写真１７　ヘルナニ地区（筆者ら撮影 2014/5/25）

写真１８　マラブ地区（筆者ら撮影 2014/5/28）

写真-1　「減災アクション！カードゲーム」開発者メンバー。前列は左から金子亮介、山田修司、久松明史。後列は左から牧野嶋文泰、渡邉俊介、久利美和講師。ポスター内のキャラクターは左から「ちん=ゲンサイ先生」と「げんサイ君」。

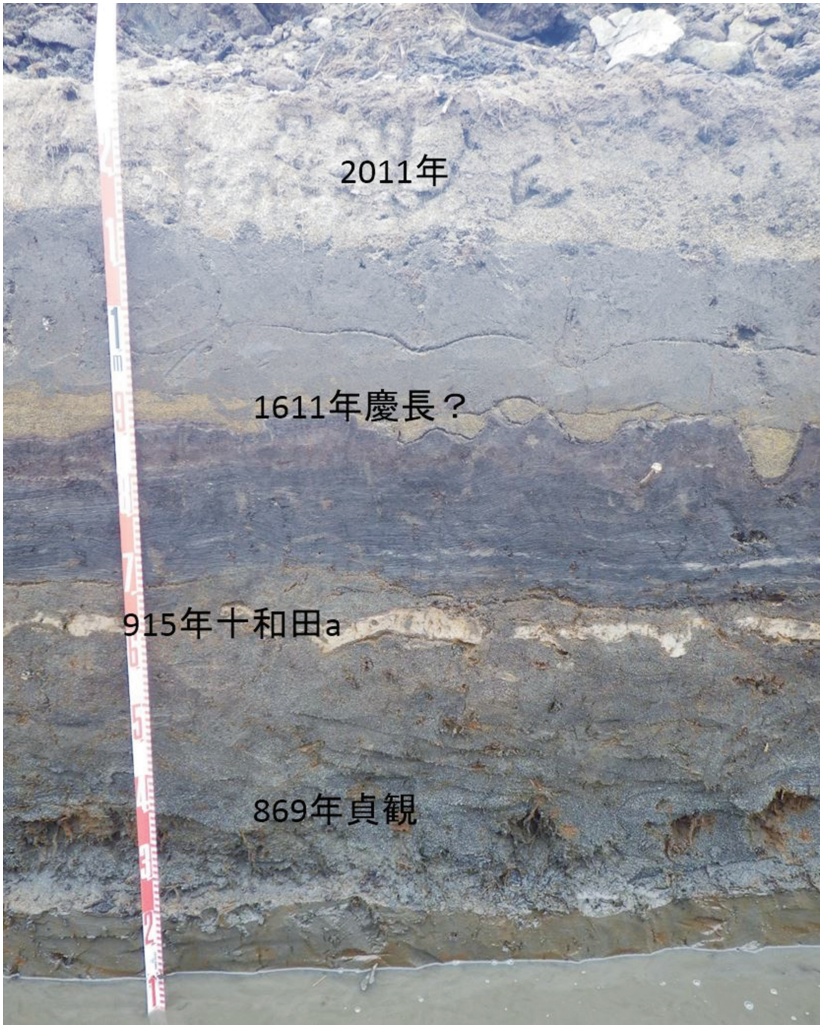

図-2　トレンチで観察できた露頭の様子

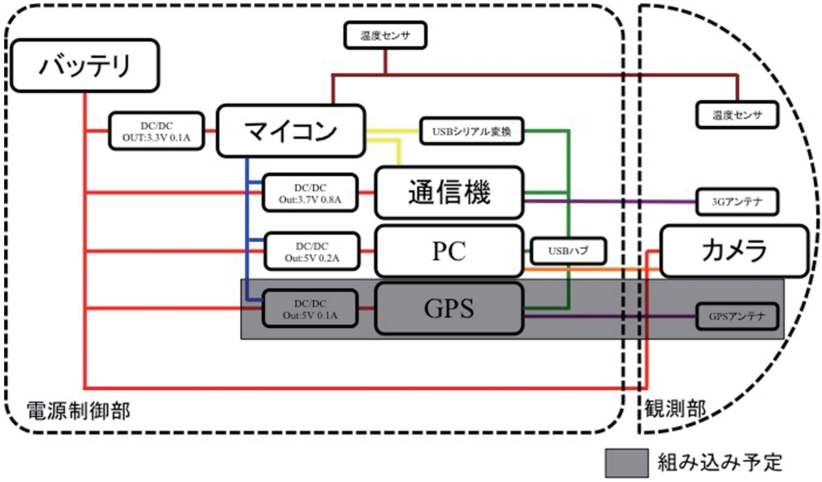

図 3-5 システム構成

図 3-17　モニタリングシステムの概略図

付録２　第３章から第９章の要約の英語版

Chapter 3. Survey concerning the Evaluation of Risks regarding Power Generation before and after the Earthquake Disaster and the Future Enhancement of Safety

The main source of electricity changed from nuclear power to thermal power in the wake of the Great East Japan Earthquake. A new energy mix is currently sought that does not rely solely on thermal power. To that end, the clarification and quantitative evaluation of the risks regarding each power source is required.

The purpose of this project is to comprehend the risks regarding each type of power source in Japan before and after the Great East Japan Earthquake. To achieve this purpose, the project clarified the changes in the past five years in each of the power generation methods at the major Japanese power companies. It also compared the amount of emissions from thermal power generation and elucidated the cause of the phenomenon of growing air pollution. In order to quantify the risk regarding emissions from thermal power plants, the marginal costs method was used. Furthermore, the project conducted a qualitative analysis of the risks regarding geothermal, photovoltaic, and wind power generation in order to clarify the risks regarding power generation using new energy sources.

As the result of this survey and analysis, we were able to clarify from a

quantitative standpoint that most of the main sources of electricity were being compensated for by thermal power through the evaluation and analysis of the electric energy generated by each of the major power companies. The project enabled us to confirm 55.1 billion kWh as the total amount of power generation reduction, as had been reported in previous surveys. An inspection of the amount of power generation using new energy sources indicated that the 55.1 billion kWh reduction in the total amount of power generation was achieved as the effect of conservation. By evaluating the risks regarding the amount of emissions from thermal power generation using the marginal costs method, it became clear that CO_2 bore the bulk of the environmental risk. Through the survey of the risks regarding geothermal power generation, it became clear that the silica scale building up in wells was a problem in the binary generation system that was being used in low temperature geothermal fields. Through the survey of the risks regarding photovoltaic power generation, it became clear that high power generation costs and a stable supply were the main problems in photovoltaic power generation systems. Through the evaluation of the risks regarding wind power generation systems from the viewpoint of mechanics, the solutions at the national and development levels became clear. The level of each risk regarding wind power generation and the future directions for their resolution were also presented.

Chapter 4. Towards the Development of a Safe and Secure Society Based on the Mediation of Various Disputations involving Science and Technology

As the Great East Japan Earthquake and the accident at Fukushima Dai-ichi Nuclear Power Station in March 2011 demonstrated, there is a widespread "mistrust of science" among citizens, as the consequence of natural disasters and accidents occurring in recent years that science could not foresee. Past dialogue between the experts who engage in science and technology on one hand, and the general public on the other, has been insufficient. Experts enclosed themselves in their respective fields of specialty, and unilaterally imposed risk evaluations which the general public unquestioningly accepted, leaving a major gap between the two sides in their positioning towards and understanding of science and technology. At the same time, in a contemporary society that cannot avoid heavy reliance on science and technology, the risks regarding issues involving these are expected to multiply and increase in complexity going forward, and it will be utterly impossible to anticipate and resolve them all solely at the hands of the experts. We aimed at devising and implementing the means for the mediation and conciliation that promote dialogue between experts and citizens, in order to resolve the discordant relationship between the two sides.

In the first year, our activities mainly focused on 1) the survey of the literature concerning the various disputes in which science and technology are involved and study sessions thereon, and 2) visits to high schools concerning energy choice. With regard to 1), we conducted participant-by-participant monthly presentations and debates regarding

divisive issues in contemporary society in which science and technology are involved. With regard to 2), we specifically focused on renewable energy sources, and conducted lectures incorporating dialogue aimed at enabling high school students to form their own opinions while have having fun. Also in 2), we conducted a survey by questionnaire for the purpose of the abstraction of the differences in the views and opinions of high school students on renewable energy sources before and after the lectures.

Through the activities in this fiscal year, all the participants were able to deepen their understanding of the various divisive issues regarding science and technology. Also, by providing examples to citizens, i.e. high school students, we conducted practical activities concerning the mediation of disputations. From the next year on, our survey will proceed with a greater emphasis on practical activities, and continue to devise and implement mediation and conciliation methods between experts and citizens aimed at the creation of a safe and secure society based on dialogue between the two sides.

Chapter 5. Proposal for an Evacuation System during Volcano Eruptions Based on a Multidisciplinary Approach: Using Mount Merapi in Indonesia as an Example

Japan and Indonesia are two of the foremost volcanic states in the world. In Japan, the risk of volcanic disasters was not a matter of concern, since there was little experience in recent years of eruption disasters resulting in human casualties. But in Indonesia, where volcano eruptions are frequent and often result in human casualties, cautionary evacuation of residents and other measures have been taken through coordination between the various relevant institutions. Thus, in this program, we took a multidisciplinary approach that brought together science and engineering, social science, and the humanities, in our investigation on "Evacuation Systems for Volcano Disasters" centered around the comparison between Japan and Indonesia in order to consider safety and security regarding volcano disasters.

As discretionary activities, we ran independent study sessions and special study sessions, and conducted a field survey in Indonesia. In the independent study sessions, we did a survey of the literature on volcano disaster prevention systems and on Mount Merapi, the subject of our field survey, and made presentations. In the special study sessions, researchers, professionals, and others relevant to our project, gave lectures and otherwise provided information. In order to understand the volcano disaster prevention system for Mount Merapi from multiple perspectives, in the Indonesian field survey, the main purpose of our project, we conducted interviews with residents and tourists in the disaster areas; exchanged information with the government institution responsible for dealing with

volcano disasters (BPPTK) regarding information dissemination systems; and received information from Gadjah Mada University regarding activities supporting the evacuation of residents, such as the development of local disaster prevention maps. Beyond that, we surveyed the locations of evacuation map signs, evacuation shelters, and evacuation dugouts established around Mount Merapi, and visualized them by plotting them on a map.

In the future, we will next attempt to understand the local volcano disaster prevention system for Mount Merapi and its environs through the multifaceted interpretation of the results of the field survey. Following that, our plans are to conduct a comparative study of the national volcano disaster prevention system in Indonesia with that of Japan's; and following that, to develop actual model evacuation systems and disaster prevention maps reflecting the results of the survey.

Chapter 6. Regarding Proposals for Preventive Measures against Natural Disasters and Directions for Reconstruction in Developing Countries—Field Survey on the Damage from Typhoon No. 30 (2013)

Typhoon No. 30, which struck November 2013 (Asian name Haiyan, Philippine name Yolanda), caused massive damage in developing countries in Asia. The Philippines were hit particularly hard, resulting in harm to more than 16 million people, according to the Philippine National Disaster Risk Reduction and Management Council. Over 1.14 million houses were destroyed or otherwise damaged, while the total amount of damage to infrastructure, agriculture, and fisheries reached approximately 85.4 billion yen. The causes of the damage ranged widely beyond powerful winds, including submersion due to high tides and waves.

In order to clarify the causes of the escalation of the damage and the current state of and concerns regarding reconstruction in the Philippines, we conducted measurement surveys and interview surveys mainly in the City of Tacloban which suffered the most serious damage, and also in Hernani, Guiuan, Ormoc, and Marabut.

In the interview surveys, we questioned the residents on the extent of the damage, and also canvassed barangays, the local resident associations which play an important in evacuation efforts and reconstruction plans, regarding disaster countermeasures and the current state of reconstruction.

As a result, we were able to identify not only the direct damage from powerful winds and high tides, but also issues concerning disaster

countermeasures, such as evacuation failures, due to the lack of established evacuation routes and evacuation shelters and lack of information on typhoons. It also became clear that disparities and poverty unique to developing countries stood in the way of reconstruction, such as could be seen from the increase in unemployment due to the massive damage suffered by agriculture, the main industry there.

Given the current state of affairs regarding the abovementioned and other intricately intertwined issues, we intend to conduct further field surveys and discussions in order to have students in different disciplines (coastal engineering, wind engineering, and sociology) work together to form, from multiple perspectives, proposals for specific preventive measures and for reconstruction.

Chapter 7. Developing New Teaching Material for Participatory Disaster Prevention Learning for Elementary and Junior High School Students and Measuring Their Effectiveness through Questionnaires

In this project, we are engaged in activities with the purpose of developing new effective teaching materials, and education programs using this new material, for enhancing disaster preventions skills (knowledge, judgment, action) and disaster prevention awareness (interest, sense of risk) in grade school and junior high school students. Focusing on the participatory learning aspect, we conceptualized new teaching material that enables students to have fun repeatedly thinking about disaster prevention while engaging in physical activities. This year, we developed the “Disaster Reduction Action Card Game” as teaching material for holding discussions and improving the ability to make snap decisions in situations, for instance after a disaster like an earthquake has occurred. We then played the game with students at community events, as well as at grade schools and junior high schools. The features of the game are that it enables participants to 1) improve their ability to make snap decisions when disaster strikes, 2) understand and share with others the dangers that they may encounter during disasters through discussions, and 3) learn disaster prevention regardless of nationality or age by the adoption of universal design. As activities mindful of universal design, we engaged pre-school children, university students, and working adults in gameplay, in addition to grade school and junior high school students. We also engaged exchange students in English-language gameplay.

In addition, we conducted questionnaire surveys for the purpose of using

the results to devise and improve new teaching material. This year, we conducted a questionnaire survey to grasp the needs (interest and questions) of the participants (grade school and junior high school students), and a questionnaire survey on their impressions of the new teaching material. We surveyed the effectiveness of the new teaching material by conducting two surveys, one before and one after the events. We have also been engaged in a variety of activities around the “Disaster Reduction Action Card Game,” including the preparation of a manual to popularize the game.

Chapter 8. Research and Development and Proposal concerning the Generation of "Safety and Security" through Local Synergies: The Coastal Areas of the City of Iwaki, Fukushima Prefecture, as an Example

In this project, we mainly focused on the following surveys and proposals aimed at installing "safety and security" in the tsunami disaster area Taira-Usuiso Ward in the City of Iwaki.

1) Elucidation of a social system that matches local characteristics and a proposal for evacuation drills that conform to that system
2) Identification of natural disasters based on scientific evidence and disaster prevention and science education using the results

The reason for this is that putting tide embankments and other physical infrastructure in place is insufficient to achieve "safety and security," and that developing the intangible framework that matches the lifestyles of the local residents and other local characteristics is indispensable.

As for our report on the outcome, we elaborate on the implementation process of these activities for this year. Specifically, in order to elucidate a social system matching local characteristics, we conducted participation observation on civic conferences being held jointly by three local wards, including Usuiso, for the purpose of reconstruction. We also canvassed the Usuiso Ward regarding the evacuation drills that were conducted there, and the evacuation drill that was conducted this year. With regard to the identification of natural disasters based on scientific evidence, we

conducted a survey of the tsunami deposits and other material through trench surveys and boring surveys using handheld geoslicers in Usuiso Ward and the neighboring areas. We conducted disaster prevention education for local residents using the strata samples obtained through the survey.

Chapter 9. Development of an Unmanned Volcano Observation Device Capable of Long-term Operation and a Proposal for a Volcanic Plume Observation System

Japan is situated in a region where the Pacific plate is sinking, which generates many natural disasters such as earthquakes and volcano eruptions. This has been the cause of massive damage as the result of disasters such as earthquakes and eruptions.

In order to mitigate the damage caused by eruptions, volcano observation systems are constructed while the volcanos are quiet, and the current status is observed and eruption forecasts are issued before and after periods of volcanic activity. However, as eruptive activities increase, entry into the area around the crater is restricted for a distance of several kilometers, making it difficult to repair or exchange a device if it is damaged by an eruption. Therefore, there are expectations for the development of a device and system that can be deployed after eruptions have begun, in addition to the current volcano observation networks that are put into place before eruptions. To this end, in the discretionary survey for this project, we decided to develop a volcano observation system that could be installed and operated unattended for the purpose of observing the current status during volcanic eruptions.

In this project, we conducted activities in two separate groups, the “Device Development Group” and the “Device Application Group,” while holding more or less bimonthly consultations. The Device Development Group established the “Development of a Volcano Observation Device in Shallow Depth” as the concept of a device to be developed with the aim to make it possible for the device to be transported and installed by an unmanned aerial vehicle, and conduct continuous observations for a month in an

environment of an approximately one meter ash fall, as well as snowfall. In the activities, the group first determined the aforementioned concept, then produced a preliminary design. Based on this design, it conducted a thermal analysis of the device in a volcanic environment. The goal for the Device Application Group was established as the definition of the level of volcanic activity from images captured by the observation device. This year, the group constructed the foundations for the volcanic plume detection algorithm and examined the validity of the algorithm by first applying it to cloud detection. As the result, it succeeded in cloud detection through interpretation using scattering theory.

In the future, we plan to conduct environmental durability experiments on the device, and to develop the volcanic plume detection algorithm.


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