Practical Example of the Use of a Volcano Hazard Map in 2000 Eruption of the Usu Volcano

– Efforts by the town of Sobetsu for coexistence with ever-changing Earth –

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1. Introduction

On March 31, 2000, at 13:07, a new crater opened near the national road at the western foot of Usuzan, a volcano in Hokkaido, Japan, and the mountain started to erupt. This was its fourth volcanic eruption in the 20th century. There were no casualties due to a number of factors; namely, the strong motivation of local residents to learn lessons from past eruptions and prepare for future eruptions, the presence of volcanologists who had been trying to identify Usuzan’s eruption characteristics and thus predict eruptions and develop regional disaster management plans, and the launching of educational programs using an Usuzan Volcano Hazard Map published and distributed to all local residents five years before the eruption.

In this report, I describe the first practical case in which a hazard map actually helped to mitigate a volcanic disaster in Japan, in the hope that the lessons from the 2000 eruption can assist in disaster management and mitigation in other regions.

2. Historical sketch of Usu Volcano, and Regional Status

Usuuzan is relatively a new volcano formed about 20,000 years ago on the southern rim of the Toya Caldera. The collapse of the volcanic edifice some 7,000 to 8,000 years ago created countless hummocks around the southern foot of the mountain down to Funkawan Bay. As of 2000, nine eruptions had occurred since the mountain resumed erupting in 1663.

Table 1 General history of Usuzan eruptions.

<table>
<thead>
<tr>
<th>Year (Era)</th>
<th>Eruption location</th>
<th>Pre-eruption tremors</th>
<th>Major activity/ disaster</th>
<th>Dormant period</th>
</tr>
</thead>
<tbody>
<tr>
<td>1663 (Kambun 3)</td>
<td>Summit</td>
<td>3 days before</td>
<td>Ko-Usu lava dome was created. Houses collapsed and were burnt down by heavy ash fall. 5 deaths.</td>
<td>Thousands of years?</td>
</tr>
<tr>
<td>Pre-Meiwa eruption</td>
<td>?</td>
<td>?</td>
<td>Unknown</td>
<td>40 years?</td>
</tr>
<tr>
<td>1769 (Meiwa 5)</td>
<td>Summit</td>
<td>Yes. Time uncertain</td>
<td>Houses were burnt down by a pyroclastic surge at the S.E. foot.</td>
<td>70 years?</td>
</tr>
<tr>
<td>1822 (Bunsei 5)</td>
<td>Summit</td>
<td>3 days before</td>
<td>Ogariryama crypt-dome was formed. A village was destroyed and burnt down by pyroclastic surge at the S.W. 103 deaths, many missing.</td>
<td>52 years</td>
</tr>
<tr>
<td>1853</td>
<td>Summit</td>
<td>10 days before</td>
<td>O-Usu lava dome created, Pyroclastic flow, residents evacuated</td>
<td>31 years</td>
</tr>
<tr>
<td>1910 (Meiji 43)</td>
<td>Northern foot</td>
<td>6 days before</td>
<td>Meiji-Shinzan crypt-dome was formed, Steam explosion, crustal movement, 1 death (from volcanic mud flow), ash-fall damage</td>
<td>57 years</td>
</tr>
<tr>
<td>1944–1945 (Showa 19-20)</td>
<td>Eastern foot</td>
<td>Half a year before</td>
<td>Showa-Shinzan lava dome was formed. Destruction of houses and railways due to crustal movements. 1 death (infant: suffocated by ash fall, digestive organ ailment), damage from eruption products</td>
<td>33 years</td>
</tr>
<tr>
<td>1977–1978 (Showa 52-53)</td>
<td>Summit</td>
<td>32 hours before</td>
<td>Usuzan-Shinzan crypt-dome was formed. Destruction of fertile lands, forests and constructions by pyroclastic falls, crustal movements. People were 3 deaths (including 1 missing) from volcanic lahar.</td>
<td>32 years</td>
</tr>
<tr>
<td>2000 (Heisei 12)</td>
<td>Western foot</td>
<td>4 days before</td>
<td>2000 crypt-dome was formed, Destruction of houses and roads by crustal movements and volcanic rocks. Low-temperature pyroclastic flow.</td>
<td>22 years</td>
</tr>
</tbody>
</table>

* Sobetsu Town Board of Education.
Before the eruption in 1977, local people tended to shun disaster management discussions because they regarded such discussions as alarmist. On August 6, the night before the eruption in 1977, the Sobetsu Town Office, amid volcanic tremors, held the Showa-Shinzan Eruption Reenactment Fireworks Festival (Showa-Shinzan, literally, “Showa New Mountain,” is a volcanic lava dome adjacent to Usuzan). Fortunately, at 9:12 the next morning, when the eruption began, there were few tourists in the area and there were no casualties in the initial stages. However, there is no doubt that a disaster could have easily occurred. The lessons learned from the eruption served as the initial step in promoting education programs in normal times.

3. Efforts during Normal Periods: Disaster Prevention Education and Hazard Map

In 1982, immediately after the volcanic activity that had started in 1977 subsided, the Sobetsu Town Board of Education, with the cooperation of Hokkaido University, sponsored the establishment and operation of the Hokkaido Citizens’ College jointly with the Hokkaido Prefectural Board of Education.

A social education project, entitled Learning from Regional Disaster Environments, was inaugurated in 1983. This included a Local History Seminar for Children (sponsored by the Sobetsu Town Board of Education). Project participants went into the field near active volcanoes to hear experts’ views and opinions on the gifts of nature and on the disasters.

From 1993 to 1995, a series of events commemorating the 50th anniversary of the formation of Showa-Shinzan were held by local volunteers. As part of these events, the Sobetsu Town Office, a town with a population of only 3,500, sponsored an International Workshop on Volcanoes (1995 Volcano Conference). A hazard map was published and distributed to all local residents in September 1995.

The Usuzan Volcano Hazard Map is printed on both sides of an A1 sheet of paper and folded to A4 size. Printed on the front are the cover, the eruption history, signs of an eruption, volcano information, and rules of conduct after an eruption, while the back contains the hazard map and information on types of disasters.

In 1998, the Sobetsu Town Office published its own hazard map, called “Preparation for Disasters,” and distributed it to all of the town’s residents. It also provided administrative information, including a series of tips on volcanic disasters, in the monthly town gazette.

Through these projects including the publication of hazard maps, the local residents gained an accurate understanding of Usuzan and bonds of trust were forged between the experts and government and among local residents, thus facilitating the evacuation of the residents before the eruption.
4. Emergency response of 2000 Eruption of the Usu Volcano

The crater at the western foot of Usuzan started to erupt on March 31, 2000. A group of craters was formed the following day (April 1) at the northwestern foot of the mountain. Volcanic activity was observed from the very beginning of the volcanic tremors on March 27 by the Japan Meteorological Agency and the Usu Volcano Observatory of Hokkaido University and was reported to the relevant local governments. On March 28, each local government established a disaster management headquarters.

When the emergency volcanic alert (i.e., warning) was issued at 11:10 on March 29, three local governments, on the basis of expert advice, rapidly instigated a series of measures, including issuing evacuation orders, providing evacuation guidance, and installing evacuation shelters. About 10,000 residents were evacuated before the eruption without any casualties, thanks to proper explanations and information on volcanic activity provided by the experts.

4.1 Roles of hazard map and evacuation recommendation/order

Volcanic activity is a phenomenon that occurs underground and is difficult to predict. The expert advice and the hazard map, which was created from an aggregation of scientific knowledge, played important roles in the implementation of a series of evacuation measures and in providing information to local residents while the local governments were having difficulty making administrative decisions.

The evacuation measures were taken in stages and were based on volcanologists advice and hazard map. The stages encompassed the period from calling for voluntary evacuation to recommending and ordering evacuation.

As the first eruption, at 13:07 on March 31, occurred at the crater at the western foot of the mountain, a decision to expand the evacuation order zone was made on the basis of the hazard map.
4.2 Hazard evaluation and flexible lifting of evacuation order

Experts from the Usu Subcommittee of the Coordinating Committee for Prediction of Volcanic Eruptions and Hokkaido University evaluated the hazardous areas and made decisions regarding brief visits home by residents and the gradual and flexible lifting of the evacuation order.

It was extremely difficult to predict and depict on the map the hazard (or safety) levels. This was implemented by taking into consideration the predicted volcanic activity, the terrain, the weather, and the wind direction according to the changes in volcanic activity.

Henceforth, it will be necessary to develop a real-time hazard map that can quickly display the results of predictions entered into a computer. It is also necessary to construct an information technology-based information-sharing system.

4.3 Resumption of tourism and development of safety guidelines

The evacuation order zone was gradually changed as the volcanic activity of Usuzan repeatedly intensified and subsided. Safety guidelines were developed for the resumption of tourism, and the Usuzan Volcano Information Map was published by Sobetsu Town Office in Japanese and English for tourists on May 2000.

5. Development of the Town by Determining Land Use According to the Hazard Map

The 2000 eruption was very small, but many public facilities, including the core disaster management base (fire station headquarters), were damaged.

On the basis of the hazard map, the municipal governments incorporated land use into its reconstruction plans and promoted measures aimed at developing a town in which a potential disaster would be mitigated by relocating service facilities such as elementary schools and hospitals to safer areas; this had been a major issue since the 1977 eruption.

In addition, the municipal governments are developing a volcanic disaster-resilient social infrastructure. This includes the establishment of transportation networks and core disaster-management bases using the hazard map information as an important decision-making tool.
6. Conclusion: For Making a Culture of Social Safety

In this report, I mainly describe the usefulness of the hazard map on the basis of my experience, as an official of local municipality office who has actually used the map to respond to a disaster. It is also important to understand that people should take actions based on their own proactive decisions, because true disaster management cannot be achieved by leaving one’s own safety to others.

The development of human resources through education emphasizing an understanding of nature and the long history of the Earth is the only way to develop a sustainable society that can coexist with natural disasters on the Japanese archipelago, where many types of natural disaster occur frequently.

Many of the cases in which risks were averted in large-scale disasters, including the evacuations before the 2000 Usuzan eruption and the 2011 Great East Japan Earthquake, were the result of educational programs implemented thoroughly and repeatedly and the outcome of efforts by the academic experts, teachers, and regional leaders involved in such programs.

I believe it is important to establish a culture of safety in which, in addition to the social education field, schools can provide more systematic and well-prepared disaster education programs based on the National Curriculum Standards for Schools.

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Photo 5 The Local History Seminar for Children, sponsored by the Sobetsu Town Board of Education, was inaugurated in 1983 to impart accurate knowledge of volcanoes and natural disasters through experience-based learning.