Formation and Bursting of Landslide dams around the Japan Alps

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Introduction

The author collected and organized case examples of historical large-scale sediment-related disasters, and published the reports at Tabata et al. (2000), Mizuyama et al. (2011), and Interpraevent 2004, 08, 10, 12 and 14 (Mizuyama et al., 2004, Inoue et al., 2008, 2012, Inoue, 2010, 2014). In particular, case examples from various parts of Japan regarding the formation and outburst of landslide dams, which are reservoirs created by closure of rivers on mountains, namely, 65 disasters and 190 case examples.

It is often difficult to identify sediment disaster phenomena in historical eras, even in areas rich with historical records like Japan. While, when we want to find data on tsunami disasters, the focus may be put on historical records solely related to large-scale ocean-trench earthquakes along coast-lines, sediment-related disasters are generally induced by a great variety of causes, including heavy rainstorms, earthquakes and volcanic eruption, and can occur in a wide variety of areas, including mountain and hills.

2. Case Examples of Landslide Dams around the Japan Alps

Fig. 1 shows a distribution of landslide dams and Table 1 is a list of landslide dams in the area around the Japan Alps. The map explains how frequently landslide dams are formed in this part of Japan. This report describes case examples of landslide dams formed in the area around the Japan Alps run north and south on the middle of Honshu inland, where the largest elevated zone in Japan exists. Since the geological structure is very complicated along the Fossa Magna (Great Rift Valley) and the median tectonic line, many large-scale sediment movements (landslide, debris-flow, etc.) where have been caused by earthquake (24 cases), heavy rain (16 cases) and eruption (1 cases).

3 . Landslide Dams Created by the Goki-Shichido Earthquake in 887

3.1 Yatsugatake Otsuki River Debris Avalanche (No. 4.1, 4.3, 4.4)

The Goki-Shichido Earthquake (a great earthquake of M8.6 along the Nankai Trough) occurred on August 22, 887, resulting in tsunami and occurred sediment-related disasters in many areas. This disaster was recorded in several historical documents. The description in "Fuso-Ryakuki " goes roughly like this: "The ground shook on August 22, 887. Many Areas in countries from Kanto to Kyushu districts were severely shaken, and many government building were damaged.

In the Shinano region (Nagano Prefecture), mountain collapsed, and a large river caused flooding that produced devastating damage along the river." "Nihon Kiryaku" recorded the event roughly like this: "A flood occurred in the Shinano region on June 20, 888, and the mountains were depleted, and the river inundated. On May 15, a government decree was issued, which said that People victimized by the flood need not or transport their taxes."

The northern part of Yatsugatake Volcano was severely shaken by this earthquake. As a result, a huge sector collapse occurred which moved 350 million m^3 of sediments and the sediments ran down the local river as the Otsuki River Debris Avalanche. It eventually closed the channel of the Chikuma River and created Japan's largest landslide dam, named Old Chikuma Lake 1 (No.4.1), dammed up to 130 m, with a volume of 580 million m^3 impounded (Fig. 2, and Inoue at el. 2010). Mitsutani (2001) counted the annual tree rings of a buried cypress tree founded in the debris avalanche deposit and clarified that edifice collapse and debris avalanche occurred in 887.

This landslide dam failed 303 days later, and the secondary debris avalanche ran down the Chikuma River closed a tributary of Aiki River, and formed Old Aiki Lake (No.4.4, water dammed with a volume of 6.6 million m^3, up to a height of 30 m). The flood induced by the debris avalanche further flowed down the Chikuma River for 95 km. Remnants of the ancient land management system in the Heian Period (9-12 centuries), buried by deposits called the Ninna Flood Sediments, were found along the river. The dammed water of Old Chikuma Lake 1 did not totally flow out, and Old Chikuma Lake 2 (No.4.3, water Dammed up to 50 m, with a volume of 41 million m^3) remained. 133 years after 888, Old Chikuma Lake 2 burst on 1011and the Bottom of the lake was dried up to become flatland. Minato Shrine still exists near a rail crossing of Route 141 near Saku Umino-kuchi Station of Koumi Line in East Japan Railway. The origin of this Shrine probably dates back to the years, when Old Chikuma Lake 2 still existed and local people crossed the the lake on the boats between Umino-kuchi and Umijiri.

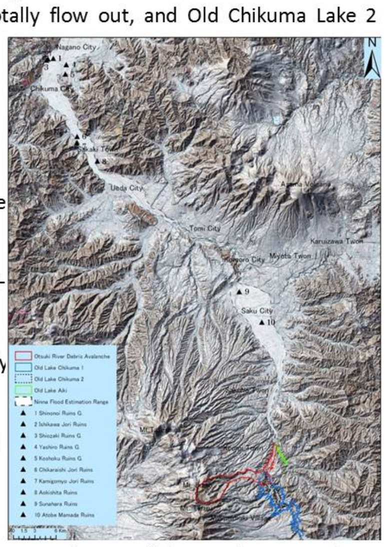

Fig.2 Distribution of the Otsuki River Debris Avalanche, land-slide dam and Outburst Flood

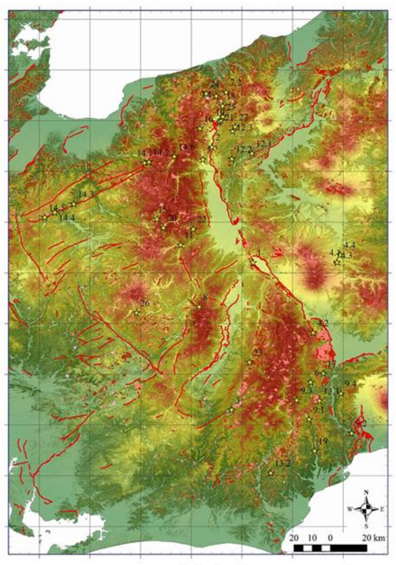

Fig.1 Landslide dams around the Japan Alps

3.2 Huge Collapse of Dondoko-Sawa of Komu River, upstream of the Fuji River (No. 4.2)

Large-scale debris avalanche deposits (No.4.2, DRAD, Volume = 19 million m^3) are distributed over Dondoko-Sawa stream in the South Alps. Kariya (2012) made a detailed survey of DRAD and provided the value of AD780 to 870 based on the carbon dating of DRAD and fossilized wood in the lake deposits (Fig. 3). Kariya, Mitsutani and Inoue (2014) used one specimen with a bark taken from a large amount of large-diameter fossilized trees contained in the lake deposit, analyzed the specimen with tree-ring dating and examined the relations with DRAD. According to their study, it was revealed that the ring specimen had 226 layers, and the tree ring patterns of these layers were compared with the standard pattern based on 2075 years of tree rings owned by Mitsutani (BC705 to AD2000) to find that both matched in the section from AD 662 to 887. It was also determined that the specimen tree died in the period. Consequently, it was concluded that the specimen in the lake deposit died in AD887.

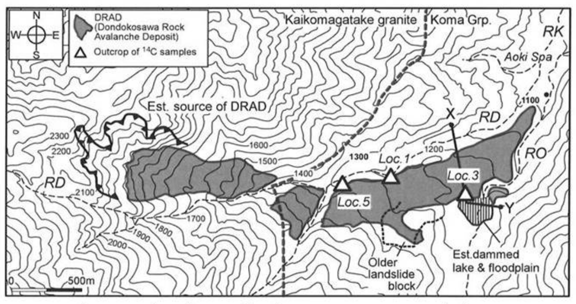

Fig.3 Debris Avalanche and Lake Depisits in Dondoko-Sawa (Kariya, 2012)

4 . Manaita-Yama Landslide by Echigo Nansei Earthquake (Jan. 28 1502, No.7.1)

The Hime River flows north along the Itoigawa – Shizuoka Tectonic line, and the catchment basin of this river has many large-scale landslides, including Lake Aoki (No.2) and Mt. Hieda (No.18). Fig. 4 is a Geomorphological map based on the analysis of aerial photos. A river-facing steep slope of Mt. Manaita-Yama (1219.3 m in altitude) that soared on the right side bank of the Hime River, collapsed in an enormous way and brocked the river channel. Part of the collapsed sediment still remains at the eastern side of the Hime River as the Kuzuha Pass (volume of collapsed sediments, 50 million m^3). A land-slide dam created by this collapse to 140 m in depth with a volume of 120 million m^3. Echigo Nansei Earth-quake (M6.5) occurred on 1502 as an Including collapsed bases on the Essa Shiryo.

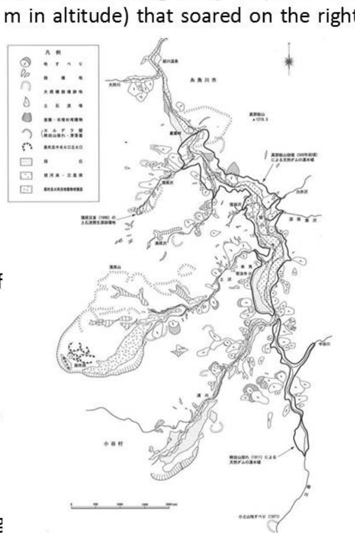

Fig.4 Geomorphological Map in Hime River (Inoue, 1997)

Table 1 List of Disaster name and Landslide Dam around Japan Alps

No.	Occurred Age	Disaster Name	Landslide Dam	No.	Occurred Age	Disaster Name	Landslide Dam
1	Before 100,000		Suwa Lake	13.1	1854.12.23	Ansei Tokai E	Sichimenzan Kuzure
2	Before 30,000		Aoki Lake	13.2	1854.12.23	Ansei Tokai E	Tomi-Yama Kuzure
3	714.07.15	Toutoumi E	Toyama L	14.1	1858.04.09	Hietsu E	Tonbi Kuzure
4.1	888.08.07	Goki-Shichido E	Old Chikuma Ⅰ	14.2	1858.04.09	Hietsu E	Tonbi Kuzure
4.2	888.08.07	Goki-Shichido E	Dondoko-Sawa	14.3	1858.04.09	Hietsu E	Maruyama Kuzure
4.3	888.06.20	After 303 Days	Old Chikuma Ⅱ	14.4	1858.04.09	Hietsu E	Hokibayashi Kuzure
4.4	888.06.20	After 303 Days	Old Aiki	14.5	1858.04.09	Hietsu E	Motoda Kuzure
5	1441.07	Heavy Rain	Kashima R.	14.6	1858.09 ?	Aftersgock	Jizodake Kuzure
6	Before 5-600	Heavy Rain	Shiojima	15	1889.07.24	Heavy Rain	Sodega-Tani Kuzure
7.1	1502.01.28	Echigo Nanseibu E	Manaita-Yama L	16	1891.06.16	Heavy Rain	Garagara-Sawa
7.2	1502.01.28	Echigo Nanseibu E	Shimizu-Yama L	17	1900.12.03	Heavy Rain	Jukkoku Kuzure
8	Before 3-400	Tensho E, 1586?	Otanairi-Yama	18	1911.08.08	Heavy Rain	Hieda-Yama Kuzure
9.1	1707.10.28	Houei E +13	Oya Kuzure	19	1914.08.28	Heavy Rain	Warabino Kuzure
9.2	1707.10.28	Houei E +13	Shiratori-Yama	20	1915.06.06	Eruption of Yakedake	Simohori-Sawa L
9.3	1707.10.28	Houei E +13	Yashio Kuzure	21	1939.09.11	Heavy Rain	Kazahari-Yama L
9.4	1707.10.28	Houei E	Yunooku Kuzure	22	1945.10.03	Heavy Rain	Shimashima-Dani
10	1714.04.28	Shinshu Otari E	Iwato-Yama L	23	1961.06.27	Heavy Rain	onishiyama Kuzure
11	1757.06.24	Heavy Rain	Tobata Kuzure	24	1967.05.04	Heavy Rain	Akahage-Yama Kuzure
12.1	1847.05.08	Zenkoji E	Iwakura-Yama L	25	1971.07.16	Heavy Rain	Kozuchi-Yama L
12.2	1847.05.08	Zenkoji E	Yanakuboike L	26	1984.09.14	Nganokenseibu E	Ontake Kuzure
12.3	1847.05.08	Zenkoji E	Iwashita L	27	1997.05.05	Heavy Rain	Okususobana Kuzure

E: Earthquake, L: Landslide, K: Kuzure (collapse), R: River   by Tabata et al., 2002, Mizuyama et al., 2011

5. Case Example by the Hoei Earthquake (1707)

The Hoei Earthquake (two mega quakes of M 8.4) occurred on Oct. 28, 1707, not only caused tsunami damage but triggered many sediment disasters over a wide area of Honshu Island from Kanto to Shikoku. Well-known large-scale landslides in the southern part of the Japan Alps caused by this mega quake include the Oya Kuzure (No.9.1) in the upstream of the Abe River, Shiratori-Yama Kuzure (No.9.2) along the midstream of the Fuji River and Yashio Kuzure (No.9.3) along the Hayakawa River, a right bank tributary of the Fuji River.

5.1 Yuno-Oku, along the Shimobe River, a left bank tributary of the Fuji River

A Large-scale landslide occurred by yhe Hoei Earthquake in Yuno-Oku, a left bank tributary of the Fuji River, and a landslide dam was formed. According to Old ducuments, at a village named Yuno-Oku, a mountain slope failed, buried the valley, and created a lake. In order to cut the bank of the landslide dam to release the impounded water, some 2800 villagers worked together to excavate a trench without success. Villagers living down stream of this dammed point were afraid of the impound water, evacuated up in the mountain and found shelter in huts. According to Fig. 5, which is a map with topographical feature enhanced by laser profiler, landslide dam and upstream deposi-tional landform are found. The impound water reached an altitude of 450 m, and the impounded water was 70 m in depth, 3.7 million m^3 in volume. The moving rocks that blocked the river channel caused deformation under the influence of Typhoon No.15 in 2011, and a shallow collapse occurred on the slope down a forest road. As deformation was also found on the mountainside retaining wall, restoration work of local roads and the river was conducted.

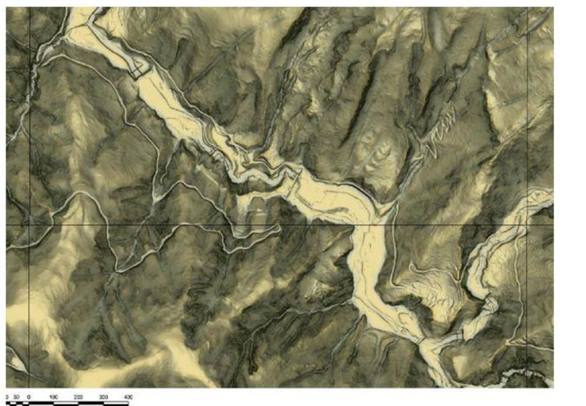

Fig.5 Topographic map of landslide dam in Yuno-Oku

6. Conclusion

This poster introduces some case examples of landslide dams around the Japan Alps. As shown in Table 1 and Fig.1, various landslide dam disasters also occurred due major earthquakes, including the Zenkoji Earthquake (1847, No.12), Ansei Tokai Earthquake (1854, No.13) and Hietsu Earthquake (1858, No.14). It is necessary to accurately research past disaster cases and have a good understanding of the relationship between local characteristics and sediment disasters. It is highly recommended that these research results be utilized by sabo works and disaster prevention administration personnel and be hamded down to local residents.

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