris flow, Shallow landslide, C-SLIDER method, Slope form of denudation grade

Japan Geoscience Union Meeting 2013
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HDS27-P12 Room:Convention Hall Time:May 24 16:15-17:30

Sea cliff landslides caused by the 2011 Tohoku earthquake and the 2011 Fukushima-Hamadori earthquake in the Joban coast

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Many of sea cliff landslides caused by large earthquakes in March and April 2011 occurred along the Joban coast facing the Pacific Ocean. We measured geomorphic parameters (e.g., length, width, volume) of 177 sea cliff landslides from the north Ibaraki to the north Fukushima. Then, we clarified the morphological characteristics of landslides by using airphoto analysis and field investigation, and examined the relationship between landslide morphology, local geology and seismic acceleration parameters (QuiQuake by AIST).

Landslides were mainly classified into the following 2 types. [Type 1, n=89] The upper part of sea cliff (unconsolidated marine or terrestrial sands and gravels, or aeolian tephras) collapsed, but lower part (marine sedimentary rocks) remained stable. [Type 2, n=79] The whole of sea cliff collapsed regardless of local geology. Nine landslides could not be classified due to the resolution problems of airphoto. Average volume of landslide block was 2.2 x 10^3 m^3 for Type 1 and 7.6 x 10^3 m^3 for Type 2. A middle scale landslide with almost 10^5 m^5 volume of a landslide block was included in an unclassified type. Landslides of Type 1 were frequently found in the southern and the northern Joban coast such as Hitachi, Kita-ibaraki and Sohma. Landslides of Type 2 were present in the middle part of Joban coast such as Kita-ibaraki and Futaba. The landslides tended to concentrate in the areas where high seismic acceleration was estimated on March 11 2011 such as Hitachi, Futaba and Tomioka.

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Effect of temperature on shear strength of slip surface clay taken from a slow-moving landslide activated in cold season

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Landslides in Japan are often associated with occurrence of swelling clay minerals such as smectite that are frequently found in Tertiary deposit rocks or layers altered by hydrothermal processes in volcanic region. Because residual friction angle of smectite is very low, landslides with slip surfaces that are rich in smectite can become easily unstable in very gentle slopes. Such landslides tend to move very slowly for a long time. Velocity of such landslides are approximately 0.01-0.1mm/min statistically. In addition, those which became active during winter revealed various behavioral patterns when monitored. Their activities start from late autumn to snow-melting season. Some landslides stop moving during heavy snow period. It is not fully understood what kinds of factors control such various behaviors. Shallow and small-size landslides generally start moving from early winter (late autumn to early snowy season) which led us to suspect seasonal fluctuation of underground temperature affecting the slope stability. In the recent years, the authors have conducted experiments focusing on the temperature dependency of shear strength of soils, and revealed that residual strength of soils rich in smectite is strongly affected by temperature condition (Shibasaki and Yamasaki, 2010). In this paper, we carried out an additional experiment in order to investigate the mechanism of slow-moving landslides activated in winter.

We directly tested the effect of temperature on shear strength of slip surface, using an undisturbed sample taken from a landslide in Joetsu district, Niigata prefecture found in Neogene sedimentary rocks. X-ray diffractometer analysis of slip surface clay showed that dominant clay mineral is smectite. Direct shear test was performed on the drilled core sample containing slickensided slip surface at the depth of GL-4.5m. A test was carried out under normal stress of 50kN/m2 to reproduce the effective normal stress in the field. Shear rate of 0.005mm/min was applied. Temperature of the specimen was controlled by a shear box bath filled with water which circulated from temperature-controlled bath installed outside which changed from 14 to 27 degrees centigrade during the test. When temperature dropped, shear strength coincidentally decreased. This result matches with ring shear experiments performed on reconstituted samples of smectite-rich clayey soils (Shibasaki and Yamasaki, 2010). Furthermore, the results support the hypothesis that seasonal fluctuation of underground temperature lower shear strength of slip surface and can trigger landslide movement.

Keywords: slow-moving landslide, swelling clay mineral, smectite, residual strength, temperature dependency, cold season

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HDS27-P14 Room:Convention Hall Time:May 24 16:15-17:30

Changes in the risk of sediment-related disasters under climate change due to global warming

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In snow-covered areas, sediment-related disasters are caused by meltwater as well as rainfall. Therefore, the risk of sediment-related disasters increases during the snow melting period, when snow melts almost every day with the progress of season. In addition, a large amount of meltwater generated by extreme weather events such as strong winds makes the risk high.

According to the latest studies, variation in precipitation, air temperature, winds and other meteorological elements in the winter time of Japan has been getting larger for the last few decades. Thus we believe that the timing, type, scale and hazard area of sediment-related disasters may change drastically in future winter seasons.

However the relationship between sediment-related disasters and climate change in snowy regions has not been fully investigated. This is because of the infrequency of extreme events and the sparseness of local meteorological stations.

Therefore, we intend to clarify the long term trends and probability of extreme weather events in a snow environment in district of heavy snow in warm-temperate zones of mountainous areas, using the meteorological data sets acquired by both the Forestry Agency and the Meteorological Agency.

Keywords: sediment-related disaster, global warming, extreme weather event

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Distribution, ages, and deformation of the Holocene dammed-up-lake sediments along the Ane River, central Japan

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The middle reaches of the Ane River, Shiga Prefecture, central Japan, are known to have been dammed by large-scale slope failure of Mt. Ibukiyama at least twice in the geologic past. Older and younger dammed-up lakes reportedly existed 30-40 ka and ˜5 ka, respectively, but precise ages and triggers of their formation and disappearance have been poorly known. Our short drilling at two sites on the modern riverbed of the Ane river recovered the lowermost part of the younger dammed-up lake sediment down to a depth of ˜4.0 m and ˜6.8 m from the riverbed. Base on radiocarbon ages of leafs and fragile plant fragments from the sediment cores as well as those from outcrops nearby, the younger dammed-up lake is most likely to have been formed ˜5.5 ka. The age of disappearance, however, is poorly constrained because the upper part of the lacustrine sediment has been mostly eroded away. On the basis of the radiocarbon dates obtained so far, the younger dammed-up lake is inferred to have existed at least until ˜4.5 ka, indicating that the lake retained for at least 1000 years. The long lake life is probably the result of very large volume of the landslide body that blocked the river, but the material of the body might be another reason for its long life: limestone gravels that lithify very quickly. We also found that the younger dammed-up-lake sediments have tilted up to as large as ˜20 degrees with small displacements at some places. Although the tilt may be partially ascribed to differential sediment compaction, we infer that active faulting has some relation to those deformations, given that the area is located in a compressional stepover between two active left-lateral faults: the Kajiya and Sekigahara faults.

Keywords: Ane River, large-scale slope failure, dammed-up lake, active fault, compaction