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Hazard mitigation of a caldera-forming eruption: From past experience in Indonesia to modern society

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A caldera-forming eruption, erupted volume˜ 10-1000 km3, causes huge direct damages caused by widespread pyroclastic flow, ash fall, and tsunami, and global impacts such as climate change. The recovering time is more than 10 years for climate, food, human health, and 100-1000 years for land use. Japanese have forgotten such a caldera-forming eruption, because the last one occurred 7,000 years ago. Indonesia was suffered twice for the last 200 years, and three times within 1,000 years. We must learn valuable experiences from Indonesia.

[Evaluation of potentiality for a caldera-forming eruption] We proposed an evolutional model to a caldera-forming eruption in Indonesia. The long-term evolution into caldera-forming eruption was studied by Toshida et al. (2012). This study can identify volcanoes evolving into caldera formation from those without caldera formation. The volcanoes became quiet with a few explosive eruptions during the last 10,000-5,000 years before the first caldera formation (Takada et al, 2012). Some volcano caused caldera-formation multiply. Furukawa et al. (2012) studied multiple cycle of caldera formation in Bali. According to the model, the candidate evolving into a caldera-forming eruption is a dormant volcano after large stratocone building. We must, however, distinguish a target volcano accumulating magma from that terminating its activity. Moreover, some volcanoes are decreasing in potentiality of eruption by continuous degassing.

[Precursor events] During the last a few months, we may have caught geologically the short-term process as the progressive activity to the climax eruption in cases of Tambora 1815 eruption and Krakatau 1883 eruption (Takada, 2010; Takada et al., 2012). If a volcano comes into the stage just before the climax at the present time, we can catch unusual geophysical signs from various monitoring system. However, the problem is to evaluate or predict when the volcano reaches a climax condition, and how much the volcano erupts. The evacuation plan depends on them.

[Linkage of disaster in the short-term (<10 years)] A caldera-forming eruption can cause wide range linkages of disaster globally, such as the secondary, and the thirdly ones as well as the direct damage. (1) The population on the earth increased abruptly. For example, the modern population in Sumbawa is 0.9 million, compared with 0.1 million when Tambora 1815 eruption. The other areas in Asian country are the same case as those above. (2) Recently human being develops its society with high technology, compared with the age of the caldera-forming eruptions in the 19th century. The lager the eruptive volume becomes, the wider the linkage is spread to cause traffic damage, energy plant damage, and various shortage, such as food, water, medicine, which connect each other. For example, the damage of traffic system in an island country will close from outside rescue. Volcanic ash fall close airports. Tsunami cause various coastal damage including ports or harbors. (3) Climate change will cause a possibility for plague (epidemic). Aftermath of Tambora 1815 eruption caused “ The year without a summer ”(Stommel and Stommel,1983).

[Long-term damage (> 10 years)] The damage in the area near the volcano that caused a caldera-forming eruption continues long-time. Accumulation of volcanic ash will cause lahar, close drainage (sewer) in a city, and ash pollution. Thick pyroclastic flow deposits remain long time without erosion, and prevent from agriculture. For example, the case of Tambora 1815 eruption, 200 years ago, and that of Rinjani 13th Century, 700 years ago are presented.

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