Chapter 6
Presenting a Model for the Revival of Rural Communities in Japan's Disaster Zones

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Abstract During our research for the Great East Japan Earthquake Recovery Assistance Project, we focused on the city of Iwanuma in Miyagi Prefecture, where we held workshops with farmers to discuss how the revival of agriculture in the area should proceed. The feedback from these workshops was subsequently reflected in our revival plan. However, scientific data on how the ground had been altered by the earthquake and tsunami was also required to hasten the area's reconstruction and revival. To this end, we used a three-dimensional (3-D) laser measurement system with MMS (Mobile Mapping System) to reveal the changes in the topography of the survey district. Our results suggest that the MMS system can be applied across a diverse range of fields related to community development, such as improving emergency evacuation routes and road infrastructure, devising town planning models, or for agricultural production forecasting. In future, we plan to survey a wider area, and to use our findings as a baseline ground map for actual restoration work as we conduct further research into how these baseline data can be applied to community development.

Keywords Workshop • Revival plan • 3-D laser measurement system • MMS (Mobile Mapping System) • Community development

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6.1   Introduction

The Faculty of Regional Environment Science and its three departments (the Department of Forest Science, the Department of Bioproduction and Environment Engineering, and the Department of Landscape Architecture Science) each utilize their areas of specialty to establish community development theories. We at the faculty consider watersheds to be units of community, and we hold symposiums to discuss frameworks for community development within watersheds. Such frameworks are structured around three key themes: human development (education theory), physical development (planning and technology theory), and conceptual development (policies and economic theory). We believe that our frameworks for community development based on these three themes can be used in efforts to revive rural communities affected by the Great East Japan Earthquake and to help them function effectively again. It was within this context, therefore, that we chose a study of community development in the coastal villages of Fukushima Prefecture's Soso area as the topic for our faculty project for the 2011 academic year, and subsequently worked to conduct research on community development.

Our research produced the following findings: (a) the functioning of drainage channels in this coastal watershed area had been seriously impaired as a result of severe land subsidence, making agricultural land susceptible to flood damage; (b) the massive deposits of sediment washed across farmland by the tsunami were unsuitable for use as agricultural soil or in building materials, and were best used as embankment material after decontamination treatment; and (c) the backfill sand in many village drainpipes had suffered some liquefaction, leaving numerous sites susceptible to future damage such as road cave-ins. Following on from our research we held agricultural workshops in the city of Iwanuma in Miyagi Prefecture, developing a long-term vision for agriculture, and presenting our suggestions to the Iwanuma Agricultural Recovery Committee.

Our research entailed conducting a baseline study aimed at facilitating further reconstruction and revival, and combining data obtained from this baseline study with 3-D digital maps of the area in collaborative research involving industry, academia, and government [topographic maps that include buildings can be created using a vehicle-mounted MMS (Mobile Mapping System) consisting of a digital camera and a 3-D laser measurement device; the level of accuracy is 1/500]. Thus, we aimed to study how rural communities should be revived by simulating local landscapes, the effects of restoration initiatives, and other scenarios.

6.2 Agricultural Revival and Workshops in Iwanuma, Miyagi Prefecture

6.2.1 Agricultural Revival Workshops

The Great East Japan Earthquake and the tsunami that followed claimed 150 lives in the city of Iwanuma (including 2 residents still missing), and damaged a total of 2,766 houses (699 completely destroyed, 421 mostly destroyed, 636 partially destroyed, and 1,010 partially damaged). In addition, the tsunami destroyed 9.9 km of seawall along the coast, flooding the inland area and causing destruction across the farmland and the industrial zone (approximately 230 businesses were affected). Overall, the area suffered more than 4 billion yen worth of damage.

The disasters wreaked the greatest destruction in agriculture, the city's main industry. In addition to despoiling about 1,240 ha of agricultural land, the tsunami also caused significant damage to agriculture-related infrastructure and farm machinery. The agricultural production systems that had been operated by individual farmers or collectives collapsed, as did the communities that had supported them.

To revive local agriculture in these circumstances, the farmers urgently needed to hold detailed discussions about the future of agriculture in the area. Such discussions would enable them to establish a range of strategies based on communal consensus and to work toward recommencing sustainable farming that could offer hope to the community.

We therefore decided to hold workshops as a means to discuss how to work toward resuming commercial agriculture in line with the community's visions for its future (Fig. 6.1). The workshops focused on postdisaster use of farmland, agricultural production, and how to cultivate organizations and individuals to lead the community going forward. Three workshops were held, on December 22, 2011, and on January 21 and 22, 2012.

Fig. 6.1 (*Left*) Schematic representation for the future of Iwanuma City's agriculture obtained from the results of the workshop (*right*)

6.2.2   Overview of Results of Agricultural Workshops

Before the Great East Japan Earthquake and tsunami, farming in Iwanuma already reflected the grim current state of Japanese agriculture as a whole. In addition to depressed prices for agricultural products and the aging of the farming community, the area also faced a lack of young successors. Then the massive tsunami generated by the earthquake brought new challenges, such as land subsidence and salt damage, as well as the loss of much of the city's production base, including farmland, agricultural machinery, and other capital equipment. The disasters left the farmers facing a whole range of additional long-term issues: lack of funding to restart farming, the collapse of the farming community, the uncertainty of the path toward agricultural revival, the fear of reputation-based economic damage, and the growing shortage of successors and other individuals to take roles of responsibility. In addition to the long-term concerns, however, the new challenges also highlighted other very immediate, practical concerns: How would the farmers farm in future? When would they be able to resume farming? How would they secure new funding to purchase the necessary machinery? Would the agricultural community really be able to recover?

To develop a revival plan that addressed the needs and wishes of local residents, we needed to ascertain what the conditions were in the area following the earthquake and ensuing disasters, and in particular how the ground, roads, water systems, and other physical features had changed. This realization prompted us to conduct a fact-finding survey using the MMS observation device outlined next.

6.3   Topographic Analysis and Community Development Using an MMS (Mobile Mapping System)

6.3.1   What Is MMS?

MMS is a three-dimensional (3-D) laser measurement system (based on technology developed by NTT Geospace Corporation) that uses a vehicle-mounted digital camera and 3-D laser measurement device to create 3-D digital maps of an area's topography, including buildings. The survey vehicle is fitted with an omnidirectional camera that captures 900 images per square meter (at 40 kph driving speed). These images are then processed by laser classification (class 1), allowing creation of 3-D maps (to 1/500 accuracy) (Fig. 6.2).
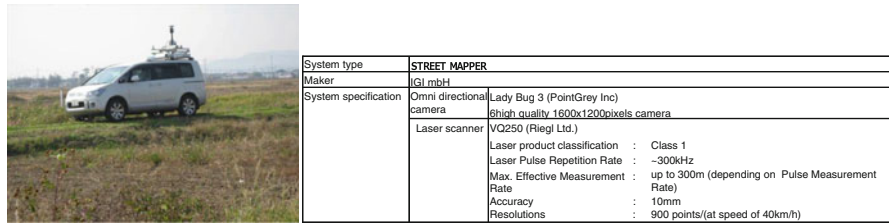
System type	STREET MAPPER	
Maker	IGI mbH	
System specification	Omni directional camera	Lady Bug 3 (PointGrey Inc)
		6high quality 1600x1200pixels camera
	Laser scanner	VQ250 (Riegl Ltd.)
		Laser product classification : Class 1
		Laser Pulse Repetition Rate : ~300kHz
		Max. Effective Measurement : up to 300m (depending on Pulse Measurement Rate) Rate
		Accuracy : 10mm
		Resolutions : 900 points/(at speed of 40km/h)

Fig. 6.2 MMS-mounted vehicle and specification of MMS

6.3.2 Details of Survey Process

We began by creating 3-D base maps using aerial photographs of the district as it was before the disasters, and postdisaster MMS data, to ascertain the changes in topography following the earthquake and tsunami in the west of the agricultural recovery zone in which the study was conducted. First, we used aerial photographs taken in October 2010 to create 1/2,500 scale 3-D topographic base data for the target district. Next, we used an MMS-equipped vehicle to take measurements of the area, and used the data obtained to construct 1/500–1/1,000 scale 3-D topographic base data. These data allowed us to identify how the earthquake and tsunami had altered the ground in the district.

6.3.3 Survey Results (Changes in Ground Topography)

Ground displacement in both the horizontal and vertical directions was observed in the survey district, with horizontal displacement of 2.72 m. Displacement of 2–4 m from the southeast to the southeast and northeast directions was also observed. Further, the vertical displacement (ground subsidence) at each point was compared using data from pre-earthquake aerial photographs and post-earthquake MMS data at points where the same features (white lines, etc.) could be clearly identified. This analysis found subsidence ranging from 20 to 70 cm (Fig. 6.3).

6.4 Summary

During our research for the Great East Japan Earthquake Recovery Assistance Project, we focused on the city of Iwanuma in Miyagi Prefecture, where we held workshops with farmers to discuss how the revival of agriculture in the area should
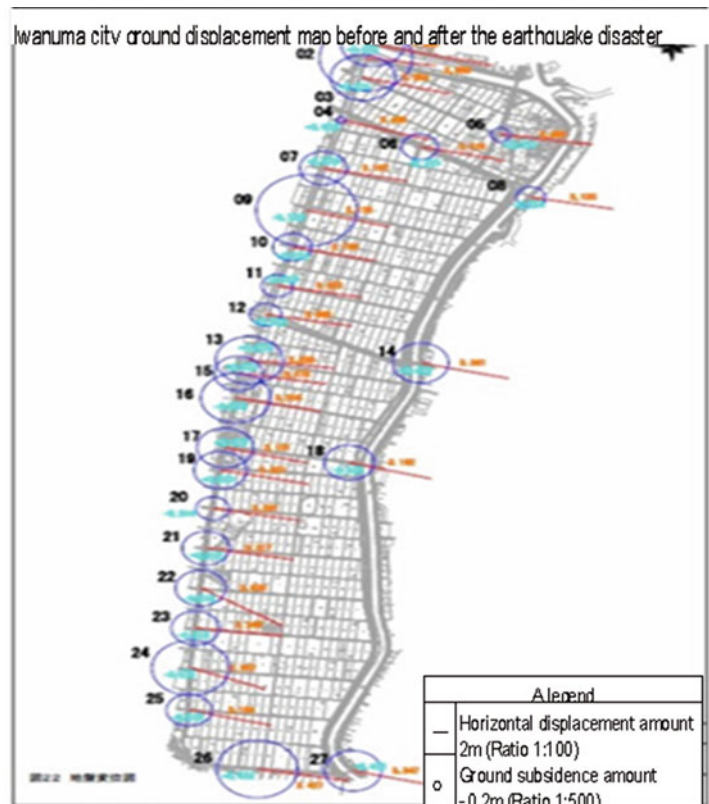
Fig. 6.3 Overview of changes of the ground in the surveyed area

proceed. The feedback from these workshops was subsequently reflected in our revival plan. However, scientific data on how the ground had been altered by the earthquake and tsunami were also required to hasten the area's reconstruction and revival. To this end, we collaborated with both government (the Iwanuma city authority) and industry in the form of a joint research project with NTT Geospace Corporation, Sankei Engineering Co., Ltd., and Asco Co., Ltd., using a 3-D laser measurement system with MMS to reveal the changes in the topography of the survey district.

Given the topographic changes, the base maps we compiled should be used for reference to plan water conduits and farm roads when maintaining or improving agricultural fields. The maps highlighted several aspects requiring caution, most notably the need for care when planning water conduits as the land is below sea level at certain points.

We were also able to confirm the utility of the MMS 3-D laser measurement device (and the MMS system as a whole) for creating agricultural and community revival plans following disasters. Furthermore, our results suggest that the MMS system can be applied across a diverse range of fields related to community development, such as improving emergency evacuation routes and road infrastructure, devising town planning models, or for agricultural production forecasting. In future, we plan to survey a wider area, and to use our findings as a baseline ground map for actual restoration work as we conduct further research into how these baseline data can be applied to community development.

We believe that ongoing, effective use of the data obtained from this type of collaborative project involving industry, academia, and government will prove beneficial in developing a model for simulating revival plans for rural communities.