5-3. Investigation on Liquid Mud Disaster at Mt. Mayon in the Philippines

From January 15-17, 2007, Dr. Rolando P. Orense, Associate Professor in Department of Civil Engineering at Yamaguchi University, and Mr. Makoto Ikeda, ADRC Researcher, conducted a field survey in the areas affected by the mudflow that occurred at southern Luzon Island in the Philippines.

Fig.5-3 Scenery of the survey

Mayon Volcano, a stratovolcano known for its almost perfect cone, reaches to a height of 2,462 m and has a base circumference of 62.8 km. Its symmetric cone was formed through alternate pyroclastic and lava flows. The upper slopes of Mayon are steep, reaching up to 35-45 degree grades. It has erupted 49 times since the first documented activity in 1616. Vulcanian eruptions in 1984, 1993, and 2000 resulted in large quantities of volcanic products which were re-deposited on the slopes of the volcano.

On 30 November 2006, the super-typhoon “Reming” (international code name: Durian) struck the southern part of Luzon Island where it caused widespread flooding, damaged property, and triggered landslides and mudflows in 11 provinces. “Reming” had maximum sustained winds of 190 kph at its center and gusts of up to 225 kph. Camarines Sur was greatly affected by the strong winds and floodwaters, while Catanduanes was isolated after being struck by strong winds. Thousands of passengers in Sorsogon ports were stranded. However, the province of Albay suffered the most damage, with the intense rainfall triggering flash floods and lahar flows from the slopes of Mayon Volcano. The casualties caused by typhoon Reming amounted to a total of 655 deaths, 2,437 injured and 445 missing (OCD-5, 2007).

A result of questionnaire survey revealed a lack of evacuation sites and imperfections in the early warning system. About 60 % of people expect another disaster of the same scale to be occur here in the future. ADRC will support community- based disaster education programs for local residents in this area.

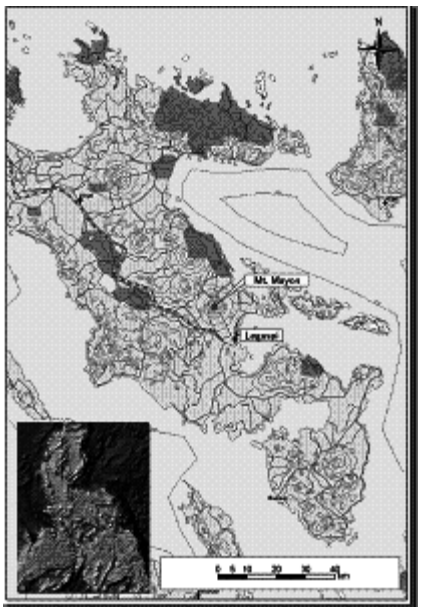
Detail information is as follows.

Introduction

The Asian Disaster Reduction Center (ADRC) made an investigation of the liquid mud disaster occurred in the vicinity of Mt. Mayon on the Luzon Island of the Philippines on Saturday, December 1, 2006. In the investigation, we made an questionnaire survey on residents concerning damages and restoration status in Legaspi. We also had opinions from Mr. Rolando P. Orense (from the Philippines), Associate Professor of Yamaguchi University, who joined our investigation, from the viewpoint of the geotechnique in which he is specialized.

Outline of Liquid Mud Disaster

After the heavy rainfall caused by the typhoon "D urian" that attacked the Philippines on November 30, 2006, the Province of Albay located in the southern part of the Luzon Island received the most serious damage. Houses collapsed, trees came down, and damage to power transmission and communication networks were found to be tremendous. Further, from the active volcano Mt. Mayon located in the Province of Albay, volcanic ashes and rocks deposited after the eruption flew out and some villages were totally buried under the ashes and rocks. It was reported that 655 persons were dead, 2,437 persons were injured and 445 persons were missing. However, most part of human damages were caused by liquid mud and the remaining damages were those including washing away of houses in flooding and collapse of houses by strong wind. The total amount of damages on agricultural facilities and infrastructure facilities reached 1.5 trillion yen.



Geological and Physiographic Conditions

The northern part of the Province of Albay has a flat ground structure, but the eastern part is mountainous with a chain of comparatively higher volcanic mountains (Mt. Mayon, Mt. Malinao), Mt. Masaraga, etc. Mt. Mayon is a composite volcano which suddenly rises in the lowland located 15km to the north-west of Legaspi in the Province of Albay and has height of 2,462m. The slope angle is 35 to 45 degrees and is considerably steep. The volcano erupted 50 times during past 400 years, which means Mt. Mayon is one of the most active volcanoes in the Philippines. Further, the symmetrically conical shape of Mt. Mayon was created by repeated pyroclastic flows and lava flows, and recently, lava flow caused by sudden great eruptions in 1984 and 1993 took many human tolls. The volcano erupted again in 2000 and August 2006. The recent eruptions a large-scale pyroclastic flow was piled up and, in the latest eruption, it was piled up on the south slope. At present, the PHIVOLCS (Philippine Institute of Volcanology and Seismology) created a hazard map, and based on the hazard information, use of lands are restricted where pyroclastic flows are likely to occur. However, there is a situation that residents are forced to plow the earth at places that are designated as hazardous zones.

Precipitation Characteristics at the Time of Disaster

Referring to the climate of the eastern part of the Province of Albay, the dry season and the rainy season are not clearly distinct, and, in the season from November to January, the area is ravaged by torrential rains. The typhoon "Durian" that developed in the east of the Philippines on November 26 was gaining strength as it headed thereafter to the west, and it moved down through the southern part of the Luzon Island, thus causing mud flow at the base of Mt. Mayon. Then, Durian moved westward on the South China Sea as it was loosing strength and caused damages to the coastal areas of Vietnam as it was flashing through the areas. Five days later, Durian became a tropical cyclone. Records obtained at the Legaspi

weather station (located at a plain region close to the cost away from the summit by 12km) of PAGASA (Philippine Atmospheric, Geophysical and Astronomical Services) showed that precipitation reached 466mm during 12 hours at Legaspi on November 30 when Durian was passing through.

According to the PAGASA records ranging from 1970 to 2000, the monthly average precipitation during the rainy season (November to January) is 457mm, but the average annual precipitation recorded at the Legaspi weather station is about 3,487mm. The data shows there was rainfall in the amount equaling to about 13% of the average annual precipitation, or the amount of rainfall exceeding the monthly average precipitation during the 12 hours. The typhoon passed the area that is very close to Mt. Mayon away about 15km with the atmospheric pressure of 940hPa at its center, and it is assumed wind and rain at the area were furiously strong, which resulted in great loss of lives due to large-scale mud flows and floods.

Outline of Mud Flow Disaster at Mt. Mayon

Concentrated heavy rain accompanied with the typhoon Durian caused large-scale mud flows and ebris avalanches at Volcano Mayon, which caused great damages in cities of Guinobatan, Camalig and Daraga which are located at the foot of Mt. Mayon. It was presumed that the heavy rain ran on the mountain slope, flowed into the river, and caused the large-scale mud flow. It was found out that the flowing sand and earth spread at the toe of the slope and deposited over the area of 10km2, the amount of sand and earth presumably reached to about 20x106m3, and they ran down up to about 12km. Many houses collapsed due to the mud flow and it reached to the height of roof of some houses. In each inundated area, settlements were devastatingly damaged, leaving a few concrete buildings. Further, the deposition of sand and earth formed a thick sand layer of 2m to 3m in depth, which covered the entire areas of all cities. The following photo shows a railway bridge destroyed by the mud flow and flood in Guinobatan. The situation is characterized by the fact that the mud flow deeply dissected the low-gradient river channel at the foot of the mountain.

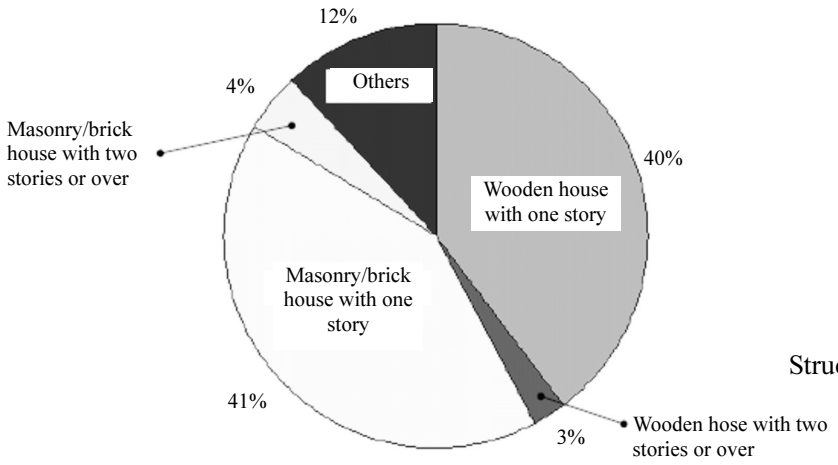
For example, referring to the Masarawag River in Guinobatan city, a river channel of about 50m in width and about 10m in depth was created by fluxing actions. Fortunately, however, residences on the land side were not damaged since the training wall that had been constructed nearby the houses prevented expansion of sand and earth flooding.

Interviews to residents revealed that the mud flow occurred during the time zone from 10 o'clock in the morning to 4 o'clock in the afternoon, which agrees the time zone in which precipitation concentrated. After 5 o'clock in the afternoon, almost no precipitation was observed. It was said that the typhoon affected living of 3,200 thousand people or over and about 240 thousand houses were damaged. Mass media reported

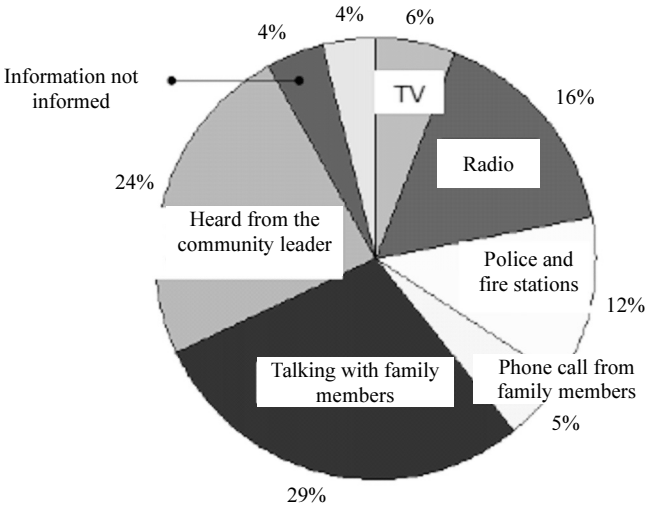
that the mud flow of Mt. Mayon caused catastrophic disaster that people first experienced since the disaster of Pinatubo Volcano which erupted in 2001. It was assumed that the pyroclastic flow and debris avalanche for the case of Pinatsube Volcano deposited over about 4,000km2 area and the sediment yield is about 6 ´ 109m3. Thus, it was recognized that the disaster occurred this time was of rather smaller scale than the mud flow of the Pinatsubo Volcano case.

Questionnaire Survey

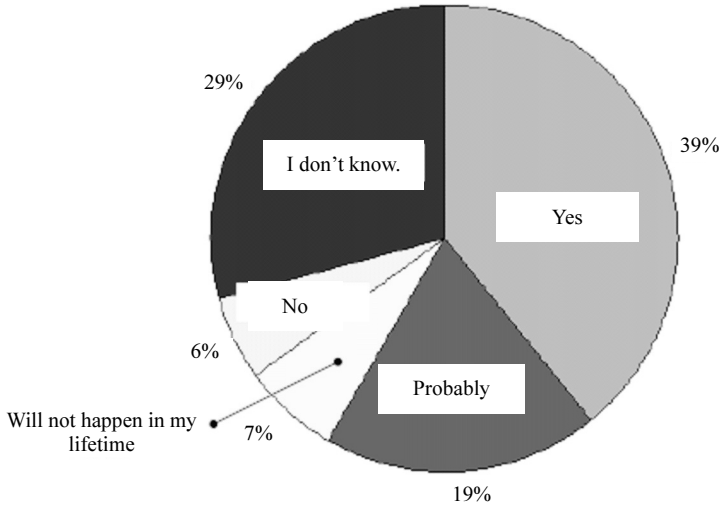
Referring to the questionnaire survey referred to earlier, we could have opinions concerning the recent disaster from 118 people. Specifically, questions were set to ask personal damages and damages caused by mud flow, methods for obtaining information, future actions to be taken, etc. As seen from the questions and answers shown below, there are quite many one-storied houses, despite that the area was repeatedly affected by catastrophic mudflow disasters. Residents have sense of uneasiness regarding future actions to be taken.



Structure of House



Means for Collecting Information right after Earthquake



Do you think the mudflow disaster of the same scale will happen in the future?

Conclusion

Fierce rain fall accompanied with the typhoon Durian caused a disaster that volcanic lapillus that deposited after the recent eruption of Mayon Volcano turned to be mud flows, thus flowing over the villages located around Mayon Volcano. Since the mud flows altered land shapes of the area, countermeasures should be taken as soon as possible to prevent future disasters. For this purpose, supports in terms of software in education fields, etc. would play important roles.